ABOUT THE DEPARTMENT

The Department of Microbiology was established in the year 1994 with UG course. The Post Graduate Microbiology course was started in the year 2000. The Department has produced 29 UG batches and 16 PG batches. Ever since its inception, the Department has been constantly concentrating to stay updated with the latest developments. The Department has well equipped laboratory and library to cater the requirements of the syllabi. All the graduates and postgraduates of the Department have been well placed in the various fields of Microbiology. The Postgraduate Department has 6 faculty members who are eminent scholars and have wide knowledge in the field.

VISION

To be a focal point of brilliance in higher education that emphasizes pioneeringeducation, knowledge on research and development in the field of microbiology.

MISSION

- To afford eminent edification in microbiology programmed to enrich the academic foundation and preparation of students for life in an intricate dynamic technological world.
- To generate and propagate awareness through interdisciplinary research in thefield of Microbiology

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The Microbiology Postgraduates of the Sourashtra College will: The Programme Educational Objectives of the **M.Sc. in Microbiology** Programme at Sourashtra College, Madurai are given below and are numbered from PEO1 to PEO5.

PEO 1	To provide in – depth knowledge about core areas of biosciences such as biotechnology, biochemistry and microbiology.
PEO 2	To make students competent in the field of biosciences and allied areas byproviding them hands on experience in basic tools and techniques
PEO 3	To instill the ability for research and entrepreneurship in the students alongwith strong ethics and communication skills.
PEO 4	To inculcate, facilitate, motivate and promote knowledge technical skills in core areas of biological sciences including advanced tools and techniques like genomics, proteomics and transcriptomics to young aspirants and to equip and motivate the students to pursue higher education and research in reputed institutes at national and international level in the field Science
PEO 5	To develop trained human resource in the field of advanced translational research and to develop graduates with a strong professional ethics and moral duties that will positively affect their profession, community, society and Nation at large.

POSTGRADUATE (PG) PROGRAMME OUTCOMES (POs)

Postgraduate (M.A., **M.Sc.,** M.Com., M. Com (CA)., M.B.A., M.C.A., etc.,) is a two year degree Programme with 4 semesters consisting the following Programme Outcomes (POs) under various criteria including critical thinking, problem solving, effective communication, societal/ citizenship/ ethical credibility, sustainable growth and employable abilities.

PO 1	**Critical Thinking**: Intellectual exploration of knowledge towards actions in clear and rational manner by understanding the logical connections between ideas and decisions.
PO 2	**Problem Solving**: Understanding the task/ problem followed by planning andnarrow execution strategy that effectively provides the solution.
PO 3	**Effective Communication**: Knowledge dissemination by oral and verbal mechanisms to the various components of our society.
PO 4	**Societal/ Citizenship/ Ethical Credibility**: Realization of various value systems/ moral dimensions and demonstrate the empathetic social concern as well as equity in all the decisions, executions and actions.
PO 5	**Environmental Concern and Sustainable Growth**: Understanding the emerging environmental challenges and provide the possible contribution in sustainable development that integrates environment, economy and employment.
PO 6	**Skill Development and Employable Abilities**: Adequate training in relevantskill sector and creating employable abilities among the PG.

PROGRAMME SPECIFIC OUTCOMES (PSOs)
MICROBIOLOGY PROGRAMME

PSO 1	**Placement** Prepare the students in varied disciplines like agriculture, industry – medical, pharma, dairy, hotel, food and food processing, immunological, cosmetics, vermitechnology and water treatment for effective and respectful placement.
PSO 2	**Entrepreneurship** To create effective entrepreneur by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups andhigh potential organizations.
PSO 3	**Research and Development** Design and implement HR systems that comply with good laboratory, practices, following ethical values, leading the organization towards growth anddevelopment.
PSO 4	**Contribution to Society** To contribute to the development of society and produce microbiological products, by collaborating with stake holders, related to the betterment of environment and mankind at the national and global level.

DISTRIBUTION OF CREDITS (PG PROGRAMME)

PART	SEMESTER	COURSES	NUMBER OF COURSES	HOURS	CREDITS	TOTAL CREDITS
I	I – II	CORE	10	5 – 6	4 – 5	40
I	III – IV	CORE	8	5 – 6	4 – 5	32
II	I – II	ELECTIVE	2	5 – 6	3 – 5	6
II	IV	ELECTIVE	1	5 – 6	3 – 5	3
IV	II&III	EXTENSION ACTIVITY	1	–	1	1
III	III	NON MAJOR ELECTIVE (NME)	1	6	5	5
III	IV	PROJECT	1	18	4 – 5	5
	III	INTERNSHIP	1		1	1
TOTAL CREDITS						93

Extra credits may be earned through SWAYAM Courses/other online courses

SOURASHTRA COLLEGE, MADURAI– 625004

(An Autonomous Institution Re-accredited with 'B+' grade by NAAC)

M.Sc. MICROBIOLOGY – SYLLABUS

(Under CBCS based on OBE)(For those admitted during 2024 – 2025 and after)

M.Sc. MICROBIOLOGY – I YEAR

COURSE STRUCTURE – I SEMESTER

S. No.	Course Code	Course Title	Hrs./ Week	Exam (Hrs.)	CA	SE	Total	Credits
1.	24PMBC11	**Core – 1:** General Microbiology and Microbial Physiology	5	3	25	75	100	4
2.	24PMBC12	**Core – 2:** Molecular Biology and Microbial Genetics	5	3	25	75	100	4
3.	24PMBC13	**Core – 3:** Bioprocess Technology	4	3	25	75	100	4
4.	24PMBCP1	**Core – 4: Core Practical – I:** Lab in General Microbiology	6	3	40	60	100	4
5.	24PMBCP2	**Core – 5: Core Practical – II:** Lab in Molecular Biology and Microbial Genetics	6	3	40	60	100	4
6.	24PMBE11	**Elective – 1: *** Microbial Biochemistry	4	3	25	75	100	3
	24PMBE12	Biophysics and Bioinstrumentation						
	24PMBE13	Nano Biotechnology						
		TOTAL	**30**					**23**

***One elective course to be chosen from THREE courses**

II – SEMESTER

S. No	Course Code	Course Title	Hrs./ Week	Exam (Hrs.)	CA	SE	Total	Credits
1.	24PMBC21	**Core – 6:** Genetic Engineering	5	3	25	75	100	4
2.	24PMBC22	**Core – 7:** Immunology	4	3	25	75	100	4
3.	24PMBC23	**Core – 8:** Bioinformatics and Microbial Omics	5	3	25	75	100	4
4.	24PMBCP3	**Core – 9: Core Practical – III:** Lab in Immunology	6	3	40	60	100	4
5.	24PMBCP4	**Core – 10: Core Practical – IV:** Lab in Genetic Engineering and Bioinformatics	6	3	40	60	100	4
6.	24PMBE21	**Elective – 2: *** Microbial Ecology and Toxicology	4	3	25	75	100	3
	24PMBE22	Biomass and Bioenergy						
	24PMBE23	Medical Virology and Parasitology						
7.		Internship	–	–	–	–	–	–
		TOTAL	**30**					**23**

***One elective course to be chosen from THREE courses**

Passed in the BoS Meeting held on 09/03/2024 **Signature of the Chairman**

III – SEMESTER

S. No.	Course Code	Course Title	Hrs./ Week	Exam (Hrs.)	CA	SE	Total	Credits
1.		**Core – 11:**Medical Microbiology and Epidemiology	5	3	25	75	100	4
2.		**Core – 12:**Food and Agricultural Microbiology	4	3	25	75	100	4
3.		**Core – 13:** Environmental Microbiology& Aquatic Microbiology	4	3	25	75	100	4
4.		**Core – 14: Core Practical – V:** Lab in Clinical Microbiology	6	6	40	60	100	4
5.		**Core – 15: Core Practical – VI:** Lab in Applied Microbiology	6	6	40	60	100	4
6.		**NME**	5	6	25	75	100	5
7.		**Internship**	–	–	40	60	–	1
		TOTAL	**30**					**26**

IV – SEMESTER

S. No.	Course Code	Course Title	Hrs./ Week	Exam (Hrs.)	CA	SE	Total	Credits
1.		**Core – 16: R**esearch Methodology and Biostatistics.	5	3	25	75	100	4
2.		**Core – 17:** Forensic Science	5	3	25	75	100	4
3.		**Core – 18**: Herbal Technology and Cosmetic Microbiology	5	3	25	75	100	4
4.		**Elective–3:**	5	3	25	75	100	3
		Bio – entrepreneurship						
		Biosafety, Bioethics and IPR						
		Pharmaceutical Technology						
5.		Project with Viva Voce	10	–	–	–	–	5
		TOTAL	30					20

COURSE STRUCTURE – I SEMESTER

S. No.	Course Code	Course Title	Hrs./ Week	Exam (Hrs.)	CA	SE	Total	Credits
1.	24PMBC11	**Core – 1:** General Microbiology and Microbial Physiology	5	3	25	75	100	4
2.	24PMBC12	**Core – 2:** Molecular Biology and Microbial Genetics	5	3	25	75	100	4
3.	24PMBC13	**Core – 3:** Bioprocess Technology	4	3	25	75	100	4
4.	24PMBCP1	**Core – 4:** **Core Practical – I:** Lab in General Microbiology	6	3	40	60	100	4
5.	24PMBCP2	**Core – 5:** **Core Practical – II:** Lab in Molecular Biology and Microbial Genetics	6	3	40	60	100	4
6.	24PMBE11	**Elective – 1: *** Microbial Biochemistry	4	3	25	75	100	3
	24PMBE12	Biophysics and Bioinstrumentation						
	24PMBE13	Nano Biotechnology						
		TOTAL	**30**					**23**

***One elective course to be chosen from THREE courses**

CA – Class Assessment (Internal)

SE – Summative Examination

T – Theory

P – Practical

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
24PMBC11	GENERAL MICROBIOLOGY ANDMICROBIAL PHYSIOLOGY	CORE – 1	5	–	4

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	I	25	75	100

NATURE OF COURSE	Employability		Skill Oriented	✓	Entrepreneurship	

COURSE DESCRIPTION:

This course is designed to introduce field of microbiology with special emphasis on microbial diversity, morphology, growth and nutrition; methods for control of microbes and viruses. Student can understand about the fundamentals of microbiology.

COURSE OBJECTIVES:

- Acquire knowledge on the principles of different types of microscopes and theirapplications.
- Illustrate about the taxonomic classification of bacteria, virus and fungi.
- Discuss the importance and conservation of microbial diversity.
- To enrich knowledge about the bacterial nutrition and their utilization.
- Discuss the metabolic pathways and photosynthesis process.

COURSE OUTCOMES (COs):

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

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	Evaluate the basics concepts of microbiology and different types of microscopy.	Upto K5
CO 2	To explain the taxonomy of microbes and their classification.	Upto K5
CO 3	Discuss the microbial diversity of microorganisms.	Upto K5
CO 4	Apply knowledge about nutritional requirement and microbial growth of an organism.	Upto K5
CO 5	Compare various metabolic pathways and discuss the properties and functions of enzyme.	Upto K5

K1–KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

GENERAL MICROBIOLOGY AND MICROBIAL PHYSIOLOGY

UNIT – I:

Historical developments of Microbiology – Contributors of Microbiology – Microscopy – Principles – types – Bright field, Dark – field, Phase – contrast, Fluorescence microscope, Transmission electron microscope (TEM) and Scanning electron microscope (SEM). Structure of prokaryotic and eukaryotic cell, Differences between Eubacteria, Archaebacteria and Eukaryotes.

UNIT – II:

Microbial Taxonomy – Classification – Binomial and numerical, phylogenetic tree, Haeckel's three kingdom, Whittaker's five kingdom; classification of bacteria – Bergey's classification; molecular taxonomy – polyphasic taxonomy and species concept. Classification of viruses – Baltimore system; classification of fungi by Alexopoulos and Mims.

UNIT – III:

Microbial diversity and extremophiles: distribution, ecological niche, abundance and density. Extremophiles – Psychrophiles, acidophiles, alkaliphiles,thermophiles, barophiles etc., non – culturable bacteria (Metagenomics). Methanogens, Methanotrophs and Methylotrophs.

UNIT – IV:

Microbial growth – Growth in batch culture, Mathematical representation of bacterial growth, Bacterial generation time, Specific growth rate, Monoauxic, Diauxic and synchronized growth curves, Measurement of microbial growth – Principles of microbial nutrition – Chemoautotrophs, chemoheterotrophs, photoautotrophs and photoheterotrophs.

UNIT – V:

Metabolic pathways in bacteria – Energy production in bacteria – energy and ATP, aerobic and anaerobic respiration, glycolysis, tricarboxylic acid cycle, electron transport and oxidative phosphorylation, phosphoketolase pathway, pentose phosphate pathway, gluconeogenesis and glyoxylate cycle. Photosynthetic bacteria and cyanobacteria – pigments of photosynthetic apparatus, mechanism of photosynthesis in bacteria – oxygenic and anoxygenic. Bacterial stress response – nutrient stress and starvation, thermalstress and the heat shock response, pH stress, and oxidative stress.

TEXT BOOKS:

1. Kanunga R. 2017. ***Ananthanarayanan and Panicker's Text book of Microbiology***. (10th Edition). Universities Press (India) Pvt. Ltd.
2. Chan E.C.S., Pelczar M. J. Jr. and Krieg N. R. 2010. ***Microbiology***. (5th Edition).Mc.Graw Hill. Inc, New York.
3. Prescott L. M., Harley J. P. and Klein D. A. 2004. ***Microbiology***. (6th Edition).McGraw – Hill company, New York.
4. White D. Drummond J. and Fuqua C. 2011. ***The Physiology and Biochemistry ofProkaryotes***, Oxford University Press, Oxford, New York.
5. Dubey R.C. and Maheshwari D. K. 2009. ***Textbook of Microbiology***. S. Chand,Limited

REFERENCE BOOKS:

1. Tortora G. J., Funke B. R. and Case C. L. 2015. ***Microbiology: An Introduction*** (12th Edition). Pearson, London, United Kingdom
2. Webster J. and Weber R.W.S. 2007. ***Introduction to Fungi***. (3rd Edition).Cambridge University Press, Cambridge
3. Schaechter M. and Lederberg J. 2004. ***The Desk encyclopedia of Microbiology***.Elsevier Academic Press, California.
4. Ingraham, J.L. and Ingraham, C.A. 2000. ***Introduction to Microbiology***. (2ndEdition). Books / Cole Thomson Learning, UK.
5. Madigan M. T., Bender K.S., Buckley D. H. Sattley W. M. and Stahl 2018. ***BrockBiology of Microorganisms***. (15th Edition). Pearson.

DIGITAL TOOLS:

1. http://sciencenetlinks.com/tools/microbeworld
2. https://www.microbes.info
3. https://www.asmscience.org/VisualLibrary
4. https://www.boundless.com/microbiology
5. www.ebooks.cambridge.org/ebook.jsf?bid=CBO9781139170635

Mapping of CO with PSO

	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2
CO2	2	3	1	3
CO3	3	3	2	1
CO4	2	1	3	2
CO5	1	3	2	3

3. Advanced Application 2. Intermediate Development 1. Introductory Level

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
24PMBC12	MOLECULARBIOLOGY AND MICROBIAL GENETICS	CORE – 2	5	–	4

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	I	25	75	100

NATURE OF COURSE	Employability		Skill Oriented	✓	Entrepreneurship	

COURSE DESCRIPTION:

This course has been designed to introduce the student to the advanced concepts in molecular biology and to become familiar with microbial gene transfer & to understand the biology of lytic and lysogenic phages

COURSE OBJECTIVES:

- Gain an in – depth knowledge of the structure of DNA, RNA and its types.
- Acquire knowledge in the mechanism of transcription and translation process.
- Understand the basis of genetic code and gene mapping.
- Gain knowledge about transduction process.
- To enlighten the molecular mechanism of transposons.

COURSE OUTCOMES (COs):

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

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	Illustrate the structure and function of DNA and RNA.	Upto K5
CO 2	Identify the transcription and translation mechanism and its process occur in prokaryotes.	Upto K5
CO 3	Give knowledge about mutation analysis and plasmids.	Upto K5
CO 4	Discuss the importance of gene transfer by conjugation methods and lytic, lysogeny cycle.	Upto K5
CO 5	To understand about the transposons and regulation of gene.	Upto K5

K1–KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

MOLECULAR BIOLOGY AND MICROBIAL GENETICS

UNIT – I:

Structure and forms of DNA. Properties of DNA, Structure and types of RNA. Replication of DNA – Types of replications. Mutability and repair of DNA; homologous recombination; site – specific recombination and transposition of DNA.

UNIT – II:

Mechanism of transcription – Initiation, Elongation and Termination. Transcription factors – activators and repressor. Gene regulation in development and evolution. Post – transcriptional Processes – processing of tRNA, rRNA and mRNA. Translational mechanism in prokaryotes.

UNIT – III:

Genetic nomenclature, wobble hypothesis. DNA damage and repair mechanism – Mutagenesis – causes and types. Genetic recombination – types, mapping and complementation analysis. Plasmids – Properties, types, replication, amplification and gene transfer. Mobile DNA – terminology, types,

UNIT – IV:

Molecular mechanism of gene transfer by conjugation. Conjugation – F and R factor. Gene Transfer by Transduction – specialized, generalized transduction and significance. Transformation – Natural transformation and competence – DNA uptake competence systems. Genetics of Phage T4 – Lytic and Lysogeny cycle.

UNIT – V:

Transposons – Classes of bacterial transposons, Molecular mechanisms of transposition, Regulation and effects of transposition in bacteria.. Gene regulation – Operon concept, co – ordinated control of structural genes. Positive and negative regulation in *E.coli*. Inducers and repressor.

TEXT BOOKS:

1. Abbas A. K., Lichtman A. H. and Pillai S. (2021). ***Cellular and MolecularImmunology***. (10th Edition). Elsevier.
2. Malacinski G.M. (2008). ***Freifelder's Essentials of Molecular Biology***.(4th Edition). Narosa Publishing House, New Delhi.
3. Gerald Karp (2014). Cell Biology (7th Edition). Wiley publishers.
4. Streips, U.N. & Yasbin, R.E., Modern Microbial Genetics edited (2nd Ed.). Wiley – Liss Publishers. 2002.
5. Freifelder. D., Stanley. R. (1994). ***Molecular Biology and Microbial Genetics.*** J and B Publications.

REFERENCE BOOKS:

1. Larry, S. Henkin. T.M., Peters. J.E. and Wendy. C (2012). ***Molecular Genetics ofBacteria*** (4th edition). ASM Press.
2. Glick B. R. and Patten C.L. (2018). ***Molecular Biotechnology*** – Principles andApplications of Recombinant DNA. (5th Edition). ASM Press.
3. Russell P.J. (2010). ***Genetics – A Molecular Approach***. (3rd Edition). Pearson NewInternational Edition.
4. Trun. N. & Trempy. J., ***Fundamentals of Bacterial Genetics.*** Wiley – BlackwellPublishing. 2004.
5. Lankenau DH, Volff JN, editors. 2009. ***Transposons and the Dynamic Genome.Genome Dynamics and Stability***. Springer Berlin Heidelberg.

DIGITAL TOOLS:

1. **https://www.britannica.com/science/genetics**
2. **https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/General_Biology_1e_(OpenStax)/3%3A_Genetics/15%3A_Genes_and_Proteins/15.2%3A_Prokaryotic_Transcription**
3. **https://wou.edu/chemistry/courses/online – chemistry – textbooks/ch450 – and – ch451 – biochemistry – defining – life – at – the – molecular – level/chapter – 11 – translation/**
4. **https://ugcmoocs.inflibnet.ac.in/assets/uploads/1/72/2120/et/Academic%20Script – MOD%201 – Microbial%20Genetics – MOOC20022405050202222.pdf**
5. **https://www.nature.com/scitable/topicpage/transposons – the – jumping – genes – 518/**

Mapping of CO with PSO

	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2
CO2	2	3	1	3
CO3	3	3	2	1
CO4	2	1	3	2
CO5	1	3	2	3

3. Advanced Application 2. Intermediate Development 1. Introductory Level

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
24PMBC13	BIOPROCESS TECHNOLOGY	CORE – 3	4	–	4

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	I	25	75	100

NATURE OF COURSE	Employability		Skill Oriented	✓	Entrepreneurship	✓

COURSE DESCRIPTION:

This course introduces the basic concepts of Bioprocess Technology with a key emphasis on parts and functions of a bioreactor, types of bioreactors, the parameters involved in scaling up and scaling down, production and recovery of fermented products.

COURSE OBJECTIVES:

- To learn basics of bioprocess techniques, bioreactors, fermentation and media.
- Design and construct different type of bioreactors.
- To impart knowledge on operations of fermentation processes with all itsprerequisites
- To select appropriate bioreactor configurations and operation modes based uponthe nature of bioproducts and other process criteria
- Evaluate and monitoring with the help of computer knowledge.

COURSE OUTCOMES (COs):

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

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	Gain an understanding of an overview of fermentation and different types of fermentation process.	Upto K5
CO 2	Appreciate the fermenter design, types, workingprinciple and product formation in batch, continuous and fed – batch cultures.	Upto K5
CO 3	Able to determine the kinetics and different parameters involved in involved in bioreactors.	Upto K5
CO 4	Able to design the bioreactor, manipulate the microorganisms and uses the strains for producing industrially important products.	Upto K5
CO 5	Able to analyze the cost structures for designing the upstream and downstream process units.	Upto K5

K1–KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

BIOPROCESS TECHNOLOGY

UNIT – I:

Fermentation process – An overview, isolation, screening, preservation and improvement of industrially important microorganisms. Strain improvement for the selected organism: mutation and screening of improved cultures, random and strategic screening methods, strategies of strain improvement for primary, secondary metabolites with relevant examples. Media for industrial fermentation – characteristics of an ideal production medium – raw material – media formulation – sterilization – addition of antifoaming agents.

UNIT – II

Bioreactors: Design and Components of a basic Bioreactor, design features – parts, baffles, impellers, foam separators, sparger, culture vessel, cooling and heating devices, control of fermentation process – manual and computer control. Reactors for specialized applications: Tube reactor and packed bed reactors, fluidized bed reactors, cyclone reactors, trickle flow reactors, their basic construction and types for distribution of gases. Types of fermentation – Solid state, Submerged and liquid state. Kinetics of microbial growth in Batch, Fed Batch and Continuous cultures. Development of inoculums for various fermentation processes.

UNIT – III:

Gas exchange and Mass transfer: O2 transfer, critical oxygen concentration, determining the oxygen uptake rate. Heat transfer. Sterilization – processes, thermal death curve, in situ sterilization mixing and mass transfer, aeration and agitation – oxygenation, oxygen requirements, determination of KLa; Scale – Up and Scale – Down concepts.

UNIT – IV:

Downstream Processing: Recovery and Purification of fermentation of Products – Biomass separation by Flocculation and floatation, Filtration, Centrifugation, Coagulation and Flocculation, Cell disruption, Liquid extraction, Precipitation, Adsorption, Chromatography, Membrane Processes, Drying and Crystallization.

UNIT – V:

Production of metabolites and Fermentation Economics: Production of Industrial Alcohol – Ethanol, Organic Acids – Citric Acid, Amino Acid – Glutamic acid; Single Cell Protein Production, Yeast Production, Fermented foods from Milk – Cheese and Yoghurt, Beta – lactam antibiotics, Ergot alkaloids, Vaccines, Microbial Insecticides – *Bacillus thuringiensis*, Microbial enzymes, Bioplastics – Polyhydroxyalkanoates, Biofertilizers – *Rhizobium.* Economics of Overall production process, Costs for fermentation processing units and Downstream processing units, Capital costs, Operating costs, Labor costs, Utilities, Economic case for investment.

TEXT BOOKS:

1. Mansi EMTEL, Bryle CFA. (2007). ***Fermentation Microbiology and Biotechnology*** (2nd Edition), Taylor & Francis Ltd, UK.
2. Peppler H.J., D Perlma (2014). ***Microbial Technology: Fermentation Technology*** (2nd Edition), Academic press.
3. Peter F Stanbury, Allan Whitaker, Stephen J Hall. 2017. ***Principles of Fermentation Technology*** (3rd Edition), Elsevier Ltd.
4. Glaser A.N & Nilaido. H (1995). ***Microbial Biotechnology***, (2nd Edition), W.H Freeman & Co.
5. Crueger. W and A. Crueger (2017). ***Biotechnology: A Textbook of IndustrialMicrobiology*** (3rd Edition), Sinauer Associates, Inc., Sunderland, Mass.

REFERENCE BOOKS:

1. Colin Ratledge and Bjorn Kristiansen, (2006). ***Basic Biotechnology*** (3rd Edition), Cambridge University Press.
2. G. Lancini, R. Lorenzetti. (2014). ***Biotechnology of Antibiotics and other BioactiveMicrobial Metabolites***, Springer publications, Germany.
3. Michael, L. Shulers and Fikret Kargi. (2002). Bioprocess Engineering: Basic concepts (2nd Edition), Prentice Hall Publishers.
4. Richard H. Baltz, Julian E. Davies, Arnold L. Demain (2010). ***Manual of Industrial Microbiology &Biotechnology*** (3rd Edition), ASM Press.
5. Reed, G. 1982. Prescott and Dunn's ***Industrial Microbiology*** (4th edition), CBS Publishers.

DIGITAL TOOLS:

1. https://onlinelibrary.wiley.com/doi/abs/10.1002/0471238961.06051813190 51407.a01.pub3
2. https://biologyease.com/types – of – fermentors/
3. https://www.toppr.com/ask/question/what – is – downstream – processing1/
4. https://unacademy.com/content/kerala – psc/study – material/general – microbiology/industrial – microbiology/microbial – processes – for – the – production – of – penicillin – and – alkaloids/
5. https://www.biotechfront.com/2021/12/control – system – devices – in – fermenter.html

Mapping of CO with PSO

	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**2**	**3**	**2**
CO2	**2**	**3**	**1**	**3**
CO3	**3**	**3**	**2**	**1**
CO4	**2**	**1**	**3**	**2**
CO5	**1**	**3**	**2**	**3**

3. Advanced Application 2. Intermediate Development 1. Introductory Level

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
24PMBCP1	LAB IN GENERAL MICROBIOLOGY	CORE – 4 PRACTICAL – I	–	6	4

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	I	40	60	100

NATURE OF COURSE	Employability	Skill Oriented	Entrepreneurship
	☐	✓	☐

COURSE DESCRIPTION:

This course has been designed is to provide practical skills on basic microbiological techniques.

COURSE OBJECTIVES:

- To familiarize on basic microbiology techniques.
- To learn the basic microbial biochemistry methods.
- Isolation and identification of bacteria and fungi by pure culture technique.
- To know about the effect of environmental conditions on microbes.
- To prepare media for bacterial growth and measure the biomass of bacteria.

COURSE OUTCOMES (COs):

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

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	To learn good microbiological practices, culture media preparation and various sterilization technique.	Upto K5
CO 2	To familiarize with aseptic techniques and Enumeration of bacteria and Fungi using pure culture technique	Upto K5
CO 3	To study morphological characters of bacteria and fungi through micrometry and staining technique	Upto K5
CO 4	Identification of bacteria through Biochemical test	Upto K5
CO 5	Gain knowledge in bacterial biomass using bacterial growth curve	Upto K5

K1–KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

LAB IN GENERAL MICROBIOLOGY

1. Sterilization, disinfection and safety in microbiological laboratory.
2. Media Preparation for cultivation of microorganisms.
3. Pure techniques – serial dilution – pour plate, spread plate, streak plate methods and stab culture techniques
4. Enumeration of bacteria – Soil, Water and Food sample
5. Enumeration of Fungi – Soil, Tree and Food Sample
6. Micrometry
7. Bacterial Staining methods – simple, Gram's, acid fast, flagella, capsule and spore.
8. Motility of bacteria
9. Fungal Staining methods – Lacto – phenol cotton blue
10. Identification of bacteria through Biochemical test
11. Bacterial growth curve

TEXT BOOKS:

1. By Hans G. Schlegel, C. Zaborosch, and M. Kogut (1993). ***General Microbiology*** /Cambridge University Press.
2. Chan E.C.S., Pelczar M. J. Jr. and Krieg N. R. (2010). ***Microbiology***. (5th Edition). Mc.Graw Hill. Inc, New York.
3. Prescott L. M., Harley J. P. and Klein D. A. (2004). ***Microbiology.*** (6th Edition).McGraw – Hill company, New York.
4. Prescott. L.M., Harley. J.P., Klein. D.A. (1993). ***Microbiology.*** 2nd edn. Wm. C. Brown publishers, Dubugue.
5. Stanier R.Y., Ingraham, J.L., Wheelis, M.L and Painter, P.R. (2010***). General Microbiology***. 5th Ed. Macmilan education Ltd. London.

REFERENCE BOOKS:

1. Tortora G. J., Funke B. R. and Case C. L. (2015). ***Microbiology: An Introduction*** (12th Edition). Pearson, London, United Kingdom.
2. Webster J. and Weber R.W.S. (2007). ***Introduction to Fungi.*** (3rd Edition). Cambridge University Press, Cambridge.
3. Salle. A.J. (1992). ***Fundamental Principles of Bacteriology***. 7th edn. McGraw Hill Inc.New York.
4. Ingraham, J.L. and Ingraham, C.A. (2000) ***Introduction to Microbiology***. (2nd Edition). Books / Cole Thomson Learning, UK.
5. Gottschalk, G. (1986). ***Bacterial Metabolism***.2nd Edn. Springer – Verlag, New York

DIGITAL TOOLS:

1. https://courses.lumenlearning.com/boundless – icrobiology/chapter/microbialnutrition/
2. https://www.lamission.edu/lifesciences/lecturenote/mic20/Chap06Growth.pdf
3. https://www.microbes.info/.

Mapping of CO with PSO

	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2
CO2	2	3	1	3
CO3	3	3	2	1
CO4	2	1	3	2
CO5	1	3	2	3

3. Advanced Application 2. Intermediate Development 1. Introductory Level

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
24PMBCP2	LAB IN MOLECULAR BIOLOGY AND MICROBIAL GENETICS	CORE – 5 PRACTICAL – II	–	6	4

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	I	40	60	100

NATURE OF COURSE	Employability		Skill Oriented	✓	Entrepreneurship	

COURSE DESCRIPTION:

This course has been designed to provide practical and technical knowledge on fundamentals of Molecular Biology and Microbial genetics.

COURSE OBJECTIVES:

- To learn the techniques for the amplification of biological molecules.
- Familiarize with routine molecular biological techniques.
- To understand the mechanism of genetic transfers in microbes.
- Illustrate the significance of artificial transformation and mutations.
- To understand different techniques used to study microbial genetics

COURSE OUTCOMES (COs):

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

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	To familiarize with molecular techniques associated with genomic and plasmid DNA isolation.	Upto K5
CO 2	Appreciate the methodology involved in quantification of DNA	Upto K5
CO 3	Comprehend the techniques involved in bacterial transformation	Upto K5
CO 4	Understand the mechanism of mutagenesis in bacteria thro physical and chemical mutagen	Upto K5
CO 5	Gain knowledge about isolation of antibiotic resistant microbes	Upto K5

K1–KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

LAB IN MOLECULAR BIOLOGY AND MICROBIAL GENETICS

1. Isolation of genomic DNA
2. Isolation of Plasmid DNA
3. Determination of quantity of DNA by spectrophotometric method.
4. Competent cell preparation and Bacterial transformation in E coli
5. Mutagenesis in given bacterial culture by U.V. radiation.
6. Isolation of auxotrophic mutants
7. Isolation of antibiotic resistant microbes
8. Polymerase Chain Reaction (Demo)
9. Blotting techniques (Southern, Northern and Western)

TEXT BOOKS:

1. Verma, P.S. and Agarwal, V.K. (2004). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand & Co. Ltd., New Delhi. Washington, D.C., USA
2. Freifelder, D. (1990). Microbial Genetics. Narosa Publishing House, New Delhi.
3. Nicholl, D.S.T. (2004). An Introduction to Genetic Engineering. 2nd Edition. Cambridge University Press, London.
4. Old, R.W. and Primrose, S.B. (1994) Principles of Gene Manipulation, Blackwell Science Publication, New York.
5. Sarma.P.V.G.K. (2021). Molecular Biology A Practical Manual. 1st edition, MJP Publisher, India

REFERENCE BOOKS:

1. Turner, P.C., Mclennan, A.G., Bates, A.D. and White, M.R.H. (1998). Instant Notes in Molecular Biology, Viva Books Pvt., Ltd., New Delhi.
2. Kannan, N. (2003). Hand Book of Laboratory Culture Medias, Reagents, Stains and Buffers. Panima Publishing Co., New Delhi.
3. Twyman, R.M. (2003). Advanced Molecular Biology. Viva books Pvt. Ltd. New Delhi.
4. Sinnot E.W., L.C. Dunn and T. Dobzhansky. (1958). Principles of Genetics. 5th Edition. McGraw Hill, New York.
5. Chaitanya. K.V.(2013). Cell and Molecular biology: A Lab Manual. Publisher PHB Learning .

DIGITAL TOOLS:

1. https://ruo.mbl.co.jp/bio/e/support/method/sds – page.html
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC93213/
3. https://us.vwr.com/store/category/uv – transilluminators/2993662

Mapping of CO with PSO

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CO1	3	2	3	2
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CO5	1	3	2	3

3. Advanced Application 2. Intermediate Development 1. Introductory Level

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
24PMBE11	MICROBIAL BIOCHEMISTRY	ELECTIVE – 1	4	–	3

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	I	25	75	100

NATURE OF COURSE	Employability		Skill Oriented	✓	Entrepreneurship	

COURSE DESCRIPTION:

This course has been designed to build upon level knowledge of biochemical principles with specific emphasis on different microbial metabolic pathways.

COURSE OBJECTIVES:

- To know about the basic knowledge of biomolecules
- To understand carbohydrate metabolism in bacteria
- To understand the structure and metabolism of protein
- To analyze the structure and metabolic process of nucleic acid and vitamins
- To understand lipid metabolism and enzyme regulation

COURSE OUTCOMES (COs):

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

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	Gain fundamental knowledge on structure, and molecular interaction of biomolecules.	Upto K5
CO 2	Become familiarize with the carbohydrate and energy metabolism in microbes.	Upto K5
CO 3	Understand the microbial protein structure and metabolism.	Upto K5
CO 4	Appreciate the metabolic pathways integrated in Nucleic acid and Vitamin synthesis.	Upto K5
CO 5	Gain knowledge about microbial enzymes and lipid biosynthesis	Upto K5

K1–KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

MICROBIAL BIOCHEMISTRY

UNIT – I:

Introduction to Basic Biochemistry – Structure of atoms and molecules. Molecular interactions – Hydrogen bonding, Covalent, Hydrophobic, Electrostatic and Vander Waals forces.

UNIT – II:

Carbohydrate & Energy metabolism – Structure, properties and classification of Carbohydrates. Anabolism – Catabolism – Embden – Mayer Hoff pathway – Entner Doudroff(ED) pathway – glyoxalate pathway – Krebs cycle – oxidative and substrate level phosphorylation – reverse TCA cycle,

UNIT – III:

Proteins structure & metabolism: Structure, properties and classification of Proteins. Proteins – primary – secondary – tertiary and quaternary structure. Structure and metabolism of amino acids.

UNIT – IV:

Structure and properties of nucleic acid bases, Nucleosides and nucleotides – Biosynthesis and degradation of purines and pyrimidines. Salvage pathway. Vitamins and Coenzymes**:** Structure and biochemical roles of fat and water – soluble vitamins and their coenzymes.

UNIT – V:

Microbial Enzymes & Lipid metabolism – Enzymes as biocatalysts, enzyme classification, specificity, active site, unit activity, isozymes. Enzyme kinetics: Michaelis – Menton equation for simple enzymes. Enzyme inhibition. Lipids – Structure, properties and classification of Lipids – Oxidation of Fatty acids, Structure and properties and biosynthesis of Cholesterol.

TEXT BOOKS:

1. Boyer R.F. (2002) ***Modern Experimental Biochemistry 3rd Edition.*** Pearson Education.
2. Wilson K., Walker J., Clokie S and Hofmann A. (2018) Wilson and Walker's ***Principles and Techniques of Biochemistry and Molecular Biology*** 8th Edition. Cambridge University Press.
3. Jain, J. L. J. &. S. J. &. N. (2022). *Fundamentals of Biochemistry*. S. Chand Publishing.
4. Lehninger, A.L., Nelson.D.L., Cox., M. M.2005 Lehninger Principles of Biochemistry, 5th ed. W. H. Freeman.
5. Satyanarayana, U. (2014). *Biochemistry*. Elsevier Health Sciences.

REFERENCE BOOKS:

1. Beedu Sasidhar Rao and Vijay Deshpande (2006) ***Experimental Biochemistry: A student companion*** IK International Pvt. Ltd
2. Sawhney, S.K and Randhir Singh (2001) ***Introductory Practical Biochemistry*** Narosa Pub House
3. Berg.J.M, Tymoczko.J.L, Stryer, L. , 2006. ***Biochemistry*** (6th ed). Freeman.
4. Murray,R.K., Rodwell,V.W., Bender, D., Botham, K.M., Weil, P.A. and Kennell, P.J. (2009). ***Harper's Illustrated Biochemistry,*** 28th Edition, McGraw Hill Professional publications.
5. Voet. D. and Voet. J.G. 2010. ***Biochemistry*** (4th ed.) John Wiley & Sons.

DIGITAL TOOLS:

1. https://egyankosh.ac.in/bitstream/123456789/68504/1/Unit – 2.pdf
2. https://bio.libretexts.org/Courses/Wheaton_College_Massachusetts/Principles_of_Biochemistry/08%3A_Carbohydrate_structure_and_metabolism
3. https://www.slideshare.net/devadevi666/protein – structure – presentation
4. https://www.lkouniv.ac.in/site/writereaddata/siteContent/20200329161234 1624kuaum_yadav_structure_and_properties_of_Nucleic_acids.pdf
5. https://egyankosh.ac.in/bitstream/123456789/80282/1/Block – 3.pdf

Mapping of CO with PSO

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CO1	3	2	3	2
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CO4	2	1	3	2
CO5	1	3	2	3

3. Advanced Application 2. Intermediate Development 1. Introductory Level

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
24PMBE12	BIOPHYSICS AND BIOINSTRUMENTATION	ELECTIVE – 1	4	–	3

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	I	25	75	100

NATURE OF COURSE	Employability	Skill Oriented	Entrepreneurship
	☐	✓	☐

COURSE DESCRIPTION:

This course is broad – based in nature encompassing several new technologies that current experimental researchers are employing to probe complex system biology questions in life – sciences.

COURSE OBJECTIVES:

- To give knowledge about theories and methods of physics to understand working of biological system.
- To provide conceptual and hands – on practical knowledge to the student in the current research areas in the field of biophysics.
- Demonstrate knowledge and practical skills to develop the theory and practice of bio analytical techniques
- The main emphasis of biophysics is on the quantitative analysis of the physical and chemical aspects of the functions of biological molecules, organisms and entities.
- Update knowledge involving new methods in bio techniques and the bioinstrumentation.

COURSE OUTCOMES (COs):

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

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	Illustrate the basic principle and techniques to understand the general Biophysics	Upto K5
CO 2	Examine and practices the techniques of Chromatography and Spectroscopy	Upto K5
CO 3	Practice and report upon a range of experimental techniques which can be applied in the qualitative and quantitative analysis of biological molecules	Upto K5
CO 4	To gain knowledge in separation technique	Upto K5
CO 5	Explain the basics of radio isotopic and blotting techniques.	Upto K5

K1–KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

BIOPHYSICS AND BIOINSTRUMENTATION

UNIT – I:

Laws of conservation of energy – first and second laws and their relevance in the biological system, entropy, enthalpy, thermodynamic equilibrium, redox potential, Gibb's free energy, bioenergetics –endothermic and exothermic reactions of biological systems, energy change in the biological reactions. Electrical properties of biological compartments. Electricity as a potential signal, electrochemical gradients, membrane potential, ATP synthesis (chemiosmotic hypothesis).

UNIT – II:

Spectroscopy – Introduction – Theories exploring the concept of light: Corpuscular theory, Wave theory, Electromagnetic theory, Planck's concept and modern theory. Basic concepts, principles and biological applications of different types of spectroscopy: absorption spectroscopy, fluorescence spectroscopy, Infrared and Raman spectroscopy, LC – MS, GC – MS.

UNIT – III:

Macromolecular Structure Determination – Basics of X – ray Crystallography – Biological applications and interpretations. Basics of Magnetic resonance spectroscopy – biological application and interpretations of Nuclear Magnetic Resonance (NMR) & Electron Spin Resonance (ESR).

UNIT – IV:

Separation Techniques I (Chromatography) – Basics principles and applications of various chromatography methods: Partition and Absorption chromatography, gel filtration, ion – exchange and affinity chromatography, GC, HPLC and FPLC.

Separation Techniques II (Hydrodynamic Methods) – Basics of centrifugation – based methods: solvent fractionation, centrifugation, Biological applications and interpretations. Basics of electrophoresis: Biological applications and interpretation of different types of electrophoresis: SDS – PAGE, 2D Electrophoresis , Agarose Gel Electrophoresis, gradient gel, Iso – electric focusing.

UNIT – V:

Radioisotopic and blotting techniques: Radioisotopic techniques – Use of radioisotopes in life sciences, radioactive labeling, principle and application of tracer techniques, detection and measurement of radioactivity using ionization chamber, proportional chamber, Geiger – Muller and Scintillation counters, autoradiography and its applications. Dosimetry – Principle, instrumentation, methods and applications of Western, Southern& Northern Blotting techniques.

TEXT BOOKS:

1. M. V. Volkenstein, · 2013, ***General Biophysics***: Volume II ,Academic press
2. N.d. HAari dass, ***Essentials of thermodynamics***, 2018, SRI Books, an imprint of the Simplicity Research Institute.
3. Veerakmari, l,(2019). ***Bioinstrumentation*** 2019, MJP Publisher.
4. Donald L. Wise. (1991). ***Bioinstrumentation and Biosensors***, CRC press
5. Clifford D. Ferris. (1979)**.** ***Introduction to Bioinstrumentation***, Humana Press

REFERENCE BOOKS:

1. Pranab Kumar Banerjee · 2008. ***Introduction to Biophysics***, S. Chand Limited.
2. M Subramanian · 2019, ***Biophysics Principles and Techniques***, MJP Publisher.
3. Andrey B. Rubin · 2014, ***Fundamentals of Biophysics***, Wiley publishers.
4. Clifford D. Ferris · 1979, ***Introduction to Bioinstrumentation***, ***With Biological, Environmental, and Medical Applications***, Humana Press.
5. John Enderle. (2022). ***Bioinstrumentation***, Springer International Publishing.

DIGITAL TOOLS:

1. https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Electronic_Structure_of_Atoms_and_Molecules/Electronic_Configurations/Pauli_Exclusion_Principle
2. https://opentextbc.ca/biology/chapter/11 – 1 – homeostasis – and – osmoregulation/
3. https://www.cleaverscientific.com/what – is – electrophoresis/
4. https://www.geeksforgeeks.org/chromatography/
5. https://www.broadinstitute.org/technology – areas/what – mass – spectrometry

Mapping of CO with PSO

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CO1	3	2	3	2
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3. Advanced Application 2. Intermediate Development 1. Introductory Level

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
24PMBE13	NANO BIOTECHNOLOGY	ELECTIVE – 1	4	–	3

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	I	25	75	100

NATURE OF COURSE	Employability		Skill Oriented	✓	Entrepreneurship	

COURSE DESCRIPTION:

The course aims at providing a general and broad introduction to multi – disciplinary field of nanotechnology and its applications.

COURSE OBJECTIVES:

- To analyse nanomaterials based on the understanding of nanobiotechnology.
- Illustrate about the advanced biological nanomaterials and nanoparticles.
- Appraise the basic characterization of nanomaterials by various techniques.
- Application of nanobiotechnology in various field of biotechnonology.
- Develop and the discover nanomaterials for targeted drug and therapeutics.

COURSE OUTCOMES (COs):

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

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	Employ knowledge in the field of Nano biotechnology for development.	Upto K5
CO 2	Identify various applications of nanomaterials in thefield of medicine and environment.	Upto K5
CO 3	Examine the prospects and significance of nanobiotechnology.	Upto K5
CO 4	To explain the application of nanomaterial's in various fields.	Upto K5
CO 5	Identify recent advances in this area and create a career or pursue research in the field. design non–toxic nanoparticles for targeted drug delivery	Upto K5

K1–KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

NANO BIOTECHNOLOGY

UNIT – I:

Nanotechnology: Introduction to nanomaterials, Historical Developments, types of nanomaterials, Nanoparticle characterization – structural and chemical, Applications of Nanotechnology in microbial nanotechnology, nanomedicine, nanowires, quantum Dots, nanocomposite, nanoparticles.

UNIT – II:

Nanomaterials: Types of Nanocrystals – zero dimensional – one dimensional – two dimensional – three dimensional. Biological nanomaterials – Enzymes, DNA and RNA, Advanced nanomaterials – CNTs, Fullerenes. Role of plants in nanoparticle synthesis.Nanotoxicity assessment.

UNIT – III:

Basic characterization techniques – Electron microscopy, structural characterization by X – Ray Diffraction, XPS and advanced microscopy – TEM, SEM and Atomic force microscopy. Photon correlation Spectroscopy and optical characterization by FTIR, UV – Vis, DLS.

UNIT – IV:

Nanobiotechnology in Agriculture – Nano – based Agri and Food Products, food preservation and toxicity. Nano pesticides and Nano fertilizers, Nano – biostimulants and soil enhancers. Nanobiotechnology for Crop improvement. Nanotechnology for environment: contamination detection and remediation

UNIT – V:

Nanomaterial based Drug delivery and therapeutics–Nanostructures for diagnostics and biosensors. Nanoparticles for diagnostics and imaging – MRI, DNA and protein. Toxicology in nanoparticles.

TEXT BOOKS:

1. Brydson R. M., Hammond, C. (2005). ***Generic Methodologies for Nanotechnology: Characterization. In Nanoscale Science and Technology.*** John Wiley & Sons, Ltd.
2. Leggett G. J., Jones R. A. L. (2005). ***Bionanotechnology. In Nanoscale Science and Technology***. John Wiley & Sons, Ltd.
3. Mohan Kumar G. (2016). ***Nanotechnology: Nanomaterials and nanodevices***.Narosa Publishing House.
4. Goodsell D. S. (2004). ***Bionanotechnology***. John Wiley & Sons, Inc.
5. PradeepT. (2007).***Nano: The Essentials–Understanding nano science and nanotechnology***. Tata McGraw–Hill.

REFERENCE BOOKS:

1. Nouailhat A. (2008). ***An Introduction to Nanoscience and Nanotechnology***,Wiley.
2. Sharon M. and Maheshwar (2012). ***Bio–Nanotechnology: Concepts and Applications.*** New Delhi. Ane books Pvt Ltd.
3. Niemeyer C.M. and Mirkin C. A. (2005). ***Nanobiotechnology***. Wiley Inter science.
4. Rehm, B. (2006). ***Microbial Bionanotechnology: Biological Self–Assembly Systems and Biopolymer–Based Nanostructures***. Horizon Scientific Press.
5. Reisner, D.E. (2009). ***Bionanotechnology: Global Prospects.*** CRC Press

DIGITAL TOOLS:

1. https://www.gale.com/nanotechnology
2. https://www.understandingnano.com/resources.html
3. http://dbtnanobiotech.com/index2.php
4. http://www.istl.org/11 – winter/internet1.html
5. https://www.cdc.gov/niosh/topics/nanotech/default.html

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CO1	2	3	3	2
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CO5	3	3	2	3

3. Advanced Application 2. Intermediate Development 1. Introductory Level

COURSE STRUCTURE – II SEMESTER

S. No.	Course Code	Course Title	Hrs./ Week	Exam (Hrs.)	CA	SE	Total	Credits
1.	24PMBC21	**Core – 6:** Genetic Engineering	5	3	25	75	100	4
2.	24PMBC22	**Core – 7:** Immunology	4	3	25	75	100	4
3.	24PMBC23	**Core – 8:** Bioinformatics and Microbial Omics	5	3	25	75	100	4
4.	24PMBCP3	**Core – 9: Core Practical – III:** Lab in Immunology	6	3	40	60	100	4
5.	24PMBCP4	**Core – 10: Core Practical – IV:** Lab in Genetic Engineering and Bioinformatics	6	3	40	60	100	4
6.	24PMBE21	**Elective – 2: *** Microbial Ecology and Toxicology	4	3	25	75	100	3
	24PMBE22	Biomass and Bioenergy						
	24PMBE23	Medical Virology and Parasitology						
7.		Internship	–	–	–	–	–	–
		TOTAL	**30**					**23**

***One elective course to be chosen from THREE courses**

CA – Class Assessment (Internal)

SE – Summative Examination

T – Theory

P – Practical

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
24PMBC21	GENETIC ENGINEERING	CORE – 6	5	–	4

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	II	25	75	100

NATURE OF COURSE	Employability		Skill Oriented	✓	Entrepreneurship	✓

COURSE DESCRIPTION:

This course has been designed to acquaint students with various approaches ofrecombinant DNA technology and their applications in biological research / industries.

COURSE OBJECTIVES:

- To familiarize the students with the basic concepts in genetic engineering.
- To acquaint the students to versatile tools and techniques employed in geneticengineering and recombinant DNA technology
- To illustrate creative use of modern tools and techniques for manipulation andanalysis of genomic sequences.
- To expose students to the applications of recombinant DNA technology inbiotechnological research.
- To train students in strategizing research methodologies employing geneticengineering techniques

COURSE OUTCOMES (COs):

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

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	Gain knowledge on tools and strategies used in genetic engineering	Upto K5
CO 2	Design cloning experiments for applications invarious genomic and proteomics studies.	Upto K5
CO 3	Identify, select and implement the PCR and its types in molecular biologyand recombinant DNA technology.	Upto K5
CO 4	Apply knowledge of genetic engineering in current applications of biotechnology. 6. comprehend	Upto K5
CO 5	Comprehend and analyze the impact of gene silencing and antisense technology	Upto K5

K1–KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

GENETIC ENGINEERING

UNIT – I:

Introduction to gene cloning – Enzymes used in genetic engineering: restriction endonucleases, type I, II, III, recognition sequences, properties, nomenclature, classification of type II endonucleases, their activity. DNA ligase: Properties and specificity, S1 nuclease, BAL 31 nuclease, DNA polymerase, polynucleotide kinase, phosphatase, reverse transcriptase – its activity and mode of action. Restriction digestion, ligation and transformation.

UNIT – II:

Cloning and Expression Vectors: Vehicles for gene cloning, Plasmids, Bacteriophages, Cosmids and Phagemids as vectors, P1 vectors, Plant and animal viruses as vector, Artificial chromosomes as vectors (YAC, BAC, PAC and MAC vectors), Expression vectors – use of promoters and expression cassettes, Baculovirus vectors system, plant based vectors, Ti and Ri as vectors, yeast vectors, Binary and shuttle vectors.

UNIT – III:

Gene Manipulation and Protein – DNA Interaction: Insertion of foreign DNA into hostcells; transformation, electroporation, transfection; Screening and selection ofrecombinants: Insertional inactivation – antibiotic resistant genes – Lac Z' gene – Blue white screening – α complementation – colony hybridization – construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; Principles for maximizing gene expression, Protein purification; His – tag; GST – tag etc.; Protein – DNA interactions.

UNIT – IV:

PCR Techniques: Principles of PCR: primer design; fidelity of thermostable enzymes; DNA polymerases; types of PCR – multiplex, nested; reverse – transcription PCR, real time PCR, touchdown PCR, hot start PCR, colony PCR, asymmetric PCR, cloning of PCR products. Recombinant DNA technology with reference to cloning and production of human growth hormone (insulin somatotropin), vaccines (hepatitis B virus vaccine, FMD vaccine), interferons, tPA.

UNIT – V:

Gene Silencing and Genome Editing Technologies: Gene silencing techniques; introduction to siRNA; siRNA technology; Micro RNA; gene knockouts and gene therapy.Gene downregulation – using antisense RNA, dsRNA and co – suppression, CRISPR – cas 9. Site directed mutagenesis (PCR based methods).Applications of genetic engineering: transgenic animals (knockout mice) and plants (Flavr savr tomato), DNase foot printing, gene therapy (in vitro and in vivo methods). Biosafety regulation: Physical and biological contaminants

TEXT BOOKS:

1. Clark DP and Pazdernik NJ. (2015). ***Biotechnology – Applying the GeneticRevolution*** (2nd Edition). Elsevier Academic Press, USA.
2. Brown T.A. (2020). ***Gene Cloning & DNA Analysis*** (8th Edition.) Wiley – Blackwell,New York.
3. Watson J.D. (2009). ***A Passion for DNA: Genes, Genomes & Society***, ColdSpring Harbor Laboratory press (CSHL).
4. Bernard R. Glick and Cheryl L. Patten. (2022). ***Biotechnology – Principles and Applications of Recombinant DNA*** (6th Edition), ASM Press, Washington, D.C
5. Primrose, S.B. & Twyman R.M. (2013). ***Principles of Gene Manipulation andGenomics*** (7th Edition.). Malden, MA: Blackwell Publisher.

REFERENCE BOOKS:

1. Sambrook, J and Russell, D.W. (2001). ***Molecular Cloning: A LaboratoryManual*** 3rd Edition. Cold Spring Harbor Laboratory Press.
2. Nair, A. J (2008). ***Introduction to Genetic Engineering and Biotechnology.*** Infinity Science Press.
3. Robert Williamson (2014). Genetic Engineering (1st Ed.) Academic Press. USA
4. Nicholl D.S.T(2002). ***An introduction to Genetic Engineering*** 2nd edition. Cambridge University Press.
5. Joceyln E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick (2017). ***Lewin's GENES XII*** 12th Edition. Jones & Barlett Learning.

DIGITAL TOOLS:

1. https://microrao.com/micronotes/genetic_engineering.pdf
2. https://bio.libretexts.org/Bookshelves/Genetics/Genetics_Agriculture_and_Biotechnology_(Suza_and_Lee)/01%3A_Chapters/1.11%3A_Recombinant_DNA_Technology
3. https://microbenotes.com/recombinant – dna – technology – steps – applications – and – limitations/
4. https://www.hudsonalpha.org/recombinant – dna – and – genetic – engineering/
5. https://avys.omu.edu.tr/storage/app/public/hmaksoy/109715/Biotechnology%202.pdf

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CO1	3	2	3	2
CO2	2	3	1	3
CO3	3	3	2	1
CO4	2	1	3	2
CO5	1	3	2	3

3. Advanced Application 2. Intermediate Development 1. Introductory Level

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
24PMBC22	IMMUNOLOGY	CORE – 7	4	–	4

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	II	25	75	100

NATURE OF COURSE	Employability		Skill Oriented	✓	Entrepreneurship	

COURSE DESCRIPTION:

This course has been designed to familiarize students with cellular, molecular, and biochemical aspects of the development of the immune system and the immune response. The course focuses on the development of the immune system and the function of itsmajor components.

COURSE OBJECTIVES:

- To introduce students about structural features of components of immune system aswell as their function
- To train the students to apply the knowledge of basic Immunology to identifyproblems and formulate solutions for the protection of human health.
- To introduce students the theories of different immunological techniques
- To prepare the students to explore strategies to improve existing vaccines.
- To expose students to immune modulatory strategies that can be used to enhanceimmune responses or to suppress unwanted immune responses during different immune disorders.

COURSE OUTCOMES (COs):

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

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	Understand types of immunity and maturation and regulation of T and B cell	Upto K5
CO 2	Understand complement component and its activation and regulation	Upto K5
CO 3	Recognize the significance of Antigen – antibody interactions	Upto K5
CO 4	Identify the magnitude of Clinical Immunology.	Upto K5
CO 5	Gain knowledge in tumor immunology and immunodeficiency	Upto K5

K1–KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

IMMUNOLOGY

UNIT – I:

Types of immunity – innate and adaptive, humoral and cell – mediated immunity; lymphoid organs – primary and secondary; cells of the immune system; immunogens and antigens – characteristics, classes of antigens; MHC – Structure and regulation of its expression; Role of APCs and TCR in antigen processing and presentation; Maturation, activation and differentiation of B and T cells. Regulation of B cell development and immune response;

UNIT – II:

Immune effector mechanisms: Cytokines – types and receptors; Complement– Components, their functions and activation; Biological consequences of complement activation and regulation; General properties of effector T cells, Cytotoxic T cells, and NK cells.

UNIT – III:

Antibody – structure, types & functions. Generation of antibody diversity. Antigen – antibody Interactions: Precipitation, agglutination and complement mediated immune reactions. Cytotoxicity assays, Apoptosis, microarrays, transgenic mice, gene knock outs. Agglutination based assays – WIDAL, VDRL, precipitation based assay – Ig quantification by SRID and Effector cell assays – ELISA .

UNIT – IV:

Clinical Immunology – Immunity to Infection: Bacteria, viral, fungal and parasitic infections. Hypersensitivity – Type I – IV. Autoimmunity; Types of autoimmune diseases; Transplantation –types of grafts – allograft rejection & its mechanism – immunosuppression – Graft – vs host disease – fetus as allograft.

UNIT – V:

Immune deficiency disorders – Tumor immunology –Tumor antigens; Immune response to tumors, Cancer immunotherapy. Immunodeficiency – Primary immune deficiencies, Acquired or secondary immune deficiencies.

TEXT BOOKS:

1. Punt, J., Stranford, S., Jones, P. & Owen, J.A. (2018) ***Kuby Immunology*** (8thEd.). Macmillan International Higher Education.
2. Delves, P.J., Martin, S.J., Burton, D.R. & Roitt. I.M. (2017) ***Roitt's EssentialImmunology*** (13th Ed.). Wiley – Blackwell Publishers.
3. Kenneth, M. & Weaver, C. (2016) ***Janeway's Immunobiology*** (9th Ed.). GarlandScience.
4. Tizard, I. (1994) ***Immunology: An Introduction*** 4th edition. Cengage LearningPublishers.
5. Rao C. V. (2016). ***Immunology: A Textbook.*** Narosa Publishing House Pvt. Ltd. – New Delhi

REFERENCE BOOKS:

1. Chakravarthy,A.K.(2006) ***Immunology and Immunotechnology***. OxfordUniversity Press.
2. Lombard, M.F., Coleman, R.M., Sicard,R.E.(1999) ***Fundamental Immunology*** 2nd edition. McGraw – Hill Higher Education.
3. Khan,F.H. (2009) ***The Elements of Immunology*** 1 st edition. Pearson Publishers.
4. Abbas, A.K., Lichtman,A.H.H., Shiv Pillai (2011) ***Cellular and MolecularImmunology*** 7 th edition. Elsevier Saunders Publishers.
5. Roohi Bansal, (2021). ***Antibodies and Their Role in Therapeutics.*** Publisher Roohi Bansal.

DIGITAL TOOLS:

1. https://microbenotes.com/category/immunology/
2. https://www.ncbi.nlm.nih.gov/books/NBK7795/
3. https://www.bellarmine.edu/faculty/mlassiter/documents/BasicImmunologyoptometryuk.pdf
4. https://bio.libretexts.org/Bookshelves/Microbiology/Microbiology_(Boundless)/11%3A_Immunology
5. https://ocw.mit.edu/courses/hst – 176 – cellular – and – molecular – immunology – fall – 2005/pages/lecture – notes/

Mapping of CO with PSO

	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2
CO2	2	3	1	3
CO3	3	3	2	1
CO4	2	1	3	2
CO5	1	3	2	3

3. Advanced Application 2. Intermediate Development 1. Introductory Level

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
24PMBC23	BIOINFORMATICS AND MICROBIAL OMICS	CORE – 8	5	–	4

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	II	25	75	100

NATURE OF COURSE	Employability	Skill Oriented	Entrepreneurship
	☐	✓	☐

COURSE DESCRIPTION:

This course has been designed to gain insight in the analytical principles behind omics – technologies such as array – based analysis (PCR, DNA sequencing), 2D and capillary electrophoresis, mass spectrometry, NMR and advanced statistical and data informatics. It will discuss the information that can or cannot be obtained by the different 'omics' – approaches, and in the novel developments of omics – applications such as miRNA arrays, analysis of the epigenome, and next generation sequencing.

COURSE OBJECTIVES:

- To make the students understand how all the genes in a genome act and how their products interact to produce a functional organism.
- To develop an understanding of basic theory of bioinformatics tools
- To introduce students the different methods of sequencing, microarrays, protein fingerprints.
- To prepare the students to explore the bioinformatics tools applied to analyse and interpret the protein – protein interactions.
- To make the students appreciate the surplus value of combining data from different omics – applications as a systems approach.

COURSE OUTCOMES (COs):

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

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	Utilize bioinformatics tools and databases for retrieving, analyzing, understanding and managing biological data.	Upto K5
CO 2	Become familiar with Sequence analysis computational methods	Upto K5
CO 3	Recognize the significance of Global patterns of gene expression	Upto K5
CO 4	Understanding of genomic data into analytical knowledge	Upto K5
CO 5	Learn basic concepts in Proteomics and their role in Life Science Research.	Upto K5

K1–KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

Passed in the BoS Meeting held on 09/03/2024 **Signature of the Chairman**

BIOINFORMATICS AND MICROBIAL OMICS

UNIT – I:

Bioinformatics and its applications – Databases, types, pairwise and multiple alignments. Structure – function relationship. Sequence assembling using computers. Computer applications in molecular biology, Protein domains and human genome analysis program (BLAST, FASTA, GCC etc.) Search and retrieval of biological information and databases sequence, databank. (PDB and gene bank), accessing information (Network expasy, EMB Net, ICGEB Net).

UNIT – II:

Sequence analysis Computational methods, homology algorithms (BLAST) for proteins and nucleic acids, open reading frames, annotations of genes, conserved protein motifs related structure / function (PROSITE, PFAM, Profile Scan). DNA analyses for repeats (Direct and inverted), palindromes, folding programmes. Use of Internet, public domain databases for nucleic acid and protein sequences (EMBL, Gene Bank), database for protein structure (PDB).

UNIT – III:

DNA Microarray Printing – Whole genome analysis for Global patterns of gene expression using fluorescent – labelled cDNA or end labelled RNA probes. Analyses of single nucleotide polymorphism using DNA chips.

UNIT – IV:

Proteome analysis Two – dimensional separation of total cellular proteins, isolation and sequence analysis of individual protein spots by Mass Spectroscopy. Protein microarray advantages and disadvantages of DNA and protein microarrays.

UNIT – V:

Meta genomics – construction, vector design and screening of meta genomic libraries – biotechnological applications of meta genomics. Whole genome analysis – Preparation of ordered cosmid libraries, bacterial artificial chromosomal libraries, shotgun libraries and sequencing, conventional sequencing (Sanger, Maxam and Gilbert Methods), automated sequencing.

TEXT BOOKS:

1. Brown T. A. (2007), ***Genomes 3***. Garland Science Publishing, New York.
2. Dunham, I., (2003). ***Genome Mapping and sequencing***. Horizon Scientific Press
3. Malcolm Campbell and Laurie J. Heyer. (2006) ***Discovering Genomics, Proteomics and Bioinformatics*** 2nd edition, Cold Spring Harbor Laboratory Press.
4. Pevsner, J., John Wiley and Sons (2015) ***Bioinformatics and Functional Genomics*** (3rd Ed.) by, New Jersey, USA.
5. De Sousa, C.S., Hassan, S.S., Pinto, A.C., Silva, W.M., De Almeida, S.S., Soares, S.D.C., Azevedo, M.S., Rocha, C.S., Barh, D. and Azevedo, V., (2018). ***Microbial omics: applications in biotechnology***. In Omics technologies and bio – engineering. Academic Press.

REFERENCE BOOKS:

1. Primrose, S.B. and Twyman, R.M., (2003). ***Principles of Genome Analysis and Genomics*** (3rd Ed.) by Blackwell Publishing Company, Oxford, UK.
2. Liebler, D.C. (2002) ***Introduction to Proteomics – Tools for the new biology*** (1st Ed.) by Humana Press Inc., New Jersey, USA.
3. Mount, D. (2004) ***Bioinformatics: Sequence and Genome Analysis***, Cold Spring Harbor Laboratory Press, New York.
4. Taymaz – Nikerel, H. and Lara, A.R.., (2016). ***Quantitative systems biology for engineering organisms and pathways***. Frontiers Media SA.L
5. Aizat, W.M., Goh, H.H. and Baharum, S.N. eds., (2018). ***Omics applications for systems biology*** (Vol. 1102). Cham, Switzerland: Springer International Publishing.

DIGITAL TOOLS:

1. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=5097
2. https://microbenotes.com/difference – between – genomics – and – proteomics/
3. https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/General_Biology_1e_(OpenStax)/3%3A_Genetics/17%3A_Biotechnology_and_Genomics/17.5%3A_Genomics_and_Proteomics
4. https://microbenotes.com/difference – between – genomics – and – proteomics/

Mapping of CO with PSO

	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2
CO2	2	3	1	3
CO3	3	3	2	1
CO4	2	1	3	2
CO5	1	3	2	3

3. Advanced Application 2. Intermediate Development 1. Introductory Level

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
24PMBCP3	LAB IN IMMUNOLOGY	CORE – 9 PRACTICAL – III	–	6	4

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	II	40	60	100

NATURE OF COURSE	Employability	✓	Skill Oriented	✓	Entrepreneurship	

COURSE DESCRIPTION:

This course has been designed to develop an understanding about practical aspects of components of immune system as well as their function.

COURSE OBJECTIVES:

- To demonstrate the features, principles and procedures of immunological testing and interpretation of their finding.
- To prepare the students to use advance and smart immunological devices for analyzing the patient's serum, whole blood and others clinical specimens.
- To make the students work collaboratively and constructively, and lead diverse teams to perform a wide range of immunological experiments with responsibility.
- To provide the students technical knowledge on the collection and processing of clinical samples
- To offer hands – on experience in basic immunological techniques for the determination of microorganisms in biological fluids and other samples

COURSE OUTCOMES (COs):

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

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	Elucidate the principles of and perform blood grouping and morphology identification of immune cells	Upto K5
CO 2	Know concepts of antigen, antibodies and their interactions.	Upto K5
CO 3	Describe the principals involved in the immune response.	Upto K5
CO 4	Gain knowledge in enumeration of RBC in human blood	Upto K5
CO 5	Understand the theory of immunological basis of tests used for diseases.	Upto K5

K1–KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

LAB IN IMMUNOLOGY

1. Haematological reactions – Blood Grouping – forward and reverse, Rh Typing
2. Identification of various immune cells by morphology –Leishman staining, Giemsa staining.
3. Widal, slide and tube agglutination test
4. Latex agglutination test – RA – test, CRP – test, ASO – test
5. Determination of differential leukocyte count.
6. Isolation and enumeration of RBC from human blood
7. ELISA (Demo) Immuno – electrophoresis and staining of precipitin lines
8. Rocket immuno electrophoresis and counter current immuno electrophoresis

TEXT BOOKS:

1. Hudson. L. and Hay, F. C. (1989), ***Practical Immunology***(3rd ed).Oxford: Blackwell Scientific Publications.
2. Abul. K. Abbas, Andrew. H.H, Lichtman & Shiv Pillai (2015). ***Basic Immunology, Functions, and Disorders of the Immune System*** (5th ed). Elsevier.
3. Abul. K. Abbas & Andrew H. Lichtman & Shiv Pillai (2014). ***Cellular and Molecular Immunology*** (8th ed). Elsevier.
4. Barbara,J.A.,Regan,F.A.,&Contreras,M.(Eds.).(2008).***Transfusionmicrobiology.***CambridgeUniversityPress.

REFERENCE BOOKS:

1. Noel. R. Rose, Herman Friedman, John. L. Fahey (1986). ***Manual of Clinical Laboratory Immunology***, American Society for Microbiology.
2. Patrick. R. Murray, Ellen Jo Baron, James Jorgensen, Michael Pfaller, Marie Louise Landry. (2007). ***Manual of Clinical Microbiology***:2Volume Set(9th Revised) American Society for Microbiology.
3. Rastogi S. C.(1996). ***Immunodiagnostics Principles and Practice.*** New Delhi. New Age International (P)Ltd.
4. Talwar, G.P. (1983). ***A Handbook of Practical Immunology***. New Delhi: Vikas Publishing House Pvt. Ltd.

DIGITAL TOOLS:

1. https://www.technologynetworks.com/analysis/articles/western – blot – procedures – analysis – and – purpose – 353918
2. https://bio.libretexts.org/Bookshelves/Microbiology/Microbiology_(Boundless)/07%3A_Microbial_Genetics/7.13%3A_Bioinformatics/7.13E%3A_Amplifying_DNA_–
3. _The_Polymerase_Chain_Reaction
4. https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/med_lab_tech_students/serology.pdf
5. https://www.clinical – laboratory – diagnostics.com/k42.html

Mapping of CO with PSO

	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2
CO2	2	3	1	3
CO3	3	3	2	1
CO4	2	1	3	2
CO5	1	3	2	3

3. Advanced Application 2. Intermediate Development 1. Introductory Level

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
24PMBCP4	LAB IN GENETIC ENGINEERING AND BIOINFORMATICS	CORE – 10 PRACTICAL – IV	–	6	4

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	II	40	60	100

NATURE OF COURSE	Employability		Skill Oriented	✓	Entrepreneurship	

COURSE DESCRIPTION:

This course has been designed to provide students with experimental knowledge of molecular biology and genetic engineering. This practical course also aims to impart training in bioinformatics methods by various software packages.

COURSE OBJECTIVES:

- To provide students with laboratory experimental knowledge of molecular biology, genetic engineering and rDNA Technology aspects.
- To teach students with different approaches to perform molecular biology, genetic engineering, rDNA technology and their practical applications in biotechnological research as well as in pharmaceutical industries.
- To gain hands on experience in gene isolation, cloning by PCR approach, DNA on and PCR amplification for DNA fingerprinting analysis via RAPD and restriction digestion.
- To make students expertise in isolation of plasmids and transformation into suitable bacteria for selection of recombinant clones.

COURSE OUTCOMES (COs):

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

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	Gain hands – on experience in isolation auxotrophic mutants	Upto K5
CO 2	Understand restriction enzyme digestion of plasmid DNA and transformation in bacteria	Upto K5
CO 3	Describe contents and properties of most important bioinformatics databases	Upto K5
CO 4	Explain major steps in pairwise and multiple sequence alignment, explain principle and execute pairwise sequence alignment by dynamic programming.	Upto K5
CO 5	Predict secondary and tertiary structures of protein sequences	Upto K5

K1–KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

LAB IN GENETIC ENGINEERING AND BIOINFORMATICS

Section A) Recombinant DNA Technology:

1. Isolation of streptomycin – resistant mutants using gradient plate technique.
2. Plasmid DNA isolation and DNA quantitation
3. Restriction Enzyme digestion of plasmid DNA
4. Transformation of E.coli with standard plasmids
5. Uninterrupted bacterial conjugation

Section B) Bioinformatics

1. Introduction to biological databases
2. Sequence retrieval from various data base – NCBI, Swissprot, PIR
3. Similarity searching through BLAST
4. Perform Multiple sequence alignment using Clustal W
5. Find out he evolutionary database between the nucleic acid protein sequence using phylogenetic tree
6. Use of gene prediction methods (GRAIL, Genscan, Glimmer).
7. Using RNA structure prediction tools(tRNASCAN)
8. Use of various primer designing and restriction site prediction tools (NetPrimer)
9. Use of different protein structure prediction databases (PDB, SCOP, CATH).
10. Construction and study of protein structures using Deepview/PyMol.

TEXT BOOKS:

1. Green, M. R., & Sambrook, J.(2012.) ***Molecular Cloning: a Laboratory Manual***. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
2. Mount, D.W.(2001.) ***Bioinformatics: Sequence and Genome Analysis***. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

REFERENCE BOOKS:

1. Baxevanis, A.D., & Ouellette, B.F.(2001.) ***Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins.*** New York: Wiley – Interscience. 2001.
2. Pevsner, J. (2015)***Bioinformatics and Functional Genomics***. Hoboken, NJ: Wiley – Blackwell..
3. Lesk, A.M.(2004) ***Introduction to Protein Science: Architecture, Function, andGenomics***. Oxford: Oxford University Press.

DIGITAL TOOLS:

1. https://www.protocols.io/view/pcr – cloning – with – blue – white – selection – and – easy – ins – t89erz6.html
2. https://amidbiosciences.com/products/pbr322 – plasmid – dna – cloning – vector
3. https://www.ncbi.nlm.nih.gov/
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3531099/

Mapping of CO with PSO

	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2
CO2	2	3	1	3
CO3	3	3	2	1
CO4	2	1	3	2
CO5	1	3	2	3

3. Advanced Application 2. Intermediate Development 1. Introductory Level

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
24PMBE21	MICROBIAL ECOLOGY AND TOXICOLOGY	ELECTIVE – 2	4	–	3

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	II	25	75	100

NATURE OF COURSE	Employability		Skill Oriented	✓	Entrepreneurship	

COURSE DESCRIPTION:

This course is designed to gain a basic understanding of the current methodologies used for surveying soil microbial diversity and the environmental factors influencing microbial distribution and abundance. This course covers the basic aspects of microbial toxicology which includes the structure and properties of microbial toxins and methods of identification of microbial toxins at cellular level.

COURSE OBJECTIVES:

- To make the students obtain in depth knowledge about microbial communities and ecosystem.
- To develop knowledge about quantitative ecology.
- To Recognize the various categories of environmental toxins and their hazardous consequence
- To enhance the knowledge of underlying etiology of bacterial diseases.
- To illustrate various techniques to isolate and characterize the toxin. Examine, interpret and discuss the certainty of toxic substances.

COURSE OUTCOMES (COs):

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

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	Predict community ecosystem and their dynamics.	Upto K5
CO 2	Apply quantitative microbial ecology for the benefit of mankind.	Upto K5
CO 3	Perceive the adverse effects of toxin and its potential	Upto K5
CO 4	Assess the toxicity, properties and mode of actions of bacterial toxins.	Upto K5
CO 5	Evaluate the toxicity level with the help o f advanced techniques.	Upto K5

K1–KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

MICROBIAL ECOLOGY AND TOXICOLOGY

UNIT – I:

Microbial Communities and Ecosystems – Development of microbial community. Microbial community and dynamics and nature. Succession within biofilm communities.

UNIT – II:

Quantitative Microbial Ecology – Sample collection, detection of microbial populations, determination of microbial numbers, detecting non culturable bacteria and determination of microbial biomass.

UNIT – III:

General Introduction – Definition of toxins, different categories of toxins.Bacterial toxins – Bacterial toxins Bacterial toxinogenesis, endotoxins, exotoxins, exotoxins, bacterial protein toxins with special reference to cholera, diphtheria and tetanus toxins, molecular mechanism of action of endotoxins, exotoxins, enterotoxins, neurotoxins and mycotoxins.

UNIT – IV:

Fungal Toxins – Structure, Properties of Aflatoxin, OchratoxinPatulin, Leukosytrine, Trichothecenes, Fumonisins and Ergot alkaloids.

UNIT – V:

Algal Toxins – Structure, Properties of CyanotoxinsMicrocystins, Nodularins, Anatoxin – A, SaxitoxinAetokthonotoxin. Others – Hepatotoxin, Neu.

TEXT BOOKS:

1. McArthur. (2006). ***Microbial Ecology*** – An Evolutionary Approach AP Publishers.
2. SubbaRao. N.S. (2005). ***Soil microorganisms and Plant Growth***. (4th Edition). Oxford and IBH PublishingPvt. Ltd.
3. Shier W. T. (1990). ***Handbook of Toxicology***. CRC Press. ISBN 9780824783747
4. Wilson K. and Walker J. (2010). ***Principles and Techniques of Biochemistry and Molecular Biology.*** (7thEdition). Cambridge University Press India Pvt.Ltd. ISBN 1 – 4051 – 3544 – 1
5. Cora Lancester. (2015). ***Molecular Toxicology Handbook***. Callisto Reference

REFERENCE BOOKS:

1. Tinsley, S. and Pillai, I. (2012). ***Environmental Management Systems*** – Understanding Organizational Drivers and Barriers. Earth scan.
2. Reilly M. J. (2018). ***Bioinstrumentation.*** CBS Publishers and Distributors Pvt Ltd. ISBN 13 978 – 8123928395.
3. Greenberg M., Hamilton R., Phillips S. and McCluskey G. J. (2003). Occupational, ***Industrial and Environmental Toxicology***. St Louis: C.V. Mosby.
4. Wiley – Vch. (2005). Ullmann's ***Industrial Toxicology***. New York: John Wiley & Sons.
5. Winder C. and Stacey N.H. and Boca Raton F. L. (2004). ***Occupational Toxicology***. (2nd Edition). CRC Press

DIGITAL TOOLS:

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5869414/
2. https://www.reseachgate.net/publication/269037373_TOXIN_AS_A_MEDICINE
3. https://pubmed.ncbi.nlm.nih.gov/12807310

Mapping of CO with PSO

	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**2**	**3**	**2**
CO2	**2**	**3**	**1**	**3**
CO3	**3**	**3**	**2**	**1**
CO4	**2**	**1**	**3**	**2**
CO5	**1**	**3**	**2**	**3**

3. Advanced Application 2. Intermediate Development 1. Introductory Level

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
24PMBE22	BIOMASS AND BIOENERGY	ELECTIVE – 2	4	–	3

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	II	25	75	100

NATURE OF COURSE	Employability		Skill Oriented	✓	Entrepreneurship	

COURSE DESCRIPTION:

This course provides an understanding on the sustainable utilization of biomass fuels and in – depth knowledge of fuel characterization, treatment and conversion technologies using environmental microorganisms related to bioenergy.

COURSE OBJECTIVES:

- To make the students Acquire knowledge on bioenergy utilizing organic wastes for energy recovery.
- To discuss methods and strategies of exploiting microbes for the production technology of biodiesel.
- To describe the students the resources and techniques for the production and estimation of eco – friendly biofuels and the extent of their use potentially.
- To make the students gain knowledge for executing biogas plant in communities.
- To explain the students the possibility of using microbes for the production of bio – hydrogen as a source of future fuel.

COURSE OUTCOMES (COs):

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

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	To know important contemporary topics in the field of environmental science especially in the area of climate change	Upto K5
CO 2	Gain more knowledge about the overview of energy sources and technologies and the social and economic implications of energy uses	Upto K5
CO 3	Understand the mechanism of greenhouse gas emissions and international concern about climate change and mitigation efforts	Upto K5
CO 4	Gain knowledge in biofuel and hydrogen production	Upto K5
CO 5	Acquire more information about carbon credit and mitigation techniques.	Upto K5

K1–KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

BIOMASS AND BIOENERGY

UNIT – I:

Biomass resource assessment: Classification and properties of biomass, Biomass characterization, different energy conversion methods, Bio Energy Resources, World Bio Energy Potential, India's Bio – Energy Potential, Biomass Resources and classification, Physio – chemical characteristics. Biomass Combustion, Loose biomass densification, Biomass – based power generation and utilization for domestic cooking, improved biomass cookstoves

UNIT – II:

Biogas Systems: Technology of Biogas production, Biogas Plants, Digester types, Digester design, Chemical kinetics and mathematical modelling of bio methanation process, Dung, Vegetable Waste and Municipal Waste based Biogas plants, Biogas as fuel for transportation, Electricity generation, Application of Biogas slurry in agriculture, Design of Biogas for cold climates

UNIT – III:

Energy Sources Environment and sustainable development – Energy sources – Sun as the source of energy – Photosynthesis – Classification of energy sources – Fossil fuel reserves and resources – Overview of global/ India's energy scenario

UNIT – IV:

Biofuel: Bioethanol production from lignocelluloses, waste material, including crop residue, sugar, and starch; biodiesel production from vegetable oil and animal fat, algae; biofuel derived from; economics of biofuel production; environmental impacts of biofuels; biofuel blends; green diesel from vegetable oil; biodiesel production process, by – product utilization. Production of biohydrogen; production of hydrogen by fermentative bacteria

UNIT – V:

Bio – refinery concept: Bio – refinery concept: definition; different types of bio – refinery; challenges and opportunities; Fuel and chemical production from saccharides, lignocellulosic biomass, protein; vegetable oil; algal biorefinery.

TEXT BOOKS:

1. Dahiya A. (2014). ***Bioenergy*** – Biomass to Biofuel. (1st Edition). Academic Press Editor.
2. Brown R. C. (2003). ***Biorenewable Resources***: Engineering New Products from Agriculture. (1st Edition). Wiley Blackwell Publishing.
3. Jawaid M., Hakeem K. R. and Rashid U. (2014). ***Biomass and Bioenergy***: Processing and Properties. (1st Edition). Springer Cham.
4. Caye M. Drapcho, Tery H. Walke***Biofuels Engineering Process Technology***. McGraw Hill.
5. Teri. ***Bio energy powering the Future***. Pearson Longman Publications.

REFERENCE BOOKS:

1. John Wiley & Sons. Bhatia, S.C. (2014). ***Advanced Renewable Energy Systems,*** Part –II, WPI Publishers
2. Lee Sunggyu. (2012). ***Biofuels and Bioenergy: Process and Technologies.*** CRC
3. Boyle, G.(2012). Renewable Energy: Power for a Sustainable Future. Oxford
4. Dahiya, A. (Ed.). (2014). ***Bioenergy: Biomass to biofuels***. Academic Press.
5. San Pietro, A. (Ed.). (2012). ***Biochemical and photosynthetic aspects of energy production***. Elsevier. New York

DIGITAL TOOLS:

1. https://www.elsevier.com Biofuels and Bioenergy
2. https://www.sciencedirect.com › book › bioenergy
3. https://www.energy.gov/eere/bioenergy/bioenergy – basics
4. https://www.iea.org/fuels – and – technologies/bioenergy

Mapping of CO with PSO

	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**2**	**1**	**3**
CO2	**2**	**3**	**3**	**2**
CO3	**1**	**3**	**3**	**3**
CO4	**3**	**1**	**2**	**3**
CO5	**3**	**2**	**3**	**1**

3. Advanced Application 2. Intermediate Development 1. Introductory Level

COURSE CODE	COURSE TITLE	CATEGORY	T	P	CREDITS
24PMBE23	MEDICAL VIROLOGY AND PARASITOLOGY	ELECTIVE – 2	4	–	3

YEAR	SEMESTER	INTERNAL	EXTERNAL	TOTAL
I	II	25	75	100

NATURE OF COURSE	Employability		Skill Oriented	✓	Entrepreneurship	

COURSE DESCRIPTION:

This course is divided into three sections: Virology, Parasitology and Mycology. Each section centers on the approach used in clinical microbiology laboratories to isolate and identify pathogens of significance from human specimens. In addition, each section gives an extensive overview of clinical infections with emphasis on the major pathogens recovered from clinical specimens.

COURSE OBJECTIVES:

- To publicize the students with working knowledge of techniques used to identify infectious agents in the clinical microbiology lab.
- To acquaint the students, explain viruses, fungi and parasites including their classification, morphology, and laboratory diagnosis and prevention measures
- To make the students perform laboratory investigations for the diagnosis of infectious diseases caused by viruses, fungi and parasites
- To expose students to various viral fungal and parasitic diseases of human.

COURSE OUTCOMES (COs):

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

No.	Course Outcomes	Knowledge Level (According to Bloom's Taxonomy)
CO 1	To understand the general characteristics and pathobiology of different classes of viruses.	Upto K5
CO 2	To learn lab diagnosis, prophylaxis and treatment of DNA viral disease	Upto K5
CO 3	Gain knowledge about diagnosis, prophylaxis and treatment of RNA viral disease	Upto K5
CO 4	To learn emerging viral infections and antiviral agent	Upto K5
CO 5	Understand general features and classification of medically important protozoans	Upto K5

K1–KNOWLEDGE (REMEMBERING), K2–UNDERSTANDING, K3–APPLY, K4–ANALYSE, K5–EVALUATE

MEDICAL VIROLOGY AND PARASITOLOGY

UNIT – I

General outline on viral infection, Classification of medically important RNA, DNA viruses, Virus cultivation, Zoonotic viral diseases – (Rabies, hantaviruses, Arenaviruses, yellow fever virus, chikungunya virus, reservoirs and transimission – brief)

UNIT – II

General properties, clinical importance, pathogenesis and laboratory diagnosis of diseases caused by DNA viruses – Pox – , Varicola, Vaccinia, Herpes – Varicella Zoster, Herpes Zozter, Adeno, Papova (brief note) and Parvoviruses.

UNIT – III

General properties, clinical importance, pathogenesis and laboratory diagnosis of diseases caused by RNA Viruses – common cold, influenza, SARS, MERS, COVID – 19, Dengue virus, hepatitis C and E, West Nile fever, Ebola virus, Rabies, polio, mumps, measles and HIV, NorovirusHepatitis A and E, Rotavirus.

UNIT – IV

Viruses and cancer – Viruses implicated in the cancers of humans (HTL virus, Hepatitis B, Hepatitis C, papilloma virus, Epstein Barr Virus, human herpes virus 8), Slow virus infections, Prion diseases, Emerging viral infections – Nippah, Zikka, HINI, Swine flu, Avian flu. Prophylaxis of viral diseases – Immunological, Chemotheraphy, antiviral agents. Mechanisms of action Interferons.

UNIT – V

Protozoa – General features and classification. Medically important protozoans. *Entamoebahistolytica*, *Giardia lamblia*, *Trichomonas*, Trypanosomes, Leishmania, Plasmodium, Toxoplasma and Pneumocystis.

TEXT BOOKS:

1. Molyneux, D.H., and Ashford, R.W.(1983). ***The biology of Trypanosoma and Leishmania, parasites of man and domestic animals (***New York, International Publications Service)
2. Garraway, M.O., and Evans, R.C. (1991). ***Fungal nutrition and physiology*** (Malabar, FL, Krieger Pub.Co.).
3. Fields, B.N., Knipe, D.M., and Howley, P.M. (2007). *Fields virology*, 5th edn (Philadelphia, Wolters Kluwer Health/Lippincott Williams &Wilkins)
4. Fraenkel – Conrat, H., and Wagner, R.R. (1974). *Comprehensive virology* (New York, Plenum Press).
5. Sood R. 2009. ***Medical Laboratory Technology – Methods and Interpretations***. (6th Edition). Jaypee Brothers Medical Publishers (P) Ltd. New Delhi. ISBN:9788184484496.

REFERENCE BOOKS:

1. Murray P. R., Baron E. J., Jorgenson J. H., Pfaller M. A. and Yolken R.H. (2003). ***Manual of Clinical Microbiology***. (8th Edition). American Society for Microbiology, Washington, DC. ISBN:1 – 555810255 – 4.
2. Bennett J. E., Dolin R. and Blaser M. J. (2019). **Principles and Practice of Infectious Diseases.** (9th Edition). Elsevier. EBook ISBN:9780323550277. Hardcover ISBN:9780323482554.
3. Ridgway G. L., Stokes E. J. and Wren M. W. D. (1987). ***Clinical Microbiology*** 7th Edition. Hodder Arnold Publication. ISBN – 10:0340554231 / ISBN – 13:9780340554234.
4. Parija, S.C., (2023). ***Textbook of microbiology and immunology***. Springer.
5. Goering, R., Dockrell, H.M., Zuckerman, M. and Chiodini, P.L., (2023). ***Mims' Medical Microbiology E – Book***. Elsevier Health Sciences.

DIGITAL TOOLS:

1. https://www.ncbi.nlm.nih.gov/books/NBK20370/
2. https://www.msdmanuals.com/en – in/home/infections/diagnosis – of – infectious3disease/diagnosis – of – infectious – disease
3. https://journals.asm.org/doi/10.1128/JCM.02592 – 20
4. https://www.sciencedirect.com/science/article/pii/S2221169116309509
5. http://www.textbookofbacteriology.net/normalflora_3.html

Mapping of CO with PSO

	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2
CO2	2	3	1	3
CO3	3	3	2	1
CO4	2	1	3	2
CO5	1	3	2	3

3. Advanced Application 2. Intermediate Development 1. Introductory Level