



Syllabus of 2nd Year M.Sc. Microbiology



UPL University of Sustainable Technology
SRICT Institute of Science & Research

AY-2025-2026

UPL University of Sustainable Technology, Ankleshwar				
SRICT-Institute of Science and Research (SRICT-ISR)				
M.Sc. Microbiology (2nd Year)				
SEM	TYPE OF COURSE	COURSE CODE	NAME OF SUBJECT	Credits
3	Major Course	MIM500-5C	Advanced Analytical Techniques and Instrumentations	4
	Major Course	MIM501-5C	Molecular Biology and Advanced Genetic Engineering	4
	Major Course	MIM502-5C	Microbial Physiology	4
	Major Course	MIM503-5C	Practicals in Microbiology-VII	6
	Major Course	MIR500-5C	Research Project-Foundation	4
Total Credits				22
4	Major Course	MIM504-5C	Pharmaceutical Microbiology and Biopharmaceuticals	4
	Minor Course	MIE500-5C	Research Methodology	2
	Major Course	MIR501-5C	Research Project- Advanced	16
Total Credits				22

M.Sc. Microbiology
M.Sc. Sem. III
Teaching/Exam Scheme

w.e.f.: July-2026

Sr. No.	Course Code	Category of course	Course title	Hours Per week			Total hrs.	Credits	E	M	I	V	Total Marks
				L	T	P							
1	MIM500-5C	Major Course	Advanced Analytical Techniques and Instrumentations	4	0	-	4	4	50	50	-	-	100
2	MIM501-5C	Major Course	Molecular Biology and Advanced Genetic Engineering	4	0	-	4	4	50	50	-	-	100
3	MIM502-5C	Major Course	Microbial Physiology	4	0	-	4	4	50	50	-	-	100
4	MIM503-5C	Major Course	Practicals in Microbiology-VII	-	-	12	12	6	75	75	-	-	150
5	MIR500-5C	Major Course	Research Project-Foundation	-	-	8	8	4	-	-	50	50	100
			Total	12	0	20	32	22	225	225	50	50	550

M.Sc. Microbiology
Semester-III
Course Code: MIM500-5C
Course Name: Advanced Analytical Techniques and Instrumentations
w.e.f.: July-2026

Type of course: Major Course

Prerequisite: Basic understanding of chemistry, biochemistry, and molecular biology concepts is required. Familiarity with laboratory practices and fundamental analytical techniques will be beneficial.

Rationale: This course provides in-depth knowledge of advanced analytical techniques essential for modern scientific research in microbiology. It enables students to understand instrumentation principles and their applications in microbiology. The course bridges theoretical concepts with practical analytical approaches used in research and industry. It prepares learners for interdisciplinary work in microbiology, biotechnology, pharmaceuticals, and material sciences.

Teaching and Examination Scheme:

Credits				Examination Marks		Total Marks
L	T	P	Total	CCE Marks	SSE Marks	
4	-	-	4	50	50	100

Contents:

Sr. No.	Content	Total Hours
SECTION - A		
1	Microscopy Bright-Field and Dark- Field Microscopy: Principles and Applications, Phase-Contrast Imaging, Fluorescence Microscopy, Confocal, super resolution microscopy, From Labels to Living, High-Resolution Electron Microscopy Methods, Cryo-EM, Live cell imaging.	10
2	Electrophoresis Techniques, Types and General Principle of Electrophoresis, Supporting Matrices in Electrophoresis, Electrophoresis of Nucleic Acids, Electrophoresis of Protein – SDS-PAGE, 2D-PAGE, Capillary electrophoresis, Isoelectric focusing.	10

3	<p>Chromatography in Analytical and Molecular Studies</p> <p>Basic Principles of Chromatography: Distribution coefficients, Column chromatography, development of analyte and elution Adsorption chromatography, Partition chromatography, Ion-exchange chromatography, Molecular (size) exclusion chromatography, Affinity chromatography, HPLC, GC, FPLC.</p>	10
SECTION - B		
4	<p>Advanced Spectroscopy techniques</p> <p>Introduction to electromagnetic radiation, UV-VIS Light Spectroscopy: Principles and Instrumentation, Infrared Spectroscopy: Principle, Instrumentation (FTIR) and Application, Surface Plasmon Resonance: Principle, Instrumentation and Application.</p>	10
5	<p>Techniques for Structural and Molecular Analysis</p> <p>NMR Spectrometry: Principles, Instrumentation and Applications, X-Ray Diffraction, Mass Spectrometry, LC-MS, Maldi-TOF.</p>	10
6	<p>Immunological Assay Methods and biosensor</p> <p>Lateral Flow–Based Diagnostic Assays, Epitope Identification Methods Protein Detection by Immunoblotting, Cell Analysis and Sorting by FACS, Electrochemical and optical biosensors, Lab on chips, microfluidics.</p>	10

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	U Level	A Level	N Level	E Level	C Level
25	30	10	15	10	10

Legends: R: Remembrance, U: Understanding, A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom’s Taxonomy)

Text Books:

1. Skoog, D. A., Holler, F. J., & Crouch, S. R. – *Principles of Instrumental Analysis*.
2. Wilson, K. & Walker, J. – *Principles and Techniques of Biochemistry and Molecular Biology*.
3. Willard, H. H. et al. – *Instrumental Methods of Analysis*

Reference Books:

1. Settle, F. A. – *Handbook of Instrumental Techniques for Analytical Chemistry*.
2. Silverstein, R. M. et al. – *Spectrometric Identification of Organic Compounds*.
3. Lottspeich, F. & Engels, J. W. – *Bioanalytical Chemistry*.
4. Griffiths, D. J. – *Introduction to Electrodynamics* (for spectroscopy fundamentals).

Course Outcomes: After completing this course, student will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Understand principles and applications of various microscopy techniques for structural and functional analysis of biological samples.	15
CO-2	Explain different electrophoretic techniques and their applications in separation and characterization of biomolecules.	20
CO-3	Analyze chromatographic methods for separation, purification, and identification of chemical and biological compounds.	18
CO-4	Interpret spectroscopic techniques and their role in qualitative and quantitative analysis of substances.	17
CO-5	Evaluate advanced techniques like NMR and mass spectrometry for molecular structure determination.	15
CO-6	Apply immunological and biosensor-based techniques for diagnostics, detection, and analytical applications.	15

M.Sc. Microbiology
Semester-III
Course Code: MIM501-5C
Course Name: Molecular Biology and Advanced Genetic Engineering
w.e.f.: July-2026

Type of course: Major Course

Prerequisite: Basic knowledge of cell biology, genetics, and biochemistry is essential. Understanding of fundamental molecular processes will support advanced learning in genetic engineering.

Rationale: This course provides a comprehensive understanding of molecular biology and modern genetic engineering techniques. It equips students with knowledge of gene structure, expression, and manipulation for research and industrial applications. The course integrates classical molecular concepts with advanced recombinant DNA technologies. It prepares learners for careers in microbiology, biotechnology, healthcare, and molecular research fields.

Teaching and Examination Scheme:

Credits				Examination Marks		Total Marks
L	T	P	Total	CCE Marks	SSE Marks	
4	-	-	4	50	50	100

Contents:

Sr. No.	Content	Total Hours
SECTION - A		
1	Structure of Nucleic Acids and Replication Structure and Properties of Nucleic Acids: DNA structure (double helix, base pairing, antiparallel strands), RNA structure and types (mRNA, tRNA, rRNA, regulatory RNA), Chromatin Organization, Nucleosome structure, Genes and Genome Organization, DNA Replication: Mechanism and steps (initiation, elongation, termination), Enzymes involved (DNA polymerase, helicase, ligase, primase).	11
2	Transcription & Translation Transcription: Mechanism and stages, RNA polymerase and promoter recognition. Translation and Post-Synthesis Modifications: Post-transcriptional (splicing,	9

	capping, polyadenylation) and Post-translational (folding, modification, activation) mechanism.	
3	<p>Gene regulation & mutation</p> <p>Regulation of Gene Expression: Prokaryotic gene regulation, Eukaryotic gene regulation and epigenetics. Regulation of Transcription: Operon model (Arabinose and Tryptophan Operon). Mutations: Definition and types (point, frameshift, chromosomal), Effects of mutations. Mutagenic Agents: Physical mutagens (UV, X-rays), Chemical mutagens. DNA Repair Mechanisms: Direct repair, Excision repair (base and nucleotide), Mismatch repair and SOS repair. Mobile Genetic Elements, Transposons.</p>	10
SECTION - B		
4	<p>Recombinant DNA technology</p> <p>Introduction to rDNA Technology: Concept and importance. Tools of Recombinant DNA Technology: Restriction enzymes, DNA ligase, Cloning vectors. Types of Cloning Vectors, Plasmids, Bacteriophages, Cosmids, Bacterial Artificial Chromosomes (BACs), Gene Cloning Strategies, Isolation of gene of interest, Vector insertion, Transformation into host, Screening and selection.</p>	12
5	<p>Gene transfer & Expression</p> <p>Methods of Gene Transfer: Transformation, Transduction, Conjugation. Expression of Recombinant Proteins: Host systems (bacterial, yeast, mammalian), Promoter systems and induction. Reporter Genes: Concept and applications, Examples (GFP, lacZ). Selection Markers: Antibiotic resistance markers, Screening methods.</p>	9
6	<p>Applications & advances in rDNA technology</p> <p>Medical and Industrial Applications: Production of insulin, vaccines, hormones, Monoclonal antibodies. Molecular Techniques: PCR (Polymerase Chain Reaction). DNA Sequencing Sanger method, Next-generation sequencing. Gene Therapy, CRISPR technology, Genomics, Proteomics, Bioethics and Intellectual Property Rights (IPR): Ethical issues in biotechnology.</p>	9

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	U Level	A Level	N Level	E Level	C Level
25	30	10	15	10	10

Legends: R: Remembrance, U: Understanding, A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Text Books:

1. Watson, J. D. et al. – *Molecular Biology of the Gene*.
2. Brown, T. A. – *Gene Cloning and DNA Analysis: An Introduction*.
3. Alberts, B. et al. – *Molecular Biology of the Cell*.

Reference Books:

1. Primrose, S. B. & Twyman, R. M. – *Principles of Gene Manipulation and Genomics*.
2. Lodish, H. et al. – *Molecular Cell Biology*.
3. Glick, B. R., Pasternak, J. J., & Patten, C. L. – *Molecular Biotechnology*.
4. Karp, G. – *Cell and Molecular Biology: Concepts and Experiments*.

Course Outcomes: After completing this course, student will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Explain the structure, properties, and functional organization of genetic material and core molecular biology concepts.	15
CO-2	Describe molecular mechanisms of DNA replication, transcription, translation, and their regulation in prokaryotes and eukaryotes.	15
CO-3	Analyze gene regulation mechanisms, types of mutations, DNA repair processes, and the role of mobile genetic elements.	20
CO-4	Understand tools, vectors, and strategies used in recombinant DNA technology and gene cloning.	20
CO-5	Evaluate different gene transfer methods and expression systems for recombinant protein production.	15
CO-6	Apply knowledge of rDNA technology in medicine, industry, and research, including genomics, proteomics, and bioethics.	15

M.Sc. Microbiology
Semester-III
Course Code: MIM502-5C
Course Name: Microbial Physiology

w.e.f.: July-2026

Type of course: Major Course

Prerequisite: Basic knowledge of microbiology, biochemistry, and cell biology is required. Understanding of fundamental metabolic processes will support learning of microbial physiology.

Rationale: This course provides detailed insights into the physiological processes and metabolic pathways of microorganisms. It helps students understand how microbes grow, utilize nutrients, and generate energy under diverse conditions. The course integrates biochemical pathways with microbial adaptation and survival strategies. It prepares learners for applications in biotechnology, environmental science, and industrial microbiology.

Teaching and Examination Scheme:

Credits				Examination Marks		Total Marks
L	T	P	Total	CCE Marks	SSE Marks	
4	-	-	4	50	50	100

Contents:

Sr. No.	Content	Total Hours
SECTION - A		
1	<p>Two component regulation</p> <p>Prototypical Two Component regulatory system, Spectrum of Functions: Osmolarity Changes and Porin Regulation, Quorum sensing and staphylococcal virulence, The Phosphorelay and Sporulation Initiation in <i>Bacillus subtilis</i>. Physiology, Biochemistry & Genetic Aspects of: Oxidative Stress Response and Regulation, Heat Shock Response, pH Stress and Acid Tolerance, Nutritional Stress and Starvation Stress Response.</p>	11
2	<p>Nitrogen and Sulfur Metabolism</p> <p>Biological Nitrogen fixation. The Nitrogen Fixation process. Symbiotic Nitrogen Fixation. Inorganic Nitrogen Metabolism. Assimilation of Inorganic Nitrogen. Regulation of Nitrogen fixation. General Reactions of Amino Acids. The</p>	9

	Stickland Reaction. Sulfate assimilation. Sulfide formation and sulphide consumption by bacteria. Dissimilatory sulfate reduction. Microbial sulphur oxidation.	
3	Energy Metabolism in Microorganisms Basic concepts of metabolism, Oxidation – reduction reactions, Energy generation by anaerobic metabolism – Glycolysis, Pentose Phosphate pathway, ED pathway, Fermentation. Energy generation by Aerobic metabolism - TCA cycle.	10
SECTION - B		
4	Oxidative Metabolism and Catabolic Processes in Microbes Glyoxylate pathway and Electron Transport chain, Mechanism of ATP synthesis – Chemiosmosis, Pasteur effect. Metabolism of lipids- β oxidation. Catabolism of carbohydrate, Catabolism of protein, Catabolism of lipid.	12
5	Energy Metabolism and Biosynthesis in Microbes Anaerobic Respiration. Nitrogen, Sulphur, Iron and Hydrogen Oxidation. Methanogens. Biosynthesis – Gluconeogenesis, Peptidoglycan synthesis, Cell wall and Capsule Biosynthesis.	9
6	Photosynthesis and Photo metabolism in Microorganisms Photosynthesis – process, antenna of light-harvesting pigments, Photochemical reaction centres, Photosynthetic Electron Transport Chain-Cyclic and Non-cyclic. Oxygenic and An oxygenic Photosynthesis. Calvin-Benson cycle. Bioluminescence - Process and application.	9

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	U Level	A Level	N Level	E Level	C Level
25	30	10	15	10	10

Legends: R: Remembrance, U: Understanding, A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Text Books:

1. Madigan, M. T. et al. – *Brock Biology of Microorganisms*.
2. Moat, A. G., Foster, J. W., & Spector, M. P. – *Microbial Physiology*.
3. Gottschalk, G. – *Bacterial Metabolism*

Reference Books:

1. Stanier, R. Y. et al. – *General Microbiology*.
2. White, D. – *The Physiology and Biochemistry of Prokaryotes*.
3. Atlas, R. M. – *Principles of Microbiology*.
4. Nelson, D. L. & Cox, M. M. – *Lehninger Principles of Biochemistry*..

Course Outcomes: After completing this course, student will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Explain nutritional requirements of microorganisms and various transport mechanisms across microbial membranes.	15
CO-2	Analyze microbial growth patterns, measurement techniques, and factors influencing microbial growth.	15
CO-3	Describe metabolic pathways involved in energy generation under anaerobic and aerobic conditions.	20
CO-4	Evaluate oxidative metabolic pathways, ATP synthesis mechanisms, and catabolic processes of biomolecules.	20
CO-5	Understand diverse energy-generating processes and biosynthetic pathways in microorganisms.	15
CO-6	Explain photosynthetic mechanisms, light reactions, and photo-metabolic processes in microorganisms.	15

M.Sc. Microbiology
Semester-III
Course Code: MIM503-5C
Course Name: Practicals in Microbiology-VII

w.e.f.: July-2026

Type of course: Major Course

Prerequisite: Students enrolling in this course should have prior knowledge of basic concepts of Microbiology, Fundamental laboratory techniques and concepts of Molecular Biology.

Rationale: This course is designed to provide hands-on experience in essential microbiological and biochemical techniques. It bridges theoretical knowledge with practical skills required for research and industry applications. Students will learn microbial cultivation, biochemical analysis, and molecular biology techniques such as DNA/RNA isolation and PCR. The course also introduces modern analytical and bio separation methods through demonstrations, preparing students for advanced studies and laboratory work in biotechnology, healthcare, and research sectors.

Teaching and Examination Scheme:

Credits				Examination Marks		Total Marks
L	T	P	Total	CCE Marks	SSE Marks	
-	-	12	6	75	75	150

Contents:

Sr. No.	Content	Total Hours
	1. Thin layer chromatography of sugars. 2. Thin layer chromatography of amino acids. 3. Determination of λ_{max} of coloured compound using spectrophotometer. 4. Isolation and cultivation of photosynthetic microorganism. 5. Study of bacterial growth curve. 6. Study of fungal growth by slide culture technique. 7. Effect of pH on microbial growth. 8. Effect of Temperature on microbial growth. 9. Effect of salt on microbial growth. 10. Isolation of bacterial genomic DNA. 11. Detection of bacterial genomic DNA using Electrophoretic technique.	120

	12. Extraction of plasmid DNA from bacteria. 13. Extraction of total RNA from yeast. 14. Study of bacterial transformation. 15. Study of RFLP. 16. Study of gel permeation chromatography (Online demonstration). 17. Study of PCR (Online demonstration). 18. Southern blot (Online demonstration). 19. Recombinant protein expression (Online demonstration). 20. Next Generation Sequencing (Online demonstration).	
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Distribution of Practical Marks:

A Level	B Level	C Level	D Level
10	15	15	10

Legends: A: Conduction of Practical, B: Regular Record Writing, C: Viva-Voce, D: Understanding

Text Books:

1. Patel, Rakesh J. and Patel Kiran, R. "Experimental Microbiology Vol. I and Vol. II". Aditya Prakashan, Ahmedabad. 2009
2. M. Gopal Reddy, M., Reddy, M.N., Saigopal, D.V.R. and Mallaiah K.V., "Laboratory Experiments in Microbiology", Himalaya Publishing House, Mumbai. 2007

Reference Books:

1. Aneja, K.R., "Laboratory Manual of Microbiology and Biotechnology. 2" Edition", Meditech Scientific International. 2018
2. Grainger. John, Hurst. Janet and Burdass. Dariel, "Basic Practical Microbiology: A Manual" The Society for General Microbiology. 2001
3. <https://microbenotes.com/introduction-to-antigen-antibody-reactions/>

Course Outcomes: After completing this course, student will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Perform chromatographic techniques such as thin layer chromatography for separation of sugars and amino acids.	20
CO-2	Apply spectrophotometric methods to determine λ_{max} and analyze biochemical compounds.	15
CO-3	Isolate, cultivate, and study growth patterns of microorganisms under different environmental conditions (pH, temperature, salinity).	15
CO-4	Demonstrate microbiological techniques including bacterial and fungal culture, growth curve analysis, and slide culture methods.	15
CO-5	Execute molecular biology techniques such as DNA/RNA extraction, electrophoresis, bacterial transformation, PCR, and RFLP analysis.	15
CO-6	Understand and interpret advanced biochemical and molecular.	20

M.Sc. Microbiology
Semester-III
Course Code: MIR500-5C
Course Name: Research Project-Foundation

w.e.f.: July-2026

Type of Course: Core course

Prerequisite: Basic knowledge of postgraduate Microbiology concepts, research methodology, and laboratory skills.

Rationale: The Research Project – Foundation is designed to provide students with in-depth exposure to real-world research or industrial practices in microbiology. It allows students to apply theoretical knowledge to practical problems, develop independent research skills, and gain experience in experimental design, data interpretation, and scientific communication. Through University Defined Projects (UDP) or Industry Defined Projects (IDP), students are trained to work in professional environments, fostering critical thinking, innovation, and problem-solving abilities essential for careers in research, academia, and industry.

Teaching and Examination Scheme:

					Examination Marks				Total Marks
L	T	P	Total	Credits	Theory Marks		Practical Marks		
-	-	8	8	4	CCE (M)	SEE (E)	CCE (I)	SEE (V)	
					-	-	50	50	100

Content:

Sr. No.	Content	Total Hrs.
1	<p>Final semester of M.Sc. is dedicated to Major project work. There are two categories offered out of which student has to opt for any one. They listed as:</p> <ol style="list-style-type: none"> 1. <i>University Defined Project (UDP)</i> 2. <i>Industry Defined Project (IDP)</i> <p>From the above two categories students have to select either of the one.</p> <p>UDP /IDP:</p>	120

	<p>Minimum twelve weeks in a University/Industry to get exposure to the practical aspects in the field of chemical science. In addition, the student may also work on a specified task or project which may be assigned to him/her by industry mentor or faculty. The outcome of the project should be presented in the form of a thesis report and defense. They must prepare a report on a specific template (Guidelines) provided by the Department of Microbiology. Upon completion of the research project, students are required to present their work before the expert committee. Students must submit 02 copy of their Project Thesis to the department.</p>	
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Note:*Assessment & evaluation of the research project-I in Semester-III will be carried out purely based on the submission of 01 copy spiral bound report comprising literature survey and proposal of the work.

Course Outcomes: After completing this course, student will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Identify and formulate research problems through literature review.	10%
CO-2	Design and perform experiments using appropriate techniques.	20%
CO-3	Analyze and interpret experimental data scientifically.	10%
CO-4	Demonstrate independent research and critical thinking skills.	20%
CO-5	Communicate research outcomes through reports and presentations.	20%
CO-6	Follow ethical practices, safety norms, and sustainability principles in research.	20%

Reference:

1. <https://www.aicte-india.org/sites/default/files/AICTE%20Internship%20Policy.pdf>
2. https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf

M.Sc. Microbiology
M.Sc. Sem. IV
Teaching/Exam Scheme

w.e.f.: July-2026

Sr. No.	Course Code	Category of course	Course title	Hour's Per week			Total hrs.	Credits	E	M	I	V	Total Marks
				L	T	P							
1	MIM504-5C	Major Course	Pharmaceutical Microbiology and Biopharmaceuticals	4	0	-	4	4	50	50	50	-	100
2	MIE500-5C	Minor Course	Research Methodology	2	0	-	2	2	-	-	25	25	50
3	MIR501-5C	Core Course	Research Project-Advanced	-	-	32	32	16	-	-	200	200	400
Total				6	0	32	38	22	50	50	225	225	550

M.Sc. Microbiology
Semester-IV
Course Code: MIR500-5C

Course Name: Pharmaceutical Microbiology and Biopharmaceuticals

w.e.f.: July-2026

Type of course: Major Course

Prerequisite: Basic knowledge of microbiology, biochemistry, and pharmaceutical sciences is essential. Understanding of microbial growth and laboratory techniques will support advanced pharmaceutical applications.

Rationale: This course provides an understanding of the role of microorganisms in pharmaceutical production and quality control. It focuses on microbial contamination, sterilization, and regulatory frameworks essential for safe drug manufacturing. The course integrates microbiology with industrial pharmaceutical practices and biopharmaceutical advancements. It prepares learners for careers in pharmaceutical industries, quality assurance, and regulatory affairs.

Teaching and Examination Scheme:

Credits				Examination Marks		Total Marks
L	T	P	Total	CCE Marks	SSE Marks	
4	-	-	4	50	50	100

Contents:

Sr. No.	Content	Total Hours
SECTION - A		
1	Introduction to pharmaceuticals Introduction to pharmaceuticals: Microorganisms and medicines, Role of microorganisms in pharmaceutical industry, Sources of contaminations (air, water, personal, equipment's), GLP.	10
2	Monitoring microbiological quality Principles of good manufacturing practice, Monitoring microbiological quality – Conventional testing methods, Monitoring microbiological quality – Application of rapid methods, Microbial limit tests, Pyrogen testing, Endotoxin detection, rapid microbiological methods.	10
3	Microbial aspects of pharmaceutical processing Microbial spoilage and preservation of pharmaceutical products, Sterilization	10

	control and sterility assurance, Advanced sterilization methods (gamma radiation, filtration, etc), Validation of sterilization process, biological indicators and validation protocols.	
SECTION - B		
4	Pharmaceutical sterile products and microbiological auditing Types of sterile products: Injections, non-injectable sterile fluids, ophthalmic preparations, dressing, implants, absorbable hemostats, surgical ligatures and sutures, instruments & equipment. Vaccines: Seed lot system, production, fermentation, blending, filling, and drying. In-vitro diagnosis, Immune sera, Human immunoglobulin & monoclonal antibodies, Microbiological auditing.	10
5	Regulatory & GMP Framework Good Manufacturing Practices (GMP), WHO, USFDA, CDSCO, EP, IP guidelines, Documentation and audit systems, Validation and compliances. Laboratory safety protocols and management.	10
6	Emerging trends in pharmaceutical Microbiology Recombinant DNA technology in pharmaceutical, Microbial production of therapeutic proteins, Biosimilars and biopharmaceutical regulations, mRNA vaccines and advanced therapeutics, Personalized medicine, AI in Pharmaceutical microbiology.	10

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	U Level	A Level	N Level	E Level	C Level
25	30	10	15	10	10

Legends: R: Remembrance, U: Understanding, A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Text Books:

- Hugo, W. B. & Russell, A. D. – *Pharmaceutical Microbiology*.
- Denyer, S. P., Hodges, N. A., & Gorman, S. P. – *Hugo and Russell's Pharmaceutical Microbiology*.
- Walsh, G. – *Biopharmaceuticals: Biochemistry and Biotechnology*.

Reference Books:

1. Aulton, M. E. – *Aulton's Pharmaceutics: The Design and Manufacture of Medicines*.
2. Ansel, H. C. – *Pharmaceutical Calculations*.
3. Crommelin, D. J. A. & Sindelar, R. D. – *Pharmaceutical Biotechnology*.
4. United States Pharmacopeia (USP) – *USP–NF Standards*.

Course Outcomes: After completing this course, student will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Explain the role of microorganisms in pharmaceutical industries and identify sources of microbial contamination.	15
CO-2	Understand principles and methods for monitoring microbiological quality, including rapid and conventional techniques.	20
CO-3	Analyze microbial spoilage, sterilization methods, and validation processes in pharmaceutical production.	15
CO-4	Evaluate types of sterile pharmaceutical products, vaccine production processes, and microbiological auditing systems.	15
CO-5	Interpret regulatory guidelines, GMP principles, and documentation required for pharmaceutical compliance.	15
CO-6	Assess modern biopharmaceutical advancements including recombinant products, biosimilars, and AI applications.	20

M.Sc. Microbiology
Semester-IV
Course Code: MIE500-5C
Course Name: Research Methodology

w.e.f.: July-2026

Type of course: Minor Course

Prerequisite: Should have familiarity with scientific literature and research concepts.

Rationale: At the end of the course, it provides students with a clear understanding of research concepts, scientific methods, problem identification, hypothesis formulation, research design, sampling techniques, and data analysis using appropriate statistical and software tools. The course also emphasizes interpretation of results, scientific writing, publication ethics, and responsible research practices, thereby preparing students to conduct independent research, critically evaluate scientific literature, and effectively communicate research findings in academic and professional environments.

Teaching and Examination Scheme:

					Examination Marks				Total Marks
L	T	P	Total	Credits	Theory Marks		Practical Marks		
2	-	-	2	2	CCE (M)	SEE (E)	CCE (I)	SEE (V)	
					-	-	25	25	50

Contents:

Sr. No.	Content	Total Hours
SECTION - A		
1	Foundations of research Meaning, objectives, motivation, utility. concept of theory, empiricism, deductive and inductive theory. characteristics of scientific method- understanding the language of research- concept, construct, definition, variable. research process.	8
2	Problem identification & formulation Research question, investigation question, measurement issues, hypothesis, qualities of a good hypothesis, null hypothesis & alternative hypothesis. hypothesis testing - logic & importance. Research design- Concept and importance in research – features of a good research design- exploratory research design- concept, types and uses, descriptive research designs – concept, types and uses. experimental design: concept of independent & dependent variables.	7

SECTION - B		
3	<p>Sampling & Data analysis</p> <p>Concepts of statistical population, sample, sampling frame, sampling error, sample size, non response. characteristics of a good sample. probability sample – simple random sample, systematic sample, stratified random sample & multi-stage sampling. determining size of the sample- practical considerations in sampling and sample size. Data analysis: Data preparation - univariate analysis (frequency tables, bar charts, pie charts, percentages), bivariate analysis - cross tabulations and chi-square test including testing hypothesis of association. uses of various software tools for chemistry.</p>	7
4	<p>Interpretation of data and paper writing</p> <p>Layout of a research paper, journals in chemistry, impact factor of journals, when and where to publish? ethical issues related to publishing, plagiarism and self-plagiarism. Tools for effective writing, Reference Manager.</p>	8

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	U Level	A Level	N Level	E Level	C Level
20	20	10	20	15	15

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom’s Taxonomy)

Text Books:

1. Donald Cooper & Pamela Schindler, Research Methods, 9th edition, Tata McGraw-Hill (TMGH), ISBN: 978-0073214870, 2006.
2. Alan Bryman & Emma Bell, Business Research Methods , Oxford University Press, 5th Edition, ISBN: 979-0-19-254590-9, 2019.
3. P.L. Bhandarkar, T.S. Wilkinson. Methodology and Techniques of Social Research, Himalaya Publishing House, Mumbai, ISBN-978-9350974728, 2016.
4. Panneerselvam. R. Research Methodology, Prentice Hall of India, New Delhi, 2nd Edition, ISBN: 9788120349469, 2004.
5. Green, P.E., Research for Marketing Decisions, Prentice-Hall of India, New Delhi, 3rd Edition, ISBN: 978-8120307575, 1994.

Reference Books:

1. Young, P.V., Scientific Social Survey and Research, Prentice-Hall sociology series, 2nd Edition, ISBN: 9788120300859, 1949.
2. Kothari.C.R. Research Methodology - Methods & Technology, New Age International Publisher, New Delhi, 4th Edition, ISBN- 978-81-224-2488-1, 2019.
3. Gupta, S.P. Statistical Methods, Sultan Chand and sons, 9788125916543, 9351611760, ISSN: 9351611760, 1999.
4. C. B. Gupta & Vijay Gupta, An introduction to Statistics Methods, Vikas Publishing House, ISBN: 9788125916543, 1998.

Course Outcomes: After completing this course, student will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Understand research fundamentals, scientific methods, and hypothesis formulation.	15%
CO-2	Design research methodologies using appropriate designs and sampling techniques.	20%
CO-3	Apply statistical tools and software for data analysis and interpretation.	20%
CO-4	Communicate research findings effectively through scientific writing and publications.	15%
CO-5	Practice research ethics, plagiarism awareness, and responsible research conduct.	15%
CO-6	Apply ethical research practices supporting sustainability principles.	15%

List of Open Source Software/learning website:

1. NPTEL - https://onlinecourses.nptel.ac.in/noc26_ge43/preview
2. <https://www.library.qmul.ac.uk/subject-guides/chemistry/useful-websites/>
3. https://blog.feedspot.com/chemistry_websites/
4. <https://egyankosh.ac.in/bitstream/123456789/85257/3/Unit-2.pdf>
5. <https://egyankosh.ac.in/bitstream/123456789/73586/3/Unit-7.pdf>
6. <https://egyankosh.ac.in/bitstream/123456789/118467/1/Unit-1.pdf>
7. <https://egyankosh.ac.in/bitstream/123456789/8380/1/Unit-10.pdf>

M.Sc. Microbiology
Semester-IV
Course Code: MIR501-5C
Course Name: Research Project-Advanced

w.e.f.: July-2026

Type of Course: Core course

Prerequisite: Basic knowledge of postgraduate Microbiology concepts, research methodology, and laboratory skills.

Rationale: The Research Project– Advanced is designed to provide students with in-depth exposure to real-world research or industrial practices in microbiology. It allows students to apply theoretical knowledge to practical problems, develop independent research skills, and gain experience in experimental design, data interpretation, and scientific communication. Through University Defined Projects (UDP) or Industry Defined Projects (IDP), students are trained to work in professional environments, fostering critical thinking, innovation, and problem-solving abilities essential for careers in research, academia, and industry.

Teaching and Examination Scheme:

					Examination Marks				Total Marks
L	T	P	Total	Credits	Theory Marks		Practical Marks		
-	-	32	32	16	CCE (M)	SEE (E)	CCE (I)	SEE (V)	
					-	-	200	200	400

Content:

Sr. No.	Content	Total Hrs.
1	<p>Final semester of M.Sc is dedicated to Major project work. There are two categories offered out of which student has to opt for any one. They listed as:</p> <ol style="list-style-type: none"> 1. <i>University Defined Project (UDP)</i> 2. <i>Industry Defined Project (IDP)</i> <p>From the above two categories students have to select either of the one.</p>	48

	<p>UDP /IDP:</p> <p>Minimum twelve weeks in a University/Industry to get exposure to the practical aspects in the field of chemical science. In addition, the student may also work on a specified task or project which may be assigned to him/her by industry mentor or faculty. The outcome of the project should be presented in the form of a thesis report and defense. They must prepare a report on a specific template (Guidelines) provided by the Department of Microbiology. Upon completion of the research project, students are required to present their work before the expert committee. Students must submit 02 copy of their Project Thesis to the department.</p>	
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Note:*Assessment & evaluation of the research project-II in Semester-IV will be carried out based Review-I, II and III presentations of the research conducted, submission of 02 copies of embossed bound project thesis and open viva-voce examination.

Course Outcomes: After completing this course, student will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Identify and formulate research problems through literature review.	10%
CO-2	Design and perform experiments using appropriate techniques.	20%
CO-3	Analyze and interpret experimental data scientifically.	10%
CO-4	Demonstrate independent research and critical thinking skills.	20%
CO-5	Communicate research outcomes through reports and presentations.	20%
CO-6	Follow ethical practices, safety norms, and sustainability principles in research.	20%

Reference:

1. <https://www.aicte-india.org/sites/default/files/AICTE%20Internship%20Policy.pdf>
2. https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English