# Syllabus of 1st Year M. Sc. Microbiology

## As Per National Education Policy 2020 (NEP 2020)

UPL UNIVERSITY OF SUSTAINABLE TECHNOLOGY

## UPL University of Sustainable Technology

## SRICT- Institute of Science & Research

## AY-2025-2026

# UPL -University of Sustainable Technology

# SRICT Institute of Science & Research

| UPL University of Sustainable Technology, Ankleshwar | | | | |
|---|---|---|---|---|
| SRICT-Institute of Science and Research (SRICT-ISR) | | | | |
| 1st Year M. Sc. Microbiology | | | | |
| **SEM** | **TYPE OF COURSE** | **COURSE CODE** | **NAME OF SUBJECT** | **Credits** |
| 1 | **MAJOR** | **MIM400-4C** | Virology and Mycology | **4** |
| | **MAJOR** | **MIM401-4C** | Enzymology and Bioinformatics | **4** |
| | **MAJOR** | **MIM402-4C** | Immunology and Medical Microbiology | **4** |
| | **MINOR** | **MIE400-4C** | Microbiology Practicals-V | **4** |
| | **CORE COURSE** | **RP400-4C/ OJT400-4C** | RP/OJT* | **6** |
| | | | Total Credits | **22** |
| 2 | **MAJOR** | **MIM403-4C** | Soil and Water Microbiology | **4** |
| | **MAJOR** | **MIM404-4C** | Food and Dairy Microbiology | **4** |
| | **MAJOR** | **MIM405-4C** | Industrial and Fermentation Microbiology | **4** |
| | **MINOR** | **MIE401-4C** | Microbiology Practicals-VI | **4** |
| | **CORE COURSE** | **RP401-4C/ OJT401-4C** | RP/OJT* | **6** |
| | | | Total Credits | **22** |

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**Teaching/Exam Scheme**

**M.Sc. Sem. I**

| Sr. No. | Course Code | Category of course | Course title | Hour s Per week | | | Total con. hrs. | Credits | E | M | I | V | Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | | | | | |
| 1 | MIM400-4C | Major Course | Virology and Mycology | 4 | - | - | 4 | 4 | 50 | 50 | - | - | 100 |
| 2 | MIM401-4C | Major Course | Enzymology and Bioinformatics | 4 | - | - | 4 | 4 | 50 | 50 | - | - | 100 |
| 3 | MIM402-4C | Major Course | Immunology and Medical Microbiology | 4 | - | - | 4 | 4 | 50 | 50 | - | - | 100 |
| 4 | MIE400-4C | Minor Course | Microbiology Practicals-V | - | - | 8 | 8 | 4 | 50 | 50 | - | - | 100 |
| 5 | RP400-4C/ OJT400-4C | Core Course | RP/OJT* | - | - | - | - | 6 | - | - | 75 | 75 | 150 |
| | | | Total | 12 | - | 8 | 20 | 22 | 200 | 200 | 75 | 75 | 550 |

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# SRICT Institute of Science & Research

## Master of Science
## Course Code: MIM400-4C
## Course Name: Virology and Mycology
## Semester: I

**w.e.f.: July 2025**

**Type of course:** Major Course

**Prerequisite:** Basic understanding of virology and mycology.

**Rationale:** By studying virology and mycology, students will gain the scientific foundation needed to tackle current and emerging microbial threats and to contribute meaningfully to the advancement of health sciences and microbiology.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | | 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** | **General Virology**<br>History and introduction to Virology, Virus Structure, Classification and Nomenclature, Virus Replication, Cultivation and Quantification of Viruses, Viral Pathogenesis, Transmission and Control, Application of Viruses. | **9** |
| **2.** | **Animal and Human Viruses**<br>General characteristics, structure, replication, transmission, pathogenesis, and control of HSV, Variola virus, Human Papilloma Virus, Hepatitis B Virus, Influenza viruses, Dengue virus, Hepatitis C virus, HIV, Rabies virus, Oncogenic Viruses, Rabbis, Zika, Chikungunya virus | **9** |
| **3** | **Plant Viruses and Bacteriophages**<br>General characteristics, structure, replication, transmission, pathogenesis, and control of TMV, Cauliflower Mosaic Virus, Bacteriophages, T-even phages, λ phage, filamentous phages, Q-phage, MS2 | **12** |
| | **SECTION – B** | |

| | | |
|---|---|---|
| **4** | **General Mycology**<br>History and introduction to mycology, Fungi Structure, Classification and Nomenclature, Fungal Physiology and Growth, Fungi Replication, Cultivation and Quantification of Fungi, Fungal Pathogenesis, Transmission and Control, Application of Fungi | **9** |
| **5** | **Medical Mycology**<br>General characteristics, structure, replication, transmission, pathogenesis, and control of Tinea infections, Piedra, Dermatophytosis, Sporotrichosis, Histoplasmosis, Blastomycosis, Cryptococcosis, Aspergillosis, Candidiasis, Mucormycosis, Pneumocystis pneumonia | **12** |
| **6** | **Applied and Industrial Mycology**<br>Fungi in Biotechnology: Fungal production of enzymes, organic acids, antibiotics, vitamins; Mycotoxins and Food Spoilage: Aflatoxins, ochratoxins, fumonisins, trichothecenes; Agricultural and Environmental Mycology: Mycorrhizal associations and plant growth promotion, Fungi as biopesticides and biocontrol agents, biodegradation, biosensors and waste treatment by fungi, Mushroom cultivation. | **9** |

**Suggested Specification table with Marks (Theory):**

| **Distribution of Theory Marks (%)** | | | | | |
|---|---|---|---|---|---|
| R Level | U Level | A Level | N Level | E Level | C Level |
| **20** | **25** | **15** | **20** | **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. Mahy, B. W. J., & ter Meulen, V. (Eds.). (2005). *Topley and Wilson's microbiology and microbial infections: Virology* (10th ed.). Hodder Arnold.
2. White, D. O., & Fenner, F. J. (1994). *Medical virology* (4th ed.). Academic Press.
3. won-Chung, K. J., & Bennett, J. E. (1992). *Medical mycology*. Lea & Febiger.
4. Alexopoulos, C. J., Mims, C. W., & Blackwell, M. (1996). *Introductory mycology* (4th ed.). John Wiley & Sons.

**Reference Books:**

1. Dimmock, N. J., Easton, A. J., & Leppard, K. N. (2016). *Introduction to modern virology* (7th ed.). Wiley-Blackwell.
2. Reiss, E., Shadomy, H. J., & Lyon, G. M. (2011). *Fundamental medical mycology*. Wiley-Blackwell

**Course Outcomes:**

**After completing this course, student will be able to**

| Sr. No. | CO statement | Marks % weightage |
|---|---|---|
| CO-1 | Understand the history, structure, classification, and replication mechanisms of viruses and fungi. | 15 |
| CO-2 | Describe the cultivation, quantification, transmission, and pathogenesis of medically and agriculturally important viruses and fungi. | 20 |
| CO-3 | Analyze the characteristics and control strategies of significant human, animal, plant viruses, and fungal pathogens. | 15 |
| CO-4 | Demonstrate laboratory techniques for the isolation, identification, and study of viruses and fungi. | 15 |
| CO-5 | Evaluate the role of viruses and fungi in disease, diagnostics, prevention, and therapy. | 20 |
| CO-6 | Explore the applied aspects of fungi and viruses in biotechnology, agriculture, industry, and environmental management. | 15 |

# UPL -University of Sustainable Technology

# SRICT Institute of Science & Research

## Master of Science
## Course Code: MIM401-4C
## Course Name: Enzymology and Bioinformatics
## Semester: I

**w.e.f.: July 2025**

**Type of course:** Major Course

**Prerequisite:** Basic knowledge of enzyme and bioinformatics.

**Rationale:** Enzymology and Bioinformatics are essential for understanding biochemical processes and managing large-scale biological data, equipping students with the tools to advance research in microbial metabolism, drug discovery.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | | 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** | **Fundamentals of Enzymology and Enzyme Classification**<br>Introduction History and Nature of Enzymes, Structure and function of enzymes: Apoenzyme, coenzymes, cofactors, prosthetic groups, Ribozymes and abzymes; Enzyme Nomenclature and Classification; Enzyme Structure and Active Site: Primary, secondary, tertiary, and quaternary structures of enzymes and substrate specificity; Lock and key, induced fit, and transition state models | **9** |
| **2.** | **Enzyme Kinetics, Regulation, and Mechanisms**<br>Enzyme Kinetics: Michaelis-Menten equation and its derivation; Lineweaver-Burk plot **and other linear transformations**, Determination of kinetic parameters ($K_m$, $V_{max}$, kcat and catalytic efficiency); Multi-substrate Reactions (Sequential and Ping-Pong mechanisms) and Enzyme Inhibition and its regulation; Isoenzymes and allosteric enzymes; Factors Affecting Enzyme Activity | **9** |
| **3** | **Applied and Industrial Enzymology** | **12** |

| | | |
|---|---|---|
| | Enzyme Production and Purification: Extracellular and intracellular enzymes, Strain improvement, Enzyme extraction and purification (precipitation, dialysis, ultrafiltration), Chromatography (ion exchange, gel filtration, affinity), electrophoresis; Enzyme Immobilization: Methods, Properties, and Applications | |
| **SECTION – B** | | |
| **4** | **Introduction to Bioinformatics and Biological Data Resources** Fundamentals of Bioinformatics: Concepts, scope, history and applications, Biological Databases: Primary and Secondary, Data Formats and File Types, Sequence retrieval and interpretation | **9** |
| **5** | **Sequence Analysis, Genomics, and Metagenomics** Methods for Sequence Alignment, Construction and interpretation of phylogenetics; Genomics: Histrory and introduction to genomics and genome structure, WGS, NGS, Genome assembly, annotation, and comparative genomics; Metagenomics: Principles of metagenomics: amplicon vs. shotgun approaches, Data processing and microbial community profiling | **12** |
| **6** | **Transcriptomics, Proteomics, Metabolomics and Systems Biology** Transcriptomics: RNA-Seq workflows and tools, Transcript assembly, quantification, and differential gene expression, Analysis of miRNAs and other non-coding RNAs; Proteomics and Metabolomics: 2D-GE, LC-MS/MS, MALDI-TOF, NMR, GC-MS, FAME analysis, Biotyper, Functional annotation and protein interaction networks for metabolite profiling; Systems Biology and Biomarker Discovery: Network analysis and visualization using Cytoscape, Pathway modeling and simulation, Integrative omics for biomarker discovery and validation | **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. Trevor Palmer
   *Enzymes: Biochemistry, Biotechnology, Clinical Chemistry* (2nd ed.). Horwood Publishing.
2. Nicholes C. Price & Lewis Stevens
   *Fundamentals of Enzymology* (4th ed.). Oxford University Press.
3. Rastogi, S. C., Mendiratta, N., & Rastogi, P.
   *Bioinformatics: Methods and Applications* (3rd ed.). PHI Learning.

**Reference Books:**

1. Berg, J. M., Tymoczko, J. L., & Gatto, G. J.
   *Stryer's Biochemistry* (8th ed.). W.H. Freeman and Company.
2. Mount, D. W.
   *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor Laboratory Press.
3. Zhang, J., & Wang, J. (2017). *Bioinformatics and functional genomics*. Wiley..
4. Oliviero, M., & Pisani, L. (2009). *Bioinformatics: A practical guide to the analysis of genes and proteins*. Springer.

**Course Outcomes:**

**After completing this course, student will be able to**

| Sr. No. | CO statement | Marks % weightage |
|---|---|---|
| CO-1 | Describe enzyme structure, types, and models of enzyme-substrate interaction. | 15 |
| CO-2 | Explain enzyme kinetics, inhibition, and factors affecting enzyme activity. | 20 |
| CO-3 | Outline enzyme production, purification, and industrial applications. | 15 |
| CO-4 | Understand bioinformatics concepts, databases, and sequence formats. | 15 |
| CO-5 | Perform sequence alignment, phylogenetic analysis, and genome annotation. | 20 |
| CO-6 | Interpret omics data for transcriptomics, proteomics, and systems biology. | 15 |

# UPL -University of Sustainable Technology

# SRICT Institute of Science & Research

## Master of Science
## Course Code: MIM402-4C
## Course Name: Immunology and Medical Microbiology
## Semester: I

**w.e.f.: July 2025**

**Type of course:** Major Course

**Prerequisite:** Basics of immune responses and microbial diseases.

**Rationale:** Immunology and Medical Microbiology are foundational to understanding how microorganisms cause disease and how the body defends itself, equipping students with essential knowledge and skills for diagnostics, therapeutics, and biomedical research.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | | 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** | **Overview of Immune System**<br>Organs and cells of the immune system, Innate and adaptive immunity, Humoral and cell-mediated responses | **9** |
| **2.** | **Antigens, Antibodies, and MHC**<br>Antigenicity, immunogenicity, Structure and types of antibodies, MHC molecules and antigen presentation | **9** |
| **3** | **Antigen-Antibody Reactions and Hypersensitivity**<br>Precipitation, agglutination, ELISA, RIA, Hypersensitivity: Type I-IV, Autoimmunity and immunodeficiency | **12** |
| | **SECTION – B** | |
| **4** | **Microbial Pathogenesis and Virulence**<br>Bacterial, fungal, protozoal and viral pathogens: Entry, adhesion, colonization, invasion, Toxins, enzymes, and evasion mechanisms, Biofilms and quorum sensing in pathogenesis | **9** |
| **5** | **Vaccines and Therapeutic Antibodies** | **12** |

| | | |
|---|---|---|
| | Types of vaccines: inactivated, live attenuated, recombinant, mRNA, Adjuvants and delivery systems, Monoclonal antibodies and nanobodies | |
| **6** | **Diagnostics and Immune-Based Detection** Immunofluorescence, flow cytometry, Western blot, immunochromatography, Immune biomarkers in disease and therapy, ELISA, DNA fingerprinting, DNA footprint, Southern blot and DNA hybridization. | **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. Kuby, J., Kindt, T. J., Osborne, B. A., & Goldsby, R. A. (2007). *Kuby Immunology* (6th ed.). W.H. Freeman and Company.
2. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2022). *Basic Immunology: Functions and Disorders of the Immune System* (6th ed.). Elsevier.
3. Jawetz, E., Melnick, J. L., & Adelberg, E. A. (2021). *Medical Microbiology* (29th ed.). McGraw Hill Education.
4. Ryan, K. J., & Ray, C. G. (Eds.). (2014). *Sherris Medical Microbiology* (6th ed.). McGraw Hill Education.

**Reference Books:**

1. Male, D., Brostoff, J., Roth, D. B., & Roitt, I. (2012). *Immunology* (8th ed.). Elsevier Health Sciences.
2. Goldsby, R. A., Kindt, T. J., & Osborne, B. A. (2003). *Immunology* (5th ed.). W.H. Freeman and Company.
3. Bailey & Scott's Diagnostic Microbiology (2020). Edited by Patricia Tille (14th ed.). Elsevier.

**Course Outcomes:**

**After completing this course, student will be able to**

| **Sr. No.** | **CO statement** | **Marks % weightage** |
|---|---|---|
| CO-1 | Describe immune system components and the basics of innate and adaptive immunity. | 15 |
| CO-2 | Explain antigens, antibodies, and the role of MHC in immune responses. | 20 |
| CO-3 | Understand antigen-antibody reactions, hypersensitivity, and immune disorders. | 15 |

| | | |
|---|---|---|
| CO-4 | Discuss microbial pathogenesis, virulence factors, and evasion strategies. | 15 |
| CO-5 | Identify types of vaccines and the use of antibodies in therapy. | 20 |
| CO-6 | Apply immunological and molecular techniques in disease diagnosis and research. | 15 |

# UPL -University of Sustainable Technology

# SRICT Institute of Science & Research

## Master of Science
## Course Code: MIE400-4C
## Course Name: Practicals in Microbiology - V
## Semester: I

**w.e.f.: July 2025**

**Type of course:** Minor Course

**Prerequisite:** Basic knowledge of microbiology, virology, mycology. Enzymology, bioinformatis and immunology principles.

**Rationale:** To develop hands-on skills in microbial techniques, enzymology assays, bioinformatics, and immunodiagnostics, essential for advanced microbiological research and applications.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | | Examination Marks | | Total Marks |
|---|---|---|---|---|---|---|
| L | T | P | Total | CCE Marks | SSE Marks | |
| - | - | 8 | 8 | 50 | 50 | 100 |

**Contents:**

| Sr. No. | Content | Total Hours |
|---|---|---|
| | 1. Isolation and Enumeration of Bacteriophages from Sewage<br>2. Cultivation of Animal Viruses Using Chick Embryo Technique (Demonstration/Simulation) (Online demonstration)<br>3. Detection haemoglobin and blood grouping<br>4. Study of Cytopathic Effects (CPE) of Viruses in Cell Cultures (Virtual/Images)<br>5. Isolation and identification of Fungi from Soil<br>6. Screening of Fungi for Antibiotic and Enzyme Production<br>7. Development of fungal inoculum and enumeration of spore<br>8. Enzyme activity of Amylase (DNSA and Iodine method), Protease (Folin method)<br>9. Effect of physicochemical factors on Enzyme Activity<br>10. Determination of $K_m$ and $V_{max}$ of an Enzyme<br>11. Enzyme Immobilization<br>12. Retrieval and Analysis of Biological Sequences from NCBI and PDB | **120** |

| | | |
|---|---|---|
| | 13. Multiple Sequence Alignment Using CLUSTAL Omega and Phylogenetic Tree Construction<br>14. Gene and Genome Annotation Using Tools like RAST/Prokka<br>15. Visualization of Omics Data Using Cytoscape (Network Biology)<br>16. Blood Cell Count and Differential Leucocyte Count (DLC)<br>17. Radial Immunodiffusion (RID) Assay for Antigen Quantification and Enzyme-Linked Immunosorbent Assay (ELISA) (Online demonstration)<br>18. Detection of blood glucose by GOP/POD<br>19. Identification of Pathogenic Bacteria from Clinical Samples (Online demonstration)<br>20. Antibiotic Sensitivity Testing by Kirby-Bauer Disk Diffusion Method and detection of MIC value | |

**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 Book**

1. Dubey, R. C., & Maheshwari, D. K. (2016). Practical Microbiology. S. Chand Publishing.
2. Patel, R. J. (2021). Practical Manual of Microbiology and Immunology. Nirav & Co.
3. Hay, F. C., & Westwood, O. M. R. (2002). Practical Immunology (4th ed.). Wiley-Blackwell.

**Reference Books**

1. Norris, J. R., & Ribbons, D. W. (Eds.). (1969–present). Methods in Microbiology (Vol. Series). Academic Press.
2. Ausubel, F. M., Brent, R., Kingston, R. E., Moore, D. D., Seidman, J. G., Smith, J. A., & Struhl, K. (1995–present). Current Protocols in Molecular Biology and Bioinformatics. Wiley-Interscience.
3. Owen, J. A., & Punt, J. (2013). Essential Immunology Laboratory Manual. Garland Science.

**Course Outcomes:**

**After completing this course, student will be able to**

| **Sr.** | **CO statement** | **Marks %** |
|---|---|---|

| No. | | weightage |
|---|---|---|
| CO-1 | Perform basic and advanced virology and mycology laboratory techniques. | 20 |
| CO-2 | Analyze enzyme activity and perform enzyme kinetics experiments. | 15 |
| CO-3 | Utilize bioinformatics tools for gene and protein sequence analysis. | 15 |
| CO-4 | Conduct immunological tests including ELISA, blotting, and agglutination. | 15 |
| CO-5 | Identify microbial pathogens using diagnostic microbiological techniques. | 15 |
| CO-6 | Apply sterile techniques and microbial assays in medical microbiology labs. | 20 |

# UPL -University of Sustainable Technology

## SRICT Institute of Science & Research

**Teaching/Exam Scheme**

**M.Sc. Sem. II**

| Sr. No. | Course Code | Category of course | Course title | Hour s Per week | | | Total con. hrs. | Credits | E | M | I | V | Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | | | | | |
| 1 | MIM403-4C | Major Course | Soil and Water Microbiology | 4 | - | - | 4 | 4 | 50 | 50 | - | - | 100 |
| 2 | MIM404-4C | Major Course | Food and Dairy Microbiology | 4 | - | - | 4 | 4 | 50 | 50 | - | - | 100 |
| 3 | MIM405-4C | Major Course | Industrial and Fermentation Microbiology | 4 | - | - | 4 | 4 | 50 | 50 | - | - | 100 |
| 4 | MIE401-4C | Minor Course | Microbiology Practicals-VI | 0 | 0 | 8 | 8 | 4 | 50 | 50 | - | - | 100 |
| 5 | RP401-4C/ OJT401-4C | RP/OJT* | RP/OJT* | - | - | - | - | 6 | - | - | 75 | 75 | 150 |
| | | | Total | 12 | - | 8 | 20 | 22 | 200 | 200 | 75 | 75 | 550 |

# UPL -University of Sustainable Technology

## SRICT Institute of Science & Research

## Master of Science
## Course Code: MIM403-4C
## Course Name: Soil and Water Microbiology
## Semester: II

**w.e.f.: July 2025**

**Type of course:** Major Course

**Prerequisite:** Basic knowledge on soil and water microbiology

**Rationale:** The subject Soil and Water Microbiology is essential for understanding the roles of microorganisms in environmental processes, nutrient cycling, pollution control, and sustainable management of soil and water ecosystems.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | | 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** | **Microbial Ecology and Environmental Interactions**<br>Microbial habitats in soil and aquatic ecosystems; Microbial community dynamics and ecological succession; Biofilms: formation, structure, and ecological importance; Microbial interactions: mutualism, antagonism, commensalism; Quorum sensing and microbial communication in ecosystems | **9** |
| **2.** | **Microbial Diversity in Extreme and Natural Environments**<br>Extremophiles: thermophiles, psychrophiles, halophiles, acidophiles, alkaliphiles; Adaptation strategies under extreme environmental conditions; Microbial diversity in marine, desert, polar, volcanic, and subsurface habitats; Ecological significance and biotechnological applications of extremophiles; Metagenomics approaches to study uncultured microbes | **9** |
| **3** | **Solid Waste Management and Compost Microbiology**<br>Microbial decomposition of organic solid waste, Composting processes: aerobic, anaerobic, vermicomposting, Microbial consortia involved in organic matter | **12** |

| | | |
|---|---|---|
| | degradation, Indicators of compost maturity and quality, Management of hazardous and biomedical waste: microbial perspective, PGPR. | |
| **SECTION - B** | | |
| **4** | **Microbial Aspects of Environmental Pollution and Biodegradation**<br>Microbial degradation of pollutants: hydrocarbons, dyes, pesticides, plastics; Mechanisms of biodegradation and biotransformation; Plasmid-encoded biodegradative pathways; Environmental impact of pollutants on microbial communities; Role of biosurfactants in biodegradation | **9** |
| **5** | **Bioremediation and Environmental Biotechnology**<br>Principles and strategies of bioremediation: in situ and ex situ; Bioaugmentation, biostimulation, and monitored natural attenuation; Rhizoremediation and phytoremediation supported by microbes; Use of recombinant microorganisms in environmental cleanup; Biosensors for pollutant detection and environmental monitoring | **12** |
| **6** | **Microbial Risk Assessment and Environmental Regulations**<br>Microbial indicators of environmental contamination (water, soil, waste); Environmental monitoring and sampling strategies; Risk assessment of genetically modified microorganisms (GMMs); Biosafety levels and containment strategies in environmental studies; National and international environmental regulations and frameworks (e.g., EPA, CPCB, MoEF, UNEP) | **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. Alexander, M. (1997). *Introduction to soil microbiology* (2nd ed.). Wiley.
2. Maier, R. M., Pepper, I. L., & Gerba, C. P. (2015). *Environmental microbiology* (3rd ed.). Academic Press.
3. Bitton, G. (2010). *Wastewater microbiology* (4th ed.). Wiley-Blackwell.

**Reference Books:**

1. Paul, E. A. (2014). *Soil microbiology, ecology, and biochemistry* (4th ed.). Academic Press.
2. Tortora, G. J., Funke, B. R., & Case, C. L. (2018). *Microbiology: An introduction* (13th ed.). Pearson

**Course Outcomes:**

**After completing this course, student will be able to**

| Sr. No. | CO statement | Marks % weightage |
|---|---|---|
| CO-1 | Understand microbial habitats, interactions, and communication in soil and water ecosystems. | 15 |
| CO-2 | Explain the diversity and adaptations of extremophiles in varied environments. | 20 |
| CO-3 | Describe microbial roles in composting and solid waste degradation. | 15 |
| CO-4 | Analyze microbial mechanisms for biodegradation of environmental pollutants. | 15 |
| CO-5 | Understand bioremediation strategies and microbial applications in environmental biotechnology. | 20 |
| CO-6 | Identify microbial indicators and apply biosafety and risk assessment in environmental monitoring. | 15 |

# UPL -University of Sustainable Technology

## SRICT Institute of Science & Research

## Master of Science
## Course Code: MIM404-4C
## Course Name: Food and Dairy Microbiology
## Semester: II

**w.e.f.: July 2025**

**Type of course:** Major Course

**Prerequisite:** Fundamental understanding of microbial roles in food and diary.

**Rationale:** The subject *Food and Dairy Microbiology* is crucial for understanding the role of microorganisms in food production, preservation, spoilage, and safety, with applications in quality control, public health, and the development of fermented dairy and food products.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | | 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** | **Fundamentals of Food and Dairy Microbiology**<br>History and Scope, Microbial Diversity in Foods: taxonomy and physiology, Sources of Microbial Contamination: Raw materials, processing environments, handlers, equipment; Intrinsic and Extrinsic Factors Affecting Microbial Growth in Foods; Classification of Foods Based on Shelf Life and Microbial Susceptibility: Perishable, semi-perishable, and non-perishable foods | **9** |
| **2.** | **Microbiology of Milk and Dairy Products**<br>Milk as a Biological Fluid: Composition, natural microflora, significance as a microbial medium; Sources of Contamination in Milk; Microbial Spoilage of Milk and Dairy Products: Sour curdling, gas production, proteolysis, lipolysis, discoloration, etc.; Pathogens in Milk: *Mycobacterium tuberculosis*, *Brucella* spp., *Listeria monocytogenes*, *Salmonella* spp, etc.; Fermented Dairy Products: Yogurt, cheese, butter, curd, kefir; Role of starter cultures with examples; Preservation and packaging | **9** |
| **3** | **Foodborne Diseases, Pathogens and Toxins** | **12** |

| | | |
|---|---|---|
| | Foodborne Infections vs. Intoxications; Important Bacterial Pathogens: *Salmonella*, *E. coli* (O157:H7), *Clostridium botulinum*, *Listeria*, *Bacillus cereus*, *Shigella*, etc.; Mycotoxins: Aflatoxins, Ochratoxins, Patulin – sources and effects; Viral Foodborne Pathogens: Noroviruses, Hepatitis A and E; Parasitic Foodborne Pathogens: *Giardia*, *Entamoeba*, *Taenia*; Sampling, Isolation, and Detection Methods: Culture methods, immunological methods, molecular techniques | |
| **SECTION - B** | | |
| **4** | **Fermentation Technology in Food and Dairy Industry**<br>Basic Principles of Food Fermentation; Types of Fermentation: Lactic acid fermentation (vegetables, milk), Alcoholic fermentation (bread, beverages), Acetic acid fermentation (vinegar); Production of Fermented Foods: Idli, dosa, sauerkraut, soy sauce, pickles, tempeh; Microorganisms Used: *Saccharomyces*, *Lactobacillus*, *Leuconostoc*, *Aspergillus*; Quality Control and Safety in Fermented Foods; Probiotics and Prebiotics: Mechanisms of action, health benefits, commercial formulations, SCP, SCO | **9** |
| **5** | **Food Preservation and Processing Technologies**<br>Goals of Food Preservation; Thermal Processing: Pasteurization, canning, sterilization; Chilling, freezing, freeze-drying, Sun drying, spray drying, drum drying; Preservatives: Organic acids, nitrites, sulfites, salt, sugar, Bacteriocins (e.g., nisin), essential oils, Gamma radiation, electron beams; Novel and Emerging Technologies: High-pressure processing, pulsed electric field, cold plasma | **12** |
| **6** | **Quality Control, Food Hygiene, and Regulatory Aspects**<br>Microbiological Quality Standards: Total viable count, coliform testing, indicator organisms; Microbial limits for milk, dairy products, meat, and canned foods; Sampling Plans and Statistical Quality Control (SQC); Food Safety Management Systems: HACCP, GMP, ISO 22000, FSSAI norms; Waste Disposal and Environmental Considerations in Dairy Industry; Packaging Microbiology: Spoilage from packaging, bioactive packaging | **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. Adams, M. R., & Moss, M. O. (2008). *Food microbiology* (3rd ed.). Royal Society of Chemistry.
2. Frazier, W. C., & Westhoff, D. C. (2004). *Food microbiology* (4th ed.). McGraw Hill Education
3. Robinson, R. K. (Ed.). (2002). *Dairy microbiology handbook: The microbiology of milk and milk products* (3rd ed.). Wiley-Interscience.

**Reference Books:**

1. Banwart, G. J. (1989). *Basic food microbiology* (2nd ed.). Springer.
2. Ray, B., & Bhunia, A. (2013). *Fundamental food microbiology* (5th ed.). CRC Press.
3. Early, R. (1998). *Technology of dairy products* (2nd ed.). Springer.

**Course Outcomes:**

**After completing this course, student will be able to**

| Sr. No. | CO statement | Marks % weightage |
|---|---|---|
| CO-1 | Understand microbial roles in food and dairy processing, preservation, and spoilage. | 15 |
| CO-2 | Identify foodborne pathogens and their detection and control methods. | 20 |
| CO-3 | Apply techniques to assess food and dairy microbial quality and safety. | 15 |
| CO-4 | Explain fermentation processes in food and dairy product development. | 15 |
| CO-5 | Evaluate probiotics, prebiotics, and starter cultures in functional foods. | 20 |
| CO-6 | Interpret food safety standards for quality control and public health. | 15 |

# UPL -University of Sustainable Technology

## SRICT Institute of Science & Research

## Master of Science
## Course Code: MIM405-4C
## Course Name: Industrial and Fermentation Microbiology
## Semester: II

**w.e.f.: July 2025**

**Type of course:** Major Course

**Prerequisite:** Fundamental understanding of role of microorganisms in industry.

**Rationale:** This subject introduces the large-scale use of microorganisms to produce valuable bioproducts, providing students with essential knowledge and skills in industrial microbiology, bioprocess engineering, and biotechnology.

**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** | **Fundamentals of Industrial and Fermentation Microbiology**<br>Historical Development and Scope; Types of Industrial Microorganisms: Bacteria, fungi, actinomycetes, yeast – screening and selection criteria; Primary and Secondary Metabolites: Definitions, examples, importance; Microbial Growth Kinetics: Phases of growth, Monod equation, substrate-limited growth; | **9** |
| **2.** | **Industrial Fermentor Design and Operation**<br>Basic Components and Design of an Industrial Fermentor; Design Considerations: Scale-up and scale-down principles; Control Systems in Fermentation: Monitoring of pH, temperature, dissolved oxygen, foam, agitation; Downstream Processing Overview: Separation, concentration, purification, drying, formulation of products; Medium sterilization, air sterilization, equipment sterilization | **9** |
| **3** | **Bioprocess Technology**<br>Types of Fermentation: SmF, SSF, Batch, Fed-batch, and Continuous fermentation – comparison and examples; Strain Improvement and Techniques; Design, types and applications of Bioreactors | **12** |

| SECTION - B | | |
|---|---|---|
| **4** | **Production of Primary and Secondary Metabolites**<br>Ethanol, Citric Acid, Lactic acid, Acetic acid, Lysine, Glutamic acid, Acetone-butanol, Penicillin, Streptomycin, Tetracycline, Amylase, Protease, Cellulase, Lipase, Vitamin B12, Riboflavin, Vitamin C, Xanthan gum, PHA-PHB, Biopesticides and Biofertilizers: *Bacillus thuringiensis*, *Rhizobium*, *Azotobacter* | **9** |
| **5** | **Fermentation Process Optimization and Quality Control**<br>Media Formulation: Carbon, nitrogen, trace elements, precursors, inducers, etc; Inoculum Development: Stages of inoculum build-up, scale-up issues; Fermentation Economics: Cost of production, yield optimization, productivity; Contamination Control and Sterility Maintenance; Quality Control in Fermentation Products: Bioassays, physicochemical tests, microbial limits | **12** |
| **6** | **Applications of Industrial Microbiology**<br>Biotransformation and Biocatalysis: Concepts, advantages over chemical synthesis; Immobilized Cell and Enzyme Technology; Applications of Fermentation: Brewery, dairy, food, pharmaceuticals, biofuels; Industrial Waste Management and Effluent Treatment: Microbial treatment of industrial waste, MFCs, bioremediation | **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. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2016). *Principles of fermentation technology* (3rd ed.). Elsevier.
2. Casida, L. E. (1968). *Industrial microbiology*. Wiley Eastern Limited.

**Reference Books:**

1. Peppler, H. J., & Perlman, D. (Eds.). (1979). *Microbial technology: Fermentation technology* (Vol. 1). Academic Press.

2. Waites, M. J., Morgan, N. L., Rockey, J. S., & Higton, G. (2001). *Industrial microbiology: An introduction*. Blackwell Science.

**Course Outcomes:**

**After completing this course, student will be able to**

| Sr. No. | CO statement | Marks % weightage |
|---|---|---|
| CO-1 | Understand fermentation principles and microbial growth in industrial systems. | 15 |
| CO-2 | Describe bioreactor types, design, and operation. | 20 |
| CO-3 | Analyze production and recovery of microbial products. | 15 |
| CO-4 | Apply strain selection and improvement methods. | 15 |
| CO-5 | Evaluate sterilization, contamination control, and process monitoring. | 20 |
| CO-6 | Explore advances in recombinant products and bioprocess optimization. | 15 |

# UPL -University of Sustainable Technology

## SRICT Institute of Science & Research

## Master of Science
## Course Code: MIE401-4C
## Course Name: Practicals in Microbiology - VI
## Semester: II

**w.e.f.: July 2025**

**Type of course:** Minor Course

**Prerequisite:** Basic knowledge of microbiology principles including microbial diversity, microbial growth, and fundamental techniques of microbiology.

**Rationale:** These courses provide practical skills in microbial isolation, identification, fermentation, and quality control for applications in agriculture, food safety, and industrial biotechnology.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | | Examination Marks | | Total Marks |
|---|---|---|---|---|---|---|
| L | T | P | Total | CCE Marks | SSE Marks | |
| - | - | 8 | 8 | 50 | 50 | 100 |

**Contents:**

| Sr. No. | Content | Total Hours |
|---|---|---|
| | 1. Study of Microbial Diversity in Soil and Water Samples<br>2. Isolation and Enumeration of Soil and Water Microorganisms<br>3. Biodegradation and Biotransformation of Hydrocarbons and Synthetic Dyes<br>4. Isolation and Identification of Extremophiles<br>5. Isolation and Quantification of Biosurfactant-Producing Microbes<br>6. Detection of Coliform from sewage sample<br>7. Isolation and identification of microbial contaminants from raw food ingredients and processed foods.<br>8. Detection and Identification of Foodborne Pathogens (Online demonstration)<br>9. Starter Culture Preparation for Dairy Products<br>10. Isolation of Yeast and *Lactobacillus* from Fermented food products<br>11. Probiotic Viability in Commercial and Laboratory Fermented Products<br>12. Production of Sauerkraut and Study the Microbial Profiling as well as Acidity and Alkalinity<br>13. Production of ethanol by yeast fermentation and estimation of ethanol yield | **120** |

| | | |
|---|---|---|
| | 14. Production of lactic acid by *Lactobacillus* spp. and its quantification<br>15. Antibiotic production (e.g., penicillin or streptomycin) and bioassay against test organisms<br>16. Enzyme production (amylase, protease, cellulose, lipase) and enzyme activity assay<br>17. Media optimization: Effect of carbon, nitrogen, and trace elements on metabolite production<br>18. Purification of Protein by Ammonium Sulphate Precipitation Method and Dialaysis<br>19. Detection of Molecular Weight of Protein by SDS-PAGE (Onlie demonstration)<br>20. Scale up of enzyme production using laboratory fermenter (Online demonstration) | |

**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. Rakesh Patel, Practical Microbiology, S. Chand Publishing, 2023.
2. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2012). Microbiology: Concepts and Applications. McGraw-Hill Education.
3. Cappuccino, J. G., & Sherman, N. (2014). Microbiology: A Laboratory Manual (10th ed.). Pearson.

**Reference Books**

4. Atlas, R. M. (2010). Handbook of Microbiological Media (4th ed.). CRC Press.
5. Collee, J. G., Fraser, A. G., Marmion, B. P., & Simmons, A. (1996). Mackie & McCartney Practical Medical Microbiology (14th ed.). Churchill Livingstone.
6. Aneja, K. R. (2017). Experiments in Microbiology, Plant Pathology and Biotechnology (5th ed.). New Age International Publishers.

**Course Outcomes:**

**After completing this course, student will be able to**

| Sr. No. | CO statement | Marks % weightage |
|---|---|---|
| CO-1 | Perform microbial isolation and identification from soil, water, and food samples. | 20 |
| CO-2 | Apply aseptic techniques for culturing and maintaining industrial microorganisms. | 15 |
| CO-3 | Conduct fermentation processes to produce primary and secondary metabolites. | 15 |
| CO-4 | Analyze microbial contamination and quality control in food and dairy products. | 15 |
| CO-5 | Use molecular and biochemical methods to characterize microbial isolates | 15 |
| CO-6 | Evaluate environmental and industrial samples for microbial activity and safety. | 20 |

# UPL -University of Sustainable Technology

## SRICT Institute of Science & Research

## As Per National Education Policy 2020 (NEP 2020)

## Master of Science

## Course Name: Research Project/on the Job Training

## Semester: VI

**w.e.f.: July 2025**

Considering that some students choose academics and research as their career while others prefer industrial jobs, the students shall get two options to meet their specific need – (i) Plan A: Research Project, and (ii) Plan B: on the Job Training. The program coordinator and placement officer shall conduct an orientation session in semester 6 so that the students can take informed decision to choose between the two options.

### PLAN A- Research Project

**Type of Course:** Core course

**Prerequisite:** Basic Knowledge of microbial processes and operations.

**Rationale:** To help students learn about the research in state-of-the-art research institutions. This will also provide the students an opportunity to practically use their life science-based skills in a typical research environment**.**

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credits | Examination Marks | | Total Marks |
|---|---|---|---|---|---|---|
| L | T | P | C | CCE Marks | SSE Marks | |
| 0 | 0 | 180 | 6 | 75 | 75 | 150 |

**Content:**

| Sr. No. | Content | Total Hrs. |
|---|---|---|
| | | |
| **1** | The students shall carry out one month research project in an academic or research institution of national/international repute. They must prepare a report on a specific template 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 01 copy of their report to the | **180** |

| | | |
|---|---|---|
| | department. | |

**PLAN B- on the Job Training**

**Type of Course:** Core course

**Prerequisite:** Basic Knowledge of microbial processes and operations.

**Rationale:** To provide students with practical, real-world experience, focusing on work experience, professional activities, or cooperative education, at the end of the course, students will learn about the application of Chemistry concepts in modern chemical industries. This will also provide the students an opportunity to practically use their microbial science-based skills in a life-science industry.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credits | Examination Marks | | Total Marks |
|---|---|---|---|---|---|---|
| L | T | P | C | CCE Marks | SSE Marks | |
| 0 | 0 | 120 | 4 | 40 | 60 | 100 |

**Content:**

| Sr. No. | Content | Total Hrs. |
|---|---|---|
| | | |
| **1** | The students shall carry out 01 month internship in an industry of national/international repute. They must prepare an internship report on a specific template provided by the University. Upon completion of the internship, students are required to present their work before the expert committee. Students must submit 01copy of their spiral internship report to the department. | **120** |