



MSc MICROBIOLOGY

2025 - 2026

Biotechnology | Microbiology | Bioinformatics
National College (Autonomous), Trichy

**PROGRAM STRUCTURE OF M.Sc. MICROBIOLOGY
ALIGNING WITH DBT PG CURRICULUM**

(Applicable to Candidates admitted from the Academic Year 2025-26 onwards)

Sl. No.	Course Code	Hrs /W k	Credit	Course Type	Course Title	Course Kind	Hrs of Exam		Int. (25)	Ext. (75)
							T	P		
Semester I										
1	P25MB1	4	3	Theory	Microbial Biochemistry	Core Course I	3	-	25	75
2	P25MB2	4	3	Theory	Microbial Genetics	Core Course II	3	-	25	75
3	P25MB3	4	3	Theory	Bacteriology	Core Course III	3	-	25	75
4	P25MB4	2	2	Theory	Microbial Systematics	Core Course IV	3	-	25	75
5	P25MB5	2	2	Theory	Immunology	Core Course V	3	-	25	75
6	P25MB6	2	2	Theory	Molecular Biology	Core Course VI	3	-	25	75
7	P25MB7	2	2	Theory	Enzyme Technology	Core Course VII	3	-	25	75
8	P25MB8P	3	3	Practical	Lab I: Microbial Biochemistry and Enzyme Technology	Core Course VIII	-	6	25	75
9	P25MB9P	3	3	Practical	Lab II: Microbial Systematics and Immunology	Core Course IX	-	6	25	75
10	P25MB10P	4	2	Practical	Lab III: Molecular Biology and Microbial Genetics	Core Course X	-	6	25	75
		30	25						250	750

Sl. No.	Course Code	Hrs/ Wrk	Credit	Course Type	Course Title	Course Kind	Hrs of Exam		Int. (25)	Ext. (75)
							T	P		
Semester II										
11	P25MB11	4	3	Theory	Virology	Core Course XI	3	-	25	75
12	P25MB12	4	3	Theory	Medical Mycology and Parasitology	Core Course XII	3	-	25	75
13	P25MB13	4	3	Theory	Food and Dairy Microbiology	Core Course XIII	3	-	25	75
14	P25MB14	3	2	Theory	Agricultural and Environmental Microbiology	Core Course XIV	3	-	25	75
15	P25MB15	3	3	Theory	Genetic Engineering	Core Course XV	3	-	25	75
16	P25MB16	2	2	Theory	Research Methodology and Scientific Communication Skills	Core Course XVI	3	-	25	75
17	P25MB17E	3	2	Theory	Biostatistics	Elective Course I	3	-	25	75
18	P25MBS18	1	1	Seminar	Seminar-I	Core Course XVII	-	6	75	25
19	P25MB19P	3	3	Practical	Lab IV: Lab in Medical Mycology, parasitology, Agricultural and Environmental Microbiology	Core Course XVIII	-	6	25	75
20	P25MB20P	3	3	Practical	Lab V: Lab in Biostatistics, Food and Dairy Microbiology, Genetic Engineering, and Biostatistics	Core Course XIX	-	6	25	75
		30	25						250	750

Sl. No.	Course Code	Hrs/ Wrk	Credit	Course Type	Course Title	Course Kind	Hrs of Exam		Int. (25)	Ext. (75)
							T	P		
Semester III										
21	P25MB21	5	4	Theory	Bioprocess Engineering and Technology	Core Course XX	3	-	25	75
22	P25MB22	3	2	Theory	Marine Biotechnology	Core Course XXI	3	-	25	75
23	P25MB23	3	2	Theory	Critical Analysis of Classical Papers	Core Course XXII	3	-	25	75
24	P25MB24	2	2	Theory	Pharmaceutical Microbiology	Core Course XXIII	3	-	25	75
25	P25MB25	2	2	Theory	Molecular Diagnostics	Core Course XXIV	3	-	25	75
26	P25MB26	2	2	Seminar	Project Proposal Preparation and Presentation	Core Course XXV	-	6	25	75
27	P25MB27	3	3	Theory	Bioinformatics	Core Course XXVI	3	-	25	75
28	P25MBS28	2	1	Seminar	Seminar-II	Core Course XXVII	-	6	75	25
29	P25MB29P	3	2	Practical	Lab VI: Bioinformatics	Core Course XXVIII	-	6	25	75
30	P25MB30P	5	4	Practical	Lab VII: Lab in Bioprocess Engineering and Technology	Core Course XXIX	-	6	25	75
		30	24							

Sl. No.	Course Code	Hrs/ Wrk	Credit	Course Type	Course Title	Course Kind	Hrs of Exam		Int. (25)	Ext. (75)
							T	P		
Semester IV										
31	P25MBP31	25	20	Project Work	Dissertation	Core Course XXX	-	6	75	25
32	P25MB32E	5	2	Theory	Emerging Technologies	Elective Course II	3	-	25	75
		30	22						250	750

Programme Outcomes (PO) for MSc Microbiology

PO 1: Advanced Disciplinary Knowledge

Graduates will demonstrate in-depth knowledge of microbiology, including advanced concepts in microbial genetics, pathogenesis, immunology, and environmental microbiology, enabling them to address complex challenges in research and industry.

PO 2: Communication and Scientific Literacy

Graduates will effectively communicate scientific ideas, research findings, and technical information in microbiology through oral, written, and digital formats to diverse audiences, including peers, professionals, and the public.

PO 3: Critical Thinking and Analytical Skills

Graduates will apply advanced critical thinking skills to analyze experimental data, evaluate scientific literature, and develop innovative solutions to contemporary microbiological problems.

PO 4: Research and Collaboration

Graduates will work collaboratively in multidisciplinary teams to design experiments, interpret results, and contribute to scientific advancements while respecting diverse perspectives in microbiological research.

PO 5: Ethical Responsibility and Sustainability

Graduates will understand the ethical implications of microbiological research and applications while addressing global challenges such as sustainability, public health, and environmental conservation responsibly.

PO 6: Lifelong Learning and Technological Adaptability

Graduates will cultivate a commitment to lifelong learning by adapting to emerging technologies and advancements in microbiology through continuous education and professional development.

Programme Specific Outcomes (PSO) for MSc Microbiology

PSO 1: Specialized Microbiological Expertise

Graduates will acquire specialized knowledge in microbial genetics, molecular biology techniques, immunology, virology, and industrial microbiology for applications in biotechnology, healthcare, and agriculture.

PSO 2: Technical Mastery

Graduates will develop advanced technical skills in molecular diagnostics (e.g., PCR, sequencing), microbial culturing techniques, bioinformatics tools, and biostatistical analysis for solving real-world microbiological challenges.

PSO 3: Research Innovation and Problem-Solving

Graduates will foster a research-oriented mindset that enables them to design experiments independently, interpret results critically, and contribute innovative solutions to global microbiological issues such as antimicrobial resistance or climate change.

PSO 4: Industrial Applications of Microbiology

Graduates will understand the principles of industrial microbiology, including fermentation technology, biofertilizers production, biopesticides development, quality control processes, and regulatory compliance relevant to the biotechnology sector.

PSO 5: Ethical Practices in Microbiology Research

Graduates will demonstrate a strong understanding of bioethics and biosafety regulations while conducting microbiological research responsibly to ensure safety in laboratory practices and environmental sustainability.

PSO 6: Career Readiness for Diverse Fields

Graduates will be prepared for careers in academia, healthcare institutions, research organizations, environmental agencies, or industries with expertise in microbiology-related roles such as diagnostics development or bioprocess engineering.

SEM - I	Prog. Code MIPG2022	Core Course I	P25MB1
MICROBIAL BIOCHEMISTRY			
CREDITS - 3	Theory		HOURS - 4

Course Description for Microbial Biochemistry

This course explores the biochemistry of biomolecules with an emphasis on their roles in microbial structure, function, and metabolism. Students will learn the principles of microbial bioenergetics, metabolic pathways, and the regulation of these pathways in diverse microorganisms. The course will also cover the biosynthesis of essential biomolecules and their significance in microbial physiology, pathogenesis, and biotechnology.

Course Objectives

1. To describe the structural organization and properties of atoms, molecules, and bonds.
2. To understand the classification, structure, and functions of carbohydrates.
3. To analyse the general structure of amino acids and the levels of protein organization.
4. To classify lipids and understand biological functions.
5. To describe the structure and biological importance of nucleic acids.
6. To understand vitamins, their types, functions and deficiency conditions.

Units	Course Content	Hours per Week (4x15)*
Unit I	<p>FOUNDATIONS OF BIOCHEMISTRY AND BIOMOLECULES</p> <p>Introduction to Biochemistry:</p> <ul style="list-style-type: none"> • The scope of biochemistry and its relevance to microbiology. • Basic chemical principles: chemical bonds, properties of water, acids, bases, and buffers. • Introduction to Biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids: Structures and Functions <p>Carbohydrates:</p> <ul style="list-style-type: none"> • Classification of carbohydrates: monosaccharides, disaccharides, polysaccharides. • Structure and function of important microbial polysaccharides: peptidoglycan, lipopolysaccharide (LPS), capsules. 	12

	<ul style="list-style-type: none"> • Glycosidic bonds and glycosylation. <p>Amino Acids, Peptides, and Proteins</p> <ul style="list-style-type: none"> • Amino Acids: Structure and Classification • Proteins: Structures and Functions <p>Lipids and Nucleic acids</p> <ul style="list-style-type: none"> • Classification of lipids: fatty acids, triacylglycerols, phospholipids, sterols. Structure and functions • Nucleic acids: Structure, types and functions 	
Unit II	<p>BIOENERGETICS</p> <p>Bioenergetics:</p> <ul style="list-style-type: none"> • Laws of thermodynamics, enthalpy, entropy, and free energy. • Standard reduction potentials and their role in biological redox reactions. • ATP: structure, synthesis, and its role as the energy currency of the cell. <p>Membrane Transport</p> <ul style="list-style-type: none"> • Membrane structure and function: the fluid mosaic model. • Membrane transport mechanisms: passive and active transport. <p>Enzymes:</p> <ul style="list-style-type: none"> • Enzymes: classification, mechanisms of action, and regulation. <p>Genetic Information Flow:</p> <ul style="list-style-type: none"> • DNA replication, transcription, and translation in bacteria. • Regulation of gene expression in prokaryotes. <p>○</p>	12
Unit III	<p>MICROBIAL INTERMEDIARY METABOLISM - CENTRAL PATHWAYS (GLYCOLYSIS & PENTOSE PHOSPHATE PATHWAY)</p> <p>Glycolysis:</p> <ul style="list-style-type: none"> • Overview of glycolysis: reactions, enzymes, regulation, and energy yield. • Alternative glycolytic pathways (e.g., Entner-Doudoroff pathway). • Fate of pyruvate: aerobic and anaerobic pathways. <p>Pentose Phosphate Pathway:</p> <ul style="list-style-type: none"> • Reactions and significance of the pentose phosphate pathway. 	12

	<ul style="list-style-type: none"> • Production of NADPH and precursors for nucleotide biosynthesis. • Regulation of the pentose phosphate pathway. <p style="text-align: center;">○</p>	
<p>Unit IV</p>	<p>MICROBIAL INTERMEDIARY METABOLISM - THE TCA CYCLE AND RESPIRATORY CHAINS</p> <p>Tricarboxylic Acid (TCA) Cycle:</p> <ul style="list-style-type: none"> • Reactions, enzymes, and regulation of the TCA cycle. • The role of the TCA cycle in energy production and biosynthesis. • Amphibolic nature of the TCA cycle. <p>Electron Transport Chain (ETC):</p> <ul style="list-style-type: none"> • Components of the ETC: electron carriers and proton pumps. • Oxidative phosphorylation and ATP synthesis. • Variations in ETC composition in different microorganisms. 	<p>12</p>
<p>Unit V</p>	<p>MICROBIAL INTERMEDIARY METABOLISM - ANAEROBIC RESPIRATION, FERMENTATION, AND ALTERNATE METABOLISM</p> <p>Anaerobic Respiration:</p> <ul style="list-style-type: none"> • Alternative electron acceptors: nitrate, sulfate, and carbon dioxide. • Energetics of anaerobic respiration. • Microbial diversity in anaerobic respiration. <p>Fermentation:</p> <ul style="list-style-type: none"> • Overview of fermentation: substrate-level phosphorylation. • Different types of fermentation and their products (e.g., lactic acid, ethanol, mixed acid). • Metabolic engineering of fermentation pathways. <p>Chemolithotrophy:</p> <ul style="list-style-type: none"> • Energy generation from the oxidation of inorganic compounds. • Examples of chemolithotrophic bacteria. <p>Other Metabolic Pathways:</p> <ul style="list-style-type: none"> • Methylophony: metabolism of one-carbon compounds. • Methanogenesis: production of methane by archaea. <p style="text-align: center;">○</p>	<p>12</p>

CO Level	Course outcome	K Level
C01	Define the structure and properties of atoms, molecules, and the types of bonds that form biomolecules.	K1
C02	Describe the classification, structure, and functions of carbohydrates, including their occurrence and various forms.	K2
C03	Discuss the general structure of amino acids and analyze the levels of protein organization, including their biological functions.	K3
C04	Interpret the classification and biological functions of lipids, including fatty acids and triglycerides and correlate it with health and disease.	K4
C05	Evaluate the structure and biological importance of nucleic acids and their properties by analytical methods.	K5
C06	Synthesize knowledge of vitamins, analyzing their biochemical roles and evaluating their impact on health and deficiency diseases.	K6

Further directions:

- **Emphasis on Microbial Diversity:** Highlight the metabolic differences between different groups of microorganisms.
- **Integration of Metabolic Regulation:** Explain how metabolic pathways are regulated in response to environmental signals.
- **Relevance to Microbial Pathogenesis:** Discuss how microbial metabolism contributes to virulence and pathogenesis.
- **Biotechnological Applications:** Explore the applications of microbial metabolism in biotechnology, such as biofuel production and bioremediation.
- **Case Studies:** Use case studies to illustrate the importance of microbial metabolism in different contexts.

Textbooks

1. Kumari, M. S. (n.d.). Microbial Physiology. MJP PUBLICATION. (Accn No: 00063323)
2. Black, G. J. (2012). Microbiology. John Wiley & Sons. (Accn No: 33013131)
3. Tortora, J. G. (n.d.). Microbiology an Intrduction. Addison-Wesley Publishing Co. (Accn No: 33012974)
4. Willey, J. (n.d.). Prescott's Microbiology. McGraw-Hill. (Accn No: 33013108)
5. Dulsy Fathima (n.d.). Biochemistry (7th ed.). Saras Publication. (Accn No: 00064191)

Reference Books

1. Weil, J. H. (n.d.). General Biochemistry. New Age International (p) Limited. (Accn No: 1010)
2. Jay, J. M. (n.d.). Modern Food Microbiology. CBS Publishers & Distributors. (Accn No: 00057913)
3. El-Mansi, E. M. T. (n.d.). Fermentation Microbiology and Biotechnology. CRC Press. (Accn No: 33013099)
4. Buchanan, B. B. (n.d.). Biochemistry & Molecular Biology of Plants. Wiley Black Well. (Accn No: 33013103)
5. Mathews, H. R. (n.d.). Biochemistry A Short *Course*. (Accn No: 33013163)

Weblink to Learning Resources

1. <https://app.lecturio.com/#/course/s/8060/5990>
2. <https://open.umn.edu/opentextbooks/textbooks/866>
3. <https://annamalaiuniversity.ac.in/studport/download/agri/soilsci/resources/SAC%20124%20fundamentals%20of%20biochemistry%20lecture%20notes.pdf>

Course Articulation Matrix: Mapping COs with POs

Co/Po	PO1	PO2	PO3	PO4	PO5	PO6
C01	3	9	1	1	1	0
C02	3	9	3	1	1	0
C03	3	9	3	1	1	0
C04	3	9	9	3	3	0
C05	9	9	9	3	3	0
C06	3	3	3	9	9	9
Weightage	20%	25%	20%	15%	10%	10%
Weighted percentage of Course contribution to PO	20%	25%	20%	15%	10%	10%

Mapping COs with Knowledge Levels and POs

CO / K-Level	High	Medium	Low	Zero
CO 1 / K1	PO2	PO1, PO3	PO4, PO5	PO6
CO 2 / K2	PO2	PO1, PO3	PO4, PO5	PO6
CO 3 / K3	PO2	PO1, PO3	PO4, PO5	PO6
CO 4 / K4	PO2, PO3	PO1, PO5	PO4, PO6	-
CO 5 / K5	PO2, PO3	PO1, PO5	PO4, PO6	-
CO 6 / K6	PO6	PO1, PO3, PO5	PO2, PO4	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (5 Marks)	CIA II (6 Marks)	Assignme nt 1 (4 Marks)	Seminar (5 Marks)	Total Scholast ic Marks	Non Scholasti c Marks (Attendan ce - 5 Marks)	Total Marks	% of Assessme nt
K1	1	1	0.5	0.5	3	0	3	12%
K2	1	1	0.5	0.5	3	0	3	12%
K3	1	1	0.5	1	3.5	0	3.5	14%
K4	1	1	0.5	1	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0.5	1	1	1	3.5	0	3.5	14%
Non Scholast ic	--	--	--	--	0	5	5	20%
Total	5	6	4	5	20	5	25	100%

The COs and POs for the course in Microbial Biochemistry in MSc Microbiology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEM - I	Prog. Code MIPG2022	Core Course II	P25MB2
MICROBIAL GENETICS			
CREDITS - 3	THEORY		HOURS - 4

Course Description for Microbial Genetics

This course provides an in-depth understanding of the genetic mechanisms in microorganisms, including bacteria, fungi, and viruses. Students will learn about plasmids, mobile genetic elements, recombination, mutation, DNA repair, and bacterial epigenetics. Emphasis will be placed on the molecular mechanisms underlying these processes and their significance in microbial evolution, adaptation, and biotechnology.

Course Objectives

- To provide a comprehensive understanding of the historical developments and fundamental principles of microbiology. [Knowledge]
- To enable students to differentiate between prokaryotic and eukaryotic microorganisms based on their structural and functional characteristics. [Comprehension]
- To familiarize students with the diversity of microorganisms, including their unique characteristics and ecological roles. [Knowledge]
- To equip students with the knowledge of various methods for controlling microbial growth and their mechanisms of action. [Application]
- To train students in basic techniques for isolating, cultivating, and identifying microorganisms. [Application]
- To foster an appreciation for the broad applications of microbiology in medicine, agriculture, industry, and environmental science. [Evaluation]

Units	Course Content	Hours per Week (4x15)*
Unit I	PLASMIDS AND EXTRACHROMOSOMAL ELEMENTS Plasmids: General Characteristics: <ul style="list-style-type: none"> • Definition and structure of plasmids • Plasmid size, copy number, and host range. • Conjugative vs. non-conjugative plasmids. Plasmid DNA Transfer: <ul style="list-style-type: none"> • Mechanisms of plasmid transfer: conjugation, transformation, and transduction 	12

	<ul style="list-style-type: none"> • Outline of the conjugation process. <p>Plasmid Replication and Partitioning:</p> <ul style="list-style-type: none"> • Replication mechanisms: rolling circle, theta replication • Plasmid partitioning systems and their role in plasmid stability. • Plasmid incompatibility: mechanisms and significance. • Regulation of copy number <p>Self-Transmissible and Mobilizable Plasmids:</p> <ul style="list-style-type: none"> • Distinction between self-transmissible and mobilizable plasmids • Mechanism of mobilization. <p>Properties of Particular Bacterial Plasmids:</p> <ul style="list-style-type: none"> • F plasmid: role in conjugation • R plasmids: antibiotic resistance and their spread • Col plasmids: production of colicins. • Ti plasmids: role in plant transformation by <i>Agrobacterium tumefaciens</i>. <p>Plasmids in Eukaryotes:</p> <ul style="list-style-type: none"> • Yeast 2μ plasmid: structure, replication, and applications in biotechnology 	
<p>Unit II</p>	<p>MOBILE GENETIC ELEMENTS</p> <p>Overview of Transposons and IS Elements:</p> <ul style="list-style-type: none"> • Definition and characteristics of transposons and insertion sequences (IS elements) • Structure of IS elements: inverted repeats and transposase gene • Structure of transposons: composite and non-composite transposons <p>Transposition Detection in Bacteria:</p> <ul style="list-style-type: none"> • Methods for detecting transposition events. <p>Types of Bacterial Transposons:</p> <ul style="list-style-type: none"> • Composite transposons: structure and mechanism of transposition • Non-composite transposons: structure and mechanism of transposition 	<p>12</p>

	<ul style="list-style-type: none"> • Tn3 transposons: structure, transposition, and antibiotic resistance genes <p>Replicative and Non-Replicative Transposition:</p> <ul style="list-style-type: none"> • Mechanisms of replicative and non-replicative transposition • Mu transposon: structure, replication, and transposition <p>Eukaryotic Transposable Elements:</p> <ul style="list-style-type: none"> • Yeast (Ty retrotransposon): structure, transposition via RNA intermediate • Drosophila (P elements): structure, transposition, and role in hybrid dysgenesis • Retroposons: LINEs and SINEs. <p>Limitations of Transposons and Transposition:</p> <ul style="list-style-type: none"> • Regulation of transposition frequency. • Host defense mechanisms against transposition. 	
<p>Unit III</p>	<p>RECOMBINATION</p> <p>Types of Recombination:</p> <ul style="list-style-type: none"> • Homologous recombination: exchange of DNA between similar sequences • Non-homologous recombination: site-specific recombination and transposition. • Illegitimate recombination. <p>Breakage and Rejoining of Heteroduplexes:</p> <ul style="list-style-type: none"> • Formation of heteroduplex DNA during recombination. • Resolution of heteroduplex DNA: mismatch repair and gene conversion <p>Pairing of DNA Molecules:</p> <ul style="list-style-type: none"> • Role of RecA protein in DNA pairing <p>Recombination in Bacterial Transformation:</p> <ul style="list-style-type: none"> • Mechanism of DNA integration during transformation <p>Models for Homologous Recombination:</p> <ul style="list-style-type: none"> • Holliday model: steps in homologous recombination • Asymmetric strand transfer models <p>The recBC Protein:</p> <ul style="list-style-type: none"> • Role of RecBCD enzyme in DNA repair and recombination. 	<p>12</p>

	<p>Transformation in Yeast:</p> <ul style="list-style-type: none"> • Mechanism of DNA uptake and integration in yeast. 	
Unit IV	<p>MUTATION</p> <p>Genotype, Phenotype, Allele, Gene, Loci:</p> <ul style="list-style-type: none"> • Definitions of key genetic terms. <p>Microbial Mutation and Evolution:</p> <ul style="list-style-type: none"> • The role of mutation in microbial evolution and adaptation • Mutation rate and factors affecting it. <p>Molecular Nature of Mutations:</p> <ul style="list-style-type: none"> • Substitution, addition, and deletion mutations <p>Spontaneous and Induced Mutation:</p> <ul style="list-style-type: none"> • Types of mutagens: chemical mutagens, radiation, and base analogs <p>Viral Mutagens:</p> <ul style="list-style-type: none"> • Mechanisms of viral mutagenesis. <p>Results of Mutation:</p> <ul style="list-style-type: none"> • Missense mutation: amino acid substitution • Nonsense mutation: premature stop codon • Frameshift mutations: insertion or deletion of nucleotides <p>Mutation Detection in Prokaryotes:</p> <ul style="list-style-type: none"> • Ames test: principle and applications <p>Mutation in Yeast and Neurospora:</p> <ul style="list-style-type: none"> • Beadle & Tatum experiment: one gene-one enzyme hypothesis 	12
Unit V	<p>DNA REPAIR AND BACTERIAL EPIGENETICS</p> <p>Types of DNA Damage:</p> <ul style="list-style-type: none"> • Deamination: removal of amino groups from bases • Oxidative damage: damage caused by reactive oxygen species • Alkylation: addition of alkyl groups to bases • Pyrimidine dimers: formation of covalent bonds between adjacent pyrimidines <p>Repair Mechanisms:</p> <ul style="list-style-type: none"> • Photoreactivation: repair of pyrimidine dimers by photolyase • Methyl-directed mismatch repair: correction of mismatched base pairs 	12

	<ul style="list-style-type: none"> • Very short patch repair: correction of mismatches in specific sequences • Nucleotide excision repair: removal of damaged DNA segments • Base excision repair: removal of damaged bases • SOS system: induction of DNA repair genes in response to extensive DNA damage • Post-replication daughter strand repair (Dam methylase) <p>Bacterial Epigenetics:</p> <ul style="list-style-type: none"> • DNA methylation: role in gene regulation. • Phase variation: reversible changes in gene expression. 	
--	--	--

CO Level	Course outcome	K Level
CO1	Recall the contributions of key figures in the history of microbiology and define basic microbiological terms and concepts. [Remembering]	K1
CO2	compare and contrast the structural and functional features of prokaryotic and eukaryotic cells. [Understanding]	K2
CO3	classify microorganisms into major groups based on their characteristics and ecological roles. [Understanding]	K2
CO4	Students will be able to apply appropriate sterilization and disinfection techniques to control microbial growth in various settings. [Applying]	K3
CO5	Students will be able to perform basic microbiological techniques, including pure culture isolation and staining procedures. [Applying]	K3
CO6	Students will be able to evaluate the role of microorganisms in different fields and propose solutions to real-world problems related to microbiology. [Evaluating]	K4

Textbooks

1. Singh, B. D. (n.d.). Genetics. Kalyani Publishers. (Accn No: 55014748)
2. Gupta, P. K. (n.d.). Genetics. Rastogi Publications. (Accn No: 55014773)
3. Tortora, J. Gerard. (n.d.). Microbiology an Introduction. Addison-Wesley Publishing Co. (Accn No: 33012974)
4. Black, G. Jacquelyn. (n.d.). Microbiology. John Wiley & Sons. (Accn No: 33013131)
5. Pommerville, Jeffrey. (n.d.). Fundamentals of Microbiology. Jones and Bartlett Publishers. (Accn No: 33013120)

Reference Books

1. Turner, P. C. (n.d.). Instant Notes in Molecular Biology. Viva Books Private Limited. (Accn No: 00057910)
2. Lai, M. B. (n.d.). Introduction To Genetics. CBS Publishers & Distributors. (Accn No: 55012620)
3. Singh. (n.d.). A Manual of Practical Genetics. Kalyani Publishers Delhi. (Accn No: 55012621)
4. Primrose, S. M. (n.d.). Principles of Gen Manipulation and Genomics. Wiley India Pvt. Ltd. (Accn No: 33013080)
5. Brown, T. A. (n.d.). Gene Cloning & DNA Analysis. Wiley Black Well. (Accn No: 33013104)

Weblink to Learning Resources

1. <https://app.lecturio.com/#/course/s/8060/5990>
2. <https://mis.alagappauniversity.ac.in/siteAdmin/dde-admin/uploads/2/PG M.Sc. Microbiology 364%2021 Microbial%20Genetics MSc %20Microbiology.pdf>
3. <https://asutoshcollege.in/new-web/Study Material/microbial genetics 07042020.pdf>
4. <https://open.oregonstate.education/generalmicrobiology/chapter/microbial-genetics/>
5. [https://bio.libretexts.org/Bookshelves/Microbiology/Microbiology_\(Boundless\)/07%3A_Microbial_Genetics](https://bio.libretexts.org/Bookshelves/Microbiology/Microbiology_(Boundless)/07%3A_Microbial_Genetics)

Course Articulation Matrix: Mapping COs with POs

Co/Po	PO1	PO2	PO3	PO4	PO5	PO6
C01	3	9	1	1	1	0
C02	3	9	3	1	1	0
C03	3	9	3	1	1	0
C04	3	9	9	3	3	0
C05	9	9	9	3	3	0
C06	3	3	3	9	9	9
Weightage	20%	25%	20%	15%	10%	10%
Weighted percentage of Course contribution to PO	20%	25%	20%	15%	10%	10%

Mapping COs with Knowledge Levels and POs

CO / K-Level	High	Medium	Low	Zero
CO 1 / K1	P02	P01, P03	P04, P05	P06
CO 2 / K2	P02	P01, P03	P04, P05	P06
CO 3 / K3	P02	P01, P03	P04, P05	P06
CO 4 / K4	P02, P03	P01, P05	P04, P06	-
CO 5 / K5	P02, P03	P01, P05	P04, P06	-
CO 6 / K6	P06	P01, P03, P05	P02, P04	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (5 Marks)	CIA II (6 Marks)	Assignme nt 1 (4 Marks)	Seminar (5 Marks)	Total Scholasti c Marks	Non Scholasti c Marks (Attendan ce - 5 Marks)	Total Marks	% of Assesse ment
K1	1	1	0.5	0.5	3	0	3	12%
K2	1	1	0.5	0.5	3	0	3	12%
K3	1	1	0.5	1	3.5	0	3.5	14%
K4	1	1	0.5	1	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0.5	1	1	1	3.5	0	3.5	14%
Non Scholasti c	--	--	--	--	0	5	5	20%
Total	5	6	4	5	20	5	25	100%

The COs and POs for the course in Microbial Genetics in MSc Microbiology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEM - I	Prog. Code MIPG2022	Core Course III	P25MB3
BACTERIOLOGY			
CREDITS - 3	THEORY		HOURS - 4

Course Description for Bacteriology

The Bacteriology course provides an extensive examination of bacterial biology, focusing on their structure, function, and significance in health, disease, and environmental contexts. Students will explore the indigenous microbial flora of the human body, mechanisms of infection, host-parasite relationships, and bacterial pathogenesis. The curriculum includes essential laboratory techniques for identifying and characterizing bacteria, along with guidelines for specimen collection and transportation. By integrating theoretical knowledge with practical applications, this course prepares students to understand the complexities of bacterial interactions and their implications for human health and environmental sustainability.

Course Objectives

1. To describe the classification, structure, and function of various bacterial species, including their morphology and physiology.
2. To explain the dynamics of host-parasite relationships, including mechanisms of pathogenesis and immune responses.
3. To apply laboratory techniques for the isolation and identification of bacteria, including specimen collection and transport protocols.
4. To analyze types of infections, sources, modes of transmission, and epidemiological factors influencing bacterial diseases.
5. To develop strategies to combat antimicrobial resistance and formulate prevention measures for nosocomial infections.
6. To assess the roles of commensal bacteria in human health and evaluate their protective mechanisms against pathogens.

Units	Course Content	Hours per Week (4x15)*
Unit I	Introduction to Bacteriology and Human Microbiome <ul style="list-style-type: none"> • Historical Perspectives: <ul style="list-style-type: none"> • Contributions of Leeuwenhoek, Koch, Pasteur, and Winogradsky. • Evolution of bacteriology as a discipline. • Indigenous Normal Microbial Flora of the Human Body: <ul style="list-style-type: none"> • Overview of human microbiota (skin, gut, oral cavity). • Role in health and disease (protection, metabolism). 	12

	<ul style="list-style-type: none"> • Infection: <ul style="list-style-type: none"> • Types: Localized vs. systemic infections. • Sources: Endogenous vs. exogenous pathogens. • Modes of Transmission: Direct contact, airborne, vector-borne. • Etiology and Epidemiology: Understanding disease outbreaks and causative agents. • Host-Parasite Relationships: <ul style="list-style-type: none"> • Nonspecific host immune mechanisms (innate immunity). • Mechanisms of bacterial pathogenesis (virulence factors). • Clinical Specimen Collection: <ul style="list-style-type: none"> • Rules for collection and transportation for microbiological diagnosis. • Nosocomial Infections: <ul style="list-style-type: none"> • Definition, prevention strategies, and treatment options. • Hospital Waste Disposal: <ul style="list-style-type: none"> • Best practices for disposal of biohazardous waste. • Bacterial Nomenclature: <ul style="list-style-type: none"> • International Code of Nomenclature of Bacteria (ICNB) and Bacteriological Code (BC). • Description of new species and culture collections. 	
<p>Unit II</p>	<p>Bacterial Cell Structure and Morphology</p> <ul style="list-style-type: none"> • Cell Morphology: <ul style="list-style-type: none"> • Cell wall structure of Gram-positive vs. Gram-negative bacteria. • Plasma membrane characteristics and functions. • Extracellular Structures: <ul style="list-style-type: none"> • Fimbriae, pili, S-layer, glycocalyx, flagella. • Intracellular Structures: <ul style="list-style-type: none"> • Bacterial chromosome organization and extra-chromosomal DNA (plasmids). • Ribosomes (Svedberg units) and their role in protein synthesis. • Intracellular Membranes: <ul style="list-style-type: none"> • Mesosomes and chromatophores. • Nutritional Storage Structures: <ul style="list-style-type: none"> • Polyhydroxyalkanoates, inclusions, gas vacuoles, microcompartments, endospores. 	<p>12</p>
<p>Unit III</p>	<p>Bacterial Motility and Communication</p> <ul style="list-style-type: none"> • Bacterial Motility: 	<p>12</p>

	<ul style="list-style-type: none"> • Principles behind bacterial flagella configuration and function. • Modes of locomotion: Swimming, swarming, twitching, gliding; non-motile bacteria characteristics. • Bacterial Taxis: <ul style="list-style-type: none"> • Types of taxis: Chemotaxis, aerotaxis, phototaxis, thermotaxis, energy taxis, magnetotaxis. • Escape Responses: <ul style="list-style-type: none"> • Geotactic components and cable bacteria; motility as a biosignature. • Bacterial Communication: <ul style="list-style-type: none"> • Bioluminescence in bacteria; biofilm formation; quorum sensing; bacterial pheromones. 	
	<p>Commensal Bacteria and Host Interactions</p> <ul style="list-style-type: none"> • Bacterial Commensals: <ul style="list-style-type: none"> • Protective roles in humans; mouse models for studying commensal interactions. • Mechanisms of Commensal Bacteria-Mediated Protection: <ul style="list-style-type: none"> • Host-mediated immunity and direct action mechanisms. • Predatory Bacteria: <ul style="list-style-type: none"> • Characteristics of bacteriovorous bacteria and their ecological roles. • Mutualistic Relationships: <ul style="list-style-type: none"> • Anaerobic bacteria with methanogenic archaea; rhizosphere bacteria; normal human gut flora's role in gut immunity (probiotic activity, competitive exclusion). 	12
	<p>Pathogenic Bacteria and Clinical Implications</p> <ul style="list-style-type: none"> • General Attributes of Pathogenic Bacteria: <ul style="list-style-type: none"> • Characteristics leading to infections; host-parasite relationships. • Mechanisms of Bacterial Pathogenesis: <ul style="list-style-type: none"> • Virulence factors (toxins, adherence factors); routes of infection. • Laboratory Diagnosis of Infections Caused by Key Organisms: <ul style="list-style-type: none"> • Staphylococcus aureus • Streptococcus pneumoniae • Neisseria meningitidis • Clostridium difficile • Escherichia coli • Salmonella enterica 	12

	<ul style="list-style-type: none"> • Vibrio cholerae • Pseudomonas aeruginosa • Mycobacterium tuberculosis • Bacillus anthracis • Prevention Strategies for Infections: <ul style="list-style-type: none"> • Vaccination strategies and antibiotic use guidelines. 	
--	--	--

CO Level	Course outcome	K Level
C01	List and describe the major groups of bacteria based on morphological and biochemical characteristics	K1
C02	Understand infection types, sources, modes of transmission, and the epidemiology of bacterial diseases.	K2
C03	Perform laboratory techniques for isolating and identifying pathogenic bacteria from clinical specimens.	K3
C04	Analyze host-parasite interactions to identify nonspecific immune mechanisms involved in bacterial infections.	K4
C05	Create comprehensive prevention strategies against nosocomial infections based on current research findings.	K4
C06	Critically evaluate the impact of antimicrobial resistance on public health and propose solutions to mitigate its effects.	K4

Textbooks

1. Dubey, R. C. (n.d.). *A Text Book of Microbiology*. S.Chand and Co. (Accn No: 44002379)
2. Tortora, J. G. (n.d.). *Microbiology an Intrduction*. Addison-Wesley Publishing Co. (Accn No: 33012974)
3. Black, G. J. (n.d.). *Microbiology*. John Wiley & Sons. (Accn No: 33013131)
4. Pommerville, J. (n.d.). *Fundamentals of Microbiology*. Jones and Bartlett Publishers. (Accn No: 33013120)
5. Arora, D. R. (n.d.). *Textbook of Microbiology*. Cbs Publication & Distribution. (Accn No: 33013166)

Reference Books

1. Russell, H. L. (n.d.). *Dairy Bacteriology*. University Publication. (Accn No: 00063765)
2. Jay, J. M. (n.d.). *Modern Food Microbiology*. CBS Publishers & Distributors. (Accn No: 00057913)

3. Vijaya Ramesh, K. (n.d.). *Food Microbiology*. Mjp Publication. (Accn No: 00063766)
4. Mehrotra. (n.d.). *Principles Of Microbiology*. Tata-Mcgraw-hill Publishing Co-Pvt. (Accn No: 16)
5. Aneja, K. R. (n.d.). *Experiments in Microbiology Plant Pathology Tissue Culture and Microbial Biotechnolog*. New Age International Publishers. (Accn No: 55014790)

Web Resources

1. <https://drive.google.com/file/d/1fbcY9SVbUz2uiOnlPb2CXU5moqAKa0u-/view>
2. <https://play.google.com/store/apps/details?id=com.dictionary.microbiology.science.bacteria.pathogens&hl=en&pli=1>
3. <https://www.ncbi.nlm.nih.gov/books/NBK8120/>

Course Articulation Matrix: Mapping COs with POs

Co/Po	PO1	PO2	PO3	PO4	PO5	PO6
C01	9	3	1	1	1	0
C02	3	3	9	3	3	0
C03	3	9	9	3	3	0
C04	3	3	9	3	9	0
C05	3	3	9	9	9	9
C06	9	3	9	9	9	9
Weightage	25%	20%	25%	15%	10%	5%
Weighted percentage of Course contribution to PO	25%	20%	25%	15%	10%	5%

Mapping COs with Knowledge Levels and POs

CO / K-Level	High	Medium	Low	Zero
CO 1 / K1	P01	P02, P03	P04, P05	P06
CO 2 / K2	P03	P01, P04	P05, P06	-
CO 3 / K3	P02, P03	P01, P04	P05, P06	-
CO 4 / K4	P03, P04	P01, P05	P02, P06	-
CO 5 / K4	P05, P06	P03, P04	P01, P02	-
CO 6 / K4	P06	P03, P05	P01, P02	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (5 Marks)	CIA II (6 Marks)	Assignment 1 (4 Marks)	Seminar (5 Marks)	Total Scholastic Marks	Non Scholastic Marks (Attendance - 5 Marks)	Total Marks	% of Assessment
K1	1	1	0.5	0.5	3	0	3	12%
K2	1	1	0.5	0.5	3	0	3	12%
K3	1	1	0.5	1	3.5	0	3.5	14%
K4	1	1	0.5	1	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0.5	1	1	1	3.5	0	3.5	14%
Non Scholastic	--	--	--	--	0	5	5	20%
Total	5	6	4	5	20	5	25	100%

The COs and POs for the course in **Bacteriology** in **MSc Microbiology** Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEM - I	Prog. Code MIPG2022	Core Course IV	P25MB4
MICROBIAL SYSTEMATICS			
CREDITS - 2	THEORY		HOURS - 2

Course Description

The course on Microbial Systematics provides an in-depth understanding of the classification, identification, and nomenclature of microorganisms. Emphasizing both traditional and molecular techniques, students will explore the phylogenetic relationships among various microbial taxa. The curriculum covers the principles of systematics, the use of molecular tools in microbial classification, and the ecological significance of microbial diversity.

Course Objectives

1. To learn the historical development, fundamental concepts, and importance of microbial systematics in ecology, evolution, and biotechnology.
2. To study morphological, biochemical, and cultural characteristics used in the traditional classification of microorganisms.
3. To understand and utilize nucleic acid-based methods, phylogenetic analysis, and molecular markers for microbial classification.
4. To examine polyphasic taxonomy, metagenomics, and the criteria for describing novel microbial taxa.
5. To gain hands-on experience with laboratory techniques for identifying microorganisms and analyzing microbial diversity.
6. To assess the implications of microbial systematics in public health, agriculture, environmental monitoring, and biotechnology.

Units	Course Content	Hours per Week (2x15)*
Unit I	Introduction to Microbial Systematics <ul style="list-style-type: none"> • Historical Perspectives: <ul style="list-style-type: none"> • Development of microbial systematics and its importance in microbiology. • Contributions of key figures (e.g., Linnaeus, Whittaker, Woese). • Basic Concepts: <ul style="list-style-type: none"> • Definitions of systematics, taxonomy, and phylogeny. • Levels of classification: Domain, Kingdom, Phylum, Class, Order, Family, Genus, Species. 	6

	<ul style="list-style-type: none"> • Importance of Microbial Systematics: <ul style="list-style-type: none"> • Role in ecology, evolution, medicine, and biotechnology. • Applications in agriculture and environmental microbiology. 	
Unit II	<p>Traditional Methods of Classification</p> <ul style="list-style-type: none"> • Morphological Characteristics: <ul style="list-style-type: none"> • Microscopy techniques (light microscopy, electron microscopy). • Cell shape, size, arrangement (cocci, bacilli, spirilla). • Biochemical Characteristics: <ul style="list-style-type: none"> • Metabolic pathways (fermentation vs. respiration). • Enzyme activity tests (catalase test, oxidase test). • Cultural Characteristics: <ul style="list-style-type: none"> • Growth media types (selective, differential). • Colony morphology and growth patterns. 	6
Unit III	<p>Molecular Techniques in Microbial Systematics</p> <ul style="list-style-type: none"> • Nucleic Acid-Based Methods: <ul style="list-style-type: none"> • DNA sequencing techniques (Sanger sequencing, next-generation sequencing). • PCR amplification and its applications in taxonomy. • Phylogenetic Analysis: <ul style="list-style-type: none"> • Construction of phylogenetic trees (distance-based vs. character-based methods). • Software tools for phylogenetic analysis (MEGA, RAxML). • Molecular Markers for Classification: <ul style="list-style-type: none"> • Use of ribosomal RNA genes (16S rRNA) and other genetic markers. • Multilocus sequence typing (MLST) and whole-genome sequencing. 	6
Unit IV	<p>Current Trends in Microbial Systematics</p> <ul style="list-style-type: none"> • Polyphasic Taxonomy: <ul style="list-style-type: none"> • Integration of phenotypic and genotypic data. • Case studies illustrating polyphasic approaches. • Metagenomics and Environmental Microbiology: <ul style="list-style-type: none"> • Importance of metagenomic studies in understanding microbial diversity. • Applications in environmental monitoring and bioremediation. • Emerging Taxa and Novel Species Descriptions: 	6

	<ul style="list-style-type: none"> Criteria for describing new species according to the International Code of Nomenclature for Bacteria (ICNB). Examples of recently discovered microorganisms and their ecological roles. 	
Unit V	<p>Practical Applications of Microbial Systematics</p> <ul style="list-style-type: none"> Laboratory Techniques for Identification: <ul style="list-style-type: none"> Hands-on experience with morphological and biochemical tests. Molecular techniques including PCR and DNA sequencing. Case Studies in Microbial Classification: <ul style="list-style-type: none"> Analysis of specific microbial groups (e.g., extremophiles, pathogens). Discussion on the implications of microbial systematics in public health. Field Studies and Ecological Surveys: <ul style="list-style-type: none"> Methods for sampling microbial communities from various environments. Data analysis and interpretation regarding microbial diversity. 	6

CO Level	Course outcome	K Level
C01	List key contributions by Linnaeus, Whittaker, and Woese to microbial systematics and explain the levels of classification (Domain to Species). (Remembering)	K1
C02	Explain traditional methods of classification based on morphological (e.g., cell shape), biochemical (e.g., enzyme activity), and cultural characteristics (e.g., colony morphology). (Understanding)	K2
C03	Apply molecular techniques such as PCR amplification and phylogenetic tree construction to classify microorganisms based on genetic markers like 16S rRNA genes. (Applying)	K3
C04	Analyze case studies involving polyphasic taxonomy and metagenomic approaches to understand microbial diversity in complex ecosystems. (Analyzing)	K4
C05	Integrate knowledge from laboratory techniques to design experiments that investigate microbial communities in environmental or clinical samples. (Creating)	K5

C06	Critically assess the role of microbial taxonomy in public health applications such as pathogen identification and outbreak tracking. (Evaluating)	K6
-----	--	----

Textbooks

1. Dubey, R. C. (n.d.). *A Text Book of Microbiology*. S.Chand and Co. (Accn No: 44002379)
2. Tortora, J. G. (n.d.). *Microbiology an Intrduction*. Addison-Wesley Publishing Co. (Accn No: 33012974)
3. Black, G. J. (n.d.). *Microbiology* (8th ed.). John Wiley & Sons. (Accn No: 33013131)
4. Arora, D. R. (n.d.). *Textbook of Microbiology* (5th ed.). Cbs Publication & Distribution. (Accn No: 33013166)
5. Pommerville, J. (n.d.). *Fundamentals of Microbiology* (7th ed.). Jones and Bartlett Publishers. (Accn No: 33013120)

Reference Books

1. Turner, P. C. (n.d.). *Instants Notes in Molecular Biology*. Viva Books Private Limited. (Accn No: 00057910)
2. Jay, J. M. (n.d.). *Modern Food Microbiology*. CBS Publishers & Distributors. (Accn No: 00057913)
3. Aneja, K. R. (n.d.). *Experiments in Microbiology Plant Pathology Tissue Culture and Microbial Biotechnolog*. New Age International Publishers. (Accn No: 55014790)
4. Mount David W. (n.d.). *Bioinformatics sequence and Genome Analysis*. Cbs Publication & Distribution. (Accn No: 33013177)
5. Gupta, P. K. (n.d.). *Genetics*. Rastogi Publications. (Accn No: 55014773)

Web Resources

1. Microbial Taxonomy:
2. GATE Microbiology Syllabus:
3. Covers microbial taxonomy, diversity, and molecular approaches to classification.
4. https://www.tutorialspoint.com/gate_syllabus/gate_xl_microbiology_syllabus.htm
5. Microbial Taxonomy Overview - Encyclopedia.com
6. Provides a general overview of microbial taxonomy concepts and methodologies.
7. <https://www.encyclopedia.com/science/encyclopedias-almanacs-transcripts-and-maps/microbial-taxonomy>
8. SUNY Microbiology Course Content (comprehensive on Microbiology)
9. Includes prokaryotic diversity, microbial growth, and mechanisms of pathogenicity.
10. <https://courses.lumenlearning.com/suny-microbiology/table-of-contents/>
11. Lecture Notes on Microbial Taxonomy

12. Detailed lecture slides covering microbial taxonomy and classification.

13. https://fire.biol.wvu.edu/cmoyer/ztemp_fire/biol345_W07/lect03.pdf

Course Articulation Matrix: Mapping COs with POs

Co/Po	P01	P02	P03	P04	P05	P06
C01	9	3	1	1	1	0
C02	3	3	9	3	3	0
C03	3	9	9	3	3	0
C04	3	3	9	3	9	0
C05	3	3	9	9	9	9
C06	9	3	9	9	9	9
Weightage	25%	20%	25%	15%	10%	5%
Weighted percentage of Course contribution to PO	25%	20%	25%	15%	10%	5%

Mapping COs with Knowledge Levels and POs

CO / K-Level	High	Medium	Low	Zero
CO 1 / K1	P01	P02, P03	P04, P05	P06
CO 2 / K2	P03	P01, P04	P05, P06	-
CO 3 / K3	P02, P03	P01, P04	P05, P06	-
CO 4 / K4	P03, P04	P01, P05	P02, P06	-
CO 5 / K4	P05, P06	P03, P04	P01, P02	-
CO 6 / K4	P06	P03, P05	P01, P02	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (5 Marks)	CIA II (6 Marks)	Assignme nt 1 (4 Marks)	Seminar (5 Marks)	Total Scholast ic Marks	Non Scholasti c Marks (Attendan ce - 5 Marks)	Total Marks	% of Assesse ment
K1	1	1	0.5	0.5	3	0	3	12%
K2	1	1	0.5	0.5	3	0	3	12%
K3	1	1	0.5	1	3.5	0	3.5	14%
K4	1	1	0.5	1	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0.5	1	1	1	3.5	0	3.5	14%
Non Scholast ic	--	--	--	--	0	5	5	20%
Total	5	6	4	5	20	5	25	100%

The COs and POs for the course in Microbial Taxonomy in MSc Microbiology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEM - I	Prog. Code MIPG2022	Core Course V	P25MB5
IMMUNOLOGY			
CREDITS - 2	THEORY		HOURS - 2

Course Description for Immunology

The Immunology course provides a comprehensive overview of the immune system, its components, and its functions in health and disease. Students will explore the mechanisms of immune responses, the role of various immune cells, and the principles underlying immunological techniques. The course emphasizes both innate and adaptive immunity, as well as the clinical applications of immunological knowledge in diagnostics and therapeutics.

Course Objectives

1. To understand the fundamental concepts of innate and adaptive immunity, immune system components, and their interrelationships.
2. To learn the principles of antigen-antibody reactions and immunological techniques for diagnostics and research applications.
3. To understand the mechanisms of T-cell activation, antigen presentation, cytokine signaling, and hypersensitivity reactions.
4. To investigate graft rejection mechanisms, immune responses to tumors, and vaccine development strategies.
5. To explore microbial immune responses such as CRISPR systems, fungal NLRs, and bacterial-fungal interactions.
6. To develop skills to use immunological tools for disease diagnosis, prevention, and therapeutic interventions.

Units	Course Content	Hours per Week (2x15)*
Unit I	Basics of Immune System <ul style="list-style-type: none"> • Overview of the immune system: Innate and acquired immunity. • Haematopoiesis: Cells, tissues, and organs of the immune system – structure and functions. • Interrelationship between innate and adaptive immunity. • Antigens: Definition, types, antigenicity, immunogenicity, epitopes, haptens, adjuvants. • Immune response: Types and mechanisms. 	6

	<ul style="list-style-type: none"> • Antibodies: Structure, types (IgG, IgA, IgM, IgE, IgD), functions. 	
Unit II	<p>Antigen-Antibody Interactions & Immunological Techniques</p> <ul style="list-style-type: none"> • In vitro testing: Agglutination, precipitation, ABO blood grouping and Rh typing. • ELISA (Enzyme-Linked Immunosorbent Assay), RIA (Radioimmunoassay), Immunofluorescence (IF). • Flow cytometry principles and applications. • HA (Hemagglutination) & HI (Hemagglutination Inhibition), CFT (Complement Fixation Test). • In vivo testing: Skin tests; immune complex tissue demonstrations. • Clonal selection theory; monoclonal antibodies (MAb) production via hybridoma technology and applications. • Complement system: Structure, properties, functions of complement components and pathways. 	6
Unit III	<p>Cell-Mediated Immunity & Hypersensitivity</p> <ul style="list-style-type: none"> • T-cells: Types and roles in immunity. • Antigen processing and presentation via MHC Class I & II molecules. • Cytokines: Interleukins and interferons – roles in immune regulation. • Hypersensitivity reactions (Gell and Coombs classification): • Type I (Anaphylaxis), Type II (Cytotoxic), Type III (Immune complex-mediated), Type IV (Delayed-type hypersensitivity). • Autoimmune diseases: Mechanisms and examples. • Immune tolerance mechanisms. 	
Unit IV	<p>Transplantation Immunology & Vaccines</p> <ul style="list-style-type: none"> • Blood transfusion reactions; tissue and organ transplantation. • Graft rejection mechanisms; graft vs host reaction. • Tumor immunology: Tumor-associated antigens; immune response to tumors. • Vaccines: Types – live attenuated vaccines, killed vaccines, purified polysaccharide vaccines, toxoid vaccines, recombinant vaccines, DNA vaccines. • Immunization strategies and principles of herd immunity. 	6

Unit V	Microbial Defense Systems <ul style="list-style-type: none"> Diversity of defense systems in prokaryotes: Responses against viral DNA – restriction enzymes; CRISPR systems (Cas proteins). CRISPR loci in archaea; innate immune responses in fungi. Fungal Nucleotide Oligomerization Domain-like receptors (NLRs) in bacterial-fungal interactions. Role of fungal NLRs controlling viral infections in bacterial-fungal ecosystems. 	6

CO Level	Course outcome	K Level
C01	Describe the structure and functions of immune system components, including innate and adaptive immunity.	K1
C02	Explain antigen-antibody interactions and demonstrate understanding of immunological techniques such as ELISA and flow cytometry.	K2
C03	Apply knowledge of cell-mediated immunity to analyze hypersensitivity reactions and autoimmune diseases.	K3
C04	Analyze graft rejection mechanisms and tumor-associated antigens to understand immune responses in transplantation immunology and cancer therapy.	K4
C05	Integrate knowledge of microbial defense systems to design experiments exploring CRISPR-Cas mechanisms or fungal NLRs in bacterial-fungal interactions.	K5
C06	Critically assess the clinical applications of immunological tools in diagnosing diseases and designing therapeutic interventions like immunotherapy or vaccine development.	K6

Textbooks

1. Kannan, I. (n.d.). *Immunology*. Mjp Publication. (Accn No: 00063770)
2. Annadurai, B. (n.d.). *A Text Book of Immunology and Immunotechnology*. S.Chand and Co. (Accn No: 44001661)
3. Shetty, Nandini. (n.d.). *Immunology*. New Age International p Limited. (Accn No: 15)

4. Punt, Jenni. (n.d.). *Kuby Immunology* (8th ed.). Macmillan Education. (Accn No: 33013113)
5. Delves, J. Peter. (n.d.). *Roitt's Essential Immunology* (13th ed.). Wiley Black Well. (Accn No: 33013114)

Reference Books

1. Abbas, K. A. (n.d.). *Cellular And Molecular Immunology*. Saunders College, Harcourt Brace College. (Accn No: 33013124)
2. Nairn, Roderick. (n.d.). *Immunology for Medical Students*. Mosby Elsevier. (Accn No: 33013126)
3. Zane, Hannah D. (n.d.). *Immunology*. W.B Saunders Company. (Accn No: 33013127)
4. Murphy, Kenneth. (n.d.). *Immunobiology* (7th ed.). Garland Science. (Accn No: 33013128)
5. Ashim K Chakravarty (n.d.). *Immunology and Immunotechnology*. Oxford University Press. (Accn No: 33012941)

Web Resources

1. https://repository.stikesbcm.ac.id/id/eprint/168/1/books_5453_0.pdf
2. https://mis.alagappauniversity.ac.in/siteAdmin/dde-admin/uploads/3/PG_M.Sc._Microbiology_36431%20IMMUNOLOGY.pdf
3. <http://www.helmberg.at/immunology.pdf>
4. https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SBMA1302.pdf
5. https://www.roswellpark.org/sites/default/files/thanavala_9-4-14_innate_immunity_part_1.pdf

Course Articulation Matrix: Mapping COs with POs

Co/Po	P01	P02	P03	P04	P05	P06
C01	9	3	1	1	1	0
C02	3	9	9	3	1	0
C03	3	9	9	3	9	1
C04	3	3	9	9	9	3
C05	1	3	9	9	9	9
C06	1	3	9	9	9	9
Weightage	20%	25%	20%	15%	10%	10%
Weighted % Contribution to PO	20%	25%	20%	15%	10%	10%

Course Outcomes Mapped with Knowledge Levels and POs

CO / K-Level	High (9)	Medium (3)	Low (1)	Zero (0)
CO1 / K1	PO1	PO2, PO3	PO4, PO5	PO6
CO2 / K2	PO2, PO3	PO1, PO4	PO5, PO6	-
CO3 / K3	PO2, PO3	PO1, PO5	PO4, PO6	-
CO4 / K4	PO3, PO4	PO2, PO5	PO1, PO6	-
CO5 / K5	PO3, PO5	PO2, PO4	PO1, PO6	-
CO6 / K6	PO6, PO5	PO3, PO4	PO1, PO2	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (5 Marks)	CIA II (6 Marks)	Assignment 1 (4 Marks)	Seminar (5 Marks)	Total Scholastic Marks	Non Scholastic Marks (Attendance - 5 Marks)	Total Marks	% of Assessment
K1	1	1	0.5	0.5	3	0	3	12%
K2	1	1	0.5	0.5	3	0	3	12%
K3	1	1	0.5	1	3.5	0	3.5	14%
K4	1	1	0.5	1	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0.5	1	1	1	3.5	0	3.5	14%
Non Scholastic	--	--	--	--	0	5	5	20%
Total	5	6	4	5	20	5	25	100%

The COs and POs for the course in Immunology in MSc Microbiology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEM - I	Prog. Code MIPG2022	Core Course VI	P25MB6
MOLECULAR BIOLOGY			
CREDITS - 2	THEORY		HOURS - 2

Course Description for Molecular Biology

The Molecular Biology course provides a comprehensive understanding of the molecular mechanisms underlying cellular processes. It covers the structure and function of nucleic acids, gene expression, replication, and regulation in prokaryotic and eukaryotic systems. Students will explore techniques used in molecular biology research, including DNA manipulation, sequencing, and recombinant DNA technology. This course aims to equip students with the foundational knowledge and practical skills necessary for advanced studies in microbiology and biotechnology.

Course Objectives

1. To gain knowledge of the structure and function of nucleic acids, proteins, and other biomolecules relevant to molecular biology.
2. To learn the processes of transcription, translation, and post-translational modifications in prokaryotic and eukaryotic cells.
3. To study the mechanisms of DNA replication, repair pathways, and their importance in maintaining genomic integrity.
4. To develop practical skills in techniques such as PCR, gel electrophoresis, cloning, and sequencing.
5. To understand the regulatory mechanisms that control gene expression and their implications in cellular functions.
6. To assess the applications of molecular biology techniques in research, medicine, and biotechnology.

Units	Course Content	Hours per Week (2x15)*
Unit I	Introduction to Molecular Biology Molecular Structures: Structure of DNA and RNA; nucleotides; base pairing. Overview of proteins: amino acids, peptide bonds, primary to quaternary structures. Central Dogma of Molecular Biology:	6

	Flow of genetic information from DNA to RNA to protein.	
Unit II	<p>Gene Expression</p> <ul style="list-style-type: none"> • Transcription: Mechanisms of transcription in prokaryotes and eukaryotes. Role of RNA polymerase and transcription factors. • Translation: Mechanisms of translation; ribosome structure; tRNA function. Post-translational modifications (phosphorylation, glycosylation). • Regulation of Gene Expression: Operons in prokaryotes (lac operon) vs. eukaryotic gene regulation. 	6
Unit III	<p>DNA Replication and Repair</p> <ul style="list-style-type: none"> • DNA Replication Mechanisms: Semi-conservative replication; enzymes involved (helicase, polymerase). • DNA Repair Pathways: Mechanisms for repairing DNA damage (nucleotide excision repair, mismatch repair). • Telomeres and Telomerase: Structure and function of telomeres; role in aging and cancer. 	6
Unit IV	<p>Molecular Techniques</p> <ul style="list-style-type: none"> • Polymerase Chain Reaction (PCR): Principles and applications of PCR. • Gel Electrophoresis: Techniques for separating nucleic acids/proteins. • Cloning Techniques: Restriction enzymes; ligation; plasmid vectors. • DNA Sequencing Methods: Sanger sequencing vs. next-generation sequencing technologies. 	6
Unit V	<p>Applications of Molecular Biology</p> <ul style="list-style-type: none"> • Molecular Diagnostics: Use of molecular techniques in disease diagnosis (e.g., PCR-based tests). • Genetic Engineering: Applications in agriculture (GMOs) and medicine (gene therapy). • Ethical Considerations: Discussion on ethical issues related to genetic manipulation and biotechnology. 	6

CO Level	Course outcome	K Level
C01	List the key components of nucleic acids and proteins as well as describe the central dogma of molecular biology. Example: Identify the structure of DNA and RNA nucleotides.	K1
C02	Explain the processes involved in transcription and translation in both prokaryotic and eukaryotic cells. Example: Describe how RNA polymerase functions during transcription.	K2
C03	Apply molecular techniques such as PCR and gel electrophoresis to analyze genetic material. Example: Conduct a PCR experiment to amplify a specific DNA sequence.	K3
C04	Analyze DNA replication mechanisms and repair pathways to understand their significance in genomic stability. Example: Compare different DNA repair mechanisms based on their efficiency.	K4
C05	Design experiments using cloning techniques to manipulate genes for research purposes. Example: Develop a cloning strategy to insert a gene into a plasmid vector.	K5
C06	Critically evaluate the ethical implications of genetic engineering applications in medicine and agriculture. Example: Assess the risks versus benefits associated with genetically modified organisms (GMOs).	K6

Textbooks

- 1.
2. Pal, J. K. (n.d.). *Fundamentals of Molecular Biology*. Oxford University Press. (Accn No: 33012931)
3. Verma, P. S. (2022). *Cell Biology, Molecular Biology Evolution And Ecology*. S Chand & Company Ltd. (Accn No: 33013123)
4. Primrose, S. M. (n.d.). *Principles of Gen Manipulation and Genomics*. Wiley India Pvt. Ltd. (Accn No: 33013080)
5. Glick, R. B. (n.d.). *Molecular Biotechnology*. SCIENTIFIC INTERNATIONAL PVT LTD. (Accn No: 33013095)
6. Brown, T. A. (n.d.). *Gene Cloning & DNA Analysis*. Wiley Black Well. (Accn No: 33013104)

Reference Books

1. Turner, P. C. (n.d.). *Instant Notes in Molecular Biology*. Viva Books Private Limited. (Accn No: 00057910)
2. Ramawat, K. G. (n.d.). *Molecular Biology and Biotechnology*. S.Chand and Co. (Accn No: 3309224)
3. Green, R. M. (n.d.). *Molecular Cloning*. COLD SPRING HARBOR LABORATORY PRESS. (Accn No: 33013081)
4. Abbas, K. A. (n.d.). *Cellular And Molecular Immunology*. Saunders College, Harcourt Brace College. (Accn No: 33013124)
5. Liljas, A. (n.d.). *Text Book of Structural Biology*. World Scientific. (Accn No: 33013180)

Web Resources

1. [https://www.aphl.org/programs/infectious_disease/tuberculosis/TBCore/Molecular Biology 101-WithNotes.pdf](https://www.aphl.org/programs/infectious_disease/tuberculosis/TBCore/Molecular_Biology_101-WithNotes.pdf)
2. https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SBC2101.pdf
3. https://pages.jh.edu/rschlei1/Random_stuff/publications/molbiogene.pdf
4. <https://www.bioinformatics.nl/courses/BioSB-AfBN/prep/Molecular%20biology%20primer.pdf>
5. http://ndl.ethernet.edu.et/bitstream/123456789/12122/1/John%20M%20Walker_.pdf
6. [https://www.fmed.uniba.sk/uploads/media/Introduction_to_Medical_and_Molecular Biology.pdf](https://www.fmed.uniba.sk/uploads/media/Introduction_to_Medical_and_Molecular_Biology.pdf)

Course Articulation Matrix: Mapping COs with POs

Co/Po	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	3	1	1	1	0
CO2	3	9	3	1	1	0
CO3	3	9	9	3	3	0
CO4	3	9	9	3	9	1
CO5	1	3	9	9	9	3
CO6	1	3	9	9	9	9
Weightage	20%	25%	20%	15%	10%	10%
Weighted % Contribution to PO	20%	25%	20%	15%	10%	10%

Course Outcomes Mapped with Knowledge Levels and POs

CO / K-Level	High (9)	Medium (3)	Low (1)	Zero (0)
CO1 / K1	P01	P02, P03	P04, P05	P06
CO2 / K2	P02, P03	P01, P04	P05, P06	-
CO3 / K3	P02, P03	P04, P05	P01	P06
CO4 / K4	P03, P05	P02, P04	P01	-
CO5 / K5	P05, P06	P02, P04	P01, P03	-
CO6 / K6	P06, P05	P03, P04	P01, P02	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (5 Marks)	CIA II (6 Marks)	Assignment 1 (4 Marks)	Seminar (5 Marks)	Total Scholastic Marks	Non Scholastic Marks (Attendance - 5 Marks)	Total Marks	% of Assessment
K1	1	1	0.5	0.5	3	0	3	12%
K2	1	1	0.5	0.5	3	0	3	12%
K3	1	1	0.5	1	3.5	0	3.5	14%
K4	1	1	0.5	1	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0.5	1	1	1	3.5	0	3.5	14%
Non Scholastic	--	--	--	--	0	5	5	20%
Total	5	6	4	5	20	5	25	100%

The COs and POs for the course in Molecular Biology in MSc Microbiology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEM - I	Prog. Code MIPG2022	Core Course VII	P25MB7
ENZYME TECHNOLOGY			
CREDITS - 2	THEORY		HOURS - 2

Course Description for Enzyme Technology

The Enzyme Technology course provides an in-depth exploration of enzymes, their mechanisms, and applications in various industries. Students will study enzyme kinetics, purification techniques, and the role of enzymes in biotechnology and pharmaceuticals. The course emphasizes practical applications, including enzyme immobilization, and the use of enzymes in bioprocessing and environmental management. By the end of the course, students will be equipped with both theoretical knowledge and practical skills necessary for careers in enzyme technology and related fields.

Course Objectives

1. To gain knowledge of enzyme classification, structure, and mechanisms of action.
2. To learn the principles of enzyme kinetics, including Michaelis-Menten kinetics and factors affecting enzyme activity.
3. To understand methods for isolating enzymes from biological sources and assessing their purity.
4. To explore techniques for immobilizing enzymes and their applications in biocatalysis.
5. To examine the role of enzymes in various industries, including food, pharmaceuticals, and biofuels.
6. To assess advancements in enzyme engineering, synthetic biology, and their implications for future technologies.

Units	Course Content	Hours per Week (2x15)*
Unit I	<p>Introduction to Enzymes – Scope for microbiology</p> <p>Enzyme Classification: Types of enzymes (holoenzymes, apoenzymes) and their functions. Enzyme nomenclature based on the International Union of Biochemistry (IUB).</p> <p>Enzyme Structure: Active sites and substrate specificity. Factors influencing enzyme structure (pH, temperature).</p> <p>Mechanisms of Enzyme Action: Catalytic mechanisms (lock-and-key vs. induced fit models).</p>	6

<p>Unit II</p>	<p>Enzyme Kinetics Order of chemical reactions – zero, first and second and their units Basic Principles of Kinetics: Michaelis-Menten kinetics; Lineweaver-Burk plot. Factors Affecting Enzyme Activity: Substrate concentration, temperature, pH, inhibitors (competitive vs. non-competitive). Units of enzyme activity, turn over Enzyme Regulation: Allosteric regulation; feedback inhibition; covalent modification.</p>	<p>6</p>
<p>Unit III</p>	<p>Enzyme Purification Techniques Methods of Purification: Source, inter/intra cellular location Cell lysis techniques; precipitation methods (ammonium sulfate). Chromatography techniques (ion exchange, affinity chromatography). Criteria of Purity: SDS-PAGE analysis; specific activity measurements. Yield Calculation: Understanding recovery percentages during purification processes.</p>	<p>6</p>
<p>Unit IV</p>	<p>Enzyme Immobilization Techniques for Immobilization: Physical adsorption; covalent bonding; entrapment methods. Advantages of Immobilized Enzymes: Stability; reusability; ease of separation from reaction mixtures. Applications in Biocatalysis: Use in biosensors; wastewater treatment; food processing.</p>	<p>6</p>
<p>Unit V</p>	<p>Applications and Emerging Trends Industrial Applications of Enzymes: Role in food industry (e.g., amylases in brewing); pharmaceuticals (e.g., proteases). Enzymes in Biofuels Production: Cellulases and ligninases in biomass conversion. Advancements in Enzyme Engineering: Directed evolution; synthetic biology approaches to enzyme design.</p>	<p>6</p>

CO Level	Course outcome	K Level
C01	Students will be able to list different classes of enzymes and describe their functions. Comprehension (Understanding):	K2
C02	Students will explain the principles of enzyme kinetics and factors affecting enzyme activity. Application (Applying):	K3
C03	Students will apply purification techniques to isolate enzymes from biological sources. Analysis (Analyzing):	K4
C04	Students will analyze data from kinetic experiments to determine enzyme characteristics such as Vmax and Km values. Synthesis (Creating):	K5
C05	Students will design an experiment to immobilize an enzyme for a specific application in biocatalysis. (Evaluation)	K6
C06	Students will critically evaluate the impact of emerging trends in enzyme technology on industrial processes. (Evaluation)	K6

Textbooks

1. Lohar, S. P. (n.d.). *Biotechnology*. MJP PUBLICATION. (Accn No: 00063333)
2. Veerakumari, L. (n.d.). *Biochemistry*. Mjp Publication. (Accn No: 00063764)
3. Dulsy Fathima. (n.d.). *Biochemistry (7th ed.)*. Saras Publication. (Accn No: 00064191)
4. Bajpai, P. K. (n.d.). *Biological Instrumentation and Methodology*. S.Chand and Co. (Accn No: 00061096)
5. Glick, R. B. (n.d.). *Molecular Biotechnology*. SCIENTIFIC INTERNATIONAL PVT LTD. (Accn No: 33013095)

Reference Books

1. Weil, J. H. (n.d.). *General Biochemistry*. New Age International (p) Limited. (Accn No: 1010)
2. Turner, P. C. (n.d.). *Instants Notes in Molecular Biology*. Viva Books Private Limited. (Accn No: 00057910)
3. Ramawat, K. G. (n.d.). *Molecular Biology and Biotechnology*. S.Chand and Co. (Accn No: 3309224)
4. El-Mansi, E. M. T. (n.d.). *Fermentation Microbiology and Biotechnology*. CRC Press. (Accn No: 33013099)

- Buchanan, B. B. (n.d.). *Biochemistry & Molecular Biology of Plants*. Wiley Black Well. (Accn No: 33013103)

Web Resources

- https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SBC2102.pdf
- <https://funaab.edu.ng/funaab-ocw/opencourseware/Advanced%20Enzymology.pdf>
- [http://14.139.155.233/lessons/21/Msc Biotech 1sem BT-1.3%20Enzymology.pdf](http://14.139.155.233/lessons/21/Msc%20Biotech%201sem%20BT-1.3%20Enzymology.pdf)
- <https://core.ac.uk/download/pdf/326762891.pdf>
- <https://gdcboysang.ac.in/About/droid/uploads/Biotech-2ndSem.pdf>

Course Articulation Matrix: Mapping COs with POs

Co/Po	PO1	PO2	PO3	PO4	PO5	PO6
C01	9	3	1	1	1	0
C02	3	9	3	1	3	0
C03	3	9	9	3	3	0
C04	3	9	9	3	9	1
C05	1	3	9	9	9	3
C06	1	3	9	9	9	9
Weightage	20%	25%	20%	15%	10%	10%
Weighted % Contribution to PO	20%	25%	20%	15%	10%	10%

Course Outcomes Mapped with Knowledge Levels and POs

CO / K-Level	High (9)	Medium (3)	Low (1)	Zero (0)
C01 / K2	PO1	PO2, PO3	PO4, PO5	PO6
C02 / K3	PO2, PO3	PO1, PO5	PO4	PO6
C03 / K4	PO2, PO3	PO4, PO5	PO1	-
C04 / K5	PO5, PO6	PO2, PO4	-	-
C05 / K6	PO6, PO5	PO3, PO4	PO1, PO2	-
C06 / K6	PO6, PO5	PO3, PO4	PO1, PO2	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (5 Marks)	CIA II (6 Marks)	Assignme nt 1 (4 Marks)	Seminar (5 Marks)	Total Scholast ic Marks	Non Scholasti c Marks (Attendan ce - 5 Marks)	Total Marks	% of Assessme nt
K1	1	1	0.5	0.5	3	0	3	12%
K2	1	1	0.5	0.5	3	0	3	12%
K3	1	1	0.5	1	3.5	0	3.5	14%
K4	1	1	0.5	1	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0.5	1	1	1	3.5	0	3.5	14%
Non Scholast ic	--	--	--	--	0	5	5	20%
Total	5	6	4	5	20	5	25	100%

The COs and POs for the course in Enzyme Technology in MSc Microbiology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEM - I	Prog. Code MIPG2022	Core Course VIIP	P25MB8P
LAB IN MICROBIAL BIOCHEMISTRY & ENZYME TECHNOLOGY			
CREDITS - 3		PRACTICAL	HOURS - 3

Course Description for lab in Microbial Biochemistry and Enzyme Technology

This laboratory course in Microbial Biochemistry and Microbial Genetics provides students with hands-on experience in techniques essential for studying the biochemical processes and genetic mechanisms of microorganisms. Through a series of experiments, students will explore the structure and function of biomolecules, enzyme activity, nucleic acid isolation, and genetic manipulation techniques. The course emphasizes practical applications in microbiology, biotechnology, and genetic research, preparing students for advanced studies and professional careers in the field.

Course Objectives

1. To learn methods for biomolecule estimation, enzyme assays, and lipid analysis.
2. To develop skills in nucleic acid isolation, electrophoresis, and plasmid manipulation.
3. To study factors affecting enzyme activity and interpret kinetic data.
4. To investigate protein profile.
5. To use TLC and paper chromatography for biomolecule separation.
6. To assess microbial enzymes and its kinetic properties.

List of lab experiments

1. **Estimation of Biomolecules:**
 - Quantification of proteins (Biuret/Lowry method), carbohydrates (DNS method), and lipids (gravimetric analysis).
2. **Enzyme Activity Assays:**
 - Catalase, oxidase, urease, and nitrate reductase tests.
3. **Chromatography Techniques:**
 - Paper and thin-layer chromatography (TLC) for amino acid separation.
4. **UV-Vis Spectrophotometry:**
 - Applications - photometric and Spectral Analysis.
5. **Protein Gel Electrophoresis- SDS-PAGE**
6. **Protein Isolation Techniques** - Precipitation methods - solvent, salt
7. **Acid Phosphatase / Amylase** - Activity, Specific Activity, Effect of Temp, pH, Substrate Concentration, Enzyme purification

CO Level	Course outcome	K Level
C01	Recall steps for biomolecule estimation (e.g., protein quantification using Biuret method)	K1
C02	Explain molecular mechanisms behind enzyme activity (e.g., catalase breaking down H ₂ O ₂)	K2
C03	Perform nucleic acid isolation and agarose gel electrophoresis to analyze DNA purity	K3
C04	Interpret mutation frequency data from UV/chemical mutagenesis experiments.	K4
C05	Design protocols for plasmid restriction mapping using EcoRI/HindIII	K5
C06	Assess conjugation efficiency and its implications for antibiotic resistance spread.	K6

Textbooks

1. Lohar, S. P. (n.d.). Biotechnology. MJP PUBLICATION. (Accn No: 00063333)
2. Veerakumari, L. (n.d.). Biochemistry. Mjp Publication. (Accn No: 00063764)
3. Dulsy Fathima. (n.d.). Biochemistry (7th ed.). Saras Publication. (Accn No: 00064191)
4. Bajpai, P. K. (n.d.). Biological Instrumentation and Methodology. S.Chand and Co. (Accn No: 00061096)
5. Aneja, K. R. (n.d.). Experiments in Microbiology Plant Pathology Tissue Culture and Microbial Biotechnolog. New Age International Publishers. (Accn No: 55014790)

Reference Books

1. Turner, P. C. (n.d.). Instants Notes in Molecular Biology. Viva Books Private Limited. (Accn No: 00057910)
2. Jay, J. M. (n.d.). Modern Food Microbiology. CBS Publishers & Distributors. (Accn No: 00057913)
3. Ramawat, K. G. (n.d.). Molecular Biology and Biotechnology. S.Chand and Co. (Accn No: 3309224)
4. El-Mansi, E. M. T. (n.d.). Fermentation Microbiology and Biotechnology. CRC Press. (Accn No: 33013099)
5. Weil, J. H. (n.d.). General Biochemistry. New Age International (p) Limited. (Accn No: 1010)

Web Resources

1. https://prsvkm.kau.in/sites/default/files/documents/prsvkm_laboratory_manual_of_biochemistry.pdf
2. <https://skyfox.co/wp-content/uploads/2020/12/Practical-Manual-of-Biochemistry.pdf>
3. https://www.bioteach.ubc.ca/wp-content/uploads/2021/11/labmanual2022_PATH547.pdf

Course Articulation Matrix: Mapping COs with POs

Co/Po	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	3	1	1	1	0
CO2	3	9	3	1	3	0
CO3	3	9	9	3	3	0
CO4	3	9	9	3	9	1
CO5	1	3	9	9	9	3
CO6	1	3	9	9	9	9
Weightage	20%	25%	20%	15%	10%	10%
Weighted % Contribution to PO	20%	25%	20%	15%	10%	10%

Course Outcomes Mapped with Knowledge Levels and POs

CO / K-Level	High (9)	Medium (3)	Low (1)	Zero (0)
CO1 / K1	P01	P02, P03	P04, P05	P06
CO2 / K2	P02, P03	P01, P05	P04	P06
CO3 / K3	P02, P03	P04, P05	P01	-
CO4 / K4	P02, P05	P03, P04	P01	-
CO5 / K5	P03, P05	P02, P04	P01	-
CO6 / K6	P06, P05	P03, P04	P01, P02	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (5 Marks)	CIA II (6 Marks)	Assignme nt 1 (4 Marks)	Seminar (5 Marks)	Total Scholast ic Marks	Non Scholasti c Marks (Attendan ce - 5 Marks)	Total Marks	% of Assessme nt
K1	1	1	0.5	0.5	3	0	3	12%
K2	1	1	0.5	0.5	3	0	3	12%
K3	1	1	0.5	1	3.5	0	3.5	14%
K4	1	1	0.5	1	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0.5	1	1	1	3.5	0	3.5	14%
Non Scholast ic	--	--	--	--	0	5	5	20%
Total	5	6	4	5	20	5	25	100%

The COs and POs for the course in Lab in Microbial Biochemistry and Enzyme Technology in MSc Microbiology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEMESTER - I	Core Course IXP	P25MB9P
LAB IN MICROBIAL SYSTEMATICS & IMMUNOLOGY		
CREDITS - 3	PRACTICAL	HOURS - 3

Course Description for the lab in General Microbiology and Immunology

The General Microbiology and Immunology laboratory course is designed to provide students with practical experience in essential microbiological techniques and immunological assays. Through a series of hands-on experiments, students will explore the morphology, physiology, and biochemical characteristics of microorganisms, as well as the principles of immune responses and diagnostic techniques. This course emphasizes the application of laboratory skills in real-world scenarios, including microbial isolation, identification, and the study of immune system functions. By integrating theoretical knowledge with practical applications, students will develop a comprehensive understanding of microbial life and its interactions with the immune system.

Lab Course Objectives

1. **Develop Practical Skills:**
Acquire hands-on experience with microbiological techniques for isolating and identifying microorganisms.
2. **Understand Microbial Characteristics:**
Explore the morphological, biochemical, and physiological properties of various microorganisms.
3. **Master Immunological Techniques:**
Gain proficiency in performing immunological assays such as ELISA, agglutination tests, and immunodiffusion.
4. **Analyze Immune Responses:**
Investigate the mechanisms of immune responses through practical experiments.
5. **Apply Laboratory Findings:**
Utilize experimental results to understand microbial behavior and immune interactions in health and disease.
6. **Evaluate Experimental Data:**
Develop skills to analyze and interpret data from microbiological and immunological experiments critically.

List of Lab Experiments

General Microbiology Experiments

1. **Microscopic Examination of Bacteria:**
 - Simple staining, Gram staining, and negative staining techniques.
2. **Isolation Techniques:**
 - Streak plate method for isolating pure cultures from mixed populations.
3. **Biochemical Tests:**
 - Catalase test, oxidase test, fermentation tests (e.g., sugar fermentation).
4. **Antibiotic Sensitivity Testing:**

- Disk diffusion method to determine susceptibility/resistance profiles.
5. **Growth Curve Analysis:**
- Measuring microbial growth phases using spectrophotometry.

Immunology Experiments

1. **Blood Grouping Tests:**
 - Determining blood types using agglutination reactions (ABO typing).
2. **Differential Leukocyte Count:**
 - Microscopic examination of stained blood smears to identify white blood cell types.
3. **ELISA (Enzyme-Linked Immunosorbent Assay):**
 - Performing ELISA to detect specific antibodies or antigens in serum samples.
4. **Immunodiffusion Tests:**
 - Ouchterlony double diffusion assay for detecting specific antigens or antibodies; Rocket Immunoelectrophoresis
5. **Western Blotting:**
 - Protein separation by SDS-PAGE followed by transfer and detection with antibodies.

CO Level	Course outcome	K Level
C01	Students will be able to list different types of staining techniques used in microbiology.	K1
C02	Students will explain the principles behind biochemical tests for microbial identification.	K2
C03	Students will perform blood grouping tests and interpret agglutination results accurately.	K3
C04	Students will analyze growth curve data to determine the growth rate of a bacterial culture under different conditions.	K4
C05	Students will design an experiment to test the efficacy of an antibiotic against a specific bacterial strain.	K5
C06	Students will critically evaluate results from ELISA tests to assess immune responses in clinical samples.	K6

Textbooks

1. Prasad, M. M. (n.d.). Laboratory Manual of Microbiology. New India Publishing Agency. (Accn No: 00063771)
2. Dubey, R. C. (n.d.). A Text Book of Microbiology. S.Chand and Co. (Accn No: 44002379)
3. Black, G. J. (n.d.). Microbiology (8th ed.). John Wiley & Sons. (Accn No: 33013131)
4. Shetty, Nandini. (n.d.). Immunology. New Age International p Limited. (Accn No: 15)

- Annadurai, B. (n.d.). A Text Book of Immunology and Immunotechnology. S.Chand and Co. (Accn No: 44001661)

Reference Books

- Turner, P. C. (n.d.). Instants Notes in Molecular Biology. Viva Books Private Limited. (Accn No: 00057910)
- Jay, J. M. (n.d.). Modern Food Microbiology. CBS Publishers & Distributors. (Accn No: 00057913)
- Aneja, K. R. (n.d.). Experiments in Microbiology Plant Pathology Tissue Culture and Microbial Biotechnolog. New Age International Publishers. (Accn No: 55014790)
- Abbas, K. A. (n.d.). Cellular And Molecular Immunology. Saunders College, Harcourt Brace College. (Accn No: 33013124)
- Kannan, I. (n.d.). Immunology. Mjp Publication. (Accn No: 00063770)

Web Resources

- https://tga.blv.ifmt.edu.br/media/filer_public/c9/3f/c93fa603-71b7-4dd7-adf2-58b5eefd2753/cappuccino - microbiology - a laboratory manual - 11ed - 2017.pdf
- [https://repository.poltekkes-kaltim.ac.id/1154/1/Microbiology%20and%20Immunology%20Textbook%20of%202nd%20Edition%20\(%20PDFDrive%20\).pdf](https://repository.poltekkes-kaltim.ac.id/1154/1/Microbiology%20and%20Immunology%20Textbook%20of%202nd%20Edition%20(%20PDFDrive%20).pdf)
- [https://repository.poltekkes-kaltim.ac.id/1154/1/Microbiology%20and%20Immunology%20Textbook%20of%202nd%20Edition%20\(%20PDFDrive%20\).pdf](https://repository.poltekkes-kaltim.ac.id/1154/1/Microbiology%20and%20Immunology%20Textbook%20of%202nd%20Edition%20(%20PDFDrive%20).pdf)

Course Articulation Matrix: Mapping COs with POs

Co/Po	P01	P02	P03	P04	P05	P06
C01	9	3	1	1	1	0
C02	3	9	3	1	3	0
C03	3	9	9	3	3	0
C04	3	9	9	3	9	1
C05	1	3	9	9	9	3
C06	1	3	9	9	9	9
Weightage	20%	25%	20%	15%	10%	10%
Weighted % Contribution to PO	20%	25%	20%	15%	10%	10%

Course Outcomes Mapped with Knowledge Levels and POs

CO / K-Level	High (9)	Medium (3)	Low (1)	Zero (0)
C01 / K1	P01	P02, P03	P04, P05	P06
C02 / K2	P02, P03	P01, P05	P04	P06
C03 / K3	P02, P03	P04, P05	-	-
C04 / K4	P02, P05	P03,P04	P01	-
C05 / K5	P03,P05	P02,P04	P01	-
C06 / K6	P06,P05	P03,P04	P01,P02	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (5 Marks)	CIA II (6 Marks)	Assignme nt 1 (4 Marks)	Seminar (5 Marks)	Total Scholast ic Marks	Non Scholasti c Marks (Attendan ce - 5 Marks)	Total Marks	% of Assessme nt
K1	1	1	0.5	0.5	3	0	3	12%
K2	1	1	0.5	0.5	3	0	3	12%
K3	1	1	0.5	1	3.5	0	3.5	14%
K4	1	1	0.5	1	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0.5	1	1	1	3.5	0	3.5	14%
Non Scholast ic	--	--	--	--	0	5	5	20%
Total	5	6	4	5	20	5	25	100%

The COs and POs for the course in General Microbiology and Immunology in MSc Microbiology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEM - I	Prog. Code MIPG2022	Core Course XP	P25MB10P
LAB IN MOLECULAR BIOLOGY AND MICROBIAL GENETICS			
CREDITS - 2	PRACTICAL		HOURS - 4

Course Description for the lab in Molecular Biology and Microbial Genetics

The Molecular Biology and Microbial Genetics laboratory course is designed to provide students with hands-on experience in essential techniques used to study the molecular mechanisms of genetic material and microbial processes. Through a series of practical experiments, students will learn how to isolate, analyze, and manipulate nucleic acids, as well as explore genetic variation and expression in microorganisms. This course emphasizes the application of molecular biology techniques such as PCR, gel electrophoresis, and cloning, alongside microbial genetics methods like transformation and conjugation. By integrating theoretical knowledge with practical skills, students will develop a comprehensive understanding of molecular biology and genetics in microbiology.

Lab Course Objectives

1. To acquire hands-on experience with molecular biology techniques for nucleic acid isolation and analysis.
2. To explore the principles of gene expression, mutation, and genetic transfer in microorganisms.
3. To gain proficiency in performing polymerase chain reaction (PCR), gel electrophoresis, and cloning experiments.
4. To interpret results from molecular assays to draw conclusions about genetic characteristics.
5. To utilize laboratory findings to understand microbial behavior and genetic interactions in health and disease.
6. To assess advancements in molecular genetics techniques and their implications for microbiological research.

List of Lab Experiments

Molecular Biology Experiments

1. Isolation of Genomic DNA:

- Extraction of genomic DNA from bacterial cells (e.g., *E. coli*).

2. Agarose Gel Electrophoresis:

- Separation and visualization of DNA fragments post-PCR.

Microbial Genetics Experiments

1. Transformation of Bacteria:

- Introduction of plasmid DNA into competent bacterial cells (e.g., *E. coli*).

2. Conjugation Studies:

- Investigation of gene transfer between bacterial strains using mating experiments.
- 3. Mutation Induction:**
 - Induction of mutations using chemical mutagens or UV radiation.
- 4. Antibiotic Resistance Testing:**
 - Assessment of microbial resistance through disk diffusion methods.
- 5. DNA Fingerprinting:**
 - Analysis of genetic variation using techniques like RAPD or RFLP.

CO Level	Course outcome	K Level
C01	Remember the steps involved in isolating genomic DNA from bacterial cells.	K1
C02	Explain the principles behind DNA isolation	K2
C03	Perform agarose gel electrophoresis to analyze PCR products and interpret the results.	K3
C04	Analyze data from transformation experiments to assess efficiency rates of plasmid uptake by bacteria.	K4
C05	Design an experiment to study gene expression using a reporter gene system in transformed bacteria.	K5
C06	Critically evaluate the implications of genetic mutations induced by UV radiation on microbial growth patterns.	K6

Textbooks

1. Singh, B. D. (n.d.). *Genetics*. Kalyani Publishers. (Accn No: 55014748)
2. Gupta, P. K. (n.d.). *Genetics*. Rastogi Publications. (Accn No: 55014773)
3. Brown, T. A. (n.d.). *Gene Cloning & DNA Analysis*. Wiley Black Well. (Accn No: 33013104)
4. Primrose, S. M. (n.d.). *Principles of Gen Manipulation and Genomics*. Wiley India Pvt. Ltd. (Accn No: 33013080)
5. Verma, P. S. (2022). *Cell Biology, Molecular Biology Evolution And Ecology*. S Chand & Company Ltd. (Accn No: 33013123)

Reference Books

1. Turner, P. C. (n.d.). *Instants Notes in Molecular Biology*. Viva Books Private Limited. (Accn No: 00057910)
2. Lai, M. B. (n.d.). *Introduction To Genetics*. CBS Publishers & Distributors. (Accn No: 55012620)

- Singh. (n.d.). *A Manual of Practical Genetics*. Kalyani Publishers Delhi. (Accn No: 55012621)
- Ramawat, K. G. (n.d.). *Molecular Biology and Biotechnology*. S.Chand and Co. (Accn No: 3309224)
- Green, R. M. (n.d.). *Molecular Cloning*. COLD SPRING HARBOR LABORATORY PRESS. (Accn No: 33013081)

Web Resources

- https://prsvkm.kau.in/sites/default/files/documents/prsvkm_laboratory_manual_of_biochemistry.pdf
- <https://skyfox.co/wp-content/uploads/2020/12/Practical-Manual-of-Biochemistry.pdf>
- https://www.bioteach.ubc.ca/wp-content/uploads/2021/11/labmanual2022_PATH547.pdf

Assumed Program Outcomes (POs):

Co/Po	PO1	PO2	PO3	PO4	PO5	PO6
C01	9	3	1	1	1	0
C02	3	9	3	1	3	0
C03	3	9	9	3	3	0
C04	3	9	9	3	9	1
C05	1	3	9	9	9	3
C06	1	3	9	9	9	9
Weightage	20%	25%	20%	15%	10%	10%
Weighted % Contribution to PO	20%	25%	20%	15%	10%	10%

Course Outcomes Mapped with Knowledge Levels and POs

CO / K-Level	High (9)	Medium (3)	Low (1)	Zero (0)
C01 / K1	P01	P02, P03	P04, P05	P06
C02 / K2	P02, P03	P01, P05	P04	-
C03 / K3	P02, P03	-	-	-
C04 / K4	P02, P05	P03, P04	P01	-
C05 / K5	P03, P05	P02, P04	P01	-
C06 / K6	P06, P05	P03, P04	P01, P02	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (5 Marks)	CIA II (6 Marks)	Assignme nt 1 (4 Marks)	Seminar (5 Marks)	Total Scholast ic Marks	Non Scholasti c Marks (Attendan ce - 5 Marks)	Total Marks	% of Assessme nt
K1	1	1	0.5	0.5	3	0	3	12%
K2	1	1	0.5	0.5	3	0	3	12%
K3	1	1	0.5	1	3.5	0	3.5	14%
K4	1	1	0.5	1	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0.5	1	1	1	3.5	0	3.5	14%
Non Scholast ic	--	--	--	--	0	5	5	20%
Total	5	6	4	5	20	5	25	100%

The COs and POs for the course in Molecular Biology and Microbial Genetics in MSc Microbiology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

*****End of Semester I with 25 Credits and 30 Hours per Cycle*****

SEM - II	Prog. Code MIPG2022	Core Course XI	P25MB11
VIROLOGY			
CREDITS - 3	THEORY		HOURS - 4

Course Description for Virology

This course on Virology provides an in-depth exploration of viruses, their structure, classification, replication mechanisms, and the diseases they cause. Students will learn about the history of virology, the properties of different viral agents, and the methodologies for studying and identifying viruses. The course covers various classes of viruses, including bacteriophages, plant viruses, and animal viruses, alongside their epidemiology and clinical significance. Emphasis is placed on laboratory techniques for virus identification, diagnosis, and the development of antiviral strategies and vaccines.

Course Objectives

1. To gain knowledge of the history, morphology, ultrastructure, and chemical composition of viruses.
2. To learn about the nomenclature and classification systems for different types of viruses and sub-viral particles.
3. To study the life cycles of bacteriophages and their genetic characteristics.
4. To understand the propagation, purification, epidemiology, symptoms, and control measures for plant viral diseases.
5. To explore the morphology, culture methods, diseases caused by animal viruses, and their clinical implications.
6. To develop skills in identifying viruses using immunological methods and understanding antiviral agents and vaccines.

Units	Course Content	Hours per Week (4x15)*
Unit I	<p>Introduction to Virology</p> <p>History and General Properties: Development of virology as a scientific discipline; key discoveries in virology; impact on human history. Morphology and ultrastructure of viruses (capsids, envelopes).</p> <p>Chemical Composition: Structure of viral proteins and nucleic acids (DNA/RNA). Classification systems: Baltimore classification scheme; disease-based classification.</p> <p>Sub-Viral Particles: Viroids: Structure, replication mechanisms in plants.</p>	12

	<p>Prions: Infectious proteins causing neurodegenerative diseases (e.g., Creutzfeldt-Jakob disease). Satellite viruses: Dependence on helper viruses for replication.</p>	
Unit II	<p>Bacterial Viruses Bacteriophages:</p> <ul style="list-style-type: none"> • Examples: T7 phage (model for replication), lambda phage (lytic/lysogenic cycles), M13 phage (used in phage display). • Morphology and structure of bacteriophages. <p>Life Cycle Mechanisms:</p> <ul style="list-style-type: none"> • Lytic cycle: Replication within bacterial cells leading to cell lysis and release of virions. • Lysogenic cycle: Integration of phage genome into host DNA; lysogenic repression mechanisms. <p>Viral Genetics:</p> <ul style="list-style-type: none"> • RNA vs. DNA genomes in bacteriophages. • Characteristics of single-stranded vs. double-stranded genomes. 	12
Unit III	<p>Plant Viruses Morphology and Characteristics:</p> <ul style="list-style-type: none"> • Structural features of plant viruses (rigid helical or icosahedral shapes). • Methods for propagation and purification of plant viruses. <p>• Plant-Viral Diseases:</p> <ul style="list-style-type: none"> • Epidemiology, symptoms, diagnosis, prevention, and treatment strategies for plant viral diseases. • Examples: DNA virus (<i>Cauliflower mosaic virus</i>), RNA virus (<i>Tobacco mosaic virus</i>). <p>Animal Viruses Morphology and Culture Methods:</p> <ul style="list-style-type: none"> • Structural features of animal viruses (enveloped vs. non-enveloped). • Culture techniques using cell lines (e.g., Vero cells) and embryonated eggs for virus propagation. <p>Animal Viral Diseases:</p> <ul style="list-style-type: none"> • DNA viruses (e.g., Orthopox virus): Clinical symptoms, epidemiology, lab diagnosis, treatment options. 	12

	RNA viruses (e.g., Corona virus, Polio virus): Pathogenesis, diagnostic methods like PCR, serological tests, and treatment approaches.	
Unit IV	<p>Characterization of Viral Products and Cellular Processes</p> <ul style="list-style-type: none"> • Viral Products Expressed in Infected Cells: Characterization of viral proteins and nucleic acids in the infected cell. • Cellular Processes Used by Viruses: How viruses use cellular processes to express their genetic information. <p>Replication Patterns and Molecular Genetics</p> <ul style="list-style-type: none"> • Replication of Positive-Sense RNA Viruses: Detailed study of replication strategies. • Replication of RNA Viruses: Replication strategies of RNA viruses requiring RNA-directed mRNA transcription. • Molecular Genetics: Viral genomes, restriction mapping, cloning, and analysis of mutations. 	12
Unit V	<p>Identification and Diagnosis</p> <p>Viral Identification Techniques:</p> <ul style="list-style-type: none"> • Serological assays (ELISA), hemagglutination tests, immunofluorescence assays, Western blotting, hybridization techniques, RT-PCR for viral detection. <p>Interferons & Antiviral Agents:</p> <ul style="list-style-type: none"> • Mechanisms of interferons in inhibiting viral replication; therapeutic applications in viral infections. • Overview of antiviral agents and their modes of action. <p>Vaccines & Phage Therapy:</p> <ul style="list-style-type: none"> • Types of vaccines (live attenuated, inactivated, subunit vaccines). • Principles behind vaccine development for emerging pathogens like COVID-19. • Applications of phage therapy in treating bacterial infections. 	12

CO Level	Course outcome	K Level
C01	Recall key characteristics of various classes of viruses and sub-viral particles.	K1
C02	Explain the differences between lytic and lysogenic cycles in bacteriophages.	K2
C03	Perform diagnostic techniques such as ELISA or RT-PCR to identify specific viral infections.	K3
C04	Analyze epidemiological data related to outbreaks caused by plant or animal viral diseases.	K4
C05	Design a diagnostic test using immunological methods to identify a specific viral infection.	K5
C06	Critically evaluate the effectiveness of vaccines against emerging pathogens like COVID-19.	K6

Textbooks

1. Black, G. J. (n.d.). *Microbiology* (8th ed.). John Wiley & Sons. (Accn No: 33013131)
2. Tortora, J. G. (n.d.). *Microbiology an Intrduction*. Addison-Wesley Publishing Co. (Accn No: 33012974)
3. Arora, D. R. (n.d.). *Textbook of Microbiology* (5th ed.). Cbs Publication & Distribution. (Accn No: 33013166)
4. Pommerville, J. (n.d.). *Fundamentals of Microbiology* (7th ed.). Jones and Bartlett Publishers. (Accn No: 33013120)
5. Vasanthakumari, R. (n.d.). *Textbook of Microbiology* (3rd ed.). Wolters Kluwer. (Accn No: 33013165)

Reference Books

1. Turner, P. C. (n.d.). *Instants Notes in Molecular Biology*. Viva Books Private Limited. (Accn No: 00057910)
2. Jay, J. M. (n.d.). *Modern Food Microbiology*. CBS Publishers & Distributors. (Accn No: 00057913)
3. Abbas, K. A. (n.d.). *Cellular And Molecular Immunology*. Saunders College, Harcourt Brace College. (Accn No: 33013124)
4. Green, R. M. (n.d.). *Molecular Cloning*. COLD SPRING HARBOR LABORATORY PRESS. (Accn No: 33013081)

- Mehrotra. (n.d.). *Principles Of Microbiology*. Tata-Mcgraw-hill Publishing Co-Pvt. (Accn No: 16)

Web Resources

- <https://samicrobiology.wordpress.com/wp-content/uploads/2018/08/modern-virology.pdf>
- <https://core.ac.uk/download/pdf/80151473.pdf>
- <https://microbenotes.com/category/virology/>

Course Articulation Matrix: Mapping COs with POs

Co/Po	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	3	1	1	1	0
CO2	3	9	3	1	3	0
CO3	3	9	9	3	3	0
CO4	3	9	9	3	9	1
CO5	1	3	9	9	9	3
CO6	1	3	9	9	9	9
Weightage	20%	25%	20%	15%	10%	10%
Weighted % Contribution to PO	20%	25%	20%	15%	10%	10%

Course Outcomes Mapped with Knowledge Levels and POs

CO / K-Level	High (9)	Medium (3)	Low (1)	Zero (0)
CO1 / K1	PO1	PO2, PO3	PO4, PO5	PO6
CO2 / K2	PO2, PO3	PO1, PO5	PO4	-
CO3 / K3	PO2, PO3	-	-	-
CO4 / K4	PO3, PO5	PO2, PO4	PO1	-
CO5 / K5	PO3, PO5	PO2, PO4	PO1	-
CO6 / K6	PO6, PO5	PO3, PO4	PO1, PO2	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (5 Marks)	CIA II (6 Marks)	Assignment 1 (4 Marks)	Seminar (5 Marks)	Total Scholastic Marks	Non Scholastic Marks (Attendance - 5 Marks)	Total Marks	% of Assessment
K1	1	1	0.5	0.5	3	0	3	12%
K2	1	1	0.5	0.5	3	0	3	12%
K3	1	1	0.5	1	3.5	0	3.5	14%

K4	1	1	0.5	1	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0.5	1	1	1	3.5	0	3.5	14%
Non Scholastic	--	--	--	--	0	5	5	20%
Total	5	6	4	5	20	5	25	100%

The COs and POs for the course in Virology in MSc Microbiology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEM - II	Prog. Code MIPG2022	Core Course XII	P25MB12
MEDICAL MYCOLOGY AND PARASITOLOGY			
CREDITS - 3	THEORY		HOURS - 4

Course Description for Medical Mycology and Parasitology

This course provides a comprehensive understanding of the biology, pathogenesis, and clinical significance of medically important fungi and parasites. The syllabus covers the taxonomy, morphology, life cycles, and pathogenic mechanisms of fungi and parasites affecting humans. Students will also explore host-pathogen interactions, diagnostic techniques, and therapeutic strategies. The course integrates theoretical knowledge with practical applications to prepare students for advanced research or clinical roles in medical microbiology.

Course Objectives

1. To gain knowledge of the taxonomy, morphology, and life cycles of medically important fungi and parasites.
2. To study the mechanisms by which fungi and parasites cause disease in humans.
3. To examine immune responses to fungal and parasitic infections and their evasion strategies.
4. To learn laboratory methods for identifying fungi and parasites in clinical specimens.
5. To understand antifungal agents, antiparasitic drugs, and resistance mechanisms.
6. To assess the epidemiology, prevention, and control measures for fungal and parasitic diseases globally.

Units	Course Content	Hours per Week (4x15)*
Unit I	Introduction to Medical Mycology and Parasitology <ul style="list-style-type: none"> • Historical Developments in Mycology: • Key milestones in fungal research; discovery of pathogenic fungi. General Characteristics of Fungi: <ul style="list-style-type: none"> • Habitat, distribution, nutritional requirements; molds vs. yeasts. Diversity of Fungi: <ul style="list-style-type: none"> • Taxonomy of fungi; fungus-like organisms (oomycetes). Economic Importance of Fungi:	12

	<ul style="list-style-type: none"> • Applications in agriculture (biocontrol), medicine (antibiotics), food industry (fermentation), biodeterioration (wood decay), and mycotoxins (aflatoxins). 	
Unit II	<p>Fungal Taxonomy, Morphology, Growth, and Reproduction</p> <ul style="list-style-type: none"> • Fungal Taxonomy and Systematics: Classification systems; phylogenetic relationships among fungi. • Fungal Morphology: • Thallus organization; aggregation patterns; ultrastructure of fungal cells. <p>Reproduction in Fungi:</p> <ul style="list-style-type: none"> • Asexual reproduction (spores); sexual reproduction (zygospores); heterokaryosis; parasexual mechanisms. <p>Growth and Metabolism:</p> <ul style="list-style-type: none"> • Nutritional modes (saprophytic/parasitic); metabolic pathways in fungi (fermentation/respiration). 	12
Unit III	<p>Fungal Diseases in Plants and Animals</p> <ul style="list-style-type: none"> • Fungal Diseases in Plants: • Wart disease of potato (<i>Synchytrium endobioticum</i>), white rust of crucifers (<i>Albugo candida</i>), leaf curl of peaches (<i>Taphrina deformans</i>), smut disease of onion (<i>Ustilago cepulae</i>), leaf spot disease of groundnut (<i>Cercospora arachidicola</i>). <p>Fungal Diseases in Animals:</p> <ul style="list-style-type: none"> • Mycoses (cutaneous/subcutaneous/systemic): candidiasis (<i>Candida</i> spp.), dermatophytosis (<i>Trichophyton</i> spp., <i>Microsporum</i> spp.), aspergillosis (<i>Aspergillus</i> spp.), otomycosis (<i>Aspergillus niger</i>), penicilliosis (<i>Penicillium marneffeii</i>). 	12
Unit IV	<p>Introduction to Parasitology</p> <ul style="list-style-type: none"> • Classification of Parasites: • Protozoa (amoeba/flagellates/ciliates/sporozoa); helminths (nematodes/cestodes/trematodes); arthropods (ticks/mites/mosquitoes). <p>Types of Parasitism:</p>	12

	<ul style="list-style-type: none"> • Commensalism; symbiosis; predatorism; host-parasite relationships. <p>Types of Hosts:</p> <ul style="list-style-type: none"> • Final host; intermediate host; paratenic host; reservoir host. • Vectors and Sources of Parasitic Infections: • Biological/mechanical vectors; environmental sources (soil/water/food). 	
Unit V	<p>Medically Important Parasitic Protozoa</p> <p>Parasitic Protozoa Life Cycle & Pathogenesis:</p> <ul style="list-style-type: none"> • Toxoplasma gondii: congenital toxoplasmosis; immune evasion mechanisms. • Plasmodium vivax: malaria pathogenesis; drug resistance mechanisms. • Giardia lamblia: intestinal giardiasis; trophozoite/cyst stages. • Trypanosoma gambiense: African sleeping sickness; vector transmission by tsetse flies. • Entamoeba histolytica: amoebiasis; ulcer formation in intestinal mucosa. • Cryptosporidium parvum: cryptosporidiosis; waterborne outbreaks. 	12

CO Level	Course outcome	K Level
C01	Recall the taxonomy, morphology, life cycles, and nutritional requirements of medically important fungi and parasites.	K1
C02	Explain the pathogenic mechanisms underlying fungal diseases like candidiasis or parasitic infections like amoebiasis.	K2
C03	Apply diagnostic techniques such as LPCB mounts for fungi or ELISA for protozoan detection.	K3
C04	Analyze epidemiological data to assess risk factors for fungal outbreaks or parasitic diseases.	K4
C05	Design a public health strategy to control zoonotic parasitic infections using vector control measures.	K5
C06	Critically assess the effectiveness of antifungal drugs or antiparasitic treatments against emerging resistant strains.	K6

Textbooks

1. Arora, D. R. (n.d.). Textbook of Microbiology (5th ed.). Cbs Publication & Distribution. (Accn No: 33013166)
2. Black, G. J. (n.d.). Microbiology (8th ed.). John Wiley & Sons. (Accn No: 33013131)
3. Tortora, J. G. (n.d.). Microbiology an Intrduction. Addison-Wesley Publishing Co. (Accn No: 33012974)
4. Vasanthakumari, R. (n.d.). Textbook of Microbiology (3rd ed.). Wolters Kluwer. (Accn No: 33013165)
5. Pommerville, J. (n.d.). Fundamentals of Microbiology (7th ed.). Jones and Bartlett Publishers. (Accn No: 33013120)

Reference Books

1. Mehrotra. (n.d.). Principles Of Microbiology. Tata-Mcgraw-hill Publishing Co-Pvt. (Accn No: 16)
2. Russell, H. L. (n.d.). Dairy Bacteriology. University Publication. (Accn No: 00063765)
3. Vijaya Ramesh, K. (n.d.). Food Microbiology. Mjp Publication. (Accn No: 00063766)
4. Jay, J. M. (n.d.). Modern Food Microbiology. CBS Publishers & Distributors. (Accn No: 00057913)
5. Aneja, K. R. (n.d.). Experiments in Microbiology Plant Pathology Tissue Culture and Microbial Biotechnolog (6th ed.). New Age International Publishers. (Accn No: 55014790)

Web Resources

1. <https://www.vnmu.edu.ua/downloads/microbiology/20131218-135731.pdf>
2. <https://nursingcollege.mespune.in/wp-content/uploads/2023/04/The-Short-Textbook-of-Medical-Microbiology-Including-Parasitology-PDFDrive.com-.pdf>
3. <http://repository.stikesrspadgs.ac.id/63/1/Medical%20Parasitology%20Shymasundari-501hlm.pdf>

Course Articulation Matrix: Mapping COs with POs

Co/Po	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	3	1	1	1	0
CO2	3	9	3	1	3	0
CO3	3	9	9	3	3	0
CO4	3	9	9	3	9	1
CO5	1	3	9	9	9	3

C06	1	3	9	9	9	9
Weightage	20%	25%	20%	15%	10%	10%
Weighted % Contribution to PO	20%	25%	20%	15%	10%	10%

Course Outcomes Mapped with Knowledge Levels and POs

CO / K-Level	High (9)	Medium (3)	Low (1)	Zero (0)
C01 / K1	P01	P02, P03	P04, P05	P06
C02 / K2	P02, P03	P01, P05	P04	-
C03 / K3	P02, P03	-	-	-
C04 / K4	P03,P05	P02,P04	P01	-
C05 / K5	P05,P03	P02,P04	P01	-
C06 / K6	P06,P05	P03,P04	P01,P02	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (5 Marks)	CIA II (6 Marks)	Assignment 1 (4 Marks)	Seminar (5 Marks)	Total Scholastic Marks	Non Scholastic Marks (Attendance - 5 Marks)	Total Marks	% of Assessment
K1	1	1	0.5	0.5	3	0	3	12%
K2	1	1	0.5	0.5	3	0	3	12%
K3	1	1	0.5	1	3.5	0	3.5	14%
K4	1	1	0.5	1	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0.5	1	1	1	3.5	0	3.5	14%
Non Scholastic	--	--	--	--	0	5	5	20%
Total	5	6	4	5	20	5	25	100%

The COs and POs for the course in Medical Mycology and Parasitology in MSc Microbiology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEM - II	Prog. Code MIPG2022	Core Course XIII	P25MB13
FOOD AND DAIRY MICROBIOLOGY			
CREDITS - 3	THEORY		HOURS - 4

Course Description for Food and Dairy Microbiology

This course provides a comprehensive understanding of the role of microorganisms in food and dairy systems. It covers microbial interactions with food, spoilage mechanisms, foodborne diseases, fermentation processes, and preservation techniques. The course also emphasizes food safety standards, quality control measures, and the application of microbial biotechnology in the food and dairy industries. Students will gain theoretical knowledge and practical skills to address challenges in food microbiology and ensure public health through safe food practices.

Course Objectives

1. To learn how microorganisms interact with food as substrates and their role in spoilage and fermentation.
2. To study the mechanisms of food spoilage, contamination, and diseases caused by pathogenic microorganisms.
3. To understand traditional and modern methods for preserving food to ensure its safety and shelf life.
4. To gain insights into the microbiology of fermented foods and beverages, including dairy products.
5. To learn about regulatory frameworks such as HACCP, FDA, and ISI for ensuring food safety and quality assurance.
6. To explore applications of probiotics, prebiotics, genetically modified organisms (GMOs), and biosensors in the food industry.

Units	Course Content	Hours per Week (4x15)*
Unit I	Microorganisms in Food Systems <ul style="list-style-type: none"> • Food as a Substrate for Microorganisms: • Nutritional composition of food supporting microbial growth. • Factors influencing microbial activity (temperature, pH, water activity). Microorganisms in Food Microbiology:	12

	<ul style="list-style-type: none"> Molds (<i>Aspergillus</i>, <i>Penicillium</i>), yeasts (<i>Saccharomyces</i>), bacteria (<i>Lactobacillus</i>, <i>Staphylococcus</i>, <i>Salmonella</i>). <p>Economic Importance of Microorganisms in Food:</p> <ul style="list-style-type: none"> Beneficial roles (fermentation, probiotics) vs. detrimental effects (spoilage, mycotoxins). 	
Unit II	<p>Food Spoilage and Foodborne Diseases</p> <ul style="list-style-type: none"> Food Spoilage Mechanisms: Contamination sources; spoilage of cereals, bakery products, dairy products, meats, fruits, vegetables. <p>Foodborne Pathogens and Diseases:</p> <ul style="list-style-type: none"> Pathogens (<i>Salmonella</i>, <i>Listeria monocytogenes</i>, <i>E. coli</i>, <i>Shigella</i>). Mycotoxins from fungi (<i>Aspergillus flavus</i>). <p>Microbiological Examination of Milk and Dairy Products:</p> <ul style="list-style-type: none"> Sources of contamination; control measures; standard plate count methods. 	12
Unit III	<p>Food Preservation Techniques</p> <p>Principles of Food Preservation:</p> <ul style="list-style-type: none"> Physical methods (pasteurization, refrigeration/freezing, drying). Chemical preservatives (organic acids, nitrites). <p>Advanced Preservation Methods:</p> <ul style="list-style-type: none"> High-pressure processing (HPP), irradiation (UV/gamma rays), aseptic packaging. <p>Role of Biosensors in Food Safety:</p> <ul style="list-style-type: none"> Applications for detecting contaminants or pathogens in food systems. 	12
Unit IV	<p>Fermented Foods</p> <p>Microbiology of Fermented Foods:</p> <ul style="list-style-type: none"> Traditional fermented foods (pickles, sauerkraut); beverages (beer, wine). <p>Dairy Fermentation Products:</p>	12

	<ul style="list-style-type: none"> • Cheese (<i>Lactococcus lactis</i>), yogurt (<i>Lactobacillus delbrueckii</i>, <i>Streptococcus thermophilus</i>), kefir. <p>Role of Microorganisms in Beverages:</p> <ul style="list-style-type: none"> • Tea/coffee fermentation; vinegar production (<i>Acetobacter aceti</i>). 	
Unit V	<p>Food Safety Standards and Applications</p> <p>Food Safety Standards:</p> <ul style="list-style-type: none"> • Regulatory frameworks (HACCP, FDA guidelines); microbiological quality standards for foods. <p>Functional Foods and Biotechnology Applications:</p> <ul style="list-style-type: none"> • Probiotics/prebiotics; genetically modified foods (GMOs); bioactive peptides from milk proteins. <p>Microbial Enzymes in the Dairy Industry:</p> <ul style="list-style-type: none"> • Applications of proteases/lipases in cheese production; lactase for lactose-free products. 	12

CO Level	Course outcome	K Level
C01	Recall the role of microorganisms in food systems and their economic importance.	K1
C02	Explain the mechanisms underlying food spoilage and microbial contamination.	K2
C03	Apply microbiological techniques to examine milk quality or detect pathogens.	K3
C04	Analyze the effectiveness of various preservation techniques on extending shelf life.	K4
C05	Design a HACCP plan for ensuring safety during yogurt production.	K5
C06	Critically evaluate the use of GMOs or biosensors in improving food safety.	K6

Textbooks

1. Tortora, J. G. (n.d.). *Microbiology an Intrduction*. Addison-Wesley Publishing Co. (Accn No: 33012974)
2. Black, G. J. (n.d.). *Microbiology* (8th ed.). John Wiley & Sons. (Accn No: 33013131)
3. Pommerville, J. (n.d.). *Fundamentals of Microbiology* (7th ed.). Jones and Bartlett Publishers. (Accn No: 33013120)
4. Adams, M. R. (n.d.). *Food microbiology*. Cambridge. (Accn No: 13)
5. Erkmen, O. (n.d.). *Food Microbiology*. John Wiley. (Accn No: 14)

Reference Books

1. Jay, J. M. (n.d.). *Modern Food Microbiology*. CBS Publishers & Distributors. (Accn No: 00057913)
2. Russell, H. L. (n.d.). *Dairy Bacteriology*. University Publication. (Accn No: 00063765)
3. Vijaya Ramesh, K. (n.d.). *Food Microbiology*. Mjp Publication. (Accn No: 00063766)
4. Ramanathan, N. (n.d.). *Food Microbiology*. New India Publishing Agency. (Accn No: 00063767)
5. Ouwehand, C. (n.d.). *Gastrointestinal Microbiology*. Taylor & Francis. (Accn No: 33013125)

Web Resources

1. <https://mis.alagappauniversity.ac.in/siteAdmin/dde-admin/uploads/2/PG M.Sc. Microbiology 364%2023 Food%20and%20Dairy%20Microbiology.pdf>
2. https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SMB2202.pdf
3. <https://www.vivekanandcollege.ac.in/uploads/dptmicrobiology/ebooks/food-microbiology-by-wc-frazier-.pdf>

Course Articulation Matrix: Mapping COs with POs

Co/Po	P01	P02	P03	P04	P05	P06
C01	9	3	1	1	1	0
C02	3	9	3	1	3	0
C03	3	9	9	3	3	0
C04	3	9	9	3	9	1
C05	1	3	9	9	9	3
C06	1	3	9	9	9	9
Weightage	20%	25%	20%	15%	10%	10%
Weighted % Contribution to PO	20%	25%	20%	15%	10%	10%

Course Outcomes Mapped with Knowledge Levels and POs

CO / K-Level	High (9)	Medium (3)	Low (1)	Zero (0)
C01 / K1	P01	P02, P03	P04, P05	P06
C02 / K2	P02, P03	P01, P05	P04	-
C03 / K3	P02, P03	-	-	-
C04 / K4	P03, P05	P02, P04	-	-
C05 / K5	-	P03, P05	P02, P04	P01
C06 / K6	-	-	-	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (5 Marks)	CIA II (6 Marks)	Assignme nt 1 (4 Marks)	Seminar (5 Marks)	Total Scholast ic Marks	Non Scholasti c Marks (Attendan ce - 5 Marks)	Total Marks	% of Assesse ment
K1	1	1	0.5	0.5	3	0	3	12%
K2	1	1	0.5	0.5	3	0	3	12%
K3	1	1	0.5	1	3.5	0	3.5	14%
K4	1	1	0.5	1	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0.5	1	1	1	3.5	0	3.5	14%
Non Scholast ic	--	--	--	--	0	5	5	20%
Total	5	6	4	5	20	5	25	100%

The COs and POs for the course in Food and Dairy Microbiology in MSc Microbiology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEM - II	Prog. Code MIPG2022	Core Course XIV	P25MB14
AGRICULTURAL AND ENVIRONMENTAL MICROBIOLOGY			
CREDITS - 2	THEORY		HOURS - 3

Course Description for Agricultural and Environmental Microbiology

This course provides an in-depth understanding of microorganisms in agricultural and environmental systems. It covers the roles of microbes in soil fertility, biogeochemical cycles, biofertilizers, biopesticides, and waste management. Students will explore microbial interactions with plants, their role in sustainable agriculture, and their applications in environmental biotechnology. The course integrates theoretical knowledge with practical applications to address global challenges such as food security, pollution control, and climate change mitigation.

Course Objectives

1. To study the diversity of soil microorganisms and their roles in nutrient cycling and soil fertility.
2. To explore the rhizosphere, phyllosphere, and mycorrhizal associations for plant growth promotion.
3. To understand the microbial processes involved in carbon, nitrogen, phosphorus, and sulfur cycles.
4. To study the production, application, and benefits of biofertilizers and biopesticides in sustainable agriculture.
5. To explore microbial roles in waste management, pollution control, and bioremediation technologies.
6. To learn microbial applications in biofuels, biodegradation of agro-waste, and climate change mitigation strategies.

Units	Course Content	Hours per Week (3x15)*
Unit I	Soil Microbiology Introduction to Soil Microorganisms: <ul style="list-style-type: none"> • Diversity of bacteria (e.g., cyanobacteria, actinobacteria), fungi, algae, protozoa, nematodes, and viruses in soil ecosystems. • Role of microbes in soil fertility and nutrient availability. Microbial Associations in Soil:	9

	<ul style="list-style-type: none"> • Rhizosphere (root-soil interface), phyllosphere (leaf surface), spermosphere (seed surface). • Mycorrhizae: Types (ecto- and endomycorrhizae) and their importance to agriculture. <p>Organic Matter Decomposition:</p> <ul style="list-style-type: none"> • Mechanisms of humus formation by soil microbes; role in carbon sequestration. 	
Unit II	<p>Biogeochemical Cycles</p> <p>Carbon Cycle:</p> <ul style="list-style-type: none"> • Microbial decomposition of organic matter; methanogenesis; carbon sequestration by soil microbes. <p>Nitrogen Cycle:</p> <ul style="list-style-type: none"> • Biological nitrogen fixation (symbiotic/asymbiotic); root nodule formation (Rhizobium, Azotobacter). • Enzymes involved: Nitrogenase, hydrogenase; biochemistry of nitrogen fixation. <p>Phosphorus and Sulfur Cycles:</p> <ul style="list-style-type: none"> • Role of phosphate-solubilizing microorganisms (Pseudomonas, Bacillus). • Sulfur oxidation/reduction by microbes (Thiobacillus). 	9
Unit III	<p>Biofertilizers and Biopesticides</p> <p>Biofertilizers:</p> <ul style="list-style-type: none"> • Types (bacterial, fungal, algal biofertilizers); mass production techniques for Rhizobium, Azolla, blue-green algae (BGA), mycorrhizae. • Quality control guidelines for biofertilizer production; plant responses to biofertilizer application. <p>Biopesticides:</p> <ul style="list-style-type: none"> • Bacterial (Bacillus thuringiensis), fungal (Trichoderma spp.), viral biopesticides; mechanisms of action. • Disease-suppressive soils; biological control of phytopathogens using Pseudomonas fluorescens. 	9
Unit IV	<p>Environmental Microbiology</p> <p>Microbial Waste Management:</p>	9

	<ul style="list-style-type: none"> • Role of microbes in solid waste decomposition; composting techniques; vermicomposting. • Liquid waste treatment using activated sludge processes; role of methanogens in anaerobic digestion. <p>Bioremediation Technologies:</p> <ul style="list-style-type: none"> • Microbial degradation of pollutants (hydrocarbons, pesticides); phytoremediation strategies. <p>Pollution Control:</p> <ul style="list-style-type: none"> • Use of biosensors for detecting environmental pollutants; microbial mitigation of heavy metals. 	
Unit V	<p>Applications in Agriculture and Environment</p> <p>Plant Growth-Promoting Rhizobacteria (PGPR):</p> <ul style="list-style-type: none"> • Mechanisms (indole acetic acid production, phosphate solubilization). • Climate Change Mitigation by Microbes: • Role of methanotrophs in reducing methane emissions; carbon capture by algae. <p>Microbial Biotechnology Applications:</p> <ul style="list-style-type: none"> • Biofuel production (ethanol from lignocellulosic biomass); biodegradation of agro-waste into value-added products. 	9

CO Level	Course outcome	K Level
C01	Remember the diversity and ecological roles of soil microorganisms.	K1
C02	Explain microbial processes involved in biogeochemical cycles.	K2
C03	Apply techniques for isolating beneficial microbes like mycorrhizae or PGPR.	K3
C04	Analyze the effectiveness of biopesticides or biofertilizers on crop yield.	K4
C05	Design a sustainable waste management system using microbial composting.	K5
C06	Critically assess the role of microbial biotechnology in mitigating climate change.	K6

Textbooks

1. Dubey, R. C. (n.d.). *A Text Book of Microbiology*. S.Chand and Co. (Accn No: 44002379)
2. Black, G. J. (n.d.). *Microbiology* (8th ed.). John Wiley & Sons. (Accn No: 33013131)
3. Pommerville, J. (n.d.). *Fundamentals of Microbiology* (7th ed.). Jones and Bartlett Publishers. (Accn No: 33013120)
4. Bhattacharyya, C. B. (n.d.). *Environmental Biotechnology*. Oxford University Press. (Accn No: 33009431)
5. Kumari, M. S. (n.d.). *Microbial Physiology*. MJP PUBLICATION. (Accn No: 00063323)

Reference Books

1. Mehrotra. (n.d.). *Principles Of Microbiology*. Tata-Mcgraw-hill Publishing Co-Pvt. (Accn No: 16)
2. Aneja, K. R. (n.d.). *Experiments in Microbiology Plant Pathology Tissue Culture and Microbial Biotechnolog*. New Age International Publishers. (Accn No: 55014790)
3. Jay, J. M. (n.d.). *Modern Food Microbiology*. CBS Publishers & Distributors. (Accn No: 00057913)
4. Evans, M. G. (n.d.). *Environmental Biotechnology*. Wiley India Pvt. Ltd. (Accn No: 33013097)
5. Arul, P. (n.d.). *A Text Book Os Environmental Studies*. Environment Agency. (Accn No: 55009324)

Web Resources

1. <https://mis.alagappauniversity.ac.in/siteAdmin/dde-admin/uploads/3/PG M.Sc. Microbiology 36433%20ENVIRONMENTAL%20AGRI CULTURAL%20MICROBIOLOGY.pdf>
2. https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SMB2201.pdf
3. <https://gyansanchay.csjmu.ac.in/agriculture-and-environment-microbiology-2/>

Course Articulation Matrix: Mapping COs with POs

Co/Po	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	3	1	1	1	0
CO2	3	9	3	1	3	0
CO3	3	9	9	3	3	0
CO4	3	9	9	3	9	1

Co/Po	PO1	PO2	PO3	PO4	PO5	PO6
C05	1	3	9	9	9	3
C06	1	3	9	9	9	9
Weightage	20%	25%	20%	15%	10%	10%
Weighted % Contribution to PO	20%	25%	20%	15%	10%	10%

Course Outcomes Mapped with Knowledge Levels and POs

CO / K-Level	High (9)	Medium (3)	Low (1)	Zero (0)
C01 / K1	PO1	PO2, PO3	PO4, PO5	PO6
C02 / K2	PO2, PO3	-	-	-
C03 / K3	PO3,PO5	PO2,PO4	PO1	-
C04 / K4	-	-	-	-
C05 / K5	-	PO3,PO5	PO2,PO4	PO1
C06 / K6	PO4,PO5	PO2,PO2	PO1	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (5 Marks)	CIA II (6 Marks)	Assignment 1 (4 Marks)	Seminar (5 Marks)	Total Scholastic Marks	Non Scholastic Marks (Attendance - 5 Marks)	Total Marks	% of Assessment
K1	1	1	0.5	0.5	3	0	3	12%
K2	1	1	0.5	0.5	3	0	3	12%
K3	1	1	0.5	1	3.5	0	3.5	14%
K4	1	1	0.5	1	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0.5	1	1	1	3.5	0	3.5	14%
Non Scholastic	--	--	--	--	0	5	5	20%
Total	5	6	4	5	20	5	25	100%

The COs and POs for the course in Agricultural and Environmental Microbiology in MSc Microbiology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEM - II	Prog. Code MIPG2022	Core Course XV	P25MB15
GENETIC ENGINEERING			
CREDITS - 3	THEORY		HOURS - 3

Course Description for Genetic Engineering

This course focuses on the principles and applications of genetic engineering techniques relevant to microbiology. It emphasizes the manipulation of microbial genomes, the use of vectors and expression systems, and advanced molecular biology techniques such as PCR, sequencing, and genome editing. Students will explore microbial applications in biotechnology, medicine, and agriculture while addressing ethical considerations associated with genetic engineering.

Course Objectives

1. To gain foundational knowledge of genetic engineering techniques and their significance in microbiology, including DNA manipulation and gene cloning.
2. To familiarize with essential molecular tools and enzymes used in genetic engineering, such as restriction endonucleases, ligases, and DNA polymerases.
3. To study various vector systems used for gene expression in microbial hosts, including plasmids, bacteriophages, and artificial chromosomes.
4. To develop proficiency in polymerase chain reaction (PCR) methodologies and their applications in microbial diagnostics and gene amplification.
5. To learn techniques for inserting foreign DNA into microbial cells and constructing genomic and cDNA libraries for functional analysis.
6. To understand the principles and applications of genome editing technologies, such as CRISPR-Cas9, in modifying microbial genomes for research and biotechnology applications.

Units	Course Content	Hours per Week (3x15)*
Unit I	Tools and Techniques in Genetic Engineering Impact of Genetic Engineering in Microbiology: <ul style="list-style-type: none"> • Applications in microbial biotechnology, medicine, agriculture, and industry. • General Requirements for Genetic Engineering Experiments: • Laboratory setup, sterile conditions, biosafety protocols. Enzymes Used in Genetic Engineering:	9

	<ul style="list-style-type: none"> Restriction endonucleases, methylases, DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase. <p>DNA Manipulation Techniques:</p> <ul style="list-style-type: none"> Cohesive and blunt-end ligation; linkers; adaptors; homopolymeric tailing. <p>DNA Labeling and Hybridization:</p> <ul style="list-style-type: none"> Nick translation; random priming; radioactive and non radioactive probes. Hybridization techniques: Southern blotting (DNA), Northern blotting (RNA), colony hybridization, fluorescence in situ hybridization (FISH). 	
<p>Unit II</p>	<p>Vectors and Expression Systems for Microbial Applications</p> <p>Types of Vectors:</p> <ul style="list-style-type: none"> Plasmids (E. coli vectors), bacteriophages (lambda vectors), cosmids, artificial chromosome vectors (YACs/BACs). <p>Expression Vectors for Gene Expression:</p> <ul style="list-style-type: none"> pMal, GST-tagged vectors, pET-based vectors for microbial protein production. <p>Protein Purification Tags:</p> <ul style="list-style-type: none"> His-tagged proteins; GST-tagged proteins; intein-based vectors. <p>Microbial Expression Systems:</p> <ul style="list-style-type: none"> Mammalian expression vectors; Baculovirus systems; yeast shuttle vectors; plant-based Ti/Ri vectors. 	<p>9</p>
<p>Unit III</p>	<p>PCR Techniques and Molecular Diagnostics</p> <p>Principles of PCR:</p> <ul style="list-style-type: none"> Primer design; fidelity of thermostable enzymes (e.g., Taq polymerase). <p>Types of PCR Techniques:</p> <ul style="list-style-type: none"> Multiplex PCR, nested PCR, reverse-transcription PCR (RT-PCR), real-time PCR (qPCR), touchdown PCR, hot-start PCR, colony PCR. <p>Applications in Molecular Diagnostics:</p>	<p>9</p>

	<ul style="list-style-type: none"> • Detection of microbial pathogens (viral/bacterial) using PCR-based methods. <p>Sequencing Methods:</p> <ul style="list-style-type: none"> • Automated DNA sequencing; RNA sequencing; mutation detection techniques (SSCP, DGGE, RFLP). 	
Unit IV	<p>Gene Manipulation and Protein-DNA Interactions</p> <p>Insertion of Foreign DNA into Microbial Hosts:</p> <ul style="list-style-type: none"> • Transformation methods (chemical/electroporation); transfection techniques. <p>Construction of Libraries:</p> <ul style="list-style-type: none"> • cDNA libraries from microbial RNA; genomic libraries for microbial genomes. <p>Microarrays for Gene Analysis:</p> <ul style="list-style-type: none"> • Genomic arrays; cDNA arrays for studying microbial gene expression profiles. <p>Protein-DNA Interactions in Microbial Systems:</p> <ul style="list-style-type: none"> • Electrophoretic mobility shift assay (EMSA); DNase footprinting; methyl interference assay; chromatin immunoprecipitation (ChIP). 	9
Unit V	<p>Gene Silencing and Genome Editing Technologies in Microbiology</p> <p>Gene Silencing Techniques for Microbes:</p> <ul style="list-style-type: none"> • siRNA technology for silencing microbial genes; microRNA applications. <p>Principles of Gene Knockouts in Microorganisms:</p> <ul style="list-style-type: none"> • Creating knockouts in bacteria (<i>E. coli</i>), yeast (<i>Saccharomyces cerevisiae</i>), and other microbes. <p>Genome Editing Technologies for Microbial Applications:</p> <ul style="list-style-type: none"> • CRISPR-Cas systems for targeted gene editing in microbial genomes. <p>Applications in Biotechnology and Medicine:</p> <ul style="list-style-type: none"> • Use of transgenic microbes for disease models and industrial production. 	9

CO Level	Course outcome	K Level
C01	Recall tools like restriction enzymes and vectors used in microbial genetic engineering.	K1
C02	Explain the principles behind PCR techniques and their application to microbial diagnostics.	K2
C03	Apply transformation methods to introduce foreign DNA into bacterial cells.	K3
C04	Analyze gene expression data obtained from microarrays or RT-PCR experiments.	K4
C05	Design a CRISPR-Cas experiment to knock out a specific gene in a bacterial genome.	K5
C06	Critically assess the ethical implications of using genome editing technologies like CRISPR-Cas9 on microbial pathogens.	K6

Textbooks

1. Primrose, S. M. (n.d.). *Principles of Gen Manipulation and Genomics*. Wiley India Pvt. Ltd. (Accn No: 33013080)
2. Glick, R. B. (n.d.). *Molecular Biotechnology*. SCIENTIFIC INTERNATIONAL PVT LTD. (Accn No: 33013095)
3. Brown, T. A. (n.d.). *Gene Cloning & DNA Analysis*. Wiley Black Well. (Accn No: 33013104)
4. Chawla, H. S. (n.d.). *Introduction to Plant Biotechnology*. Oxford & IBH. (Accn No: 33013084)
5. Singh, B. D. (n.d.). *Genetics*. Kalyani Publishers. (Accn No: 55014748)

Reference Books

1. Turner, P. C. (n.d.). *Instants Notes in Molecular Biology*. Viva Books Private Limited. (Accn No: 00057910)
2. Ramawat, K. G. (n.d.). *Molecular Biology and Biotechnology*. S.Chand and Co. (Accn No: 3309224)
3. Green, R. M. (n.d.). *Molecular Cloning*. COLD SPRING HARBOR LABORATORY PRESS. (Accn No: 33013081)
4. El-Mansi, E. M. T. (n.d.). *Fermentation Microbiology and Biotechnology*. CRC Press. (Accn No: 33013099)
5. Gupta, P. K. (n.d.). *Genetics*. Rastogi Publications. (Accn No: 55014773)

Web Resources

1. https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SBB2102.pdf
2. <https://gdcboysang.ac.in/About/droid/uploads/Biotech5thSemGE.pdf>
3. <https://www.houstonisd.org/cms/lib2/TX01001591/Centricity/Domain/5364/Ch%2013%20Genetic%20Engineering%20Notes%20WP.pdf>
4. <https://www.toshniwalcollege.ac.in/uploaddata/StudyMaterial/Science/Zoology/P-VIII.pdf>
5. <https://fcen.uncuyo.edu.ar/catedras/techniques-in-genetic-engineering.pdf>

Course Articulation Matrix: Mapping COs with POs

Co/Po	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	3	1	1	1	0
CO2	3	9	3	1	3	0
CO3	3	9	9	3	3	0
CO4	3	9	9	3	9	1
CO5	1	3	9	9	9	3
CO6	1	3	9	9	9	9
Weightage	20%	25%	20%	15%	10%	10%
Weighted % Contribution to PO	20%	25%	20%	15%	10%	10%

Course Outcomes Mapped with Knowledge Levels and POs

CO / K-Level	High (9)	Medium (3)	Low (1)	Zero (0)
CO1 / K1	PO1	PO2, PO3	PO4, PO5	PO6
CO2 / K2	PO2, PO3	PO1, PO5	PO4	-
CO3 / K3	PO2, PO3	-	-	-
CO4 / K4	PO3, PO5	PO2, PO4	PO1	-
CO5 / K5	PO5, PO3	PO2, PO4	PO1	-
CO6 / K6	PO6, PO5	PO3, PO4	PO1, PO2	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

K Levels	CIA I (5 Marks)	CIA II (6 Marks)	Assignment 1 (4 Marks)	Seminar (5 Marks)	Total Scholastic Marks	Non Scholastic Marks (Attendance - 5 Marks)	Total Marks	% of Assessment
K1	1	1	0.5	0.5	3	0	3	12%
K2	1	1	0.5	0.5	3	0	3	12%
K3	1	1	0.5	1	3.5	0	3.5	14%
K4	1	1	0.5	1	3.5	0	3.5	14%

K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0.5	1	1	1	3.5	0	3.5	14%
Non Scholastic	--	--	--	--	0	5	5	20%
Total	5	6	4	5	20	5	25	100%

The COs and POs for the course in Genetic Engineering in MSc Microbiology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEM - II	Prog. Code MIPG2022	Core Course XVI	P25MB16
RESEARCH METHODOLOGY AND SCIENTIFIC COMMUNICATION SKILLS			
CREDITS - 2	THEORY		HOURS - 2

Course Description for Research Methodology and Scientific Communication Skills

This course focuses on the principles and applications of genetic engineering techniques relevant to microbiology. It emphasizes the manipulation of microbial genomes, the use of vectors and expression systems, and advanced molecular biology techniques such as PCR, sequencing, and genome editing. Students will explore microbial applications in biotechnology, medicine, and agriculture while addressing ethical considerations associated with genetic engineering.

Course Objectives

1. To gain knowledge of empirical science, experimental design, and the principles of deductive and inductive reasoning.
2. To learn how to choose a research mentor, select a laboratory, and define a clear research question.
3. To explore techniques for effective verbal and non-verbal communication in scientific contexts.
4. To acquire skills for preparing and delivering formal presentations, including the use of visual aids like PowerPoint.
5. To understand the components of scientific writing, including report layout, abstract drafting, and publication processes.
6. To discuss ethical issues related to research methodology, publication practices, and scientific misconduct.

Units	Course Content	Hours per Week (2x15)*
Unit I	History of science and science methodologies Empirical science; scientific method; manipulative experiments and controls; deductive and inductive reasoning; descriptive science; reductionist vs holistic biology.	6
Unit II	Preparation for research Choosing a mentor, lab and research question; maintaining a lab notebook.	6
Unit III	Process of communication	6

	Concept of effective communication- setting clear goals for communication; determining outcomes and results; initiating communication; avoiding breakdowns while communicating; creating value in conversation; barriers to effective communication; non-verbal communication-interpreting non-verbal cues; importance of body language, power of effective listening; recognizing cultural differences;	
Unit IV	Presentation skills formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions; Computing skills for scientific research - web browsing for information search; search engines and their mechanism of searching; hidden Web and its importance in scientific research; internet as a medium of interaction between scientists; effective email strategy using the right tone and conciseness.	6
Unit V	Scientific communication Technical writing skills - types of reports; layout of a formal report; scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; publishing scientific papers - peer review process and problems, recent developments such as open access and nonblind review; plagiarism; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct.	6

CO Level	Course outcome	K Level
C01	Remember fundamental concepts of the scientific method and experimental design.	K1
C02	Explain the importance of effective communication in scientific research.	K2
C03	Apply presentation skills to deliver a formal presentation using visual aids.	K3
C04	Analyze different types of technical reports and their structures.	K4
C05	Design an email strategy for communicating with peers about research findings.	K5
C06	Critically assess ethical issues related to scientific misconduct in research practices.	K6

Textbooks

1. Kothari, C. R. (n.d.). *Research Methodology*. Wishwa Prakashan. (Accn No: 00056674)
2. Gupta, S. P. (n.d.). *Elementary Statistical Methods*. Sultan Chand & Sons. (Accn No: 55011940)
3. Gurumani, N. (n.d.). *Research Methodology for Biological Sciences*. Mjp Publications. (Accn No: 33009445)
4. NPTEL. (n.d.). *Biotechnology*. (Accn No: 1107)
5. Bull, T. A. (n.d.). *Biotechnhology International Trends and Perspectives*. Oxford &IBH. (Accn No: 00052230)

Reference Books

1. Bhatia, R. (n.d.). *Quality Assurance In Microbiology*. CBS Publishers & Distributors. (Accn No: 55012613)
2. Rastogi, S. C. (n.d.). *Bioinformatics Concepts, Skills & Applications*. Cbs Publication & Distribution. (Accn No: 33013171)
3. Lesk, A. M. (n.d.). *Introduction to Bioinformatics*. Oxfrud University Press. (Accn No: 33012955)
4. Gimble, M. J. (n.d.). *Academia To Biotechnology*. Academic Press. (Accn No: 00064209)
5. Ramawat, K. G. (n.d.). *Comprehensive Biotechnology*. S.Chand and Co., (Accn No: 00062003)

Web Resources

1. <https://www.mastersincommunications.com/features/guide-to-communication-research-methodologies>
2. https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SVCA5301.pdf
3. <https://paperpal.com/blog/academic-writing-guides/what-is-research-methodology#penci-What is research methodology>

Course Articulation Matrix: Mapping COs with POs

Co/Po	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	3	1	1	1	0
CO2	3	9	3	3	3	0
CO3	3	9	9	3	3	0
CO4	3	9	9	9	9	1
CO5	1	3	9	9	9	3
CO6	1	3	9	9	9	9
Weightage	20%	25%	20%	15%	10%	10%
Weighted % Contribution to PO	20%	25%	20%	15%	10%	10%

Course Outcomes Mapped with Knowledge Levels and POs

CO / K-Level	High (9)	Medium (3)	Low (1)	Zero (0)
CO1 / K1	P01	P02, P03	P04, P05	P06
CO2 / K2	P02, P03	P01, P05	P04	-
CO3 / K3	-	-	-	-
CO4 / K4	-	P02,P04	P01	-
CO5 / K5	-	P02,P04	P01	-
CO6 / K6	-	P03,P04	P01,P02	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (5 Marks)	CIA II (6 Marks)	Assignment 1 (4 Marks)	Seminar (5 Marks)	Total Scholastic Marks	Non Scholastic Marks (Attendance - 5 Marks)	Total Marks	% of Assessment
K1	1	1	0.5	0.5	3	0	3	12%
K2	1	1	0.5	0.5	3	0	3	12%
K3	1	1	0.5	1	3.5	0	3.5	14%
K4	1	1	0.5	1	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0.5	1	1	1	3.5	0	3.5	14%
Non Scholastic	--	--	--	--	0	5	5	20%
Total	5	6	4	5	20	5	25	100%

The COs and POs for the course in Research Methodology and Scientific Communication Skills in MSc Microbiology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEM - II	Prog. Code MIPG2022	Elective Course I	P25MB17E
BIOSTATISTICS			
CREDITS - 2	THEORY		HOURS - 3

Course Description for Biostatistics

This course introduces students to the principles and applications of biostatistics in microbiological research. Topics include data collection, descriptive and inferential statistics, probability distributions, hypothesis testing, regression analysis, and experimental design. Students will learn to analyze microbiological data, interpret results, and apply statistical methods to solve real-world problems in microbiology. Emphasis is placed on using statistical software (e.g., R, SPSS) for data analysis and ethical considerations in statistical reporting.

Course Objectives

1. To learn foundational principles of biostatistics, including data types, measures of central tendency, and variability.
2. To study probability theories and distributions relevant to microbiological data (e.g., binomial, Poisson, normal).
3. To perform parametric and non-parametric tests (t-tests, ANOVA, chi-square) for microbiological data analysis.
4. To use correlation and regression techniques to explore associations between variables in microbial studies.
5. To learn principles of experimental design (randomization, replication) and sampling methods for microbiological research.
6. To develop proficiency in statistical software for data analysis and visualization.

Units	Course Content	Hours per Week (3x15)*
Unit I	Introduction to Biostatistics Basic Concepts: <ul style="list-style-type: none"> • Data types (nominal, ordinal, interval, ratio); measures of central tendency (mean, median, mode); measures of dispersion (variance, standard deviation). Graphical Representation: <ul style="list-style-type: none"> • Histograms, box plots, scatter plots; interpretation of microbial data trends. 	9

	<p>Ethical Considerations:</p> <ul style="list-style-type: none"> • Avoiding bias in data collection; ethical reporting of statistical results. 	
Unit II	<p>Probability and Distributions</p> <p>Probability Basics:</p> <ul style="list-style-type: none"> • Rules of probability; conditional probability; Bayes' theorem. <p>Probability Distributions:</p> <ul style="list-style-type: none"> • Binomial (e.g., microbial colony counts), Poisson (rare events), normal (Gaussian) distributions. <p>Applications in Microbiology:</p> <ul style="list-style-type: none"> • Modeling microbial growth rates; predicting contamination probabilities. 	9
Unit III	<p>Hypothesis Testing</p> <p>Parametric Tests:</p> <ul style="list-style-type: none"> • Student's t-test (paired/unpaired); ANOVA (one-way, two-way); post-hoc tests (Tukey's HSD). <p>Non-Parametric Tests:</p> <ul style="list-style-type: none"> • Mann-Whitney U test; Kruskal-Wallis test; chi-square test for categorical data. <p>Interpreting p-values:</p> <ul style="list-style-type: none"> • Significance levels ($\alpha = 0.05$); Type I and Type II errors. 	9
Unit IV	<p>Correlation and Regression</p> <p>Correlation Analysis:</p> <ul style="list-style-type: none"> • Pearson's r; Spearman's rank correlation. <p>Regression Models:</p> <ul style="list-style-type: none"> • Simple linear regression; logistic regression for binary outcomes (e.g., pathogen presence/absence). <p>Model Diagnostics:</p> <ul style="list-style-type: none"> • Residual analysis; checking assumptions (normality, homoscedasticity). 	9
Unit V	<p>Experimental Design and Software Applications</p> <p>Experimental Design:</p> <ul style="list-style-type: none"> • Randomization; blocking; factorial designs; sample size determination. 	9

	<p>Statistical Software:</p> <ul style="list-style-type: none"> Hands-on training in R/SPSS for data analysis (ANOVA, regression, visualization). <p>Case Studies:</p> <ul style="list-style-type: none"> Analyzing antimicrobial resistance data; outbreak investigation datasets. 	
--	---	--

CO Level	Course outcome	K Level
C01	Recall key statistical terms (e.g., mean, variance) and probability distributions.	K1
C02	Explain the principles of hypothesis testing and experimental design.	K2
C03	Apply t-tests or ANOVA to compare microbial growth under different conditions.	K3
C04	Analyze correlations between environmental factors and microbial populations.	K4
C05	Assess the validity of experimental designs in published microbiological studies.	K5
C06	Design a statistically robust experiment to test a hypothesis in microbial ecology.	K6

Textbooks

- Shukla, R. S. (n.d.). *Cytogenetics, Evolution and Biostatistics*. S.Chand and Co. (Accn No: 00061098)
- Gupta, S. P. (n.d.). *Elementary Statistical Methods*. Sultan Chand & Sons. (Accn No: 55011940)
- NPTEL. (n.d.). *Biotechnology*. (Accn No: 1107)
- Bull, T. A. (n.d.). *Biotechnhnology International Trends and Perspectives*. Oxford &IBH. (Accn No: 00052230)
- Lohar, S. P. (n.d.). *Biotechnology*. MJP PUBLICATION. (Accn No: 00063333)

Reference Books

- Rastogi, S. C. (n.d.). *Bioinformatics Concepts, Skills & Applications*. Cbs Publication & Distribution. (Accn No: 33013171)
- Lesk, A. M. (n.d.). *Introduction to Bioinformatics*. Oxford University Press. (Accn No: 33012955)

3. Mount, D. W. (n.d.). *Bioinformatics sequence and Genome Analysis*. Cbs Publication & Distribution. (Accn No: 33013177)
4. Turner, P. C. (n.d.). *Instants Notes in Molecular Biology*. Viva Books Private Limited. (Accn No: 00057910)
5. Jay, J. M. (n.d.). *Modern Food Microbiology*. CBS Publishers & Distributors. (Accn No: 00057913)

Web Resources

1. <https://pmc.ncbi.nlm.nih.gov/articles/PMC4517688/>
2. <https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture-notes/env-health-science-students/ln-biostat-hss-final.pdf>
3. <https://paperpal.com/blog/academic-writing-guides/what-is-research-methodology#penci-What is research methodology>
4. <https://kamarajcollege.ac.in/wp-content/uploads/Elective-Biostatistics-VI-Sem.pdf>
5. [https://cbpbu.ac.in/userfiles/file/2020/STUDY MAT/ZOO/PK%20\(2\).pdf](https://cbpbu.ac.in/userfiles/file/2020/STUDY MAT/ZOO/PK%20(2).pdf)
6. <https://www.uou.ac.in/sites/default/files/slm/MSCBOT-606.pdf>

Course Articulation Matrix: Mapping COs with POs

Co/Po	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	3	1	1	1	0
CO2	3	9	3	3	3	0
CO3	3	9	9	3	3	0
CO4	3	9	9	9	9	1
CO5	1	3	9	9	9	3
CO6	1	3	9	9	9	9
Weightage	20%	25%	20%	15%	10%	10%
Weighted % Contribution to PO	20%	25%	20%	15%	10%	10%

Course Outcomes Mapped with Knowledge Levels and POs

CO / K-Level	High (9)	Medium (3)	Low (1)	Zero (0)
CO1 / K1	PO1	PO2, PO3	PO4, PO5	PO6
CO2 / K2	PO2, PO3	PO1, PO5	PO4	-
CO3 / K3	PO2, PO3	-	-	-
CO4 / K4	PO3, PO5	PO2, PO4	-	-
CO5 / K5	-	-	-	-
CO6 / K6	-	PO3, PO4	PO1, PO2	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (5 Marks)	CIA II (6 Marks)	Assignme nt 1 (4 Marks)	Seminar (5 Marks)	Total Scholast ic Marks	Non Scholasti c Marks (Attendan ce - 5 Marks)	Total Marks	% of Assessme nt
K1	1	1	0.5	0.5	3	0	3	12%
K2	1	1	0.5	0.5	3	0	3	12%
K3	1	1	0.5	1	3.5	0	3.5	14%
K4	1	1	0.5	1	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0.5	1	1	1	3.5	0	3.5	14%
Non Scholast ic	--	--	--	--	0	5	5	20%
Total	5	6	4	5	20	5	25	100%

The COs and POs for the course in Biostatistics in MSc Microbiology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEM - II	Prog. Code MIPG2022	Seminar I	P25MB18S
SEMINAR-I			
CREDITS - 1		Seminar	HOURS - 1

Course Description for Seminar

The Seminar in Microbiology course is designed to enhance students' communication and presentation skills through the exploration of current research topics in microbiology. Students will select a research article or topic relevant to their field of study, critically analyze the content, and prepare a presentation to convey their findings effectively. This course emphasizes the importance of scientific communication, enabling students to articulate complex ideas clearly and engage with their peers in academic discourse.

Course Objectives

1. To learn to identify and select relevant research articles or topics in microbiology for presentation.
2. To analyze and interpret scientific literature, understanding methodologies, results, and implications.
3. To practice effective verbal and non-verbal communication techniques for presenting scientific information.
4. To gain proficiency in using visual aids (e.g., PowerPoint) to enhance presentations and engage the audience.
5. To promote an environment of constructive feedback through peer evaluations and discussions following presentations.
6. To recognize the importance of ethical standards in scientific communication and the responsible use of sources.

Guidelines for Seminar Preparation

Selecting a Topic:

- Choose a current research article or topic relevant to microbiology.
- Ensure the topic is appropriate for your level of understanding and interest.

Researching the Content:

- Read the selected article thoroughly, taking notes on key concepts, methodologies, results, and discussions.
- Supplement your understanding with additional literature as necessary.

Preparing Your Presentation:

- Create a structured outline that includes an introduction, methodology, results, discussion, and conclusion.

- Design visual aids (e.g., PowerPoint slides) that complement your spoken presentation without overwhelming it.

Practicing Delivery:

- Rehearse your presentation multiple times to build confidence.
- Seek feedback from peers or mentors during practice sessions to refine your delivery.

Engaging Your Audience:

- Encourage questions during or after your presentation.
- Be prepared to discuss your topic further based on audience interest.

Reflecting on Feedback:

- After your presentation, reflect on feedback received from peers and instructors.
- Consider how you can improve future presentations based on this feedback.

CO Level	Course outcome	K Level
C01	Recall key concepts from selected research articles or topics in microbiology.	K1
C02	Explain the significance of the research findings and their implications in the field of microbiology.	K2
C03	Apply effective presentation techniques to convey complex scientific information clearly.	K3
C04	Analyze feedback from peers and instructors to improve presentation skills and content delivery.	K4
C05	Integrate information from multiple sources to create a comprehensive overview of a selected topic in microbiology.	K5
C06	Critically assess the quality and relevance of research articles selected for presentation, including methodology and conclusions drawn by authors.	K6

Textbooks

1. Kothari, C. R. (n.d.). *Research Methodology*. Wishwa Prakashan. (Accn No: 00056674)
2. Bull, T. A. (n.d.). *Biotechnology International Trends and Perspectives*. Oxford & IBH. (Accn No: 00052230)
3. NPTEL. (n.d.). *Biotechnology*. (Accn No: 1107)
4. Raven (n.d.). *Biology*. Wm.C.Broun Publishers. (Accn No: 00060305)
5. Weisz, Paul B. (n.d.). *The Science of Biology*. Mc Graw Hill Book Co. (Accn No: 00025426)

Reference Books

1. Turner, P. C. (n.d.). *Instant Notes in Molecular Biology*. Viva Books Private Limited. (Accn No: 00057910)
2. Lesk, Arthur M. (n.d.). *Introduction to Bioinformatics*. Oxford University Press. (Accn No: 33012955)
3. Ramawat, K. G. (n.d.). *Molecular Biology and Biotechnology*. S.Chand and Co. (Accn No: 3309224)
4. Bhatia, Rajesh (n.d.). *Quality Assurance In Microbiology*. CBS Publishers & Distributors. (Accn No: 55012613)
5. Gimble, M. Jeffrey. (n.d.). *Academia To Biotechnology*. Academic Press. (Accn No: 00064209)

Articles

1. Sullivan, K. (2009). Building professional communication skills in microbiology: Integrating oral presentations into laboratory courses. Retrieved from SERC Carleton College:
2. Bond, J. B., & Sullivan, K. (2009). The importance of oral presentations in microbiology education: Reflections from students and instructors. Retrieved from SERC Carleton College:
3. Jordan, E., & Kennesaw State University Institutional Review Board (2018). Communicating microbiology concepts through poster presentations: A transferable skill for all disciplines. *Journal of Microbiology & Biology Education*, 19(1), 1-6.
4. Gallo, C. (2020). How to rock every microbiology lecture with engaging presentation techniques. Retrieved from McGraw Hill Education:
5. Mansoor Ali, M., & Unnikrishnan, A., et al. (2023). Effective use of PowerPoint in microbiology seminars: Best practices for student engagement. Retrieved from Homeobook:

Web Resources

1. <https://USIC.sheffield.ac.uk/blog/how-to-improve-your-presentation-skills>
2. <https://www.youtube.com/watch?v=6Ty3OB3IoDo> (PRESENT LIKE A PRO)
3. <https://www.prepareforsuccess.org.uk/skills-for-presenting-in-seminars.php>
4. <https://www.youtube.com/watch?v=A2TwNWiYIMI> (37 VITAL PHRASES IN ENGLISH TO SPEAK LIKE A PRO)

Course Articulation Matrix: Mapping COs with POs

Co/Po	P01	P02	P03	P04	P05	P06
C01	9	3	1	1	1	0
C02	3	9	3	3	3	0
C03	3	9	9	9	3	0
C04	3	9	9	9	9	1
C05	1	3	9	9	9	3
C06	1	3	9	9	9	9
Weightage	20%	25%	20%	15%	10%	10%
Weighted % Contribution to PO	20%	25%	20%	15%	10%	10%

Course Outcomes Mapped with Knowledge Levels and POs

CO / K-Level	High (9)	Medium (3)	Low (1)	Zero (0)
C01 / K1	P01	P02, P03	P04, P05	P06
C02 / K2	P02, P03	P01, P05	P04	-
C03 / K3	P02, P03	-	-	-
C04 / K4	P03, P05	P02, P04	-	-
C05 / K5	-	-	-	-
C06 / K6	-	P03, P04	P01, P02	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (5 Marks)	CIA II (6 Marks)	Assignment 1 (4 Marks)	Seminar (5 Marks)	Total Scholastic Marks	Non Scholastic Marks (Attendance - 5 Marks)	Total Marks	% of Assessment
K1	1	1	0.5	0.5	3	0	3	12%
K2	1	1	0.5	0.5	3	0	3	12%
K3	1	1	0.5	1	3.5	0	3.5	14%
K4	1	1	0.5	1	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0.5	1	1	1	3.5	0	3.5	14%
Non Scholastic	--	--	--	--	0	5	5	20%
Total	5	6	4	5	20	5	25	100%

The COs and POs for the course in Seminar in MSc Microbiology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEM - II	Prog. Code MIPG2022	Core Course XIXP	P25MB19P
LAB IN MEDICAL MYCOLOGY, PARASITOLOGY, AGRICULTURAL AND ENVIRONMENTAL MICROBIOLOGY			
CREDITS - 3	PRACTICAL		HOURS - 3

Course Description for the lab in Medical Mycology, Parasitology, Agricultural and Environmental Microbiology

This practical course provides hands-on experience in microbiological techniques relevant to medical mycology, parasitology, and agricultural/environmental microbiology. Students will perform experiments to isolate, identify, and characterize fungi, parasites, and environmental microbes. The lab emphasizes diagnostic methods, pathogenicity studies, and applications in agriculture and environmental sustainability. Techniques include microscopy, culturing, molecular diagnostics, and bioassays.

Course Objectives

1. To learn to isolate and identify pathogenic fungi and parasites using microscopy, staining, and culturing.
2. To study host-pathogen interactions and microbial roles in soil fertility and bioremediation.
3. To use PCR, ELISA, and sequencing for microbial identification and characterization.
4. To test efficacy of antifungal drugs and biocontrol agents against pathogens.
5. To explore microbial applications in agriculture (biofertilizers) and environmental cleanup (biodegradation).
6. To adopt biosafety practices and ethical standards in handling pathogens and environmental samples.

List of Laboratory Experiments

Unit I: Medical Mycology

Fungal Staining and Microscopy:

- Use Lactophenol Cotton Blue (LPCB) to stain and identify *Candida*, *Aspergillus*, and dermatophytes.

Antifungal Susceptibility Testing:

- Perform disk diffusion/Kirby-Bauer assay to test antifungal agents (e.g., fluconazole).

Clinical Sample Culture:

- Isolate fungi from sputum/nail scrapings on Sabouraud Dextrose Agar (SDA)

Germ Tube Test:

- Differentiate *Candida albicans* from other species using serum incubation.

Molecular Identification of Fungi:

- Amplify ITS regions via PCR and analyze sequences for fungal identification.

Unit II: Parasitology

Microscopic Identification of Parasites:

- Identify Plasmodium, Entamoeba, and Giardia in blood/stool samples using Giemsa staining.

ELISA for Parasitic Antigens:

- Detect Cryptosporidium or Toxoplasma antigens in clinical samples.

Egg Hatching Assay:

- Study the effect of anthelmintic drugs on helminth egg viability.

Kato-Katz Technique:

- Quantify soil-transmitted helminth eggs in stool samples.

PCR for Parasite Detection:

- Amplify Plasmodium 18S rRNA gene from blood samples.

Unit III: Agricultural Microbiology

Isolation of Rhizobia:

- Culture root nodule bacteria from legumes and test nitrogen-fixing activity.

Phosphate Solubilization Assay:

- Screen soil bacteria (Pseudomonas) for phosphate-solubilizing ability on Pikovskaya agar.

Biofertilizer Preparation:

- Mass-produce Azotobacter or Azospirillum for seed inoculation

Antagonistic Activity of Trichoderma:

- Test biocontrol potential against phytopathogens (e.g., Fusarium).

Soil Microbial Diversity Analysis:

- Use serial dilution and spread-plate methods to quantify soil bacteria/fungi.

Unit IV: Environmental Microbiology

Biodegradation of Hydrocarbons:

- Isolate oil-degrading bacteria from contaminated soil using Bushnell-Haas medium

Biosurfactant Production:

- Test bacterial isolates for emulsification activity (oil-spreading test).

Heavy Metal Resistance Assay:

- Screen microbes for tolerance to lead/mercury on nutrient agar plates.

Composting Efficiency Test:

- Monitor microbial activity during organic waste decomposition (CO₂ evolution).

BOD/COD Analysis:

- Assess microbial degradation of organic pollutants in water samples.

CO Level	Course outcome	K Level
C01	Identify fungal/parasitic structures under the microscope.	K1
C02	Explain principles of antifungal susceptibility testing or biofertilizer preparation.	K2
C03	Perform ELISA or PCR to detect pathogens in clinical/environmental samples.	K3
C04	Compare microbial diversity in compost vs. untreated soil using CFU counts.	K4
C05	Design an experiment to test the efficacy of Trichoderma as a biocontrol agent.	K5
C06	Assess the environmental impact of heavy metal-resistant bacteria in bioremediation.	K6

Textbooks

1. Dubey, R. C. (n.d.). *A Text Book of Microbiology*. S.Chand and Co. (Accn No: 44002379)
2. Arora, D. R. (n.d.). *Textbook of Microbiology* (5th ed.). Cbs Publication & Distribution. (Accn No: 33013166)
3. Pommerville, J. (n.d.). *Fundamentals of Microbiology* (7th ed.). Jones and Bartlett Publishers. (Accn No: 33013120)
4. Black, G. J. (n.d.). *Microbiology* (8th ed.). John Wiley & Sons. (Accn No: 33013131)
5. Prasad, M. M. (n.d.). *Laboratory Manual of Microbiology*. New India Publishing Agency. (Accn No: 00063771)

Reference Books

1. Aneja, K. R. (n.d.). *Experiments in Microbiology Plant Pathology Tissue Culture and Microbial Biotechnolog* (6th ed.). New Age International Publishers. (Accn No: 55014790)
2. Mehrotra. (n.d.). *Principles Of Microbiology*. Tata-Mcgraw-hill Publishing Co-Pvt. (Accn No: 16)
3. Russell, H. L. (n.d.). *Dairy Bacteriology*. University Publication. (Accn No: 00063765)
4. Vijaya Ramesh, K. (n.d.). *Food Microbiology*. Mjp Publication. (Accn No: 00063766)
5. Jay, J. M. (n.d.). *Modern Food Microbiology*. CBS Publishers & Distributors. (Accn No: 00057913)

Web Resources

1. https://www.researchgate.net/profile/Mohammed-Saleem-Ali-Shtayeh/publication/233945721_Laboratory_Manual_for_Mycology/links/57fcc6fc08ae4189fee40478/Laboratory-Manual-for-Mycology.pdf
2. <https://eportal.mountsinai.ca/Microbiology/manual/myc/index.shtml> (Medical Microbiology)
3. https://www.researchgate.net/profile/Mohammed-Saleem-Ali-Shtayeh/publication/233945721_Laboratory_Manual_for_Mycology/links/57fcc6fc08ae4189fee40478/Laboratory-Manual-for-Mycology.pdf (MYCOLOGY MANUAL)
4. <https://msptm.org/wp-content/uploads/2020/05/DVS-ManualParasitology-web.pdf>
5. <https://www.k-state.edu/michellab/lab%20manual%20biol546-2012.pdf>
6. [https://iris.who.int/bitstream/handle/10665/40793/9241544104_\(part1\).pdf;jsessionid=622960502ED2233A497BECE113F10D0F?sequence=1](https://iris.who.int/bitstream/handle/10665/40793/9241544104_(part1).pdf;jsessionid=622960502ED2233A497BECE113F10D0F?sequence=1)
7. <https://jru.edu.in/studentcorner/lab-manual/agriculture/agriculture%20microbiology%20manual.pdf>
8. <https://www.bhumipublishing.com/wp-content/uploads/2022/06/A-Laboratory-Manual-in-Agricultural-Microbiology-Microbiology-and-Biotechnology.pdf>
9. <https://kau.in/document/microbiology-laboratory-manual>
10. https://www.uni-due.de/imperia/md/content/water-science/ss16/4521_script_ag siebers.pdf (env. Micro)

Course Articulation Matrix: Mapping COs with POs

Co/Po	P01	P02	P03	P04	P05	P06
CO1	9	3	1	1	1	0
CO2	3	9	3	1	3	0
CO3	3	9	9	3	3	0
CO4	3	9	9	3	9	1
CO5	1	3	9	9	9	3
CO6	1	3	9	9	9	9
Weightage	20%	25%	20%	15%	10%	10%
Weighted % Contribution to PO	20%	25%	20%	15%	10%	10%

Course Outcomes Mapped with Knowledge Levels and POs

CO / K-Level	High (9)	Medium (3)	Low (1)	Zero (0)
CO1 / K1	P01	P02, P03	P04, P05	P06
CO2 / K2	P02, P03	P01, P05	P04	-
CO3 / K3	P02, P03	-	-	-
CO4 / K4	P03, P05	P02, P04	-	-
CO5 / K5	-	-	-	-
CO6 / K6	-	P03, P04	P01, P02	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (5 Marks)	CIA II (6 Marks)	Assignment 1 (4 Marks)	Seminar (5 Marks)	Total Scholastic Marks	Non Scholastic Marks (Attendance - 5 Marks)	Total Marks	% of Assessment
K1	1	1	0.5	0.5	3	0	3	12%
K2	1	1	0.5	0.5	3	0	3	12%
K3	1	1	0.5	1	3.5	0	3.5	14%
K4	1	1	0.5	1	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0.5	1	1	1	3.5	0	3.5	14%
Non Scholastic	--	--	--	--	0	5	5	20%
Total	5	6	4	5	20	5	25	100%

The COs and POs for the course in Lab in Medical Mycology, Parasitology, Agricultural and Environmental Microbiology in MSc Microbiology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEM - II	Prog. Code MIPG2022	Core Course XXP	P25MB20P
LAB IN BIOSTATISTICS, GENETIC ENGINEERING, FOOD AND DAIRY MICROBIOLOGY			
CREDITS - 3	PRACTICAL		HOURS - 3

Course Description for the lab in Biostatistics, Genetic Engineering, Food and Dairy Microbiology

This laboratory course integrates hands-on experiments in biostatistics, genetic engineering, and food and dairy microbiology. Students will gain practical experience in statistical data analysis, molecular techniques for genetic manipulation, and microbiological methods for food safety and quality control. The course emphasizes the application of these techniques to real-world problems in microbiology, fostering critical thinking and technical proficiency.

Course Objectives

1. To learn to analyze experimental data using biostatistical tools and interpret results effectively.
2. To gain proficiency in genetic engineering methods, including PCR, cloning, and plasmid isolation.
3. To develop skills to detect microbial contamination in food and dairy products using microbiological assays.
4. To explore the role of microbes in food fermentation and analyze their metabolic activities.
5. To combine statistical analysis with microbiological techniques to address complex research questions.
6. To follow biosafety and ethical guidelines in handling microorganisms and analyzing data.

List of Laboratory Experiments

Unit I: Biostatistics

Descriptive Statistics:

- Calculate mean, median, mode, standard deviation, and variance for microbiological data (e.g., CFU counts).

Graphical Representation of Data:

- Create histograms, scatter plots, and box plots for microbial growth patterns using statistical software (e.g., R/SPSS).

Hypothesis Testing:

- Perform t-tests and ANOVA to compare microbial growth under different conditions (e.g., pH or temperature variations).

Correlation and Regression Analysis:

- Analyze relationships between environmental factors (e.g., temperature) and microbial activity using regression models.

Chi-Square Test for Categorical Data:

- Apply chi-square tests to analyze microbial contamination patterns in food samples.

Unit II: Genetic Engineering

Plasmid Isolation:

- Extract plasmids from E. coli cultures using alkaline lysis methods.

Restriction Digestion and Ligation:

- Perform restriction enzyme digestion of DNA and ligate fragments into vectors for cloning purposes.

Polymerase Chain Reaction (PCR):

- Amplify target DNA sequences using PCR; optimize reaction conditions for specific microbial genes.

Agarose Gel Electrophoresis:

- Visualize DNA fragments from PCR or restriction digestion experiments using gel electrophoresis techniques.

Transformation of Competent Cells:

- Introduce recombinant plasmids into E. coli via heat shock or electroporation methods.

Unit III: Food Microbiology

Microbial Load Analysis in Food Samples:

- Perform total plate count (TPC) to determine microbial load in milk, cheese, or yogurt samples.

Detection of Pathogens in Food Products:

- Use selective media to isolate Salmonella, E. coli, or Listeria from contaminated food samples.

Milk Quality Testing:

- Conduct methylene blue reduction test (MBRT) to assess milk quality based on microbial activity levels.

Antimicrobial Activity of Preservatives:

- Test the efficacy of food preservatives (e.g., sodium benzoate) against spoilage microbes using disk diffusion assays.

Fermented Food Microbiology:

- Isolate lactic acid bacteria (*Lactobacillus*, *Streptococcus*) from yogurt or pickles; study their fermentation properties.

Unit IV: Dairy Microbiology

Microbial Analysis of Dairy Products:

- Identify spoilage organisms in butter or cream using differential media (e.g., SDA for fungi).

Starter Culture Preparation for Yogurt Production:

- Prepare starter cultures (*Lactobacillus delbrueckii*, *Streptococcus thermophilus*) for yogurt fermentation experiments.

Detection of Coliforms in Milk Samples:

- Use the Most Probable Number (MPN) method to detect coliform contamination in raw milk samples.

Enzyme Activity Assays in Dairy Microbes:

- Measure protease or lipase activity from dairy-associated microbes (*Bacillus*, *Pseudomonas*).

Study of Probiotic Properties of Dairy Microbes:

- Evaluate bile salt tolerance and acid resistance of probiotic strains (*Lactobacillus* spp.).

Unit V: Integrated Applications

Statistical Analysis of Experimental Data Using R/SPSS:

- Analyze data from genetic engineering or food microbiology experiments using statistical software tools.

Microbial Growth Kinetics Study Using Biostatistics Tools:

- Model microbial growth curves under varying environmental conditions using regression analysis.

PCR-Based Pathogen Detection in Food Samples:

- Detect specific pathogens (*Salmonella*, *Listeria*) in food products using PCR techniques.

Quality Control in Fermented Foods Using Statistical Methods:

- Assess the consistency of fermentation processes by analyzing pH changes statistically over time.

Ethical Reporting of Experimental Results:

- Prepare lab reports adhering to ethical standards for data representation and interpretation.

CO Level	Course outcome	K Level
CO1	Recall basic statistical methods and molecular techniques used in microbiology experiments.	K1
CO2	Explain the principles behind PCR amplification or statistical hypothesis testing.	K2
CO3	Apply biostatistical tools to analyze experimental data from food microbiology studies.	K3
CO4	Analyze experimental results to identify trends or relationships between variables.	K4
CO5	Design an experiment integrating genetic engineering techniques with biostatistical analysis.	K5
CO6	Critically assess the reliability of experimental results based on statistical significance.	K6

Textbooks

1. Gupta, S. P. (n.d.). *Elementary Statistical Methods*. Sultan Chand & Sons. (Accn No: 55011940)
2. Primrose, S. M. (n.d.). *Principles of Gen Manipulation and Genomics*. Wiley India Pvt. Ltd. (Accn No: 33013080)
3. Adams, M. R. (n.d.). *Food microbiology*. Cambridge. (Accn No: 13)
4. Erkmen, O. (n.d.). *Food Microbiology*. John Wiley. (Accn No: 14)
5. Black, G. J. (n.d.). *Microbiology* (8th ed.). John Wiley & sons. (Accn No: 33013131)

Reference Books

1. Jay, J. M. (n.d.). *Modern Food Microbiology*. CBS Publishers & Distributors. (Accn No: 00057913)
2. Ramawat, K. G. (n.d.). *Molecular Biology and Biotechnology*. S.Chand and Co., (Accn No: 3309224)
3. Bhatia, R. (n.d.). *Quality Assurance In Microbiology*. CBS Publishers & Distributors. (Accn No: 55012613)
4. Rastogi, S. C. (n.d.). *Bioinformatics Concepts, Skills & Applications*. Cbs Publication & Distribution. (Accn No: 33013171)
5. Mount, D. W. (n.d.). *Bioinformatics sequence and Genome Analysis*. Cbs Publication & Distribution. (Accn No: 33013177)

Web Resources

<https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture-notes/env-health-science-students/ln-biostat-hss-final.pdf>

https://faculty.ksu.edu.sa/sites/default/files/145_stat_textbook.pdf

<https://www.uou.ac.in/sites/default/files/slm/MSCBOT-606.pdf>

Course Articulation Matrix: Mapping COs with POs

Co/Po	PO1	PO2	PO3	PO4	PO5	PO6
C01	9	3	1	1	1	0
C02	3	9	3	1	3	0
C03	3	9	9	3	3	0
C04	3	9	9	9	9	1
C05	1	3	9	9	9	3
C06	1	3	9	9	9	9
Weightage	20%	25%	20%	15%	10%	10%
Weighted % Contribution to PO	20%	25%	20%	15%	10%	10%

Course Outcomes Mapped with Knowledge Levels and POs

CO / K-Level	High (9)	Medium (3)	Low (1)	Zero (0)
C01 / K1	PO1	PO2, PO3	PO4, PO5	PO6
C02 / K2	PO2, PO3	-	-	-
C03 / K3	-	-	-	-
C04 / K4	PO3,PO5	PO2,PO4	-	-
C05 / K5	-	-	-	-
C06 / K6	-	PO3,PO4	PO1,PO2	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (5 Marks)	CIA II (6 Marks)	Assignment 1 (4 Marks)	Seminar (5 Marks)	Total Scholastic Marks	Non Scholastic Marks (Attendance - 5 Marks)	Total Marks	% of Assessment
K1	1	1	0.5	0.5	3	0	3	12%
K2	1	1	0.5	0.5	3	0	3	12%
K3	1	1	0.5	1	3.5	0	3.5	14%
K4	1	1	0.5	1	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0.5	1	1	1	3.5	0	3.5	14%

Non Scholastic	--	--	--	--	0	5	5	20%
Total	5	6	4	5	20	5	25	100%

The COs and POs for the course in Lab in Biostatistics, Genetic Engineering, Food and Dairy Microbiology in MSc Microbiology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

*****End of Semester II with 25 Credits and 30 Hours per Cycle*****