

SENGUNTHAR ARTS AND SCIENCE COLLEGE

(Autonomous)

(Affiliated to Periyar University, Salem and Approved by AICTE, New Delhi)

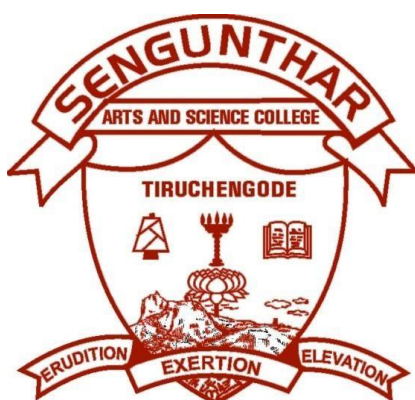
An ISO 9001:2015 Certified Institutions.

Recognised under section 2(f) and 12 (B) of the UGC Act, 1956 and

Accredited by NAAC with A⁺

TIRUCHENGODE-637205, NAMAKKAL DT., TAMIL NADU

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SYLLABUS

M.Sc., BIOTECHNOLOGY (CBCS –LOCF)

(With Effects from Academic Year 2024-25 onwards)

CHAIRMAN

CDC

PRINCIPAL

CORRESPONDENT

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 entrepreneurial skills.

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.
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	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 Correlation

I YEAR
SEMESTER-I

S.No	Course Category	Course code	Title of the course	Hrs/Week		Credit Points	Max Marks		
				L	P		CIA	ESE	Total
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	Phytochemistry						
6	Elective-II	24S1PBTE03	Enzymology	3	-	2	25	75	100
		24S1PBTE04	Food Technology						
Total				24	06	20			600

I YEAR
SEMESTER–II

S.No	Course category	Course code	Title of the course	Hrs/Week		Credit Points	Max Marks		
				L	P		CIA	ESE	Total
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	24S2PHR01	Fundamentals of Human Rights	2	-	1	25	75	100
Total				26	6	23			800

**II YEAR
SEMESTER-III**

S.No	Course Category	Course code	Title of the course	Hrs/Week		Credit Points	Max Marks		
				L	P		CIA	ESE	Total
1	Core Paper-VII	24S3PBT07	Bioinformatics	6	-	5	25	75	100
2	Core Paper-VIII	24S3PBT08	Immunology	6	-	5	25	75	100
3	Core Paper-IX	24S3PBT09	Bioprocess Technology	6	-	5	25	75	100
4	Core Practical -III	24S3PBTP03	Practical – III (D) Bioinformatics (E) Immunology (F) Bioprocess Technology	-	6	4	40	60	100
5	Elective Paper-V	24S3PBTE09	Nano Biotechnology	3	-	2	25	75	100
		24S3PBTE10	Molecular Developmental Biology						
		24S3PBTE11	Medical Laboratory Techniques						
6	NME II	24S3PB TN02	Tissue Engineering	3	-	2	25	75	100
		24S3PB TN03	Bioentrepreneurship						
7	Internship/ Industrial Activity	24S3PB IT1	Internship in Industries to Biotechnology Field (food / clinical trial/ dairy/ aqua sciences, pharmaceutical) CSIR/DBT/DST research laboratories	-	-	2	-	-	-
Total				24	6	25			600

**II YEAR
SEMESTER-IV**

S.No	Course Category	Course code	Title of the course	Hrs/Week		Credit Points	Max Marks		
				L	P		CIA	ESE	Total
1	Core Paper-X	24S4PBT10	Research Methodology	6	-	5	25	75	100
2	Core Paper-XI	24S4PBT11	Biostatistics	6	-	5	25	75	100
3	Project Work & Vive Voce	24S4PBTPR01	Project	10	-	7	60	240	300
4	Elective Paper-VI	24S4PBTE12	Stem Cell Biology	4	-	3	25	75	100
		24S4PBTE13	Bioethics, Biosafety, Clinical Trials, IPR & Entrepreneurship						
		24S4PBTE14	Dairy Technology						
5	SBEC	24S4PBTS01	Ecotechnology	4	-	3	25	75	100
6	Extension Activity	24S4PEX01		-	-	1			-
Total				30		24			700

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, gluconeogenesis, pentose phosphate pathway, glycolysis, citric acid cycle, glyoxalate 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, glycolipids. Cholesterol biosynthesis, bile acids and salt formation. Oxidation of fatty acids, β -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 Anoxygenic), 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. <i>De novo</i> 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, A Text-book of Inorganic Chemistry, 12th Edition, 2015, S. Chand & Sons publications
- ❖ Abhilasha Shourie, Shilpa S, Chapadgoankar & Anamika Singh (2020) Text book of Biochemistry 1st Edition
- ❖ J.L.Jain, 2016, Fundamentals of Biochemistry, S. Chand publication, 7th edition.
- ❖ A.C. Deb, 2016, Fundamentals of Biochemistry, New central book agencies, 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

- ❖ mcdm-webarchive.mcdm.ucsb.edu/.../biochemistry/.../website-tourf.htm
- ❖ www.biochemweb.org/
- ❖ <http://golgi.harvard.edu/biopages.html>

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

Course Coordinator

BOS Chairman

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. *Report on Field Visit to Genetics Laboratory	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. Self-Study: Cystic Fibrosis (CF)	18
Total		90
*Model Preparation and Report on 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

Course Coordinator

BOS Chairman

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 secretory 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. *Report on Field Visit to Adyar Cancer Institute	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. Self-study: Caspase 9 structure and mechanisms	19
Total		90
*Model Preparation and Report on 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

Course Coordinator

BOS Chairman

**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
C01	Illustrate basic biochemistry procedures	PO1
C02	Study the methods of estimation of bio molecules	PO1,PO2
C03	Isolate &Analyze DNA,RNA & protein	PO4,PO6
C04	Critically analyze the isolated bio molecules	PO4,PO5,PO6
C05	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

Course Coordinator

BOS Chairman

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 be able to	Programme Outcomes
C01	Introduction and various types of Microscopic techniques	PO1
C02	Impart understanding on centrifugation instruments and techniques	PO1,PO2
C03	Separation of Bio molecules	PO4,PO6
C04	Analytical methods on Spectroscopic Analysis	PO4,PO5
C05	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. *Power Point Presentation on NMR	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. Self-Study : Inverted Microscope	9
Total		45
*Model Preparation and Power Point Presentation - 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
- ❖ Metzler D.E. 2001, the chemical reactions of living cells– Academic Press. 2nd edition.
- ❖ L.Veerakumari (2016), Bioinstrumentation MJP Publisher Kindle edition.
- ❖ Holcapek, M., Byrdwell, Wm. C. 2017. Handbook of Advanced Chromatography/Mass Spectrometry Techniques, Elsevier.

Mapping with Programme Outcomes and Programme Specific Outcomes

	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

Course Coordinator

BOS Chairman

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, Cocoa). 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. *Poster Preparation on Bioactive compounds	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. 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

	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

Course Coordinator**BOS Chairman**

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. *Field Visit – Food Industry and Report Submission	9
V	Challenges and future Trends: Catalytic antibodies and Non-protein biomolecules as catalysts, Biocatalysts from extreme thermophilic and Hyper thermophilic Archaea and Bacteria, application of enzymes in research diagnostics and industry. 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
- ❖ Geoffrey L, Zubay, Biochemistry-2018.

Web Reference

- ❖ www.lsbu.ac.uk/biology/enztech/
- ❖ www.lsbu.ac.uk/biology/enzyme/
- ❖ <http://www.aetltd.com/tech/applications.html>.

Mapping with Programme Outcomes and Programme Specific Outcomes

	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

Course Coordinator

BOS Chairman

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
C01	Explain the basics food preservative techniques	PO1
C02	Classify and summarize the detailed methodologies of food preservative techniques	PO1,PO2
C03	Examine the packing system of food and additives	PO4,PO6
C04	Assess extraction and downstream processing of food	PO4,PO5
C05	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 borne 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. Power Point Presentation on HACCP	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. Self-Study: Food Good Manufacturing Practices	9
Total		
*Power Point Presentation and Power point Presentation - 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 Programme Specific Outcomes

	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

Course Coordinator

BOS Chairman

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
C01	To understand the major discoveries of microbiology and describe microbial diversity, Microbial growth and metabolism.	PO1
C02	To provide basic knowledge about microbial culture, identification of microbes, Principle and working of microscopes and sterilization techniques	PO1, PO2
C03	To enlightenthe students on host microbe interaction and Epidemiology of Microbial disease	PO4, PO6
C04	To update the knowledge on epidemic and pandemic diseases.	PO4, PO5
C05	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. *Power Point Presentation on AIDS	15
V	Agricultural Microbiology: Biological nitrogen fixation, free living, symbiotic nitrogen fixation, mechanism of Nitrogen, Biofertilizers- types and applications; Rhizosphere, Rhizobium Azospirillum, Azolla, BGA. Self-study - Preservation of microbes	15
Total		75
*Model Preparation and Power Point Presentation - 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.

Web Resources

- ❖ <https://www.who.int/emergencies/diseases/managing-epidemics-interactive.pdf> ISBN978-92-4-156553-0.
<https://doi.org/10.3389/fmicb.2020.631736>
- ❖ <https://www.agrimoon.com/wp-content/uploads/AGRICULTURAL-Microbiology.pdf>.

Mapping with Programme Outcomes and Programme Specific Outcomes

	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

Course Coordinator

BOS Chairman

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
C01	To impart theoretical knowledge on various techniques of plant biotechnology like Tissue culture, plant genetic transformation and their application in industries.	PO1
C02	Importance of secondary metabolites and production in plants.	PO1,PO2
C03	To develop concepts, principles and processes in animal biotechnology.	PO4,PO6
C04	Concept and different types in Animal Cell Culture and animal cell lines.	PO4,PO5
C05	Use of molecular biology techniques genetically engineer the animals to improve 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 Embryogenesis	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 CO ₂ , serum, antibiotics, and growth factor in cell lines *Report on Field Visit to Veterinary College	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. Self-study - MTT assay	15
Total		75
*Power Point Presentation and Report On 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.

Mapping with Programme Outcomes and Programme Specific Outcomes

	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

Course Coordinator

BOS Chairman

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 (Bacillus subtilis)	15
III	Cloning in yeast Saccharomyces cerevisiae. 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. *Power Point Presentation on Modern Concept in Genetic Analysis	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. Self-study -Lambda bacteriophage	15
Total		75
*Power Point Presentation - 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. Primrose and Richard Twyman, 2006. Principles of Gene Manipulation and genomics, 7th edition, Wiley-Blackwell.
- ❖ Lewin, 2009. Genes X, 10th edition, Jones & Barlett Publishers

Mapping with Programme Outcomes and Programme Specific Outcomes

	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

Course Coordinator

BOS Chairman

**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
C01	Isolate and identify microbes from various sources.	PO1
C02	Characterize microbes.	PO1,PO2
C03	Examine Plant and Animal cells and their functions	PO4,PO6
C04	Assess extracted DNA, RNA and protein for rDNA technology	PO4,PO5
C05	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

Course Coordinator

BOS Chairman

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
C01	Elucidate the basic requirements of establish laboratory for testing samples as per the regulatory body's requirements	PO1
C02	Describe the Scientific, technical knowledge about various food preservation techniques	PO1,PO2
C03	Describe the basic concepts of packing of food materials, various parameters observed during packaging	PO4,PO6
C04	Describe the testing of food materials and identifying of microbial food contaminant	PO4,PO5
C05	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 ohmic 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, saccharomycetic, coliforms, faecal coliforms, enteric pathogens and emerging	9

	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, <i>Bacillus cereus</i> and other <i>Bacillus</i> 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.	
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, Quality management systems – Requirements
- ❖ ISO17034 General requirements for the competence of reference material producers
- ❖ ISO/IEC17043 Conformity assessment – General requirements for proficiency testing.
- ❖ Food safety standards authority regulation 2011.

Mapping with Programme Outcomes and Programme Specific Outcomes

	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

Course Coordinator

BOS Chairman

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
C01	Explain the basic components of pharmaceutical and biotechnology industry and methods and applications of biosensor	PO1
C02	Describe the Scientific, technical and economic aspects of vaccine & rDNA technology	PO1,PO2
C03	Describe the basic concepts of protein Engineering, therapeutic proteins and enzyme immobilization techniques	PO4,PO6
C04	Describe the concept so hybridoma technology, microbial biotransformation and microbial bio-transformed products	PO4,PO5
C05	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, Glutamic acid 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 Chemicals in 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
		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.
- ❖ Carlos A. Guzmán and Giora Z. Feuerstein, 2009. Pharmaceutical Biotechnology, 1st edition, Springer.
- ❖ Daniel Figey (Ed.). 2005. Industrial Proteomics: Applications for Biotechnology and Pharmaceuticals. Wiley, John & Sons, Incorporated.
- ❖ Kayser, O and Muller R.H.. 2004. Pharmaceutical Biotechnology Drug Discovery and Clinical Applications. WILEY-VCH.

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 Programme Specific Outcomes

	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

Course Coordinator

BOS Chairman

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
C01	Explain Various Waste Management Methods	PO1
C02	Classify Potential Methods Of Biodegrading Organic Pollutants.	PO1,PO2
C03	Examine The Techniques Involved In Remediation Of Polluted Environments	PO4,PO6
C04	Assess Types Of Pollution &Its Control	PO4,PO5
C05	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; <i>In-situ and Ex-situ</i> Bioremediation of contaminated soils and waste land; Microbiology of degradation of Xenobiotics in environment; Pesticides, Surfactants, Degradative plasmids. Solid waste: Composting, Vermiculture and methane production. 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 Programme Specific Outcomes

	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

Course Coordinator

BOS Chairman

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 biocorrosion.	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 alginate 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.
- ❖ Rita R. Colwell 1984. Biotechnology in the Marine Sciences (Advances in Marine Science & Biotechnology) Wiley Interscience.
- ❖ Scheupr, P.J. (Ed.), 1984. Chemistry of Marine Natural Products, Chemical and Biological Perspectives. Vol. III, Academic Press, New York.

Reference books

- ❖ Italy, (Eds). 1998, New Developments in Marine Biotechnology, Plenum Pub. Corp. E
- ❖ Milton Fingerman and Rachakonda Nagabhushanam, 1996, Molecular Genetics of Marine Organisms, Science Pub Inc.

Mapping with Programme Outcomes and Programme Specific Outcomes

	Pos										PSOs				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03	PS04	PS05
C01	3	3	3	2	2	2	2	3	3	3	3	3	3	3	2
C02	2	2	2	3	3	2	3	3	2	2	2	3	3	2	3
C03	2	2	2	3	3	3	3	2	2	2	2	3	3	3	3
C04	3	3	3	2	2	2	3	3	2	3	2	3	2	3	2
C05	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

Course Coordinator

BOS Chairman

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. Brown 1995. Gene Cloning and Introduction.
- ❖ Thiel 2002. Biotechnology Nucleic Acids to Protein: A Laboratory Project. Tata McGraw. Hill
- ❖ R.W. Old & S.B. Primrose, Principles Of Gene Manipulation, Fifth Edition, Blackwell Science
- ❖ Genetic Engineering Principles And Methods By Setlow, Jane K. (VOLUME 24).
- ❖ Bernard R Glick and Jack. J. Pasternack, 1994, Molecular Biotechnology, ASM Press.
- ❖ Kaushik. B. D. Deepak Kumar. Shamim. Md. 2019. Biofertilizers and Biopesticides in Sustainable Agriculture. 1st Edition. Apple Academic Press. USA.

Mapping with Programme Outcomes and Programme Specific Outcomes

	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

Course Coordinator

BOS Chairman

SEMESTER – III

SECOND YEAR - SEMESTER III

Core- VII - Bioinformatics

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S3PBT07	Core- VII	Theory	Y	Y	-	6	5

Learning Objective:

- ❖ To manage health, medical, and bio-informatics information using best practices in data stewardship.
- ❖ Data science and data analytics; and human-centered design and systems.
- ❖ To Define and successfully address a tractable research question or real-world problem in health, medical, and bio-informatics using the appropriate scientific and/or research methods.
- ❖ To maintain the highest level of ethical standards.
- ❖ To apply best practices for providing value, leadership and team building in health, medical, and bio-informatics.

<u>Course Outcomes</u>		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	To get introduced to the basic concepts of Bioinformatics and its significance in Biological data analysis.	PO1
CO2	Describe the history, scope and importance of Bioinformatics and role of internet in Bioinformatics.	PO4,PO7
CO3	Explain about the methods to characterize and manage the different types of Biological data.	PO5,PO8
CO4	Classify different types of Biological Databases.	PO6,PO7
CO5	Introduction to the basics of sequence alignment and analysis	PO2,PO3

Unit	Details	No. of Hours
I	Database concepts, Introduction to bioinformatics, Protein and nucleotide databases, Information retrieval from biological databases, Sequence alignment and database searching-similarity searches using BLAST and FASTA. Artificial Intelligence: Introduction to biological neural network, motivation for artificial neural network (ANN), Big data analysis - DNA/RNA/protein sequence.	18
II	Sequence alignment basics, match, mismatch, similarity, scoring an alignment, gap penalty, protein vs DNA alignments, Dot-matrix alignment, pair wise alignment. Global and local alignment algorithms, multiple sequence alignment-progressive alignment and Iterative alignment algorithms, Multiple sequence alignment based database searching. PSI-Blast, PAM and Blosum matrices.	18
III	Bioinformatics for genome sequencing, EST Clustering and analyses, Finding genes in prokaryotic and eukaryotic genomes, Regulatory sequence analysis, Bioinformatics for Genome maps and markers, Bioinformatics for understanding Genome Variation.	18
IV	Molecular visualization tools. Rasmol, Chime and Spdb viewer. Structure analysis tools. VAST and DALI, Structural biology - Homology modeling, Bioinformatics for micro array designing and transcriptional profiling, Bioinformatics for metabolic reconstruction, Bioinformatics for phylogenetic analysis.	18
V	Medical application of Bioinformatics. Disease genes, Drug Discovery. History. Steps in drug discovery. Target Identification. Target Validation. QSAR. Lead Identification. Preclinical pharmacology and toxicology. ADME, Drug designing. Rational drug design. Computer aided drug design.	18

Text Books:

- Dassanayake S.Ranil, Y.I.N. Silva Gunawardene, 2011. Genomic and Proteomic Techniques, Narosa Publishing House Pvt. Ltd, New Delhi.
- Thiagarajan B, Rajalakshmi.P.A., 2009. Computational Biology, MJP publishers, Chennai.
- BosuOrpita, SimminderKaurThukral, 2007. Bioinformatics Databases, Tools and Algorithms, Oxford University press, New Delhi.
- Rastogi.S.C, Mendiratta.N, Rastogi.P, 2004. Bioinformatics methods and applications, Prentice-Hall of India private limited, New Delhi.
- Lohar s. Prakash, 2009. Bioinformatics, MJP Publishers, Chennai.

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	2	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	12	12	15	14	13	13
Average	2.1	2.4	2.4	2.4	2.4	2.4	2.6	2.6	2.4	2.4	2.4	3	2.8	2.8	2.8

Course Coordinator

BOS Chairman

Core- VIII - Immunology

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S3PBT08	Core- VIII	Theory	Y	Y	-	6	5

Learning Objective:

- ❖ The paper imparts a thorough knowledge on the basics of immunology
- ❖ The student will get to understand the core concepts of immune systems and their non-specific and specific mechanisms, vaccine.
- ❖ To provide students with knowledge on how the immune system works building on their previous knowledge from biochemistry, genetics, cell biology and microbiology.
- ❖ To able to clearly state the role of the immune system.
- ❖ To able to compare and contrast the innate versus adaptive immune systems.

<u>Course Outcomes</u>		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Illustrate various mechanisms that regulate immune responses and maintain Tolerance	PO1
CO2	To describe key events and cellular players in antigen presentation, and how the nature of the antigen will shape resulting effectors responses	PO4,PO5
CO3	To learn the concepts of cellular and molecular processes that represents the human immune system.	PO5,PO6
CO4	To elucidate the role of immunological regulation and tolerance at a cellular and molecular level	PO6,PO7
CO5	To compile concepts on immunological principles and diagnosis	PO2,PO4

Unit	Details	No. of Hours
I	History and overview of the immune system. Types of immunity - innate, acquired, passive and active, self vs non-self-discrimination. Physiology of immune response: HI and CMI specificity and memory. Cells and organs of the immune system. Lymphoid tissue, origin and development. Hematopoiesis and differentiation of lymphocytes	18
II	Lymphocyte-sub-populations of mouse and man. APC cells, lymphokines, Phagocytic cells, macrophage, dendritic cells, K and NK Cells. Nature and biology of antigens, epitopes, haptens, adjuvants. Immunoglobulins - structure, distribution and function.	18
III	Monoclonal antibody production and its applications. Types of vaccine and vaccination schedule. Role of MHC antigens in immune responses, Structure and function of class I and class II MHC molecules. Transplantation immunology, Tumour Immunology - Tumour antigen, Immune response to tumours	18
IV	Effector mechanisms in immunity - macrophage activation, cell mediated cytotoxicity, cytotoxicity assay. Hypersensitivity reactions and types. The complement system, mode of activation, classical and alternate pathway, biological functions of C proteins	18
V	Immuno techniques- Principle and Applications: Immuno diffusion, Immuno fluorescence, Insitu localization technique - FISH and GISH. RIA and ELISA, FACS, Western blot, ELISPOT assay. Agglutination tests. VDRL test.	18

Text Books:

- Roitt.S Essential Immunology, 12 editions, Wiley-Blackwell. USA.
- Kannan. I., 2010. Immunology. MJP Publishers, Chennai.
- Abbas, A.K., A.H.L. Lichtman and S.Pillai, 2010. Cellular and Molecular Immunology. 6th Edition. Saunders Elsevier Publications, Philadelphia.
- Seemi Garhat Bashir, 2009. Text Book of Immunology, PHI Learning Pvt. Ltd. New Delhi.

Useful Websites:

- www.library.csusm.edu/course_guides/biology
- www.immunologylink.com
- <http://www.wiley.com/college/bio/karp12791/weblinks.html>

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	2	3	3	3	2	2	2	3	3	3	3	3	3	3	2
CO2	2	2	2	3	3	2	3	3	2	2	3	3	3	2	3
CO3	2	2	2	3	3	3	3	2	2	2	3	3	3	3	3
CO4	3	3	3	3	2	2	3	3	2	3	3	3	2	3	2
CO5	2	2	2	3	2	3	2	2	3	3	3	3	3	3	3
Total	12	12	12	15	12	12	13	13	12	12	15	15	14	13	13
Average	2.4	2.4	2.4	3	2.4	2.4	2.6	2.6	2.4	2.4	3	3	2.8	2.6	2.6

Course Coordinator

BOS Chairman

Core- IX - BIOPROCESS TECHNOLOGY

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S3PBT09	Core- IX	Theory	Y	Y	-	6	5

Learning Objective:

- ❖ The paper imparts a thorough knowledge on the basics of bioprocess and industrial fermentation.
- ❖ The student will get to understand the core concepts of fermentation and its commercial application.
- ❖ Explain how separations, mass transfer, fluid dynamics and biocatalysis principles are applied in bio processing.
- ❖ Assess the performance of bioprocessing operations including cell processing, product extraction and purification and troubleshoot operational problems.

<u>Course Outcomes</u>		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Outline the basis of Bioprocess Engineering	PO1
CO2	Relate reactors in fermentation	PO4,PO5
CO3	Differentiate fermentation processes	PO5,PO7
CO4	Assess Scale up and Scale down	PO6,PO7
CO5	Compile the output of fermentation processes	PO2,PO5

Unit	Details	No. of Hours
I	Introduction to fermentation. General requirements of fermentation. Microbial growth kinetics of batch and continuous culture. Solid substrate, slurry fermentation and its application. Microbial cell culture. Immobilization of cells and enzymes.	18
II	Types of bioreactors: Submerged reactors, surface reactors, mechanically agitated reactors, non- mechanically agitated reactors. Design of fermenters, body construction. Production of citric acid, penicillin and insulin. Isolation and improvement of Industrially important Micro-organisms.	18
III	Introduction to bio products and bio separation. Primary recovery process: Cell disruption methods. Flocculation by electrolysis; polymorphic flocculation. Precipitation methods. Filtration: Principles, Conventional, Cross flow filtration. Sedimentation: Principles, Sedimentation coefficients. Extraction Principles, Liquid liquid extraction, aqueous two phase extraction, supercritical fluid extraction.	18
IV	Down Stream Processing: Chromatography Techniques, Membrane separation, ultra filtration. Drying .Principles and operation of vacuum dryer, shelf dryer, rotary dryer, freezer and spray dryer. Crystallization and Whole broth processing.	18
V	Aerobic and anaerobic fermentation processes and their application in the field of biotechnology industry. Production of commercially important primary and secondary metabolites, Effluent Treatment and Fermentation Economics.	18

Text Books:

- Min-tzeLiong, 2011. Bioprocess Sciences and Technology. Nova Science Pub Inc.
- Michael L.Shuler, FikretKargi. 2003. Bioprocess Engineering. PHI publishers.
- P.A.Belter, E.L.Cursler, and W.S.Hu. 1988. Bioseparation: Downstream processing for Biotechnology. John Wiley and sons.
- R.G. Harrison, P.Todd, SR.Rudge and D.P. Petrides. 2003. Bioseparation science and engineering. Oxford Press.

Useful Websites:

- [www.wildfermentation.com/John Schollar and Benedikte Watmore, Practical Fermentation-a technical guide](http://www.wildfermentation.com/John_Schollar_and_Benedikte_Watmore,_Practical_Fermentation-a_technical_guide)
- web.mit.edu/professional/short/fermentation_technology.html

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	2	3	3	3	2	2	2	3	3	3	3	3	3	3	2
CO2	2	3	2	3	3	2	3	3	2	2	3	3	3	2	3
CO3	2	3	2	3	3	3	3	2	2	2	3	3	3	3	3
CO4	3	3	3	3	2	2	3	3	2	3	3	3	2	3	2
CO5	2	2	2	3	2	3	2	2	3	3	2	3	3	3	3
Total	12	14	12	15	12	12	13	13	12	12	14	15	14	13	13
Average	2.4	2.8	2.4	3	2.4	2.4	2.6	2.6	2.4	2.4	2.8	3	2.8	2.6	2.6

Course Coordinator

BOS Chairman

Core Practical - III - Bioinformatics, Immunology & Bioprocess Technology

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S3PBTP03	Core Practical-III	Practical	-	-	-	6	4

Learning Objectives:

- ❖ The practical will establish a basic study skill on the subject and will improve the student's ability to calculate and improve their practical skill and knowledge.
- ❖ To understanding fundamental concepts, applying computational tools for data analysis, exploring immune mechanisms, and developing skills for biotechnology applications and industrial processes.
- ❖ Techniques and methods to study different classes of microbes, immune system related molecules will be performed.
- ❖ Learn various bioprocess related terms and principles.
- ❖ Learn about microbial growth kinetics in various mode of fermentation.

<u>Course Outcomes</u>		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	To learn the Bioinformatics tools for sequence retrieval and alignment	PO4
CO2	To apply the learned tools for various applications	PO5,PO6
CO3	To isolate, identify & enumerate immune cells	PO6,PO7
CO4	To learn the technique of immunodiagnostics	PO6,PO7
CO5	To study upstream & downstream techniques	PO4,PO5

Unit	Details	Hours
A	Bioinformatics–Practical Major 1. Prediction of signal sequence using SignalP online tool 2. Pattern Search (Domains & Motifs) using Pfam 3. ORF gene Search - Genscan Minor Experiments 1. Sequence retrieval from Genbank 2. Sequence retrieval from Uniprot. 3. Sequence identity search- Sequence similarity search using BLAST 4. Sequence similarity search using FASTA 5. Sequence similarity search using PSI BLAST	30
B	Immunology –Practical Major 1. Identification of various immune cells from human peripheral blood. 2. Determination of lymphocyte viability by trypan blue method 3. Radial Immunodiffusion 4. Ouchterlony Immunodiffusion 5. Immunoelectrophoresis 6. Counter current immunoelectrophoresis. Minor 1. Immunodiagnosics: CRP 2. Immunodiagnosics: ASO 3. Immunodiagnosics: Widal 4. Immunodiagnosics: RA 5. Immunodiagnosics: Blood grouping and typing 6. Immunodiagnosics: hCG 7. Preparation of serum and plasma	30
C	Bioprocess Technology - Practical Major 1. Isolation of industrially important microorganisms for microbial processes. 2. Production and estimation of protease 3. Production and estimation of amylase. 4. Production of wine using grapes 5. Production of penicillin 6. Determination of penicillin activity 7. Citric acid production 8. Use of alginate for cell immobilization. Minor 1. Solid state and Submerged fermentation 2. Media preparation and sterilization	30

Course Coordinator

BOS Chairman

Elective - V - NANO BIOTECHNOLOGY

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S3PBTE09	Elective-V	Theory	Y	Y	-	3	3

Learning Objective:

- ❖ The subject imparts knowledge on the fundamentals of nanoparticles.
- ❖ The student will be provided with a basic knowledge and understanding about the role of nanoparticles in biotechnology.
- ❖ To understand the nature and properties of nanomaterials.
- ❖ To provide scientific understanding of application of nanomaterials and nanotechnology in agriculture, health and environmental conservation.
- ❖ To understand the ethical, social, and environmental implications of nanotechnology, including potential risks associated with the use and disposal of nanomaterials.

<u>Course Outcomes</u>		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Understand the bases for Introduction to Nanotechnology	PO5
CO2	To impart understanding on Nanoparticle based Drug Delivery.	PO6,PO7
CO3	Fabrication of nanomaterials for bone tissue grafting	PO4,PO6
CO4	Methods of Nanofabrication	PO5,PO7
CO5	Understand the application of Nanotechnology	PO4,PO5

Unit	Details	No. of Hours
I	Introduction to Nanotechnology- Scientific revolution, Feynman's vision, Classification of nanobiomaterials - Types of nanomaterials – nanoparticles, nanotubes, nanowires, Nanofibers, Size dependent variation in the properties of Nanomaterials,	9
II	Preparation of Nanomaterials, Top down and bottom up approaches, Biosynthesis, Nanobiomaterials- Polymer, Ceramic, Metal based Nanobiomaterials, Carbon based Nanomaterials, DNA based Nanostructures, Protein based Nanostructures.	9
III	Application of Nanomaterials in Bone substitutes and Dentistry, Food and Cosmetic applications, Bio- sensors and Lab-on-a-chip, Bio-devices and implantable devices, Bioremediation, Nanomaterials for anti-microbial coating – medical implants and paints, Application of Nanotechnology in textile industry.	9
IV	Nanomaterials for diagnosis and therapy, Implications of drug delivery, Nano-carriers for application in medicine, polymeric nanoparticles as drug carriers, Drug release mechanism, Targeted Drug Delivery using nanocarriers, Nanoparticle technologies for cancer therapy and diagnosis.	9
V	Nanotoxicology, Portals of Entry of the nanoparticles into the Human Body, Bio-toxicity of Nanoparticles, Nanoparticles in Mammalian systems and Health threats, Risk assessment and Safety Regulation of nanoparticles.	9

Text Books:

- Nanotechnology, S.Shanmugam, Mjp publication. 2011.
- Advanced nanomaterials, kurt E. geckeler, Hiroyuki Nishide , Wiley VHC.2010.
- Nanotechnology and tissue engineering. T.Laurencin, Lakshmi S. Nair, CRC press. 2012.
- Handbook of carbon nanomaterials. Francis D souza, Karl M. Kadish.
- World scientific publishing co. pte. ltd. 2011.
- OdedShoseyov (Editor), Ilan Levy, 2010. NanoBioTechnology: BioInspired Devices and Materials of the Future, Humana Press.
- Chad A. Mirkin and Christof M. Niemeyer, 2007. Nanobiotechnology II: More Concepts and Applications, Wiley-VCH.
- ChallaS.S.R.Kumar (Ed). 2006. Biologicals and pharmaceutical nanomaterials, Wiley-VCH Verlag GmbH & Co, KgaA.

Useful Websites:

- <http://www.zyvex.com/nano> www.fda.gov/nanotechnology/ www.nature.com/nnano

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	2	3	3	3	2	2	2	3	3	3	3	3	3	3	2
CO2	3	3	2	3	3	2	3	3	2	2	3	3	3	2	3
CO3	2	3	2	3	3	3	3	2	2	2	3	3	3	3	3
CO4	3	3	3	3	2	2	3	3	2	3	3	3	2	3	2
CO5	3	2	2	3	2	3	2	2	3	3	2	3	3	3	3
Total	14	14	12	15	12	12	13	13	12	12	14	15	14	13	13
Average	2.8	2.8	2.4	3	2.4	2.4	2.6	2.6	2.4	2.4	2.8	3	2.8	2.6	2.6

Course Coordinator

BOS Chairman

Elective - V - MOLECULAR DEVELOPMENTAL

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S3PBTE10	Elective-V	Theory	Y	Y	-	3	3

Learning Objective:

- ❖ The subject imparts knowledge on the fundamentals of developmental biology.
- ❖ The student will be provided with a basic knowledge and understanding about the molecular aspects of developmental biology.
- ❖ To provide a comprehensive understanding of the concepts of early animal development.
- ❖ Students taking this course must develop a critical appreciation of methodologies specifically used to study the process of embryonic development in animals.

<u>Course Outcomes</u>		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Illustrate the structure and function of developmental biology, Gametogenesis	PO5
CO2	Discuss basic fertilization process of animals	PO4
CO3	Demonstrate the functions of embryonic development process	PO3
CO4	Illustrate the organ development of vertebrate animals	PO5
CO5	Demonstrate the impact of gene in developmental biology and developmental disorders	PO4,PO5

Unit	Details	No. of Hours
I	Definition and scope of developmental biology. Gametogenesis - Spermatogenesis and Oogenesis. Structure of Sperm and oocyte. Instructive and permissive interactions, competence, epithelial - mesenchymal interactions. Important signaling pathways in vertebrate development	9
II	Fertilization - Definition, mechanism of fertilization in mammal & sea urchin. Types of fertilization. Nieuwkoop center, Molecular role of organizer	9
III	Cleavage in Xenopus, Chick and mammals, Regulation of cleavage cycle. Morphogenetic movements, Gastrulation in Xenopus, Chick and mammals. Fate Maps	9
IV	Vertebrate Development: Formation of the neural tube, myogenesis, and hematopoiesis. Mechanism of vertebrate eye development	9
V	Drosophila Maternal effect genes, induction at single cell level - differentiation of photoreceptors in ommatidia. Developmental disorders Spina bifida, Anencephaly, and craniorachischis, Cyclopia, Thanotrophic dysplasia	9

Text Books:

- Scott F. Gilbert, 2010. Developmental Biology, 9th edition, Sinauer Associates Inc.
- Subramoniam, T. 2002. Developmental Biology. 1st edition. Narosa publications.
- Richard M. Twynman, 2001 Developmental Biology. (2nd edition), Viva Publications, New Delhi.

Useful Websites:

- sackler.tufts.edu/.../Cell-Molecular-and-Developmental-Biology www.devbio.com/

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	2	3	3	3	2	2	2	3	3	3	3	3	3	3	2
CO2	3	3	2	3	3	2	3	3	2	2	3	3	3	2	3
CO3	2	3	2	3	3	3	3	2	2	2	3	3	3	3	3
CO4	3	3	3	3	2	2	3	3	2	3	3	3	2	3	2
CO5	3	2	2	3	2	3	2	2	3	3	2	3	3	3	3
Total	14	14	12	15	12	12	13	13	12	12	14	15	14	13	13
Average	2.8	2.8	2.4	3	2.4	2.4	2.6	2.6	2.4	2.4	2.8	3	2.8	2.6	2.6

Course Coordinator

BOS Chairman

Elective - V – Medical Laboratory Techniques

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S3PBTE11	Elective-V	Theory	Y	Y	-	3	3

Learning Objective:

- ❖ The organisation of clinical laboratory.
- ❖ To undergo training in all fields of laboratory medicine (Biochemistry, Microbiology, Pathology and Blood bank departments respectively).
- ❖ The processing of clinical samples.
- ❖ The Importance of SOP in laboratory testing.
- ❖ To maintain log books and registers

<u>Course Outcomes</u>		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	To understand the organization of clinical laboratory	PO4
CO2	Apply suitable antiseptics and disinfectants in laboratory conditions	PO4,PO5
CO3	Analyze various clinical samples.	PO4,PO6
CO4	Calibrate the instruments for quality assurance	PO5,PO6
CO5	Formulate SOP in clinical laboratory	PO4,PO6

Unit	Details	No. of Hours
I	Introduction to Clinical laboratory Basic laboratory principles Organization of clinical laboratory Biosafety in containment laboratory National and International GLP (Good laboratory Practices) Role of medical laboratory technician personnel hygiene and safety measures.	9
II	Antiseptics & Disinfectants Definition -Types Mode of Action Uses. Antimicrobial agents and Antibiotics: Introduction, mechanism of action, classification and uses, Antibiotic susceptibility testing Stokes, Kirby-Bauer method.	9
III	Collection and processing of blood Collection and processing of blood sample separation of serum and plasma Sampling errors Preservation of samples. Determination of Total Count, ABO Blood group system. Detection of blood glucose, Urea, Cholesterol and Bilirubin. Profiling Liver function test, Renal function tests. Hormones-T3, T4, TSH, FSH, LHL, Prolactin, Insulin.	9
IV	Processing of Urine, Stool and Sputum sample Collection, transport and Storage of Urine, Stool and Sputum sample. Macroscopic and Microscopic examination Urine: sugar, albumin, bile salts, bile pigments and ketone bodies Pregnancy Test.	9
V	Maintenance of Laboratory Maintenance of Laboratory Equipment's Centrifuge, calorimeter, microscope, incubator, autoclave. Laboratory Certification process National Accreditation Board for Laboratories, Indian Standard Organization Standard Operating Procedure Clinical Laboratory records. Biomedical waste management Bureau of Indian Standards-danger signs and Symbols.	9

Text Books:

- Ananthanarayanan R and CK Jayaram Panicker, 2020, "Textbook of Microbiology, 11^a Edition, Delhi: Orient Longman.
- Monica Cheesbrough, 2018, "District Laboratory Practice in Tropical Countries", 2nd Edition, USA: Cambridge University Press.

References

- Bailey and Scotts, 1994, "Diagnostic Microbiology", 96 Edition, New Delhi: Baron and Finegold CVMosby Publications,
- Jawetz E Melnic JL and Adel berg EA, 1998, "Review of Medical Microbiology", 10th Edition, USA: Lange Medical Publications.
- Mackie and McCatney, 1994, "Medical Microbiology", 14th Edition, New Delhi: Church will Livingston.
- Patrick K. Murray IN, 2012, "Medical Microbiology", 4th Edition, USA: Mosboy Publishers.

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	2	3	3	3	2	2	2	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	2	3	3	2	2	3	3	3	2	3
CO3	2	3	2	3	3	3	3	2	2	2	3	3	3	3	3
CO4	2	3	3	3	2	2	3	3	2	3	3	3	2	3	3
CO5	2	2	2	3	2	3	2	2	3	3	2	3	3	3	3
Total	12	14	12	15	12	12	13	13	12	12	14	15	14	13	15
Average	2.4	2.8	2.4	3	2.4	2.4	2.6	2.6	2.4	2.4	2.8	3	2.8	2.6	2.8

Course Coordinator

BOS Chairman

NME –II - TISSUE ENGINEERING

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S3PBTN02	NME-II	Theory	Y	Y	-	2	3

Learning Objective:

- ❖ The subject imparts knowledge on the fundamentals of tissue and its function.
- ❖ The student will be provided with a basic knowledge and understanding about the functions of tissue and its biomedical applications.
- ❖ Understand the interdisciplinary nature of Tissue Engineering and the need for a close collaboration between engineers, biologists and clinicians.
- ❖ Describe the basic principles of Tissue Engineering, and understand how they interact with each other.
- ❖ Evaluate and critically discuss scientific papers specifically related to Tissue Engineering.

<u>Course Outcomes</u>		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Understand the Basics of Tissue Engineering	PO4
CO2	Apply the knowledge to create tissue culture methods	PO4,PO5
CO3	Acquire adequate knowledge in the use of tissue in medical application	PO4,PO6
CO4	Evaluate the benefits of Tissue Engineering & Pharmaceutical Products	PO5,PO6
CO5	Analyze the importance of applications of tissue engineering	PO4,PO6

Unit	Details	No. of Hours
I	Basic biology of tissue engineering: The basis of growth and differentiation-morphogenesis and tissue Engineering	9
II	In vitro control of tissue development-Growth factors- Tissue engineering bioreactors- In vitro synthesis of Tissue and organs- Organotypic and histotypic engineered tissues. 3D cell culture-Tissue assembly in Microgravity	9
III	Biomaterials in tissue engineering-Scaffolds, extracellular matrix, polymers and nano composites. Approaches to transplanting engineered cells	9
IV	Bio artificial pancreases, Hepatitis liver support system, Artificial Womb, Haematopoietic system: Red blood cell substitutes, Renal replacement devices	9
V	Structural tissue engineering-Bone regeneration through cellular engineering, Skin tissue engineering, Brain implants-Neural stem cells, Periodontal Applications	9

Text Books:

- Sylvia, S. Mader, 2011, Human Biology, Twelfth edition, Mc Graw Hill, USA.
- Robert P. Lanaza, Robert Langer and Joseph Vacanti, 2007. Principles of Tissue Engineering. Third edition Academic Press.
- Micklem.H.S., Loutit John.F., 2004, Tissue grafting and radiation, Academic Press, New York..
- Penso.G., Balducci.D., 2004.Tissue cultures in biological research, Elsevier, Amsterdam
- Cecie Starr, 1996, Biology, Third edition, Wordsworth, America.

Useful Websites:

- www.nuigalway.ie/anatomy/tissue_engineering.htm

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	2	3	3	3	2	2	2	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	2	3	3	2	2	3	3	3	2	3
CO3	2	3	2	3	3	3	3	2	2	2	3	3	3	3	3
CO4	2	2	3	3	2	2	3	3	2	3	3	3	2	3	3
CO5	2	2	2	3	2	3	2	2	3	3	2	3	3	3	3
Total	12	12	12	15	12	12	13	13	12	12	14	15	14	13	15
Average	2.4	2.4	2.4	3	2.4	2.4	2.6	2.6	2.4	2.4	2.8	3	2.8	2.6	2.8

Course Coordinator

BOS Chairman

NME –III - BIOENTREPRENEURSHIP

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S3PBTN03	NME-III	Theory	Y	Y	-	2	3

Learning Objective:

- ❖ The paper imparts a thorough knowledge of the sources of innovation opportunities and development of the skills to identify and analyze these opportunities for Bioentrepreneurship and innovation.
- ❖ The students to develop personal skills set for creativity, innovation and entrepreneurship and specific concepts and tools for combining and managing creativity in organization.
- ❖ Student will have an understanding of how Entrepreneurship can impact their lives and society.
- ❖ Describe the importance of entrepreneurship.
- ❖ Distinguish between entrepreneur and promoter.

<u>Course Outcomes</u>		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Students will know the legal and financial conditions for starting a business venture	PO4
CO2	Will be able to explain the importance of marketing and management in small businesses venture and can interpret their own business plan	PO5
CO3	Able to identify the elements of success of bioentrepreneurial scheme and projects	PO4,PO5
CO4	Can able to specify the basic performance indicators of various entrepreneurial activities	PO4,PO6
CO5	Student will be able to analyse the business environment in order to identify business Opportunities	PO4,PO5

Unit	Details	No. of Hours
I	BASICS OF BIOENTREPRENEURSHIP: Introduction to bioentrepreneurship – Biotechnology in a global scale, Scope in Bioentrepreneurship, Importance of entrepreneurship. Meaning of entrepreneur, function of an entrepreneur, types of entrepreneur, and advantages of being entrepreneur. Innovation – types, out of box thinking, opportunities for Bioentrepreneurship. Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Startup and Make in India).	9
II	MANAGEMENT, ACCOUNTING AND FINANCE: Business plan preparation: business feasibility analysis by SWOT, socio-economic costs benefit analysis, Sources of financial assistance – making a business proposal, approaching loan from bank and other financial institutions, budget planning and cash flow management. Collaborations and partnerships, information technology for business administration and expansion.	9
III	KNOWLEDGE CENTRE AND R & D: Knowledge centers - Universities, innovation centre, research institutions and business incubators. R&D - technology development and upgradation, assessment of technology development, managing technology transfer, industry visits to successful bio-enterprises, regulations for transfer of foreign technologies.	9
IV	MEDIUM & SMALL SCALE INDUSTRY: Definition, characteristics, need and rationale, objectives, scope and advantages of small scale industries. Types of bioindustries – Pharma, Agri and Industry. Biofertilizers production - Azospirillum, Azolla, Cyanobacteria and its applications. Biopesticides production - Bacterial, fungal, viral and plant insecticides.	9
V	MARKETING AND HUMAN RESOURCE DEVELOPMENT: Assessment of market demand for potential product(s) of interest, Market conditions, segments, prediction of market changes, identifying needs of customers. Branding issues, developing distribution channels – franchising policies, promotion, advertising, and branding and market linkages.	9

Text Books:

- Entrepreneurship Ideas in Action-South-Western,
- Principles of Management, PC Tripathi, PN Reddy,–Tata Mc Graw Hill
- Dynamics of Entrepreneurial Development & Management Vasant Desai Himalaya Publishing House
- Management Fundamentals, Robert Lusier – Concepts, Application, Skill Development Thomson

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	2	3	3	3	2	2	2	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	2	3	3	2	2	3	3	3	2	3
CO3	2	3	2	3	3	3	3	2	2	2	3	3	3	3	3
CO4	2	2	3	3	2	2	1	3	2	3	3	3	2	3	3
CO5	2	2	2	3	2	3	2	2	3	3	2	3	3	3	3
Total	12	12	12	15	12	12	12	13	12	12	14	15	14	13	15
Average	2.4	2.4	2.4	3	2.4	2.4	2.4	2.6	2.4	2.4	2.8	3	2.8	2.6	2.8

Course Coordinator

BOS Chairman

SEMESTER – IV

Core X– Research Methodology

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S4PBT10	Core X	Theory	Y	Y	-	6	5

Learning Objective:

- ❖ The paper imparts a thorough knowledge on the basics of academic research.
- ❖ The student will get to understand the core concepts of methodologies & ethics to pursue research.
- ❖ To give an overview of the research methodology and explain the technique of defining a research problem
- ❖ To explain the functions of the literature review in research.
- ❖ To explain the details of sampling designs, and also different methods of data collections.

<u>Course Outcomes</u>		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Understand the bases for research	PO4
CO2	To know about research proposal and dissertation writing.	PO5
CO3	To know about Statistical application in research	PO4,PO6
CO4	To know about office tools used in research	PO4,PO5
CO5	To know about search engines.	PO6

Unit	Details	No. of Hours
I	Research Methodology - An Introduction: Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Importance of knowing how research is done, Research Process, Criteria of good research. Defining the Research Problem; Research Design; Sampling Design; Methods of Data Collection; Processing and Analysis of Data; Sampling Fundamentals	18
II	Review of literature , Writing the Research Report (Thesis and publications): Components of research report - Title, Authors, Addresses, Abstract, Keywords, Introduction, Materials and Methods, Results, Discussion, Summary, Acknowledgements and Bibliography	18
III	Standard Deviation - T test. Analysis of Variance components (ANOVA) for fixed effect model; Total, treatment and error of squares, Degrees of freedom, Confidence interval; ANOVA for random effects model, Estimation of variance components, Model adequacy checking. Two factor Factorial Design.	18
IV	Spreadsheet Tool : Introduction to spreadsheet application, features and functions, Using formulas and functions, Data storing, Features for Statistical data analysis, Generating charts/ graph and other features. Presentation Tool: Introduction to presentation tool, features and functions.	18
V	Web Search : Introduction to Internet, Use of Internet and WWW, Using search engine like Pubmed, Science direct, Scopus etc, and Using advanced search techniques	18

Text Books:

- Montgomery, Douglas C. (2007), 5/e, Design and Analysis of Experiments, (Wiley India).
- Montgomery, Douglas C. & Runger, George C. (2007), 3/e, Applied Statistics & Probability for Engineers (Wiley India).
- Kothari C.K. (2004), 2/e, Research Methodology- Methods and Techniques (New Age International, New Delhi).

Useful Websites

- www.ask.com/Methodology+Research
- www.qmethod.org/

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	2	3	3	3	2	2	2	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	2	3	3	2	2	3	3	3	2	3
CO3	2	3	2	3	3	3	3	2	2	2	3	3	3	3	3
CO4	2	3	3	3	2	2	3	3	2	3	3	3	2	3	3
CO5	2	2	2	3	2	3	2	2	3	3	2	3	3	3	3
Total	12	14	12	15	12	12	13	13	12	12	14	15	14	13	15
Average	2.4	2.8	2.4	3	2.4	2.4	2.6	2.6	2.4	2.4	2.8	3	2.8	2.6	2.8

Course Coordinator

BOS Chairman

Core XI– BIOSTATISTICS

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S4PBT11	Core XI	Theory	Y	Y	-	6	5

Learning Objective:

- ❖ The paper imparts a thorough knowledge on the basics of all the statistical concepts, in biology.
- ❖ The student will get to understand the core concepts of computation principles for the data analysis.
- ❖ Understand and interpret commonly reported statistical measures published in healthcare research
- ❖ Analyze the different type of data using appropriate statistical software
- ❖ Demonstrate a good understanding of descriptive statistics and graphical tools.

<u>Course Outcomes</u>		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	To understand the major Methods of collection & presentation of data	PO5
CO2	To provide basic knowledge about methods of analysis of variance	PO4
CO3	To enlighten the students about the methods of setting hypothesis and calculation of errors.	PO5,PO6
CO4	To update the knowledge on Tests of significance for large and small samples.	PO4
CO5	To assess and appraise the role of novel microbes in environment and integrate them in specific innovative approaches.	PO6

Unit	Details	No. of Hours
I	Statistics – Scope –collection, classification, tabulation of Statistical Data – Diagrammatic representation – graphs – graph drawing – graph paper – plotted curve –Sampling method and standard errors –random sampling – use of random numbers.	18
II	Correlation and regression – correlation table – coefficient of correlation – Z transformation – regression – relation between regression and correlation. Probability – Markov chains applications – Probability distributions.	18
III	Normal distribution – graphic representation.– frequency curve and its characteristics –measures of central value, dispersion, coefficient of variation and methods of computation – Basis of Statistical Inference – Sampling Distribution – Standard error – Testing of hypothesis – Null Hypothesis –Type I and Type II errors	18
IV	Tests of significance for large and small samples based on Normal, t, z distributions with regard to mean, variance, proportions and correlation coefficient – chi-square test of goodness of fit – contingency tables – c2 test for independence of two attributes –	18
V	Tests of significance –t tests – F tests – Analysis of variance – one way classification – Two way classification, CRD, RBD, LSD. Spreadsheets – Data entry –mathematical functions – statistical function.	18

Text Books:

- Montgomery, Douglas C. (2007), 5/e, Design and Analysis of Experiments, (Wiley India).
- Montgomery, Douglas C. &Runger, George C. (2007), 3/e, Applied Statistics & Probability for Engineers (Wiley India).
- Kothari C.K. (2004), 2/e, Research Methodology- Methods and Techniques (New Age International, New Delhi).

Useful Websites

- www.ask.com/Methodology+Research
- www.qmethod.org/

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	2	3	3	3	2	2	2	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	2	3	3	2	2	3	3	3	2	3
CO3	2	3	2	3	3	3	3	2	2	2	3	3	3	3	3
CO4	2	3	3	3	2	2	3	3	2	3	3	3	2	3	3
CO5	2	2	2	3	2	3	2	2	3	3	2	3	3	3	3
Total	12	14	12	15	12	12	13	13	12	12	14	15	14	13	15
Average	2.4	2.8	2.4	3	2.4	2.4	2.6	2.6	2.4	2.4	2.8	3	2.8	2.6	2.8

Course Coordinator

BOS Chairman

Elective – VI – Stem Cell Biology

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S4PBTE12	Elective -VI	Theory	Y	Y	-	4	3

Learning Objective:

- ❖ The subject imparts knowledge on the fundamentals of stem cells.
- ❖ The student will be provided with a basic knowledge and understanding about the application of stem cell biology.
- ❖ The course is designed to give a broad view of mammalian stem cells, reviewing where they are found in the body, the different types and how they are cultured.
- ❖ The topics will cover the basic biology of these stem cells as well as bioengineering and application of these stem cells to potential treatments of human diseases.

<u>Course Outcomes</u>		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	To understand the major discoveries of stem cell biology	PO1
CO2	To provide basic knowledge about stem cell niche and functions	PO2
CO3	To enlighten the students on Stem cell isolation and culture techniques	PO3,PO4
CO4	To update the knowledge on Stem cell cycle	PO5
CO5	To assess and appraise Applications of Embryonic stem cells.	PO6

Unit	Details	No. of Hours
I	Stem cells - Definition, Characterization, Pluripotency, Self-renewal and differentiation. Types of stem cells- Embryonic stem cells, Adult stem cells and mesenchymal stem Cells, Adipose stem cells	9
II	Stem cell niche, Niche specification - Drosophila germ line stem cells. Receptors, genes and markers of stem cells	9
III	Stem cell isolation and culture techniques. Characterization of stem cells	9
IV	Stem cell cycle. Chromatin modification and transcriptional regulation, chromatin modifying factors, Chromosomal inactivation. JAK -STAT pathway, Ras\Raf pathway, PI3K cell signaling, p53 check points, Role of LIF pathway in cell cycle control	9
V	Applications of Embryonic stem cells, Bone marrow stem cells, Adipose derived stem cells and Hematopoietic stem cells. Ethics in human stem cell research	9

Text Books:

- Stem Cell Biology, Daniel Marshak, Richard L. Gardener and David Gottlieb, Cold Spring Harbour Laboratory Press
- Stem cell biology and gene therapy, Booth C., Cell Biology International, Academic Press
- Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine, Alexander Battler, Jonathan Leo, Springer, STEM CELL TECHNOLOGY Syllabus - Semester First References:
- Stem Cell Biology and Gene Therapy. Quesenberry PJ, Stein GS, eds. (£65.00.) Wiley, 1998.

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	2	3	3	3	2	2	2	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	2	3	3	2	1	3	3	3	2	3
CO3	2	3	2	3	3	3	2	2	2	2	3	3	3	3	3
CO4	3	3	3	3	2	2	3	3	2	3	3	3	2	3	3
CO5	3	2	2	3	2	3	2	2	3	3	2	3	3	3	3
Total	14	14	12	15	12	12	12	13	12	13	14	15	14	13	15
Average	2.8	2.8	2.4	3	2.4	2.4	2.4	2.6	2.4	2.6	2.8	3	2.8	2.6	2.8

Course Coordinator

BOS Chairman

Elective – VI - BIOETHICS, BIOSAFETY, CLINICAL TRIALS, IPR & ENTREPRENEURSHIP

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S4PBTE13	Elective -VI	Theory	Y	Y	-	4	3

Learning Objective:

- ❖ This course provides the guidelines and regulations governing research; evaluate ethical conduct and social responsibilities.
- ❖ To adhere to safe working practices; to appreciate the need for protection of human subjects
- ❖ To recognize the potential harms in research and show sensitivity to cultural and ethical issues; to create a general awareness about IPR.
- ❖ The students to learn in detail about Indian patent law, regulation of excise, national and international ethical issues, bio safety and health hazards and good laboratory practices and good manufacturing practices.

<u>Course Outcomes</u>		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Understand the basics of biosafety and bioethics and its impact on biological sciences and the importance of human life.	PO5
CO2	Apply the knowledge to recognize the importance of biosafety guidelines and good clinical practices.	PO4
CO3	Acquire adequate knowledge in the use of genetically modified organisms and its effect on human health.	PO5,PO6
CO4	Evaluate the benefits of GM technology and importance of IPR	PO4
CO5	Analyse the importance of protection of new knowledge and innovations and its role in business and entrepreneurship	PO6

Unit	Details	No. of Hours
I	Introduction to Bioethics Need for bioethics in social and cultural issues. Bioethics & GMO's Issues and concerns pertaining to Genetically modified foods & food crops, Organisms and their possible health implications and mixing up with the gene-pool. Bioethics in Medicine Protocols of ethical concerns related to prenatal diagnosis, gene therapy, Organ transplantation.	9
II	Clinical trials –Regulations. Bioethics & Cloning Permissions and Procedures in Animal Cloning, Human cloning, Risks and hopes. Bioethics in Research Stem cell research, Human Genome Project, Use of animals in research, human volunteers for Clinical research, Studies on Ethnic races. Ethics in patient care, Informed consent.	9
III	Biosafety – Biological risk assessment. Biological agents and Hazard groups. Criteria in biological risk assessment. Guidelines for categorization of genetically modified plants for field test. Biosafety levels. Safety equipments and Biological Safety cabinets.	9
IV	IPR: Introduction to Intellectual Property rights, Patenting – Factors for patentability – Novelty, Non-obviousness, Marketability. Procedures for registration of Patents. Copyright works, ownership, transfer and duration of Copyright. Renewal and Termination of Copyright. Industrial Designs - Need for Protection of Industrial Designs. Procedure for obtaining Design Protection. Infringement, Right of Goodwill, Passing Off. Trademarks - Introduction to Trademarks. Need for Protection of Trademarks. Classification of Trademarks. Indian Trademarks Law. Procedural Requirements of Protection of Trademarks	9
V	Geographical Indications - Indication of Source and Geographical Indication. Procedure for Registration, Duration of Protection and Renewal. Infringement, Penalties and Remedies. Layout- Designs of Integrated Circuits: Conditions and Procedure for Registration. Duration and Effect of Registration Protection of Plant variety and Plant breeders' rights in India. Protection of traditional knowledge, Bioprospecting and biopiracy. India's new IP Policy (2016), Govt of India's steps to promote IPR. Career opportunities in IP. Entrepreneurship: Definition and importance, Characteristics and functions of an entrepreneur	9

Text Books:

- Bioethics & Biosafety by Sateesh MK, IK International publications, 2008
- USPTO Web Patent Databases at: www.uspto.gov/patft
- Government of India's Patents Website: patinfo.nic.in
- Intellectual property India: www.ipindia.nic.in
- Indian Patent Law: Legal and Business Implications by Ajit Parulekar, Sarita D'Souza Macmillan India publication, 2006
- Agriculture and Intellectual Property Rights, edited by: Santaniello,V., Evenson, R.E., Zilberman, D. and Carlson, G.A. University Press publication, 2003

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	2	3	3	3	2	2	2	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	2	3	3	2	2	3	3	3	2	3
CO3	2	3	2	3	3	3	2	2	2	2	3	3	3	3	3
CO4	2	3	3	3	2	2	3	3	2	3	3	3	2	3	3
CO5	2	2	2	3	2	3	2	2	3	3	2	3	3	3	3
Total	12	14	12	15	12	12	12	13	12	12	14	15	14	13	15
Average	2.4	2.8	2.4	3	2.4	2.4	2.4	2.6	2.4	2.4	2.8	3	2.8	2.6	2.8

Course Coordinator

BOS Chairman

Elective – VI

Dairy Technology

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S4PBTE14	Elective -VI	Theory	Y	Y	-	4	3

Learning Objective:

- ❖ Students will embark on an exploration of Dairy Technology, commencing with an introduction to the dairy industry, milk composition, processing techniques, and quality control.
- ❖ To learn the processing of milk microbiological methods.
- ❖ Quality and Safety, covering quality assessment, microbiology, food safety, hygiene, packaging, storage, and regulatory standards.
- ❖ To understand how the milk products are in quality make through dairy industry
- ❖ Entrepreneurship and marketing, providing a comprehensive understanding of the dynamic field of dairy technology and its future directions.

<u>Course Outcomes</u>		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	The student will be able to know about basic knowledge of milk microbes and its changes in maintaining the storage of milk.	PO4
CO2	The student will be able to understand mechanism of processing of milk through microbiological methods	PO4
CO3	The student will be able to understand dairy products quality and its changes through microbes	PO5
CO4	The student will be able to differentiate dairy products in industry and homemade	PO5
CO5	The student will be able to know various application of milk and milk borne microbial diseases.	PO4

Unit	Details	No. of Hours
I	Introduction to Dairy Technology: Introduction to dairy technology, Dairy industry and its importance, Milk composition and properties, Dairy processing and value addition, Quality control and safety in dairy products.	9
II	Dairy Processing Techniques: Dairy product manufacturing, Milk pasteurization and homogenization, Cheese and yogurt production, Butter and ice cream manufacturing, Fermented dairy products.	9
III	Dairy Product Quality and Safety: Dairy product quality assessment, Microbiology of dairy products, Food safety and hygiene in dairy processing, Packaging and storage of dairy products, Regulatory standards for dairy industry.	9
IV	Emerging Trends in Dairy Technology: Innovations in dairy processing, Dairy biotechnology and probiotics, Sustainable dairy production, Value-added dairy products, Dairy entrepreneurship and marketing.	9
V	Milk-borne diseases – viral and bacterial, zoonotic infections, pathogens associated with fluids milks, dairy products and their public health significance. sources of pathogens and their prevention ,importance of bio flims, their role in transmission of pathogens in dairy products and preventive strategies.	9

Text Books:

- Adams MR and Moss MO.(1995).food microbiology, the royal society of chemistry, Cambridge.
- Andrews AT, Varley J (1994) biochemistry of milk products. Royal society of chemistry.
- Banwart G J (1989), basic food microbiology, Chapman & hall, new York.
- Frazier WC and Westhoff D C. (1988) food microbiology, TATA McGraw hill publishing company Ltd. New Delhi.
- Arnold (a division of Hodder and Stoughton), London. May JM. (1987) modern food microbiology, CBS publishers and distributors, NewDelhi.
- Edward Harth ,J.T.Steele. Applied dairy microbiology .1998. Marcel DeckerInc.

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	2	3	3	3	2	3	2	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	3	3	3	2	2	3	3	3	2	3
CO3	2	3	2	3	3	3	2	2	2	2	3	3	3	3	3
CO4	3	3	3	3	2	3	3	3	2	3	3	3	2	3	3
CO5	3	2	2	3	2	3	2	2	3	3	2	3	3	3	3
Total	14	14	12	15	12	15	12	13	12	12	14	15	14	13	15
Average	2.8	2.8	2.4	3	2.4	3	2.4	2.6	2.4	2.4	2.8	3	2.8	2.6	2.8

Course Coordinator

BOS Chairman

SBEC – Ecotechnology

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S4PBTS01	SBEC	Theory	Y	Y	-	4	2

Learning Objective:

- ❖ This course will give the student an understanding of the basic principles of technologies adopted in various aspects of biotechnology.
- ❖ This course will elaborate the latest trends and applications in the field of Biofuels, Eco-friendly polymers, Biofertilizers, Biopesticides and Biostimulants.
- ❖ The student will understand the critical issues in waste management.
- ❖ Student will acquire knowledge about these modern eco technologies as a resource for further technological processing and application.

<u>Course Outcomes</u>		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Understanding the basics of bioresources	PO3
CO2	Understanding the concepts of polymers developed using biological contents	PO4
CO3	Acquiring the knowledge about biocontrol methods	PO4
CO4	Develop and inferencing the biological products in agriculture fields	PO5
CO5	Examining the quality and categorizing the biological products in the environment	PO6

Unit	Details	No. of Hours
I	Introduction to Biofuel, Bioenergy sources – Sugar waste, Starch waste, Lignocellulosic waste, livestock waste	9
II	Introduction to Biopolymers ; Sources – natural sources, microbial polysaccharides, poly hydroxyl Alkaonates	9
III	History, Principles & scope of Biological control, Principles of classical Biological control, Microbial control – definition & concept.	9
IV	Definition & types, Importance of Biofertilizers in Agriculture, Commercial Biofertilizers – Rhizobium, Azatobacter, Acetobacter, Blue Green Algae	9
V	Definition & categories – Humic Acid, Protein hydrolysate, Sea weed extract, Inorganic compounds, Microbial Innoulants	9

Text Books:

- John Love. Bryant. A. J. 2017. Biofuels and Bioenergy. Wiley Blackwell. UK.
- Shakeel Ahmed, SuvadahanKanchi., Gopalakrishnan Kumar. 2019. Handbook of Biopolymers advances and multifaceted applications. Pan Stanford Publishing Pte. Ltd. New York.
- Leo M. L. Nollet., Hamir Singh Rathore. 2015. Biopesticides handbook. CRC Press. USA.
- Arshad Anwer. Md. 2017. Biopesticides and Bioagents: Novel tools for pest management. Apple Academic press. USA.

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	2	3	3	3	2	3	2	3	3	3	3	3	3	3	3
CO2	2	3	2	3	3	3	3	3	2	2	3	3	3	2	3
CO3	2	3	2	3	3	3	2	2	2	2	3	3	3	3	3
CO4	2	3	3	3	2	3	3	3	2	3	3	3	2	3	2
CO5	3	2	2	3	2	3	2	2	3	3	2	3	3	3	2
Total	12	14	12	15	12	15	12	13	12	12	14	15	14	13	13
Average	2.4	2.8	2.4	3	2.4	3	2.4	2.6	2.4	2.4	2.8	3	2.8	2.6	2.6

Course Coordinator

BOS Chairman