FACULTY OF SCIENCE
DEPARTMENT OF MICROBIOLOGY
SUBJECT: MICROBIOLOGY

SYLLABUS REVISED: 2025-2026

Department of Microbiology
OSMANIA UNIVERSITY
HYDERABAD, TELANGANA
M.Sc Microbiology

The Department of Microbiology offers student-centric M.Sc. Microbiology program grounded in the principles of Outcome-Based Education. This framework emphasizes measurable learning achievements rather than traditional content delivery. The curriculum integrates interdisciplinary concepts and embeds elements of the Indian Knowledge System (IKS) across both core and elective courses. It also incorporates technology-enhanced learning through online offerings such as SWAYAM courses. In addition, the program provides skill-based training, research methodology, and a dissertation component tailored to industry ready task force. The Program Outcomes (POs) and Course Outcomes (COs), structured across various cognitive levels, are complemented by a systematic PO–CO mapping. This mapping creates a matrix that shows the alignment between individual course goals, broader program goals, and the overall educational goals for graduates. This systematic approach ensures that the curriculum is coherent and effectively guides students toward achieving the intended graduate attributes.

Program Outcomes (PO):

PO1: Graduates will gain fundamental knowledge of the microbial world, cellular and molecular processes crucial for rigorous scientific investigations.

PO2: Graduates will possess the research skills, ability to design experiments, use computational tools for data interpretation and analysis

PO3: Graduates will be equipped with critical problem-solving and innovative thinking skills, alongside robust communication abilities, allowing them to thrive in diverse arenas of Microbial Sciences.

PO4: Graduates will apply their disciplinary knowledge to combat the global challenges using different research methodologies

PO5: Graduates will be trained for conceptual learning, practice ethics and contribute to research and development

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Program Specific Outcome (PSO):

PSO1: Graduates will be able to understand about the importance of microorganisms and their use in agriculture, environment, food, medical and pharma sectors.

PSO2: Graduates will be able use different instrumentation techniques, analyze data using statistical and computations tools to corelate research on microorganisms

PSO3: Graduates will be able to apply the microbial system as bio factories for natural and recombinant products such as antibiotics, biosimilars, bio stimulants, vaccines etc.

PSO4: Graduates will be able to take up research activities, scientific writing, and application SOPs for quality assurance

Program Educational Objectives (PEOs):

PEO1: Graduates will have a strong foundation in the fundamental understanding of microbial sciences including bacteria, virus, fungi and interdisciplinary research

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PEO2: Graduates will be able to develop concepts of research, critical and experimental thinking, trouble shooting in experimental research and evaluate the importance of microbial technology.

PEO3: Graduates will become an insightful individual with orientation towards research to identify gaps, formulate meaningful questions and carve out unique investigations.

PEO4: Graduates will be trained with instrumentation and analytical studies and be ready with technical savoir-faire for industries and take up research towards goals of Sustainable Development

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DEPARTMENT OF MICROBIOLOGY

M.Sc. MICROBIOLOGY (CBCS) COURSE OUTCOMES

COURSE OUTCOMES OF M.Sc. MICROBIOLOGY		
SEMESTER - I		
Course Code	**Course Title**	**Course Outcome**
MB 101	**General Microbiology & Microbial Physiology (Core)**	**CO1 :** Recall traditional information, major discoveries and scientific theories to understand fundamentals of microbial life. **CO 2:** Competency and SOPs to handle microorganisms in the lab and their purification techniques. **CO 3 :** Understanding microbial diversity, phenotypic studies, classification, phylogenetic analysis using computational tools.. **CO 4 :** Analyze the sigmoidal growth curve to draw conclusions about the cell cycle, microbe's growth, physiology and metabolism
MB 102	**Virology (Core)**	**CO1:** Understanding viral classification using ICTV and metadata for virome research. **CO2:** Comprehend Virus – Host Interactions and replication strategies **CO3:** Explain the traditional use of Indian spices, natural proteins and synthetic antiviral agents. **CO4:** Demonstrate appropriate *in-vitro* techniques, such as embryonated eggs and cell culture to cultivate viruses and create awareness on virus multiplication.

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MB 103	**Molecular Biology and Microbial Genetics** (Core)	**CO 1**: Articulate the relationship between genes, nucleic acids and proteins in the context of the molecular processes. **CO 2:** Evaluate the distinct roles of gene regulation and genetic recombination in bacterial adaptation and survival. **CO 3:** Strategies of cloning, genetic engineering techniques and applications. **CO 4:** Acquire hands-on molecular biology skills, develop technical lab proficiency and precision.
MB 104	**Microbial Biochemistry (Core)**	**CO 1** : Explain the chemical composition of living matter, critical roles of pH and its regulation **CO 2:** Analyze the structure, function and significance of biomolecules in metabolic regulation. **CO 3:** Perform qualitative and quantitative analysis to interpret Lineweaver - Burk plot. **CO 4:** Analyze the principles of enzyme kinetics and apply this knowledge to understand inhibition and regulation.

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SEMESTER – II		
MB 201	**Artificial Intelligence and Computational Microbiology (Core)**	**CO 1:** Explain the core concepts of AI, ML, and DL in microbial aspects. **CO 2**:Apply AI models and complementary technologies (IoT, cloud) to analyse microbial data sets **CO 3 :** Apply programming skills in Python and R to analyse biological data through bioinformatics tools. **CO 4:** Demonstrate the applications of AI and informatics for research on microbiome, precision medicine and drug discovery
MB 202	**Immunology (Core)**	**CO 1:** Comprehensive understanding of the immune system, including its key components, responses, and related clinical applications. **CO 2:** Define immunological tolerance and critique the effectiveness of the immune system's response during persistent infections **CO3:** Compare and contrast the features and activation triggers of the classical and alternate complement pathways. **CO4:** Understand the fundamental principles behind the development of vaccines and hands on training on diagnostic assays to handle controlled clinical samples.

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MB 203	**Industrial Microbiology (Core)**	**CO 1:** Design and implement effective microbial strain improvement strategies and BioE3 policies **CO 2:** Demonstration and Handling lab scale level fermenter, operational protocols. **CO 3:** Apply bioprocess techniques and nanotechnology for research **CO 4:** Comprehensive understanding of industrial-scale microbial production, qualitative and quantitative assays.
MB 204	**Pharmaceutical Microbiology (Core)**	**CO 1 :** Critical knowledge and skills necessary for working in the pharmaceutical industry, focusing on quality assurance, regulatory compliance, and sterile manufacturing practices. **CO 2:** Encompass a broad range of regulatory, technological, and scientific principles essential for the modern pharmaceutical and biotechnology industries **CO 3 :** Equip with a strong foundation in the history, principles, and applications of chemotherapy, traditional medicine and novel antimicrobial compounds **CO 4:** Perform techniques such as antibiotic susceptibility tests (e.g., Kirby-Bauer) and determine the Minimum Inhibitory Concentration (MIC) of an antimicrobial agent.

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COURSE OUTCOMES AND PROGRAMME OUTCOMES MAPPING

SEMESTER - I

MB 101- General Microbiology & Microbial Physiology (Core)

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	2	1
CO2	2	3	2	2	2
CO3	3	3	2	2	2
CO4	3	3	2	2	1
Average	2.8	2.8	1.8	2	1.5

MB 102– Virology (Core)

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	2	1
CO2	3	2	2	2	1
CO3	2	3	2	2	2
CO4	3	3	2	3	2
Average	2.8	2.5	2	2.3	1.5

MB 103 - Molecular Biology and Microbial Genetics (Core)

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	2	1
CO2	3	2	3	3	2
CO3	2	3	3	3	1
CO4	2	3	2	2	2
Average	2.5	2.5	2.5	2.5	1.5

MB 104 - Microbial Biochemistry (Core)

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	1	2
CO2	3	3	2	2	2
CO3	2	3	2	2	2
CO4	3	3	2	3	2
Average	2.8	2.8	1.8	2	2

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SEMESTER -II

MB 201- Artificial Intelligence and Computational Microbiology (Core)

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	1	1
CO2	2	3	2	3	2
CO3	1	3	2	2	2
CO4	3	3	3	3	3
Average	2.3	2.8	2.3	2.3	2

MB 202– Immunology (Core)

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	2	1
CO2	3	2	3	2	1
CO3	3	1	2	1	1
CO4	2	3	2	3	2
Average	2.8	2	2	2	1.3

MB 203 – Industrial Microbiology (Core)

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5
Course Outcomes (COs)	2	3	3	3	2
CO1	2	3	2	2	2
CO2	2	3	3	3	2
CO3	3	3	2	3	2
CO4	2.3	3	2.5	2.8	2

MB 204 – Pharmaceutical Microbiology (Core)

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	3	3
CO2	3	2	2	2	3
CO3	3	1	2	2	2
CO4	2	3	2	3	2
Average	2.8	2	2	2.5	2.5

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Mapping of PEOs with POs

	PO1	PO2	PO3	PO4	PO5
PEO1	3	2	2	2	2
PEO2	2	3	3	3	3
PEO3	2	3	3	3	3
PEO4	1	3	2	2	2
Average	**2**	**2.8**	**2.5**	**2.5**	**2.5**

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DEPARTMENT OF MICROBIOLOGY, OSMANIA UNIVERSITY
MSc MICROBIOLOGY
CHOICE BASED CREDIT SYSTEM (CBCS)
Schedule for Instruction and Examination
(Proposed Scheme of Syllabus for Academic year 2025 onwards)

SEMESTER – I						
Paper Code	**Subject/ Paper titles**	**Credits**	**Teaching Hours**	**Marks**		
				Internal Assessment	**Semester Exam**	**Total**
THEORY						
MB 101	General Microbiology & Microbial Physiology (Core)	4	4	30	70	100
MB 102	Virology (Core)	4	4	30	70	100
MB 103	Molecular biology and Microbial Genetics (Core)	4	4	30	70	100
MB 104	Microbial Biochemistry (Core)	4	4	30	70	100
PRACTICALS						
MB 151	General Microbiology & Microbial Physiology	2	4		50	50
MB 152	Virology	2	4		50	50
MB 153	Molecular biology and Microbial Genetics	2	4		50	50
MB 154	Microbial Biochemistry	2	4		50	50
	Total	**24**	**32**	**120**	**480**	**600**

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Examination Evaluation Pattern

Continuous and Comprehensive Evaluation (CCE)

Internal Assessment Pattern: 30 M

Semester end Examination: 70 M

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M.Sc. (Previous) I Semester (CBCS)

Paper I MB 101 General Microbiology and Microbial Physiology (Core)
(8 Hrs per week = 6 credits)

Course Objectives: This course provides students with fundamental knowledge in microbiology, including microscopic identification, cell structure, growth, and nutritional needs. The objective of the practical lab is to develop students' laboratory skills in aseptic and culturing techniques, microbial growth dynamics and quantification.

CO. No.	Course Outcomes	Levels
CO1	Recall traditional information, major discoveries and scientific theories to understand fundamentals of microbial life	Review, Understand
CO2	Competency and SOPs to handle microorganisms in the lab and their purification techniques	Skill
CO3	Understanding microbial diversity, phenotypic studies, classification, phylogenetic analysis using computational tools.	Knowledge, Skill
CO4	Analyze the sigmoidal growth curve to draw conclusions about the cell cycle, microbe's growth, physiology and metabolism	Analyze, Evaluate

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Paper – I: General Microbiology and Microbial Physiology (Core)

Unit I

Pioneers of Microbiology. Early conceptualization of microorganisms within ancient tradition and literature.

Microscopy- Principles, working and applications of bright field microscope, fluorescent microscope, Phase contrast microscope, electron microscope.

Microbial Cell Structure: Prokaryotic cell, Eukaryotic cell. Organization and function of cellular organelles. Biomechanics and Mechanobiology to understand bacterial physiology. Proteins FtsZ, MreB, crescentin. Mechanosensors and motility appendages. Bacterial endospore structure, biochemistry and genetics of sporulation.

Unit II

Methods of sterilization: Physical methods and chemical methods.

Microbiological media - Autotrophic media, synthetic media, heterotrophic media. The concept of prototrophs and auxotrophs. Minimal media, defined media, complex media. Cultivation of Bacteria, Fungi and Algae : Routine and special culture methods.

Isolation of pure cultures. Preservation and Maintenance of Microbial Cultures: Routine methods and Liquid nitrogen preservation, freeze-drying (lyophilization), etc.

Unit III

Microbial identification: staining methods and microscopic. Ecological, Nutritional (cultural) biochemical methods, immunological characteristics, Molecular and genetic characteristics (16s rRNA and ITS). Principles of bacterial taxonomy and classification: - Numerical taxonomy, Bergey's manual and its importance.

Microbial nutrition and metabolism: autotrophy – Photoautotrophy and bacterial photosynthesis Chemoautotrophy and heterotrophic metabolism.

Unit IV

Microbial growth: The concept of growth and definition, formation of protoplasm, building of macromolecules from elemental nutrients, supramolecules, organelles of cell and cellular components. Cell cycle in microbes and generation time.

Growth phases of bacteria and importance of each growth phase.

Synchronous cultures – methods of synchronous culturing. Continuous culturing methods, factors (pH, temperature, drought, salinity) affecting growth. Methods of microbial growth measurement.

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I Semester MB 151 General Microbiology and Microbial Physiology
Practical PAPER I

1. General instructions, Microbiology laboratory and its discipline
2. Handling of microscopes, Calibration and measurement of microscopic objects
3. Staining techniques for bacteria – simple, differential and special stainings
4. Sterilization procedures/methods
5. Preparation of microbiological media. Autotrophic media, minimal media, basic media, enriched media, enrichment media, differential media.
6. Isolation and cultivation of pure cultures
7. Identification methods of bacteria: Biochemical and molecular (demonstration)
8. Isolation and culturing of fungi (yeasts and molds) and algae
9. Culturing methods of microbes – slant and stab cultures, tube culture, flask cultures, shake flask cultures
10. Anaerobic culturing methods – anaerobic jar and its use, pyrogallol method, thioglycollate media culturing, anaerobic glove box and its application
11. Microbial growth experiments – Viable count
12. Calculation of generation time of bacteria
13. Study of bacterial growth curve
14. Effect of temperature and pH on microbial growth
15. Bacterial growth experiments under drought and osmotic stress.

Recommended books

1. Pelczar's A Textbook of Microbiology, 7th Edition (2025) by Michael J. Pelczar Jr
2. Brock Biology of Microorganisms 16th Edition (2023) by Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley, David A. Stahl
3. Prescott's Microbiology 11th Edition (2020) by Joanne Willey, Kathleen Sandman, Chris Woolverton
4. Bergey's Manual of Systematic Bacteriology Vol. 1-5; 2nd Edition
5. Microbiology: An Introduction 14th Edition (2021) by Gerard J. Tortora, Berdell R. Funke, Christine L. Case
6. Microbial Physiology 4th Edition by Albert G. Moat, John W. Foster, Michael P. Spector
7. A Textbook of Microbiology 10th Edition (2024) by Ananthanarayan and Panikar
8. Microbiology Practical Manual 3rd Edition (2024) by Shukla Das
9. Practical Handbook of Microbiology 4th Edition (2020) by Lorrence H. Green (Editor)
10. Microbiology Laboratory Theory and Application 5th Edition (2023) by Michael J. Pelczar Jr. et al.
11. Alfred Brown and Heidi Smith, 2017, Bensons Microbiological application: A laboratory manual in General Microbiology, Indian Edition, Mc.Graw Hill (13e)
12. Laboratory manual of Microbiology and Biotechnology by K.R. Aneja. 2014

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M. Sc. I Semester Microbiology (CBCS)
Paper II MB 102 Virology (Core)
(8 Hrs per week = 6 credits)

Course Objectives:

The objective of this course is to summarize the key discoveries that shaped the field of virology. compare the characteristics of major plant and animal viruses, and evaluate strategies for viral diagnosis, prevention, and making of viral vaccines. At the practical lab, students will be trained for essential virology techniques *in vitro*

CO. No.	Course Outcomes	Levels
CO1	Understanding viral classification using ICTV and metadata for virome research	Review, Understand
CO2	Comprehend Virus – Host Interactions and replication strategies	Understand
CO3	Explain the traditional use of Indian spices, natural proteins and synthetic antiviral agents	Review
CO4	Demonstrate appropriate *in-vitro* techniques, such as embryonated eggs and cell culture, to cultivate viruses and create awareness on viruses	Understand and Skill

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Paper -II: Virology

Unit I

History of Virology (Latest Scientific Investigations), Viral Classification: Baltimore, Recent changes to Virus Taxonomy, ICTV-Virosphere and Hierarchical Ranks. Viral Metadata Resource, Viral Metagenomics-Virome. Virus Structure and Morphology. Detection of Viruses: Physical, Biological, Serological and Molecular methods. Cultivation and Quantification of bacteriophages, plant and animal viruses. Significance of Emerging Viruses: Ebola, Nipah, Hantavirus, Zika virus. General idea about Cyanophages, Actinophages and Mycophages. Sub-Viral Particles: Satellites Virus, Viroids and Prions.

Unit II

Viral replication Strategies. Cellular interactions - Clathrin Coated Pits, Lipid Rafts, Endocytosis and Virus Uncoating mechanisms. Host response to viral infection-Apoptosis, Necrosis, Stress Response. Cellular basis of transformation, Types of Cytopathic Effects.

Structure, Characteristics and Replication strategies of T4 and Lambda, ds/ssDNA virus: Pleolipoviridae- Archaeal virus; ds DNA viruses: Adenoviridae - Adenovirus; ss DNA: Nanoviridae - BBTV; ds RNA viruses: Reoviridae - Rota virus; (+) ssRNA virus: Coronaviridae - SARS-CoV-2; Virgaviridae: Tobacco Mosaic Virus (TMV); (–) ssRNA virus: Paramyxoviridae - Measles virus; ssRNA-RT virus: Retroviridae- HIV; dsDNA-RT virus: Hepadnaviridae - Hepatitis B virus.

Unit III

Introduction to traditional medicine; role of spices used in Indian foods for prevention and treatment of Viral Infections.

Pathogenicity, Lab Diagnostics, Prevention and Control of Plant viruses:

Cauliflower Mosaic Virus, Gemini viruses.

Pathogenicity, Lab Diagnostics, Prevention and Control of Animal viruses: Air borne viral infections: Influenza, Rubella, Mumps; Water borne viral infections - Hepatitis (HAV), Polio myelitis. Zoonotic viral infections - Rabies, Dengue. Sexually transmitted viral diseases – Herpes (Herpes Simplex Virus) Hepatitis B viruses, HIV-acquired immunodeficiency syndrome (AIDS)

Unit IV

Recombination in Phages, Multiplicity Reactivation and Phenotypic Mixing.

General account of Tumor virus (RNA and DNA). Viral Interference and Interferons. Classification of Interferons. Antiviral agents (chemical) and their mode of actions.

Different types of Viral Vaccines, Viral Vectors used for Cloning and Sequencing: λ phage, M13, Retro viruses, Use of Baculoviruses and CaMV 35S promoter and its applications.

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I Semester MB 152 Virology
Practical PAPER II

1. GLP and BSL facilities demonstration for virology lab
2. Isolation of *E. coli* and specific phage from soil
3. Isolation of *E. coli* and specific phage from sewage
4. Isolation of phages from contaminated food samples
5. Demonstration for the application of bacteriophages as food preservatives
6. Demonstration of one step growth curve, burst size and phage induction
7. Quantification and preservation of phages
8. Demonstration of plant viral infections using different samples
9. Cultivation of animal viruses in egg allantoic, amniotic and CAM (dye insertion method)
10. Demonstration of cytopathological changes of animal virus
11. Immunodiagnostics – Tridot test for HIV
12. Diagnosis of Dengue by detection of IgG and IgM antibody and NS1 antigen
13. Demonstration of NPV production and its role as biopesticide.
14. Awareness and participation in vaccination programs (extension activity).
15. Survey bases studies on viral epidemics, pandemics and vaccine drive

Recommended Books

1. Fields Virology 7th Edition (2023) by Peter M. Howley, David M. Knipe
2. Molecular and Cellular Biology of Viruses 2nd Edition (2024) by Phoebe Lostroh
3. Virology: Principles and Applications 2nd Edition (2013) by John Carter, Venetia Saunders
4. Principles of Virology 5th Edition (2020) by S. Jane Flint, Vincent R. Racaniello, Glenn F. Rall, Theodora Hatziioannou, Anna Marie Skalka
5. Molecular Biology of the Gene 7th Edition (2013) by James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick
6. Molecular Virology of Human Pathogenic Viruses by Wang-Shick Ryu
7. Textbook of Medical Virology 2nd Edition (2025) Baijayantimala Mishra
8. Recent Advances in Animal Virology (2019) Yashpal Singh Malik
9. Essentials of Virology (2007) by S. Ram Reddy, S.M. Reddy
10. Alfred Brown and Heidi Smith, 2017, Bensons Microbiological application: A laboratory manual in General Microbiology, Indian Edition, Mc.Graw Hill (13e)
11. Laboratory manual of Microbiology and Biotechnology by K.R. Aneja. 2014

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M.Sc. (Previous) Microbiology I Semester (CBCS)
Paper III MB 103 Molecular Biology and Microbial Genetics (Core)
(8 Hrs per week = 6 credits)

Course Objectives:

This course aims to connect the foundational principles of cellular genetics, from the blueprint of DNA to the mechanics of replication, and the practical applications of microbial genetics and modern gene cloning strategies

CO. No.	Course Outcomes	Levels
CO1	Articulate the relationship between genes, nucleic acids and proteins in the context of the molecular processes	Remember
CO2	Evaluate the distinct roles of gene regulation and genetic recombination in bacterial adaptation and survival.	Evaluation
CO3	Strategies of cloning, genetic engineering techniques and applications	Review
CO4	Acquire hands-on molecular biology skills, develop technical lab proficiency and precision	Skill, Analyze

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Paper III: Molecular Biology and Microbial Genetics (Core)

Unit I

Detailed structure of DNA , Z-DNA, A & B DNA, Denaturation and melting curves.
Genome organization in prokaryotes and eukaryotes.
DNA replication- Meselson and Stahl Experiment. Mechanism of Semiconservative replication. Rolling circle model, theta model. Etc. Enzymology of DNA replication
Eukaryotic telomere and its replication.
Prokaryotic and eukaryotic transcription.
Ribozyme, Genetic code and Wobble hypothesis, Translation in Prokaryotes and eukaryotes. Post translational modifications. Structure and processing of m-RNA, r-RNA t-RNA.

Unit II

Concept of gene, Benzer's fine structure of gene – muton, cistron, recon. Types of genes – structural, constitutive, regulatory, split genes, overlapping genes, pseudogenes and oncogenes.
Gene regulation and expression – Lac operon, arabinose and tryptophan operons. Gene regulation in eukaryotic systems, repetitive DNA, gene rearrangement, promoters, enhancer elements.
Mutation: Molecular basis of mutations, Physical, chemical and biological mutagens.
Detection and analysis of mutations (Replica plating, Antibiotic enrichment, Ames test, etc).
DNA damage and repair mechanisms. Global response to DNA damage.

Unit III

Bacterial Recombination -Discovery, gene transfer, molecular mechanism, detection, efficiency calculation and applications. Bacterial transformation- Competency and resistance.
Bacterial conjugation – Sex factor in bacteria, F and HFR transfer, linkage mapping .
Bacterial transduction – transduction phenomenon, methods of transduction.
Transposable elements – Definition, detection of transposition in bacteria, types of bacterial transposons. DNA transposons, Retrotransposons and mechanism. Giant extrachromosomal element – Inocle and its significance

Unit IV

Principles of genetic engineering: Vectors : Plasmids, phagemids/ viral vectors, cosmids, Artificial chromosomes. Restriction Enzymes, Polymerases, ligases, etc.
General methods of gene cloning: Cloning Techniques: cloning in *E. coli*, Cloning in *Bacillus subtilis*, Cloning in Yeast. Promoters. Cloning strategy, blue white selection of recombinant colonies. Selection, expression and detection of cloned genes. Polymerase chain reaction and Quantitative real time PCR.
Genomic/ c DNA Library construction, screening and applications

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I Semester MB 153 Molecular Biology and Microbial Genetics
Practical Paper - III

1. Isolation of genomic DNA from *E. coli*
2. Isolation of genomic DNA from Yeast.
3. Isolation of of genomic DNA from Human Blood.
4. Estimation of DNA (colorimetry)
5. Estimation of RNA
6. Estimation of protein by Folins's method
7. Induction of mutations by physical mutagens (UV)
8. Induction of mutations by chemical mutagens
9. Screening and isolation of mutants
10. Isolation of mutants by Replica plating technique
11. Digestion of DNA by restriction endonucleases
12. Determination of molecular weight of DNA resolved on agarose gel electrophoresis
13. Induction of Lac operon and observation of lac operon concept in *E. coli*
14. Demonstration of Transformation in bacteria using $CaCl_2$ heat shock method
15. Protoplast preparation, Fusion and regeneration

Recommended books

1. Principles and Techniques of Biochemistry and Molecular Biology 8th Edition (2018) Keith Wilson, John Walker
2. Genes XII 12th edition (2017) Benjamin Lewin
3. Molecular Biology of the Cell 6th Edition (2014) Bruce Alberts
4. Molecular Biology of the Gene 7th Edition (2013) James D. Watson
5. Molecular Biology David Freifelder
6. MOLBIO (Fundamentals of Molecular Biology) 2023 Avinash Upadhyay, Kakoli Upadhyay
7. Basic Molecular Biology (2010) Avinash Upadhyay, Kakoli Upadhyay
8. Cytology, Genetics and Molecular Biology by Sushil Kumar Upadhyay, Harendra Kumar Gaur
9. Molecular Biology Techniques: A Classroom Laboratory Manual 3rd Edition (2024) Carolyn D. Bustamante, Jan Vaughan
10. Molecular Biology: A Laboratory Manual. 2013. S. K. Gakhar, Monika Miglani, Ashwani Kumar
11. Laboratory Manual of Microbiology, Biochemistry and Molecular Biology. 2015. J. Saxena, M. Baunthiyal, I. Ravi

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M.Sc. Microbiology I Semester (CBCS)
Paper IV MB 104 Microbial Biochemistry (Core)
(8 Hrs per week = 6 credits)

Course Objectives:

Students will gain a fundamental understanding of biochemistry by exploring the chemical basis of life, the structure and function of key biomolecules, determine enzyme kinetics, including Km, Vmax, and specific activity.

CO. No.	Course Outcomes	Levels
CO1	Explain the chemical composition of living matter, critical roles of pH and its regulation	Review
CO2	Analyse the structure, function and significance of biomolecules in metabolic regulation	Comprehend
CO3	Perform qualitative and quantitative analysis to interpret Lineweaver - Burk plot.	Understand, Analysis
CO4	Analyze the principles of enzyme kinetics and apply this knowledge to understand inhibition and regulation.	Analyze

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Paper IV: Microbial Biochemistry

Unit I

Prominent Biochemists and their contributions-Emil Bloch, Dorothy Hodgkin, Carl Neugerg, Paul Boyer, John Walker, Kamala Sohonie

pH and its biological relevance

Determination of pH, preparation of buffers and maintenance of pH.

Concept of entropy, free-energy, free energy changes, high energy compounds. Equilibrium constants, Redox potentials, Biological redox systems, Biological oxidation, biological membranes, electron transport, oxidative phosphorylation and mechanism.

Unit II

Lipids classification: Bacterial lipids, prostaglandins, structure, function, Major steroids of biological importance.

Carbohydrates: Classification, basic chemical structure, monosaccharides, aldoses, and ketoses, cyclic structure of monosaccharides, steroisomerism, anomers and epimers.

Sugar derivatives, deoxy sugars, amino sugars, and sugar acids.

Nucleic acids: Structure and properties of purines, pyrimidines, nucleosides and nucleotides.

Metabolism of purines and pyrimidines - Biosynthesis and degradation

Unit III

Proteins and amino acids: Properties of amino acids, structure, confirmation and properties of proteins, metabolism of amino acids, biosynthesis and degradation – an overview.

Enzymes nomenclature, classification methods for determination of enzyme activity. Isolation and purification of enzymes. Enzyme kinetics: Effect of pH, substrate concentration , temperature and inhibitors.

Unit IV

Control of enzymes. Mechanism of enzyme action – Action of Hydrolases, Oxidases and reductases. Coenzyme catalysis(pyridoxal phosphate and TPP). Isoenzymes. Competitive and non-competitive inhibition. Methods for increased microbial enzymes production and activity. Enzyme engineering. Control of enzymes. Regulation of enzyme activity: allosteric enzymes and feed back mechanisms. Metabolic compartmentalization in relation to enzyme, enzymes and secondary metabolites

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I Semester MB 154 Microbial Biochemistry
Practical Paper IV

1. Safety and good lab practices
2. Preparation of buffers and adjustment of pH
3. Qualitative tests for carbohydrates
4. Qualitative tests for amino acids
5. Qualitative tests for lipids
6. Quantitative estimation of glucose by DNS method
7. Quantitative estimation of fructose Roe's Resorcinol method
8. Estimation of cholesterol by Zak's method
9. Estimation of Inorganic phosphate by Fiske- Subbarow method
10. Determination of saponification value of fats
11. Determination of enzyme activity (β-amylase, urease and catalase)
12. Determining the effect of pH, Temperature, Substrates and Inhibitor on enzyme activity
13. Enzyme kinetics - Calculation of specific activity, Km and Vmax for partially purified enzyme

Recommended Books

1. Biochemistry 9th Edition (2019) by Jeremy M. Berg, John L. Tymoczko, Lubert Stryer
2. Lehninger Principles of Biochemistry 8th Edition (2021) by David L. Nelson, Michael M. Cox
3. Fundamentals of Biochemistry 6th Edition (2024) by Donald Voet, Judith G. Voet, Dustin Heilman, Stephen Woski, Charlotte W.Pratt
4. Biochemistry – Satyanarayana-7th edition. 2026.
5. Biochemistry 9th Edition Mary K. Campbell, Shawn O. Farrell. (2022)
6. Outlines of Biochemistry 5th Edition by Eric E. Conn, Paul K. Stumpf, George Bruening, Roy H. Doi (2016).
7. Practical Manual of Biochemistry 8th Edition (2025) S. P. Singh
8. Laboratory Manual in Biochemistry 2nd Edition (2020) J. Jayaraman
9. Practical manual of Biochemistry Dr. G. Sattanathan, Ph.D., Dr. S.S. Padmapriya, Ph.D., Dr. B. Balamuralikrishnan, Ph.D., 2020

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DEPARTMENT OF MICROBIOLOGY, OSMANIA UNIVERSITY
MSc MICROBIOLOGY
CHOICE BASED CREDIT SYSTEM (CBCS)
Schedule for Instruction and Examination (Syllabus Revised Academic year 2025)

SEMESTER – II						
Paper Code:	**Subject / Paper titles**	**Credits**	**Teaching Hours**	**Marks**		
				Internal Assessment	**Semester Exam**	**Total**
THEORY						
MB 201	Artificial Intelligence and Computational Microbiology (Core)	4	4	30	70	100
MB 202	Immunology (Core)	4	4	30	70	100
MB 203	Industrial Microbiology (Core)	4	4	30	70	100
MB 204	Pharmaceutical Microbiology (Core)	4	4	30	70	100
PRACTICALS						
MB 251	Artificial Intelligence and Computational Microbiology	2	4	--	50	50
MB 252	Immunology	2	4	--	50	50
MB 253	Industrial Microbiology	2	4	--	50	50
MB 254	Pharmaceutical Microbiology	2	4	--	50	50
	Total	**24**	**32**	**120**	**480**	**600**

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Examination Evaluation Pattern

Continuous and Comprehensive Evaluation (CCE)

Internal Assessment Pattern: 30 M

Semester end Examination: 70 M

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M.Sc. (Previous) Microbiology II Semester (CBCS)
Paper I MB 201 Artificial Intelligence (AI) and Computational Microbiology (core)
(8 Hrs per week = 6 credits)

Course Objectives: The objective of the course is to introduce the fundamental concepts of Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL) and its use in microbiological research. To familiarize the students with basic bioinformatics, principles and use computational tools to analyse the microbiological data for future research analysis.

CO. No.	Course Outcomes	Levels
CO1	Explain the core concepts of AI, ML, and DL in microbial aspects.	Review, Understand
CO2	Apply AI models and complementary technologies (IoT, cloud) to analyse microbial data sets.	Apply
CO3	Apply programming skills in Python and R to analyse biological data through bioinformatics tools.	Skill
CO4	Demonstrate the applications of AI and informatics for research on microbiome, precision medicine and drug discovery.	Understand, Analyze

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Paper I - Artificial Intelligence (AI) and Computational Microbiology

UNIT I

Introduction to Artificial Intelligence (AI). Basics of complementary technologies: Internet of Things (IoT), Cloud computing in Microbial Sciences. AI models: Logic-based, rule-based, probabilistic, machine learning models; Foundations of Machine Learning (ML), Deep Learning (DL). Understanding basics of Data Science for Big Data management in Microbial Sciences. Evolution of AI in Microbiology: Key breakthroughs, and future potential. AI Tools used for Gram stain interpretation, bacterial colony count and culture plate analysis. AI-assisted Whole Genome Sequencing (WGS) interpretation and classification. Ethical use of AI in microbiology and data privacy.

UNIT II:

Integrating ML/DL to analyze complex data sets and its applications. Basics of metagenomics: Using AI and Principal Component Analysis (PCA) to compare microbial community compositions. AI to understand Microbial Pathogenesis: Pathogenicity predictions using sequence or phenotype data. AI for epidemiological surveillance of pathogens. Use of AI for Antimicrobial Resistance (AMR) and Predicting Antibiotic Resistance Genes using AI and MALDI -TOF MS analysis. Applications of AI in Clinical Microbiology and Diagnostics. AI for drug discovery and antibiotics: Halicin, Abaucin. AI in bioprocess optimization and microbial fermentation systems.

UNIT III:

Bioinformatics Basics: Use of computational tools in biology and diagnostic studies. Introduction to Unix and Linux systems and basic commands. DNA sequence studies. Database concepts. Proteins and nucleic acid databases. Structural databases, Biological XML DTDs, pattern matching algorithm basics.

Python for Microbiology: Basics of Python: Syntax, variables, loops, functions. Handling biological data using Biopython, Pandas, NumPy, Matplotlib. Simple data visualizations: bar plots, heatmaps, scatter plots. Reading FASTA/GenBank files, parsing microbial genomes. Sequence analysis. Microbial growth curve modelling.

R for Microbiology: Introduction to R environment and RStudio, Importing and cleaning microbiological datasets (CSV, TXT), Data visualization using ggplot2, dplyr, tidyr, Microbiome data analysis, Creating boxplots, volcano plots, diversity plots. Statistical tests (ANOVA, t-test) in R.

UNIT IV

Biological databases for microbiologists: NCBI, EMBL, DDBJ, UniProt, KEGG. Sequence-based microbial identification: NCBI BLAST, genome annotation tools. Introduction to multiple sequence alignment: CLUSTALW, MAFFT. Primer design using AI tools (Primer3, NCBI tools). Phylogenetic tree construction using Distance Matrix, UPGMA, Neighbor-Joining (via MEGA or R). Structure-based drug discovery: Docking tools: AutoDock, GOLD, AI in drug screening and scoring. In silico ADME and toxicity prediction for antimicrobials. Case Studies: AI in COVID-19 genome tracking; AI-based pipeline for gut microbiome analysis.

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II Semester MB 251 Artificial Intelligence (AI) and Computational Microbiology
Practical Paper - I

1. Demonstration of Artificial Neural Networks (ANNs) and Convolutional Neural Networks (CNNs) for their use in microbial sciences
2. Colony Count using CNN and digital image processing tools
3. Growth Analysis of Clinically important bacteria and yeast Using Digital Image Processing.
4. Demonstration of Clinical Trial Data Interpretation using Publicly Available Microbial Datasets.
5. Integration of Bacterial Culture Images with MALDI-TOF MS Profiles for Clinical Pathogen Identification.
6. Prediction of Antimicrobial Resistance Genes (ARGs) from Clinical Isolates using Online Tools (CARD or ResFinder).
7. Demonstration of Neoantigen Prediction Workflow for Microbial Vaccine Design.
8. Demonstration of microbiome data analysis using gut microbiome to understand healthy and diseased individuals
9. Protein modelling (Swiss model)
10. Demonstration of BLAST and sequence alignment (multiple and pair – wise) and phylogenetic tree construction by MEGA software

Reference material:

1. Open source tools for AI and ML.
2. Artificial Intelligence in Microbiology: Scope and Challenges 1st Edition (2024) Akanksha Srivastava, Vaibhav Mishra
3. Bioinformatics and Beyond: AI Applications in Healthcare 1st Edition (2025) Moolchand Sharma, Deepak Kumar Sharma, Deevyankar Agarwal, Khoula Al Harthy
4. Artificial Intelligence in Bioinformatics and Chemoinformatics (2023) Yashwant Pathak, Surovi Saikia, Sarvadaman Pathak, Jayvadankumar Patel, Bhupendra Gopalbhai Prajapati
5. Implementation of convolutional neural networks for microbial colony recognition (2025) by Fanhui Kong, Mingkuan Su, Jingli Guo, Jiafu Li, and Jiancheng Huang - Microbiology Spectrum
6. Artificial intelligence applications in diagnosis and treatment of bacterial infections 2024 Xiaohui Zhang et al.
7. Artificial Intelligence for Microbiology and Microbiome 2024 Yang-Yu Liu et al.
8. The Impact of Artificial Intelligence on Microbial Diagnosis 2024 A. Alsulimani et al.
9. Qu K, Guo F, Liu X, Lin Y and Zou Q (2019) Application of Machine Learning in Microbiology. Front. Microbiol. 10:827. doi: 10.3389/fmicb.2019.00827
10. Computational Genomics and Structural Bioinformatics in Microbial Science Vol 2 1st Edition (2025) Javed Ahmad Parray, Niraj Singh, Wen-Jun Li
11. Paul P. Bourbeau, Nathan A. Ledeboer; Automation in Clinical Microbiology, Journal of Clinical Microbiology May 2013, 51 (6) 1658-1665; DOI: 10.1128/JCM.00301-13 2
12. LeCun, Y., Bengio, Y. & Hinton, G. Deep learning. Nature 521, 436–444 (2015). https://doi.org/10.1038/nature14539
13. Kenneth P. Smith, Anthony D. Kang, James E. Kirby, Automated Interpretation of Blood Culture Gram Stains by Use of a Deep Convolutional Neural Network, Journal of Clinical Microbiology Feb 2018, 56 (3) e01521-17; DOI: 10.1128/JCM.01521-17

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M.Sc. (Previous) Microbiology II Semester (CBCS)
Paper II MB 202 Immunology (core)
(8 Hrs per week = 6 credits)

Course Objectives:

To familiarize students with immunological concepts, including hypersensitivity, hybridoma technology, and cancer biology, and to connect these theories to real-world diagnostic and research applications.

CO. No.	Course Outcomes	Levels
CO1	Comprehensive understanding of the immune system, including its key components, responses, and related clinical applications.	Review, Understand
CO2	Define immunological tolerance and critique the effectiveness of the immune system's response during persistent infections	Remember
CO3	Compare and contrast the features and activation triggers of the classical and alternate complement pathways.	Comprehend
CO4	Understand the fundamental principles behind the development of vaccines and hands on training on diagnostic assays to handle controlled clinical samples	Knowledge and Skill

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Paper II - Immunology

Unit I

History of immunology. Hematopoiesis, Cell lineage, components of immune system, cells and organs of immune system.

Antigens –Nature, properties and types. Haptens

Antibody -Structure, functions and classification. Isotypes, allotypes and idiotypes. Immunoglobulin genes. Generation of antibody diversity. Clonal nature of the immune response - clonal selection theory.

Generation of T cell receptor diversity by genomic rearrangement

Structure of B and T cell receptors

Unit II .

Overview of Innate and adaptive immunity

Toll-like receptors, cell-mediated and humoral immune responses, inflammation.

Major Histocompatibility Complex (MHC). Human leucocyte antigen (HLA) restriction Processing and presentation of antigen by MHC. Transplantation immunity,

Immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections. Congenital and acquired immunodeficiencies. Immunodeficiency disorders: Animal models of primary immunodeficiency (SCID mouse). Specific impaired functions in lymphoid lineage (SCID, DiGeorge syndrome), myeloid lineage (CGD and Chediak, Higashi Syndrome). Immunological tolerance-central and peripheral.

Unit III

Auto immunity and Hypersensitivity - immediate and delayed type hypersensitivity reactions.

Classical and alternate Complement pathways.

Introduction to inflammasome pathway and its components

Antigen and antibody reactions–Agglutination, Precipitation, neutralization, and function. Labeled antigen-antibody reactions- ELISA, RIA, immune blotting, CFT, immunoflourescence. Flow cytometry (Fluorescence activated cell sorter) and its applications in Immunology. Development Of immunodiagnostic kits.

UNIT –IV

Types of conventional vaccines and principles of Immunization.

Modern vaccines; peptide, DNA, recombinant / vector, and anti-idiotypic vaccines

Schedules of common vaccination, Benefits and adverse consequences of vaccination.

Production of polyclonal antibodies; Animals models for production of antibodies

Hybridoma techniques and monoclonal antibody production. Applications of monoclonals in biomedical research, clinical diagnosis and treatment. Chimeric Antibodies.

Immunosuppression and its mechanism of action.

Immune evasion by bacteria and viruses.

Tumor immunology. Immuno-diagnosis and immune therapy of cancer

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II Semester MB 252 Immunology
Practical Paper - II

1. Agglutination reactions – WIDAL, VDRL, HA, Blood typing – tube method
   Precipitation test: Ring interphase, single radial diffusion.
2. Ouchterlony double diffusion
3. Immuno-electrophoresis
4. Neutralization test – Plaque neutralization, Hemadsorption test
5. WBC and RBC count and differential blood picture.
6. Separation of serum proteins.
7. Blot transfer and detection of protein on blot by staining.
8. ELISA
9. Purification of IgG from serum
10. Lymphocyte culture, viable staining and heamocytometer count.
11. Indirect agglutination (Pregnancy hCG Ag)

Recommended Books

1. Kuby Immunology 8th Edition (2018) Sharon Stranford, Judy Owen, Patricia Jones. Jenni Punt
2. Immunology 10th Edition (2025) David Male, R. Stokes Peebles, Victoria Male
3. Cellular and Molecular Immunology 11th Edition (2025) Abul K. Abbas, Andrew Lichtman, Shiv Pillai, Sarah Henrickson
4. Paul's Fundamental Immunology 8th Edition (2022) Martin F. Flajnik, Nevil J. Singh, Steven M. Holland
5. Test Book of Immunology by Edward J. Barrett (1988).
6. Roitt's Essential Immunology 13th Edition by Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt (2017).
7. Veterinary Immunology 11th Edition (2024) Ian R. Tizard
8. Textbook of Microbiology & Immunology 4th Edition (2023) Subhash Chandra Parija
9. Immunology and Serology in Laboratory Medicine 8th Edition (2025) Mary Louise Turgeon
10. Practical Immunology 4th Edition (2002) Frank C. Hay, Olwyn M.R. Westwood

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M.Sc. (Previous) Microbiology II Semester (CBCS)
Paper III MB 203 Industrial Microbiology (Core)
(8 Hrs per week = 6 credits)

Course Objectives:

This course objective integrates knowledge of microbial, metabolic and bioprocess optimization, to create efficient and robust biological production processes. The objective of the practical lab is train skill set of microbial biotechnology.

CO. No.	Course Outcomes	Levels
CO1	Design and implement effective microbial strain improvement strategies and BioE3 policies	Knowledge
CO2	Demonstration and Handling lab scale level fermenter, operational protocols.	Skill
CO3	Apply bioprocess techniques and nanotechnology for research	Apply
CO4	Comprehensive understanding of industrial-scale microbial products, qualitative and quantitative assays	Analyse

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Paper III - Industrial Microbiology

Unit I

Introduction to industrial microbiology and Biotechnology for Economy, Environment, Employment and/or Entrepreneurship. Screening and selection of microorganisms for industrially important products like amylase, organic acid, antibiotic, amino acid and vitamins.

Concept of life cycle assessment and sustainable production of bio-based products using microorganisms. Strain improvement strategies. Environmental and genetic factors for strain improvement. Inoculum media, inoculum preparation. Fermentation media and sterilization.

Upstream strategies and raw materials for fermentation process. Cost economics and use of low-cost agro-industrial wastes as carbon, nitrogen sources for production media.

Unit II

Design of fermenter, type of fermenter, agitation, aeration, antifoam, pH and temperature control. Inoculum media and seed culture preparation and frozen stocks. Types of fermentations processes – Solid state, surface and submerged fermentations. Batch, fed batch and continuous fermentations. Direct, dual or multiple fermentations.

Fermentative production of beer – Medium components, malt, malt adjuncts, hops, water. Preparation of wort, mashing, wort boiling, microorganism, inoculum preparation, fermentation, cold storage maturation, carbonation, packing and preservation.

Principles of wine making – Fruit selection, picking, crushing, sulphite addition, processing, fermentation, aging and bottling.

Unit III

Fermentative production of industrial alcohol, uses, raw materials, microorganisms, inoculum preparation, preparation of wort, fermentation and recovery. Designing microbial cell factories for production of different bioproducts and Biofuels. Fermentation and recovery process of Antibiotics – Commercial production of benzyl penicillin, and semi-synthetic penicillin. Fermentative production of tetracyclines – uses, chlortetracycline, oxy-tetracycline, tetracycline and semisynthetic tetracyclines. Production of monoclonal antibodies and antimicrobial peptides at industrial level. Microbial nanotechnology. Bio-fabrication of nanoparticles, characterization and optimization studies.

Unit IV

Microbial products: Qualitative and quantitative assays for detection of enzymes, amino acids, organic acids, vitamin B12, steroids. Bio-transformations used in microbial process. Down stream strategies for product recovery. Detection and assay of fermentation products. Physico-chemical methods and biological assays. Immobilization methods used in industries – Absorption, covalent linkage, entrapment and cross linkage, types of carriers, advantage and disadvantages.

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II Semester MB 253 Industrial Microbiology
Practical Paper III

1. Isolation and screening for amylase producing microorganisms
2. Isolation and screening for lipolytic microorganisms
3. Isolation of antibiotic producing microorganisms by crowded plate technique
4. Estimation of glucose
5. Estimation of maltose
6. Estimation of ethanol by dichromate method
7. Production of ethanol by flask fermentation, recovery of ethanol by distillation and calculation of fermentation efficiency.
8. Preparation of wine from grapes/fruits by fermentation
9. Isolation of *Penicillium* spp. from different source samples
10. Production of Penicillin by fermentation process and its characterization
11. Biosynthesis of nanoparticles using microorganisms
12. Immobilization of microbial cells by entrapment method

Recommended Books

1. Industrial Microbiology: An Introduction (2001)by Michael J. Waites, Neil L. Morgan, John S. Rockey, Gary Higton
2. Industrial Microbiology: Fundamentals and Applications (2017) Agrawal, Parihar
3. Industrial Microbiology 3rd Edition (1986) by L. E. Casida J.R
4. Industrial Microbiology 4th Edition (1959) Samuel Cate Prescott, Cecil Gordon Dunn
5. Microbial Technology: Fermentation Technology (1979) by H.J Peppler, D. Perlman
6. Biochemistry of Industrial Microorganisms (1963) by C. Rainbow, A.H.Rose
7. Comprehensive Biotechnology 3rd Edition (2019) by Murray Moo-Young
8. Industrial Microbiology: A Laboratory Manual (2010) by N. Mathur
9. Alfred Brown and Heidi Smith, 2017, Bensons Microbiological application: A laboratory manual in General Microbiology, Indian Edition, Mc.Graw Hill (13e)

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M.Sc. Microbiology II Semester (CBCS)
Paper IV MB 204 Pharmaceutical Microbiology (Core)
(8 Hrs per week = 6 credits)

Course Objectives:

The course aims to integrate multidisciplinary understanding of the pharmaceutical industry, fundamental concepts of antimicrobial action, principles of pharmacokinetics, pharmacodynamics along with the practical application of microbiological and analytical testing methods.

CO. No.	Course Outcomes	Levels
CO1	Critical knowledge and skills necessary for working in the pharmaceutical industry, focusing on quality assurance, regulatory compliance, and sterile manufacturing practices.	Knowledge and skills
CO2	Encompass a broad range of regulatory, technological, and scientific principles essential for the modern pharmaceutical and biotechnology industries	Understand
CO3	Equip with a strong foundation in the history, principles, and applications of chemotherapy, traditional medicine and novel antimicrobial compounds	Apply
CO4	Perform techniques such as antibiotic susceptibility tests (e.g., Kirby-Bauer) and determine the Minimum Inhibitory Concentration (MIC) of an antimicrobial agent.	Skill and Techniques

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Paper IV Pharmaceutical Microbiology

Unit I

Pharmaceutical industry. Importance of various pharmacopeias with special reference to Indian pharmacopeia, British pharmacopeia, United States pharmacopeia and international pharmacopeia. Design and layout of sterile product manufacturing unit.

Microbiological issues for inspection of pharmaceutical facilities: Sterilization (D value, z value, F value, F_0 value, survival curve), Depyrogenation, Environmental monitoring, Room design and Equipment, Water purification and Delivery system, Personnel, Product sampling, Method suitability test, Sample analysis (Bioburden, Sterility test. Concept of GxP and Quality Assurance in pharmaceuticals.

Unit II

Introduction to FDA's CAPA (Corrective and Preventive action) steps requirements and regulations, OOPs, SOPs. ISO, WHO and US certification. Understanding the changing dynamics of pharma ecosystem. Digitization of equipment, instrument, air and water systems. Adherence to guidelines like GAMP (Good automated manufacturing practice and 21 CFR (Code of federal regulations). Drug metabolism and Response; Pharmacokinetics (ADME), Pharmacodynamics, pharmacogenomics. Emerging antimicrobial resistance (AMR) and antimicrobial resistance genes (ARG) in different environments.

Unit II

History of chemotherapy –Paul Ehrlich and his contributions. Arsenicals as therapeutics. Research on Indian medicinal plants derived natural products and their applications. Classification of antimicrobial agents. Drugs, Semi-synthetic drugs and Antibiotics, Topical agents. Choice of drug, dosage, route of administration, combined multi drug therapy. Selective toxicity, molecular principles of drug targeting. Development of synthetic antibiotics/drugs: Sulfonamides, Chloramphenicol, Antitubercular compounds, Quinolinones, Metronidazole, Anti-tumor drugs. Mode of action of important drugs – Cell wall inhibitors (Beta-lactam e.g. Penicillins), membrane inhibitors (polymyxins), macromolecular synthesis inhibitors (streptomycin), Macrolides (Nafithromycin). Recently developed antibiotics (Enmetazobactam, Zaynich) and antifungal medications.

Unit IV

Antimicrobial Effectiveness Testing (AET): Microbial contamination and spoilage of certain pharmaceutical products sterile injectable, non-injectable, ophthalmic preparations, implants, Cosmetic products and preservatives (PET). Bacterial endotoxin testing. Non antibiotic antimicrobial compounds: Metals and Biocides (Phenol coefficient/RWC). Drug sensitivity testing methods and their importance. Antibiotic potency tests / Microbial assays for antibiotics – Determination of MIC, the liquid tube assay, solid agar tube assay, agar plate assay (disc diffusion, agar well and cylinders cup method).

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II Semester MB 254 Pharmaceutical Microbiology
Practical Paper IV

1. Bioburden testing methods for pharmaceutical and cosmetic products
2. Sterility testing by *Bacillus stearothermophilus* or any other method
3. Sampling of pharmaceuticals for microbial contamination and load (syrups, suspensions, creams and ointments, ophthalmic preparations).
4. Determination of D value, Z value for heat sterilization in pharmaceuticals.
5. Determination of antibacterial spectrum of drugs/antibiotics
6. Testing for antibiotic/drug sensitivity/resistance
7. Determination of MIC, LD 50 of antimicrobial chemicals
8. Microbiological assays for antibiotics (Liquid tube, agar tube , agar plate assays)
9. Antimicrobial effectiveness testing
10. Bioassay with Griesofulvin / chloremphenicol
11. Bacterial endotoxin test (BET): Demonstration through kit or tutorial mode
12. Bioassays with any plant / microbial secondary metabolites against Gram positive and Gram negative bacteria
13. Tests for disinfectants (Phenol coefficient/RWC)
14. Determination of antimicrobial activity of a formaldehyde to that of phenol under Standardized experimental conditions
15. Treatment of bacterial cells with cetrimide, phenol and detection of Leaky substances.

Recommended Books

1. Pharmaceutical Microbiology: A Comprehensive Approach 1st Edition (2015) Tim Sandle
2. Block's Disinfection, sterilization and preservation 6th edition (2020) byBlock, S.S. (ed). Gerald McDonnell, Joyce Hansen
3. Pharmaceutical Microbiology 9th Edition (2023) W. B. Hugo & A. D. Russell
4. Principles and methods of sterilization in health sciences (1983- 2nd edition 8th printing) by J. K. Perkins
5. Inhibition and Destruction of Microbial Cells (2012) by Hugo, W. B. (Ed) Academic Press, New York
6. Russell, Hugo and Ayliffe's Principles and Practices of disinfection 5th Edition (2013) by Adam P. Fraise. Jean-Yves Maillard, Syed Sattar (Eds)
7. Antimicrobial Drug Action (1996) R.A.D. Williams
8. Microbiological Assays for Pharmaceutical Analysis (2003) by Willam Hewitt
9. Indian Pharmacopea(2020); United States Pharmacopea(2023); British Pharmacopea(2020)
10. Pharmaceutical Microbiology (2007) by Ashutosh Kar CBS Publishers

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