Kurukshetra University, Kurukshetra

(Established by the State Legislature Act-XII of 1956)
("A++" Grade, NAAC Accredited)

Syllabus
for
Post Graduate Programme

M.Sc. MICROBIOLOGY
(3rd and 4th semester)

as per NEP 2020
Curriculum and Credit Framework for Postgraduate Programme

CBCS-LOCF
With effect from the session 2025-26

DEPARTMENT OF MICROBIOLOGY
FACULTY OF LIFE SCIENCES

KURUKSHETRA UNIVERSITY, KURUKSHETRA -136119
HARYANA, INDIA

Session: 2025-26			
Part A – Introduction			
Name of Programme	**M.Sc. Microbiology**		
Semester	**3**		
Name of the Course	**Microbial biotechnology & industrial microbiology-I**		
Course Code	**M24-MIC-301**		
Course Type	**CC-9**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**NA**		
Course Learning Outcomes (CLO)	**CO1.** Student will be able to describe industrially important microbes, their selection, and strain improvement methods. **CO2.** Student will be able to explain fermenter design, types of fermentation, and microbial growth kinetics. **CO3.** Student will be able to interpret bioprocess control parameters and downstream processing techniques. **CO4.** Student will be able to describe microbial applications in food, biofertilizers, and biocontrol products.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Introduction to industrial microbiology**: Historical Development and significance for microbial products and fermentation processes. Criteria, sources and isolation of industrially important microorganisms. Biosynthetic pathways and regulation for metabolic products of industrially important microorganisms. **Culture collection** and methods of preservation for microbial cultures. Selection and strain improvement for overproduction of microbial metabolites for industrial applications (mutant selection, protoplast fusion, recombination and Recombinant DNA technology).	15
II	**Fermenter design and technologies:** Basic components of a fermenter, fermenter construction materials, designing of laboratory and industrial scale fermenters, types of impellers, baffle and spargers, foam controller, types of fermenters like stirred tank, bubble column, airlift, packed beds, fluidized beds, perfusion cultures, Immobilized cell reactor, photo-bioreactors and animal cell culture bioreactor, Single use bioreactor. Different types of sterilization strategies, sterilization of large-scale bioreactors, sterilization innovations (Plasma sterilization, UV-C sterilization, Continuous sterilization**)** **Fundamentals of fermentation systems:** Types of Fermentation, Substrates for industrial fermentation, Submerged and solid-state fermentation, batch cultivation, continuous cultivation and fed-batch cultivation. Multistage chemostat and feedback systems. Monod kinetics of microbial growth, growth and non-growth associated product formation, product formation kinetics.	15

III	**Bioprocess instrumentation and control parameters**: Measurement of various control parameters in bioreactor like pH, dissolved oxygen, temperature, antifoam, principles of feed back control, PID control, respiratory quotient, effect of dissolved oxygen on microbial production processes, effect of foam and anti-foam on oxygen transfer, oxygen mass transfer coefficient, measurement of KLa values using sulfite oxidation techniques, gassing-out techniques, fluid rheology, newtonian and non-newtonian fluids, bingham plastic, pseudo plastic, power number, Reynolds number. **Downstream processing**: Downstream processing for filtration (DSP) cell disruption, liquid liquid extraction, solvent recovery, supercritical fluid extraction, various chromatography techniques in product recovery, diafiltration, ultrafiltration and reverse osmosis, drying (lyophilization and spray drying), whole broth processing and crystallization, upstream processing and product recovery.	15
IV	**Use of whole cells for food related purpose:** •Single Cell Protein production •Yeast Production •Production of microbial insecticides •Production of Biofertilizers.	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Stanbury, P. F., Whitaker, A., & Hall, S. J. (2016). *Principles of fermentation technology* (3rd ed.). Butterworth-Heinemann.
- Shuler, M. L., Kargi, F., & DeLisa, M. P. (2017). *Bioprocess engineering: Basic concepts* (3rd ed.). Pearson Education.
- Okafor, N., & Okeke, B. C. (2017). *Modern industrial microbiology and biotechnology* (2nd ed.). CRC Press.
- El-Mansi, E. M. T., Bryce, C. F. A., Demain, A. L., & Allman, A. R. (Eds.). (2012). *Fermentation microbiology and biotechnology* (3rd ed.). CRC Press.
- Glazer, A. N., & Nikaido, H. (2007). *Microbial biotechnology: Fundamentals of applied microbiology* (2nd ed.). Cambridge University Press.
- Walsh, G. (2014). *Pharmaceutical biotechnology: Concepts and applications* (2nd ed.). John Wiley & Sons.
- Crommelin, D. J. A., Sindelar, R. D., & Meibohm, B. (2019). *Pharmaceutical biotechnology: Fundamentals and applications* (5th ed.). Springer.
- Crueger, W., & Crueger, A. (2005). *Biotechnology: A textbook of industrial microbiology* (2nd Indian ed.). Panima Publishing Corporation.
- Srivastava, M. L. (2008). *Fermentation technology: Principles and applications* (1st ed.). Alpha Science International.
- Bhatia, R. K., & Walia, A. (Eds.). (2024). *Advancements in microbial biotechnology for soil health*. Springer Nature.
- Verma, P. (Ed.). (2024). *Industrial microbiology and biotechnology: A new horizon*. Springer.
- Wenli, Z. (2023). *Fermentation technology and microbial proteins*. LAP Lambert Academic Publishing.
- Maddela, N. R., Laldinsangi, C., Chhipa, H., & Khan, A. (Eds.). (2024). *Microbial biotechnology for bioenergy*. Elsevier.

Session: 2025-26			
Part A – Introduction			
Name of Programme	**M.Sc. Microbiology**		
Semester	**3**		
Name of the Course	**Immunology & Virology**		
Course Code	**M24-MIC-302**		
Course Type	**CC-10**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**NA**		
Course Learning Outcomes (CLO)	CO1. Student will be able to describe the fundamental concept in immunology like immunity and antibodies. CO2. Student will be able to describe the immune responses and immunological disorders. CO3 Student will be able to describe the principle of virus classification, list the virus families, and virus replication. CO4. Student will be able to describe how viruses are grown and vaccines are made.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Immunity:** Innate immunity, factors affecting innate immunity. Acquired immunity- natural and artificial immunity, active and passive immunity. Humoral and cell-mediated immune response; Innate immune response and pattern recognition. Antigen, hapten and adjuvants. Lymphoid organs and cells of immune system. **Immunoglobulins**: types, structure and functions. **Immune response:** Cellular and humoral immune response. Brief account of Complement system and Major histocompatibility complex. Cell signaling through MAP kinases and NF-κB.	15
II	Molecular mechanisms responsible for generating diversity of antibodies and T cell receptors. Genetic organization of MHC-I and MHC-II complex. Hybridoma technology and monoclonal antibodies, and its applications. **Mechanisms of autoimmunity**; Immune checkpoints, Autoimmune components of diabetes mellitus (DM), multiple sclerosis (MS), pernicious anemia; Infections leading to autoimmune diseases. Immunodeficiency diseases. Comparative study of Type I-V hypersensitivities with examples. Tumor antigens, immune response to tumors and immunotherapy of tumors.	15
III	**Classification, Properties of viruses, Morphology and Structure of viruses-** Capsid and its symmetry with special reference to bacteriophage, Lytic and lysogenic cycle. Viroids and Prions, Virus genome types. Double stranded DNA (dsDNA). Gapped DNA genomes. Single-stranded (ssDNA) genomes. Double stranded RNA (dsRNA). Single stranded RNA (ssRNA): (+) strand RNA. Single stranded (+) sense RNA with DNA intermediate. Single stranded RNA (-) sense. **Principal events involved in replication**: Adsorption, penetration, uncoating nucleic acid and protein synthesis, intracellular trafficking, assembly, maturation and release, viral-host interaction, Host response to viral infection.	15

IV	**Virus growth:** Primary cell, Diploid cell strains, Continuous cell lines. One step growth curve, Detection of virus growth in cell culture. Techniques for visualization and enumeration of viral particles, assays for virus estimation. **Vaccines & Anti-Viral drugs**: Herd Immunity. Requirement of an effective vaccine. Different ways of making vaccine. Inactivated vaccine. Subunit vaccines. Subunit vaccines. Live attenuated vaccines. Polio eradication. Anti-Viral drugs. Search for antiviral drugs. The path for drug discovery. Mechanism based screens. Cell based screen. Antiviral screening. Resistance to antiviral drugs.	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Carter JB & Saunders VA. Virology-Principles and Applications, John Wiley and Sons.
2. Flint S.J., Enquist L.W., Racaniello V.R., and Skalka A.M. Principles of Virology: Molecular Biology, Pathogenesis and Control of Animal Viruses. 2nd edition. ASM Press.
3. Dimmock N., Easton A. and Leppard K. Introduction to Modern Virology. 5thedition. Blackwell Publishing.
4. Kuby Immunology by J.A. Owen, J. Punt , S.A. Stranford. 7th edition. WH Freeman. 2013.
5. Abbas A.K., Lichtman A.H., Pillai S. Cellular and Molecular Immunology. 9th edition. Saunders Elsevier.
6. Murphy K. and Casey W. Janeway's Immunobiology. 9th edition. Garland Science Publishing.
7. Delves PJ., Martin S.J., Burton D.R., Roitt I.M.. Roitt's Essential Immunology. 13th edition. Blackwell Publishing

Session: 2025-26			
Part A – Introduction			
Name of Programme	**M.Sc. Microbiology**		
Semester	**3**		
Name of the Course	**Environmental Microbiology**		
Course Code	**M24-MIC-303**		
Course Type	DEC-1		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**NA**		
Course Learning Outcomes (CLO)	**CO1.** Student will be able to describe microbial diversity and methods for studying environmental microbes. **CO2.** Student will be able to explain microbial communities in soil, water, and air, including biofilms and microbial interactions. **CO3.** Student will be able to describe microbial adaptations in extreme environments and their role in biogeochemical cycles. **CO4.** Student will be able to identify microbial indicators and apply tools for environmental monitoring and public health safety.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Fundamentals of Environmental Microbiology** Definition, scope, and importance of environmental microbiology. Cultivation-dependent and -independent methods for studying environmental microorganisms. Techniques for microbial community analysis: FAME, BIOLOG, 16S rRNA gene sequencing, slot-blot hybridization, fluorescent in-situ hybridization (FISH), and metagenomics of soil and aquatic sediments. Environmental sampling techniques: Methods for air, soil, water, and sediment sampling. .	15
II	**Microbial Habitats and Community Structures** Aquatic microbiology: Microbial communities in freshwater, marine, estuarine, and groundwater ecosystems. Soil microbiology: Microbial diversity in bulk soil and rhizosphere; roles in soil structure, fertility, and nutrient cycling; rhizosphere interactions and plant-microbe symbiosis; microbial antagonism and endophytes. Air microbiology: Sources, dispersion, survival of airborne microorganisms, and their impact on human health and climate. Quorum sensing and quorum quenching: Microbial communication systems in environmental contexts. Biofilms: Formation, structure, ecological relevance, and resistance mechanisms**.**	15

III	**Microbial Adaptations and Extreme Environments** Microbial diversity in extreme environments: Occurrence, diversity, adaptations and biotechnological applications of oligotrophs, thermophiles, psychrophiles, organic solvent and radiation tolerants, metallophiles, acidophiles, alkaliphiles and halophiles. Microbial Ecology and Evolution: Population dynamics, community interactions, and evolutionary adaptations of microorganisms in response to environmental pressures. Horizontal gene transfer and microbial genome plasticity in natural ecosystems. Biogeochemical cycling of carbon, nitrogen, sulfur, and phosphorus: Microbial involvement and ecosystem implications.	15
IV	**Environmental Monitoring and Public Health Microbiology** Indicators of water and air quality: Coliforms, fecal bacteria, viruses. Microbial contamination in drinking water and its assessment using MPN, membrane filtration, and PCR-based methods. Biosensors: Types, working principles, and applications in environmental monitoring. Emerging environmental pathogens and dissemination of antibiotic resistance genes in ecosystems. Microbial risk assessment: Principles, methods, and applications in environmental health. Regulatory frameworks and standards: WHO, BIS, CPCB, and EPA guidelines for microbial quality of water and air..	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Atlas, R. M., & Bartha, R. (1997). *Microbial ecology: Fundamentals and applications* (4th ed.). Benjamin Cummings.
- Varnam, A. H., & Evans, M. G. (2000). *Environmental microbiology*. Manson Publishing Ltd.
- Hurst, C. J., Crawford, R. L., Garland, J. L., Lipson, D. A., Mills, A. L., & Stetzenbach, L. D. (Eds.). (2007). *Manual of environmental microbiology* (3rd ed.). ASM Press.
- Mitchell, R., & Gu, J.-D. (Eds.). (2010). *Environmental microbiology* (2nd ed.). Wiley-Blackwell.
- Maier, R. M., Pepper, I. L., & Gerba, C. P. (2015). *Environmental microbiology* (3rd ed.). Academic Press.
- Jjemba, P. K. (2004). *Environmental microbiology: Principles and applications*. Science Publishers.
- Kuhad, R. C., & Singh, A. (Eds.). (2007). *Lignocellulose biotechnology: Future prospects*. I.K. International.
- Okafor, N. (2011). *Environmental microbiology of aquatic and waste systems*. Springer.
- Kumar, V., Garg, V. K., Kumar, S., & Biswas, J. K. (Eds.). (2023). *Omics for environmental engineering and microbiology systems* (1st ed.). CRC Press.
- Maddela, N. R., Eller, L. K. W., & Prasad, R. (Eds.). (2023). *Microbiology for cleaner production and environmental sustainability* (1st ed.). CRC Press.
- Ivanov, V. (2024). *Environmental microbiology for engineers* (3rd ed.). CRC Press.
- Goswami, D., Maheshwari, D. K., & Saraf, M. (Eds.). (2025). *Climate change and soil microorganisms for environmental sustainability* (1st ed.). Springer Nature.
- Verma, P. (Ed.). (2024). *Industrial microbiology and biotechnology: A new horizon of the microbial world* (1st ed.). Springer.
- Karnwal, A., & Al-Tawaha, A. R. M. S. (2022). *Environmental microbiology: Advanced research and multidisciplinary applications*. Bentham Science Publishers.
- Shah, M. P. (Ed.). (2022). *Environmental microbiology: Emerging technologies*. De Gruyter.

Session: 2025-26			
Part A – Introduction			
Name of Programme	**M.Sc. Microbiology**		
Semester	**3**		
Name of the Course	**Food & Dairy Microbiology**		
Course Code	**M24-MIC-304**		
Course Type	DEC-1		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**NA**		
Course Learning Outcomes (CLO)	**CO1.** Student will be able to describe food microbes, growth factors, and detection methods. **CO2.** Student will be able to explain food spoilage and preservation techniques. **CO3.** Student will be able to describe fermented foods, probiotics, and their health benefits. **CO4.** Student will be able to identify food-borne diseases and food safety systems.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Food Microbiology: Principles, Practices, and Emerging Trends** Development of food microbiology as a scientific discipline; scope and significance of food microbiology. Overview of food-associated microorganisms, including molds, yeasts, yeast-like fungi, and bacteria. Intrinsic and Extrinsic Factors affecting Microbial Growth in Foods: *Intrinsic factors:* Nutrient content, pH, moisture content/water activity, Redox potential, natural antimicrobial barriers, and antimicrobial substances. *Extrinsic factors:* Relative humidity, temperature, and gaseous atmosphere. **Methods for Microbiological Examination of Food:** Direct Examination, Enumeration Methods, Dye reduction test, electrical methods Rapid Methods for Detection of Specific Organisms and Toxins.	15
II	**Microbial spoilage of foods:** Principles and Sources of microbial food spoilage. Spoilage of cereals, sugar products, vegetables, fruits, meat and meat products, milk and milk products, fish and sea foods, poultry; spoilage of canned foods. Study of microorganisms responsible for spoilage and microbial succession during spoilage. **Food preservation:** General principles of food preservation, various classical physical, chemical, and biological methods of preservation. Emerging methods of food preservation, food protection with modified atmosphere	15

III	**Fermented and Microbial Foods:** Fermented dairy products such as yogurt, cheese, and kefir; fermented vegetable and cereal products including sauerkraut, kimchi, soy sauce, pickles, idli, dosa, bread, baker's yeast, tempeh, and miso; fermented meat and fish products such as sausages and fermented fish. Edible mushrooms including *Agaricus*, *Volvariella*, and *Pleurotus*. Production and application of single-cell proteins (SCP)**.** **Health Aspects of Fermented Foods:** Overview of prebiotics and probiotics, functional foods and their health benefits, safety issues, and quality control measures. Bioactive Compounds from Fermented Foods: Introduction to the concept and health relevance of bioactive compounds derived from fermented foods, including malt beverages, wines, distilled liquors, and vinegar.	15
IV	**Food microbiology and public health-** **Food-borne diseases:** Food hazards, Food-borne infections including bacterial, viral, and fungal infections. Bacterial food diseases: Various types and causes of food intoxication. Botulism, *Staphylococcal* food poisoning, *Clostridium perfringens* food poisoning, *Bacillus cereus* gastroenteritis, *Salmonellosis*, *Escherichia coli* diarrhoea: different pathotypes, *Vibrio cholerae*. Fungal poisoning: *Aspergillus*, *Penicillium*, *Claviceps*, *Fusarium*. Food-borne viruses. **Concept and principles of quality assurance in food production;** Good Manufacturing Practices (GMP), Good Hygiene Practices (GHP), and Sanitation Standard Operating Procedures (SSOP). Quality systems including ISO 9001, ISO 22000, FSSC 22000, and HACCP-based food safety management. Role of indicator organisms and microbial criteria in quality assurance. Overview of food safety regulatory frameworks: FSSAI, FDA, EU standards. Role of GMO in food safety. Role of quality assurance personnel and training in maintaining food safety compliance.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Frazier, W. C., Westhoff, D. C., & Vanitha, K. N. (2013). *Food microbiology* (5th ed.). McGraw Hill Education.
- Jay, J. M., Loessner, M. J., & Golden, D. A. (2005). *Modern food microbiology* (7th ed.). Springer.
- Ray, B., & Bhunia, A. (2025). *Fundamental food microbiology* (6th ed.). CRC Press.
- Adams, M. R., Moss, M. O., & McClure, P. (2024). *Food microbiology* (5th ed.). Royal Society of Chemistry.
- Doyle, M. P., & Beuchat, L. R. (Eds.). (2012). *Food microbiology: Fundamentals and frontiers* (4th ed.). ASM Press.
- Montville, T. J., Matthews, K. R., & Kniel, K. E. (2025). *Food microbiology: An introduction* (5th ed.). Wiley-Blackwell.
- Doyle, M. P., Buchanan, R. L., & Diez-Gonzalez, F. (Eds.). (2012). *Food microbiology: Fundamentals and frontiers* (4th ed.). ASM Press.
- Nehra, M., & Nain, V. (2024). *Handbook of industrial food microbiology*. Apple Academic Press.
- Matthews, K. R., Kniel, K. E., & Critzer, F. J. (2024). *Food microbiology: An introduction* (5th ed.). Wiley-Blackwell.

Session: 2025-26			
Part A – Introduction			
Name of Programme	**M.Sc. Microbiology**		
Semester	**3**		
Name of the Course	**Agriculture Microbiology**		
Course Code	**M24-MIC-305**		
Course Type	**DEC-2**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**NA**		
Course Learning Outcomes (CLO)	CO1: understand different MO present in soil ecosystem and their role and different interactions for sustainable agriculture alongwith beneficial attributes of PGPR. CO2: Understand the concept of plant nutrition by microbial inoculants through biological nitrogen fixation and mycorrhiza and other biofertilizers. CO3: understand role of microorganisms in different biotransformation and biodegradation strategies of different organic matter, organic polymers, and pesticides. They will gain basic idea of biogas, composting, vermicomposting. CO4: Understand mechanism of common plant diseases of cereals, vegetables and crops and will learn different biocontrol and transgenic approaches for protection of plant from diseases.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Soil microbial ecology:** Soil biota, types of organisms in different soils; Soil microbial biomass; Factors influencing the soil microflora. Different Agriculturally important beneficial microorganisms – free living, symbiotic (rhizobial, mycorrhizal, actinorhizal), associative and endophytic nitrogen fixers including cyanobacteria. **Microbial interactions:** Different interfaces of interactions - Plant-microbe, microbe-microbe, soilmicrobe, soil-plant-microbe interactions leading to symbiotic, associative, endophytic and pathogenic interactions, unculturable soil biota. Plant growth promoting rhizobacteria (PGPR). Mechanism of plant growth promotion by PGPR.	15
II	**Introduction to biofertilizers**- definition, types of biofertilizers; Characterstic features of the following biofertilizer organisms: *Azospirillium*, *Azotobacter*, *Bacillus, Pseudomonas, Rhizobium*, *Frankia, Anabaena* and *Nostoc*. Mechanisms of action of different bio-inoculants for plant growth. Significance of biofertilizers. Mass scale production and quality control of bioinoculants. Biofertilizer inoculation and microbial communities in the soil. **Biological nitrogen fixation**- Biochemistry of N2fixation, nif operon, mechanism of nitrogen fixation. Symbiotic nitrogen fixation: Rhizobium-Legume association, Actinorhizal associations, contribution of symbiotic nitrogen fixation. Denitrification. Phosphate solubilization and mobilization. Mycorrhizae- Ecto and endomycorrhizae, VAM and their importance in agriculture.	15
III	**Microbial transformations** of nitrogen, phosphorus, sulphur, iron and manganese in soil. Biochemical composition and biodegradation of soil organic matter and crop residues. Biodegradation of pesticides, Organic wastes and their use for production of biogas and manures. **Microbial degradation of polymers:** lignin, cellulose, hemicelluloses. Factors affecting the degradation of organic matter. **Organic manures:** Preparation, properties, and use in crop production, nutrient enriched compost, green manure; Composting, vermicomposting.	15

IV	**Some important plant diseases and their etiological studies**: diseases of some important cereals, vegetables and crops. Genetical basis of plant diseases: Genetics of host-pathogen interactions, resistance genes, resistance mechanism in plants, transgenic approach for plant protection. **Biocontrol** – Concept, types, mode of action, uses and practical constraints & applications of biocontrol agents. Biocontrol agent for sustainable agriculture. Different types of biocontrol agents. Biopesticides and bioherbicides, Biopesticides- classification, advantages. Major biopesticides based on bacteria, viruses & fungi (*Bacillus thuringiensis* (Bt) toxin, Boverin, DeVine, Collego).	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Paul, E.A., & Frey, S. (2023). Soil Microbiology, Ecology and Biochemistry (5th ed.). Elsevier. ISBN: 9780128229415
- Varnam, A.H., & Evans, M.G. (2000). Environmental Microbiology. Manson Publishing Ltd. ISBN: 9781874545781
- Hurst, C.J., Crawford, R.L., Garland, J.L., Lipson, D.A., & Mills, A.L. (2007). Manual of Environmental Microbiology (3rd ed.). ASM Press. ISBN: 9781555813796
- Spencer, J.F.T., & Ragout de Spencer, A.L. (2004). Environmental Microbiology: Methods and Protocols. Humana Press. ISBN: 9781588291165
- Burlage, R.S., Atlas, R.M., Stahl, D., Geesey, G., & Sayler, G. (1998). Techniques in Microbial Ecology. Oxford University Press. ISBN: 9780195092233
- Gaur, A.C. (2006). Handbook of Organic Farming and Biofertilizers. Ambica Book Agency. ISBN: 9788187118039
- Alexander, M. (1977). Soil Microbiology. John Wiley & Sons. ISBN: 9780471027349
- Kosuge, T., & Nester, E.W. (1984). Plant-Microbe Interactions: Molecular and Genetic Perspectives (Vols. I–IV). McGraw Hill.
- Pradhan, S. (2008). Soil Health Improvement by Biofertilizer. Biotech Books. ISBN: 9788189729301
- Pand, H., & Hota, D. (2010). Biofertilizer and Organic Farming. Gene Tech Books. ISBN: 9788189729349
- Sharma, A.K. (2002). Biofertilizer for Sustainable Agriculture. Agrobios. ISBN: 9788177541262
- Bergersen, F.J. (1980). Methods for Evaluating Biological Nitrogen Fixation. John Wiley & Sons. ISBN: 9780471045213
- Kannaiyan, S., Kumar, K., & Govindarajan, K. (2004). Biofertilizers Technology. Saujanya Books. ISBN: 9788189602451
- van Elsas, J.D., Trevors, J.T., Soares Rosado, A., & Nannipieri, P. (Eds.). (2019). Modern Soil Microbiology, Third Edition (3rd ed.). CRC Press. https://doi.org/10.1201/9780429059186

Session: 2025-26			
Part A – Introduction			
Name of Programme	**M.Sc. Microbiology**		
Semester	**3**		
Name of the Course	**Microbial pathogenesis & Epidemiology**		
Course Code	**M24-MIC-306**		
Course Type	**DEC-2**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**NA**		
Course Learning Outcomes (CLO)	CO1. Student will be able to understand the basics of classical and molecular microbial pathogenicity. CO2. Student will be able to understand the spread of microbes through body, their strategies and mechanism to cause the damage. CO3 Students will understand the emergence of new infections as well as various methods of molecular microbial epidemiology. CO4. Students will be able to understand the various mechanisms of antimicrobial resistance and new rapid diagnostic principles.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Classical view of microbial pathogenicity**: Define pathogenicity and virulence; Quantitative measures of pathogenicity: minimal lethal dose (MLD), LD50, ID50, TCID50. Virulence determinants: colonization, toxins, enzymes and invasiveness. Facultative / obligate intracellular pathogens. **Molecular microbial pathogenicity:** Molecular Koch's postulates, multiplicity of virulence determinants, coordinated regulation of virulence genes, and environmental regulation of virulence determinants by two component signal transudation systems, antigenic variation; clonal and panmictic nature of microbial pathogens, type three secretion system (TTSS, T3SS), Role of biofilms and quorum sensing in microbial pathogenicity.	15
II	**The spread of microbes through the body:** direct and indirect spread, microbial factor promoting spread, spread via lymphatic, blood and via other pathways. **Microbial strategies in relation to immune responses:** Immune tolerance immune suppression, molecular mimicry, induction of ineffective antibodies antibody mopping, antigenic variation, avoidance of immune responses and interference to immune response induction. **Mechanisms of tissue inquiry in relation to bacterial infection:** infection with no cell or tissue damages, direct damage by micro-organisms, microbial toxins, extra cellular enzymes, indirect damage via inflammation, immune responses.	15

III	**Emerging and re-emerging pathogens**: Illustrate emerging and re-emerging pathogens using V. cholerae 0139, X-*MDR M. tuberculosis, Helicobacter pylori, Enterohaemorrhagic E. coli (EHEC), Cryptosoridium parvum,* Bird/swine flu, AIDS and Dengue Hemorrhagic Fever, opportunistic fungal pathogens. Mechanisms of emergence of new pathogens: horizontal gene transfer (HGT) and pathogenicity islands (PAI). **Molecular microbial epidemiology:** Objectives of microbial epidemiology. Biochemical and Immunological tools - biotyping, serotyping, phage typing, multilocus enzyme electrophoresis (MLEE); Molecular typing: RAPD, rep (REP, ERIC, BOX)-PCR, IS based typing, PFGE, AFLP, MLST, VNTR and whole genome sequence; Use of geographical information system (GIS) for microbial epidemiology.	15
IV	**Antimicrobial resistance (AMR)**: Recent concepts – Multidrug efflux pumps, extended spectrum beta-lactamases (ESBL), X-MDR *M. tuberculosis*, Methacillin-resistant *S. aureus* (MRSA), Role of integrons. **Rapid diagnostic principles:** Nucleic acid probes in diagnostic microbiology, nucleic acid amplification methods, Real-time PCR, Lateral flow assays, diagnostic sequencing and mutation detection, automated instruments for detection / diagnosis of infectious agents (BACTAC and Vitek-2, GeneExpert).	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	**Theory**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Carroll, K. C., Hobden, J. A., Miller, S., Morse, S. A., Mietzner, T. A., Detrick, B., ... & Mitchell, T. G. (2019). *Jawetz, Melnick, & Adelberg's Medical Microbiology* (28th ed.). McGraw-Hill Education.
2. Edwards, D. J., & Holt, K. E. (2013). Beginner's guide to comparative genome analysis using next generation sequence data. *Microbial Informatics and Experimentation, 3*(1), 2. https://doi.org/10.1186/2042-5783-3-2
3. Wilson, B. A., Salyers, A. A., Whitt, D. D., & Winkler, M. E. (2019). *Bacterial Pathogenesis: A Molecular Approach* (4th ed.). ASM Press.
4. Locht, C., & Simonet, M. (2012). *Bacterial Pathogenesis: Molecular and Cellular Mechanisms*. Caister Academic Press.
5. Persing, D. H., Tenover, F. C., Hayden, R. T., Levy, M., Miller, M. B., Nolte, F. S., Tang, Y. W., & van Belkum, A. (2016). *Molecular Microbiology: Diagnostic Principles and Practice* (3rd ed.). ASM Press.
6. Nelson, K. E., & Williams, C. M. (2020). *Infectious Disease Epidemiology: Theory and Practice* (3rd ed.). Jones & Bartlett Learning.

Session: 2025-26			
Part A – Introduction			
Name of the Programme	**M.Sc. Microbiology**		
Semester	**3**		
Name of the Course	**Practical based on Papers M24-MIC-301& M24-MIC-302**		
Course Code	**M24-MIC-307**		
Course Type	**PC-5**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**NA**		
Course Learning Outcomes (CLO)	CO1. The student can isolate and screen industrially important microorganisms from soil and enhance their traits using UV mutagenesis. CO2. The student can perform microbial fermentation, enzyme production, partial purification, and analyze microbial growth kinetics and biomass estimation. CO3. The student can differentiate and count lymphocytes, neutrophils, monocytes, eosinophils, and basophils based on morphological and staining characteristics. CO4. The student can perform various immunological tests like immnodiffusion and agglutination reactions.		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time	0	4 hours	

Part B- Contents of the Course

	Practicals	**Contact Hours**
Course Contents	1. Isolation and Screening of Industrially Important Microorganisms from Soil 2. Strain Improvement of Bacteria Using UV Mutagenesis 3. Batch Fermentation in Flask for Amylase Production by microbial isolate 4. Partial Purification of Enzymes Using Ammonium Sulfate Precipitation 5. Solid-State Fermentation for Enzyme Production Using Agro-Waste Substrates 6. Isolation and Growth Curve Analysis of yeast in Glucose Broth 7. Production and Biomass Estimation of Single Cell Protein Using Yeast 8. Enumeration of bacteriophage in a sample by plaque forming unit (PFU) 9. Determination of total leucocytes count 10. Determination of differential leucocytes count 11. Determination of total erythrocytes count 12. Ouchterlony Double Immunodiffusion technique 13. Radial Immunodiffusion technique 14. Agglutination reactions	120

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Cappuccino, J. G., & Welsh, C. T. (2023). *Microbiology: A laboratory manual* (12th ed.). Pearson Education.
- Thompson, D. A. (2018). *Biochemistry lab manual* (3rd ed.). Independently published.
- Segel, I. H. (1976). *Biochemical calculations: How to solve mathematical problems in general biochemistry* (2nd ed.). John Wiley & Sons.
- Collee, J. G., Fraser, A. G., Marmion, B. P., & Simmons, A. (Eds.). (1996). *Mackie & McCartney practical medical microbiology* (14th ed.). Churchill Livingstone.
- Atlas, R. M., Parks, L. C., & Brown, A. E. (1995). *Laboratory manual of experimental microbiology* (1st ed.). Mosby-Year Book, Inc..

Session: 2025-26			
Part A – Introduction			
Name of the Programme	**M.Sc. Microbiology**		
Semester	**3**		
Name of the Course	**Practical based on Papers M24-MIC 303/304 & M24-MIC-305/306**		
Course Code	**M24-MIC-308**		
Course Type	**PC-6**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**NA**		
Course Learning Outcomes (CLO)	CO1. The student will be able to Analyze environmental samples (water, air, soil, and plant) for microbial diversity and contamination. CO2 The student will be able to Assess antibiotic resistance and physiological adaptations in environmental isolates. OR CO1. The student will be able to check the fecal contamination, potability of the water. CO2. The student will be able to study the various other properties of environmental water. AND CO3. The student will be able to perform sterility testing of a sample and is acquainted with the resident microflora of skin and oral cavity. CO4. The student will be able to identify human pathogenic microorganisms on selective/ differential media following biosafety norms. OR CO3. Student will be able to isolate rhizospheric and non rhizospheric microorganism for different PGPR attributes. CO4. The student will be able to isolate the microorganism for cellulose degradation and will be able to identify pathogenic fungi from plants		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time	0	4 hours	

Part B- Contents of the Course

	Practicals	**Contact Hours**
Course Contents	**Based on M24-MIC-303** 1. Analysis of Water Quality Using Most Probable Number (MPN) Method for Coliform Detection 2. Air Sampling and Enumeration of Airborne Microorganisms Using Settle Plate Method 3. Assessment of Antibiotic Resistance in Environmental Isolates Using the Kirby-Bauer Method 4. Observation of Rhizosphere Microflora and Root Nodule Bacteria from Leguminous Plants 5. Isolation and Enumeration of Soil extremophiles 6. Effect of Temperature or Salinity on Growth of extremophiles OR **Based on M24-MIC-304** 1. Isolation and Microscopic Observation of Spoilage Microorganisms from Fruits and Vegetables 2. Determination of pH, Moisture Content of Perishable Food Items 3. Enumeration of Total Viable Count (TVC) from Milk or Juice Samples 4. Dye Reduction Test (MBRT) to Determine Microbial Quality of Milk	120

5. Detection of Coliforms in Food Samples.
6. Comparative Study of Microbial Load in Preserved vs. Fresh Foods
7. Detection of Pathogens from Food Samples Using Selective Media
8. Evaluation of Food Handlers' Hygiene Through Swab Test and Microbial Load Assessment
9. Microbiological Quality Check of Packaged Drinking Water

AND

Based on M24-MIC-305

1. To demonstrate the reduction of nitrates to nitrogen gas (denitrification).
2. Isolation of rhizosphere and nonrhizosphere microflora.
3. Isolation of cellulose degrading and phosphate solubilizing microorganisms from soil.
4. Identification of pathogenic fungi:
   (a) *Puccinia*(b) *Colletotrichum*(c)*Phytophthora* 11. Isolation of Rhizobium from root nodules.
5. Isolation of antibiotic producing bacteria from soil.
6. Detection of siderophores produced by a given microorganism

OR

Based on M24-MIC-306

1. To study cultural characteristics of pathogenic bacteria on following selective/differential media: TCBS agar; Hektoen Enteric agar; XLD agar; Endo agar; Salmonella-Shigella agar; Deoxycholate citrate agar
2. To study pathogenicity of *Staphylococcus aureus* by coagulase test
3. To perform sterility testing of a sample.
4. To study resident microflora of skin.
5. To study resident microflora of oral cavity

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Cappuccino, J. G., & Welsh, C. T. (2023). *Microbiology: A laboratory manual* (12th ed.). Pearson Education.
- Thompson, D. A. (2018). *Biochemistry lab manual* (3rd ed.). Independently published.
- Segel, I. H. (1976). *Biochemical calculations: How to solve mathematical problems in general biochemistry* (2nd ed.). John Wiley & Sons.
- Collee, J. G., Fraser, A. G., Marmion, B. P., & Simmons, A. (Eds.). (1996). *Mackie & McCartney practical medical microbiology* (14th ed.). Churchill Livingstone.
- Atlas, R. M., Parks, L. C., & Brown, A. E. (1995). *Laboratory manual of experimental microbiology* (1st ed.). Mosby-Year Book, Inc.

Session: 2025-26			
Part A – Introduction			
Name of Programme	**M.Sc. Microbiology**		
Semester	**3**		
Name of the Course	**General and Applied Microbiology**		
Course Code	**M24-OEC-332**		
Course Type	**OEC**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**NA**		
Course Learning Outcomes (CLO)	• CLO1. Student will know the history and morphological features of bacteria. • CLO2. Student will know isolation and preservation of pure cultures. • CLO3 Students will know Rhizosphere, biofertilizers and modes of transmission of disease. • CLO4. Students will know about the control of microbes and use of GEMs.		
Credits	Theory	Practical	Total
	2	0	2
Teaching Hours per week	2	0	2
Internal Assessment Marks	15	0	15
End Term Exam Marks	35	0	35
Max. Marks	50	0	50
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.
The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**History, development, scope and applications of Microbiology.** General methods of sterilization. Introduction to Microscopy: bright field microscopy, dark field microscopy, phase contrast microscopy, electron microscopy. Various methods of staining of bacteria (simple, negative and Gram) and fungus (mold and yeast). Whittaker system of classification.	8
II	**Morphology & fine structure of bacterial:** cell wall, cell membrane, flagella and capsules. Formation of spores. Bacterial growth curve and measurement. Nutritional requirements and nutritional types of bacteria. **Pure culture techniques** –pour plate, spread plate, streak plate and serial dilution agar plate method. **Preservation of microbial culture-**serial subculture, at very low temperature, overlaying culture with mineral oil, lyophilization or freeze drying, in liquid nitrogen.	7
III	**Rhizosphere** & Rhizoplane micro-organisms and its significance. **Biofertilizers** and its examples. Nitrogen fixing bacteria: Symbiotic & non-symbiotic. **Modes of transmission of disease**: air, water, soil, contact, animals. Coliforms as the biological indicators of water safety and their assessment.	8
IV	**Control of microbes** in food by physical methods: temperature, irradiation, filtration, osmotic pressure. **Use of Genetically Engineered Micro-organisms (**GEMs) (a) Production of antibiotics: Penicillin (b) Biopesticides: Bt toxin, Boverin, DeVine (c) Control of pollution: degradation of xenobiotic compound	7

		Total Contact Hours	30
Suggested Evaluation Methods			
Internal Assessment: 15		**End Term Examination: 35**	
➢ **Theory**	**15**	➢ **Theory:**	**35**
• Class Participation:	4	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	4		
• Mid-Term Exam:	7		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Stanier, R. Y., Ingraham, J. L., Wheelis, M. L., & Painter, P. R. (1986). *General microbiology* (5th ed.). Macmillan Education.
2. Tortora, G. J., Funke, B. R., & Case, C. L. (2019). *Microbiology: An introduction* (13th ed.). Pearson Benjamin Cummings.
3. Madigan, M. T., Martinko, J. M., Stahl, D. A., & Clark, D. P. (2021). *Brock biology of microorganisms* (16th ed.). Pearson.
4. Collee, J. G., Fraser, A. G., Marmion, B. P., & Simmons, A. (Eds.). (1996). *Mackie & McCartney practical medical microbiology* (14th ed.). Churchill Livingstone.
5. Atlas, R. M., Parks, L. C., & Brown, A. L. (1995). *Laboratory manual of experimental microbiology* (1st ed.). Mosby-Year Book, Inc.
6. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. (2008). *Prescott, Harley, and Klein's microbiology* (7th ed.). McGraw-Hill Education.
7. Arora, D. R., & Arora, B. (2015). *Medical parasitology* (5th ed.). CBS Publishers & Distributors.

Session: 2025-26				
Part A – Introduction				
Name of Programme		**M.Sc. Microbiology**		
Semester		**4**		
Name of the Course		**Bioinformatics and Computational Biology**		
Course Code		**M24-MIC-401**		
Course Type		**CC-11**		
Level of the course		**500-599**		
Pre-requisite for the course (if any)		**NA**		
Course Learning Outcomes (CLO)	CO1. Student is able to understand the basics of bioinformatics like file formats, databases, etc. CO2. Student is able to understand the basic alignments tools like BLAST, PAM, etc CO3 Students will gets familiar with different types multiple sequence alignment tools for analysis and will get to know about the basics of genome and transcriptome. CO4. Students will be able to understand the various methods of phylogenetic analysis.			
Credits		Theory	Practical	Total
		4	0	4
Teaching Hours per week		4	0	4
Internal Assessment Marks		30	0	30
End Term Exam Marks		70	0	70
Max. Marks		100	0	100
Examination Time		3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Introduction, overview and needs of bioinformatics technology**. Biological databases – nucleic acid, genome, protein sequence and structure, gene expression databases, Database of metabolic pathways, SNP, chemical, metabolic pathways, signalling pathways, general human genetics, cancer gene. **Mode of data storage** - File formats - FASTA, Genbank and Uniprot, Data submission & retrieval from NCBI, EMBL, DDBJ, Uniprot, PDB.	15
II	**Introduction to sequence alignment and its applications.** Pair wise sequence alignment: Concept of global and local alignment, Dot Plot, algorithm for pair wise sequence alignment (Needleman Wunsch, Smith-watterman methods). **Introduction to BLAST:** types of BLAST, algorithm of BLAST and interpretation of its result. Substitution matrices: Introduction to substitution matrices: PAM and BLOSUM matrices, concept of log odd ratio.	15
III	**Multiple sequence alignment:** Local and Global Sequence alignment, pairwise and multiple sequence alignment. Methods of multiple sequence alignment, Tools of MSA– ClustalW, TCoffee; Position specific scoring matrices, introduction to consensus sequences, motifs and profiles. **Significance of alignments:** E value, Scores Diversity of Genomes: Viral, prokaryotic & eukaryotic genomes. Basic concepts of Genome, transcriptome, proteome.	15
IV	**Phylogenetic Analysis:** Introduction to phylogenetic analysis and its application. Types of phylogenetic trees, Different approaches of phylogenetic tree construction - UPGMA, Neighbour joining, Maximum Parsomony, Maximum likelihood. **Genome Annotation:** Concept of genome annotation, methods of gene identification. Tools of gene identification: GenScan, Grail, GeneID and Glimmer.	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. **Baxevanis, A. D., & Ouellette, B. F. F.** (2018). *Bioinformatics: A practical guide to the analysis of genes and proteins* (4th ed.). Wiley.
2. **Rastogi, S. C., Mendiratta, N., & Rastogi, P.** (2006). *Bioinformatics: Methods and applications – Genomics, proteomics and drug discovery* (2nd ed.). Prentice Hall India. *(No newer edition found.)*
3. **Lesk, A. M.** (2019). *Introduction to bioinformatics* (5th international student ed.). Oxford University Press.
4. **Primrose, S. B., & Twyman, R. M.** (2002). *Principles of genome analysis and genomics* (3rd ed.). Wiley.
5. **Attwood, T. K., & Parry-Smith, D. J.** (1999). *Introduction to bioinformatics* (1st ed.). Prentice Hall.

Session: 2025-26			
Part A – Introduction			
Name of Programme	**M.Sc. Microbiology**		
Semester	**4**		
Name of the Course	**Microbial biotechnology & Industrial microbiology-II**		
Course Code	**M24-MIC-402**		
Course Type	**CC-12**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**NA**		
Course Learning Outcomes (CLO)	**CO1**. Student will be able to describe microbial production of alcohols, acids, enzymes, and amino acids. **CO2**. Student will be able to explain microbial production of antibiotics, alkaloids, and vaccines. **CO3.** Student will be able to analyse waste valorisation, biomass utilization, and circular bioeconomy concepts. **CO4**. Student will be able to describe microbial roles in biofuels, biomining, and use of AI in bioprocessing.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	430
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Alcohol based fermentation industry** • Production of Beer, wines and sprits • Production of Vinegar **Biotechnological application of microbes in commercial production of :** • Organic acids: Citric, lactic and acetic acid. • Microbial enzymes: Cellulases, amylases, proteases and lipases. • Amino acids: Glutamic acid, lysine.	15
II	**Production of Metabolites of medical importance** • Production of Antibiotics • Production of Ergot Alkaloids • Microbial biotransformation of steroids and sterols • Production of Vaccines	15
III	**Industrial Waste Valorisation and Circular Bioeconomy** Utilization of agro-industrial residues such as molasses, bagasse, fruit peels, whey, and spent grains in microbial fermentation processes; Role of microbial consortia and specific strains in efficient substrate utilization. **Pretreatment of lignocellulosic biomass** (physical, chemical, biological methods) for enhancing accessibility of cellulose and hemicellulose; Application of microbial consortia in aerobic and anaerobic wastewater treatment systems; Role of bacteria, fungi, and archaea in removal of pollutants and recovery of resources. Concept of circular bioeconomy in industrial microbiology; Integration of waste reduction, resource recovery, and sustainable microbial processing.	15

IV	**Bioenergy and Emerging Industrial Applications** Microbial systems for bioethanol production from sugars, starch, and lignocellulosic. Biogas generation using anaerobic digestion of organic waste; Methanogenesis by archaea; Microbial electrochemical systems: Working principles of microbial fuel cells (MFCs) and microbial electrolysis cells (MECs); Role of electrogenic bacteria; Applications in waste-to-energy conversion. **Application of microbes in the mining industry:** Bioleaching and biomining of metals like copper, gold, and uranium; Mechanisms of microbial oxidation and metal solubilization; Emerging trends in industrial microbiology: Use of artificial intelligence (AI), sensors, and automation tools for monitoring microbial fermentation; Predictive modeling, data analytics, and real-time process optimization in large-scale bioprocessing.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Stanbury, P. F., Whitaker, A., & Hall, S. J. (2016). *Principles of fermentation technology* (3rd ed.). Butterworth-Heinemann.
- Shuler, M. L., Kargi, F., & DeLisa, M. P. (2017). *Bioprocess engineering: Basic concepts* (3rd ed.). Pearson Education.
- Okafor, N., & Okeke, B. C. (2017). *Modern industrial microbiology and biotechnology* (2nd ed.). CRC Press.
- El-Mansi, E. M. T., Bryce, C. F. A., Demain, A. L., & Allman, A. R. (Eds.). (2012). *Fermentation microbiology and biotechnology* (3rd ed.). CRC Press.
- Glazer, A. N., & Nikaido, H. (2007). *Microbial biotechnology: Fundamentals of applied microbiology* (2nd ed.). Cambridge University Press.
- Walsh, G. (2014). *Pharmaceutical biotechnology: Concepts and applications* (2nd ed.). John Wiley & Sons.
- Crommelin, D. J. A., Sindelar, R. D., & Meibohm, B. (2019). *Pharmaceutical biotechnology: Fundamentals and applications* (5th ed.). Springer.
- Crueger, W., & Crueger, A. (2005). *Biotechnology: A textbook of industrial microbiology* (2nd Indian ed.). Panima Publishing Corporation.
- Srivastava, M. L. (2008). *Fermentation technology: Principles and applications* (1st ed.). Alpha Science International.
- Bhatia, R. K., & Walia, A. (Eds.). (2024). *Advancements in microbial biotechnology for soil health*. Springer Nature.
- Verma, P. (Ed.). (2024). *Industrial microbiology and biotechnology: A new horizon*. Springer.
- Wenli, Z. (2023). *Fermentation technology and microbial proteins*. LAP Lambert Academic Publishing.
- Maddela, N. R., Laldinsangi, C., Chhipa, H., & Khan, A. (Eds.). (2024). *Microbial biotechnology for bioenergy*. Elsevier.

Session: 2025-26			
Part A – Introduction			
Name of Programme	**M.Sc. Microbiology**		
Semester	**4**		
Name of the Course	**Microbial Genomics and Proteomics**		
Course Code	**M24-MIC-403**		
Course Type	**DEC-3**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**NA**		
Course Learning Outcomes (CLO)	CO1. Will have gathered understanding of diversity of viral, prokaryotic, eukaryotic genomes and their organization, sequencing strategies, also the knowledge of current techniques in genomic and interactomics along with current concepts in gene organization, challenges in gene prediction, primer designing. CO2. Will be familiar with various (online as well as standalone) tools available for protein structure visualization. CO3 Students will understand the basis of protein classification in databases like CATH and SCOP. CO4. Will understand the details of primary, secondary and tertiary structure of proteins, knowledge of domains, motifs and folds, strategies on protein structure prediction, Protein modeling approaches and rational drug designing and discovery		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Genomics and Gene Annotation:** Organization and structure of prokaryotic and eukaryotic genomes; Genome annotation and databases; Automated in-silico methods of finding gene and relevant features; Genome Sequencing using first and seconding generation sequencing methods; Advantages of genome sequencing projects in modern biological research. **Genomics Analysis:** Diversity and features of completed genomes: Viral, prokaryotic (*E .coli*) and eukaryotic genomes (*Arabidopsis,* Human). Codon bias and optimization. Primer designing. Gene prediction methods. Techniques used in genomics and transcriptomics: NGS, Microarray, RNAseq.	15
II	**Protein structure and proteomics:** Hierarchy and features of protein structure: primary, secondary, tertiary and quaternary structures. Structural classes, motifs, folds and domains. Modelling of tertiary structure of protein in presence and absence of template. Energy minimizations and evaluation by Ramachandran plot. Proteome, interactome, 2-D gel electrophoresis, MALDI-TOF spectrometry, STRING, MMDB. Computer aided drug discovery.	15
III	**Protein Structure Databases:** Different databases of macro-molecular biomolecules; Accessing and mining protein structure classification databases such as SCOP, CATH; Tools for viewing and interpreting macromolecular structures. **Protein Structure Comparison:** Various algorithms and programs for superimposition of structures; RMSD calculations, multiple structure alignment methods such as DALI and VAST.	15

IV	**Protein Structure Prediction &Molecular Modeling:** Principles of secondary and tertiary structure predictions; *Ab-initio* and homology based methods of secondary and tertiary structure predictions; Homology modeling; Threading and *ab-initio* protein structure prediction. **Inferring Function from Protein Sequence &Structure:** Using evolutionary information; Gene neighborhood; Phylogenetic profiles; Gene fusion; Catalytic templates; Prediction and analysis of binding cavities for function prediction.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Haubold, B., & Wiehe, T. (2006). *Introduction to computational biology: An evolutionary approach* (1st ed.). Springer International.
- Lesk, A. M. (2014). *Introduction to bioinformatics* (3rd ed.). Oxford University Press India.
- Ewens, W. J., & Grant, G. R. (2010). *Statistical methods in bioinformatics: An introduction* (2nd ed.). Springer-Verlag
- Mount, D. W. (2004). *Bioinformatics: Sequence and genome analysis* (2nd ed.). Cold Spring Harbor Laboratory Press.
- Baxevanis, A. D., & Ouellette, B. F. F. (2005). *Bioinformatics: A practical guide to the analysis of genes & proteins* (2nd ed.). John Wiley & Sons.
- Zimmermann, K. H. (2005). *An introduction to protein informatics* (1st ed.). Springer International.
- Krane, D. E. (2003). *Fundamental concepts of bioinformatics* (1st ed.). Pearson Education.
- Burkowski, F. J. (2001). *Structural bioinformatics: An algorithmic approach* (1st ed.). Chapman & Hall/CRC.

Session: 2025-26			
Part A – Introduction			
Name of Programme	**M.Sc. Microbiology**		
Semester	**4**		
Name of the Course	**Bioremediation and Waste Management**		
Course Code	**M24-MIC-404**		
Course Type	**DEC-3**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**NA**		
Course Learning Outcomes (CLO)	**CO1.** Student will be able to explain the principles and types of bioremediation and the role of microbes, plants, and fungi. **CO2.** Student will be able to classify waste types and evaluate sustainable waste management methods. **CO3.** Student will be able to assess microbial and nanotech-based approaches for pollutant bioremediation. **CO4.** Student will be able to analyze the role of biosensors, circular economy, and policies in waste management.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Fundamentals of Bioremediation** Definition, scope, and significance of bioremediation. Types of bioremediations: in situ and ex situ techniques. Principles and mechanisms of bioremediation: microbial metabolism of pollutants, enzymatic degradation pathways. Factors affecting microbial degradation of pollutants: pH, temperature, redox potential, bioavailability, nutrient limitation. Phytoremediation: Types (rhizofiltration, phytoextraction, Phyto stabilization) and role of plant-microbe interactions. Mycoremediation: Use of fungi in degradation of complex pollutants. Microbial consortia and genetically engineered microbes in bioremediation	15
II	**Waste and its Management Approaches** Classification of waste: Solid, liquid, biomedical, hazardous, e-waste, and radioactive waste. Sources, characteristics, and environmental impact of different types of wastes. Solid waste management composting, landfill development, incineration methods, composting and sustainable agriculture, biogas production, plastic degrading microorganisms as a tool for bioremediation, challenges in waste management. Sewage and wastewater microbiology: treatment processes (primary, secondary, tertiary), microbial flora involved. Sludge treatment and disposal. treatment of industrial effluents (distillery, textile, pulp and paper),	15
III	**Bioremediation of Pollutants** Bioremediation of hydrocarbons, xenobiotics and petroleum compounds: aerobic and anaerobic degradation. Bioremediation of heavy metals: microbial metal resistance mechanisms and biosorption. Bioremediation of pesticides, herbicides, and industrial	15

	solvents. E-waste: Global trends and toxic components, e-waste recycling, nanoparticle for heavy metal recovery from e-waste, e-waste to profitable products, AI in smart bins for e-waste segregation.	
IV	**Modern Tools, Risk, and Management Practices in Bioremediation** Biosensors and bioindicators in environmental monitoring and bioremediation assessment. Nanobiotechnology in bioremediation: nano-remediation and engineered nanoparticles. Health hazards and ecological risks associated with bioremediation processes. Sustainable Waste Management Practices: Circular economy and zero-waste initiatives, waste to energy technologies, Role of policy and public awareness in waste management, Corporate Social Responsibility (CSR) in waste management Role of government programs and financial institutions in supporting waste management startups. Startups in e waste refurbishment.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Alexander, M. (1999). *Biodegradation and bioremediation* (2nd ed.). Academic Press.
- Evans, G. M., & Furlong, J. C. (2010). *Environmental biotechnology: Theory and application* (Reprint ed.). John Wiley & Sons.
- Mohapatra, P. K. (2006). *Textbook of environmental microbiology*. I.K. International Publishing House.
- Fulekar, M. H. (2010). *Bioremediation technology: Recent advances*. Springer.
- Tchobanoglous, G., Theisen, H., & Vigil, S. A. (2003). *Integrated solid waste management: Engineering principles and management issues* (2nd ed.). McGraw-Hill Education.
- Pepper, I. L., Gerba, C. P., & Gentry, T. J. (Eds.). (2015). *Environmental microbiology* (3rd ed.). Academic Press.
- Singh, S. N. (Ed.). (2011). *Bioremediation: Applications for environmental protection and management*. Springer.
- Varjani, S., Agarwal, A., & Ngo, H. H. (Eds.). (2020). *Bioremediation: Applications for environmental protection and management*. Springer.
- Basu, A., Bhattacharya, A., & Mukherjee, S. (2022). *Nanotechnology in environmental science: Fundamentals and applications*. Wiley.

Session: 2025-26			
Part A – Introduction			
Name of Programme	**M.Sc. Microbiology**		
Semester	**4**		
Name of the Course	**Bioentrepreneurship and IPR**		
Course Code	**M24-MIC-405**		
Course Type	**DEC-4**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**NA**		
Course Learning Outcomes (CLO)	• CO1. Will have learnt the concepts of IPR and its protection. • CO2. Will have gathered understanding of protection of IP through Patents, Copyright and related rights, Trademarks, Geographical indications, Industrial designs and New Plant Varieties • CO3 Will get acquainted with Agreements, Treaties and Acts in relation to IP protection. • CO4. Will understand the licensing agreements and infringements of IPR Act and basics of entrepreneurship		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Introduction to Intellectual Property:** importance of IPR – patentable and non patentables. Trade secrets and know-how agreements. Utility models: Differences between a utility model and a patent. Types of inventions protected by a patent. Need for a patent. Relevance of IPR in Life Sciences. **Grant of Patent and Patenting Authorities:** Claims. Searching a patent, Drafting of a patent, Filing of a patent, Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures.	15
II	**Copyrights:** Definition, need, coverage and duration. Related rights. Distinction between related rights and copyright. Rights covered by copyright. **Trademarks:** Definition. Rights of trademark, signs that can be used as trademarks, types of trademark. Protection and registration a trademark. Duration of protection. Well-known trademarks**.** **Geographical indications**: Definition. Need for Protection. Examples. **Industrial design**: Overview, kind, duration and need for protection provided by industrial designs. **New Plant Varieties:** Requirements, Rights of breeder, Extent and Duration, Examples. Biotechnology Research and Intellectual Property Rights Management	15
III	**Agreements and Treaties:** GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions. Patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO). Patent Co-operation Treaty (PCT). **Indian Patent Act** 1970 & recent amendments.	15

IV	**Patent licensing and agreement**: Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner. Commercializing Biotechnology Invention, Case studies of Biotechnology. **Entrepreneurship:** Selection of a product, line design and development processes, economics on material and energy requirement, stock the product and release the same for making etc. **The basic regulations of excise:** Demand for a given product, feasibility of its production under given constraints of raw material, energy input, financial situations export potential etc**.**	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Wooley, D. P., & Byers, K. B. (Eds.). (2017). *Biological safety: Principles and practices* (5th ed.). ASM Press.

2. Ramakrishna, B., & Kumar, H. S. A. (2023). *Fundamentals of intellectual property rights: For students, industrialists and patent lawyers* (1st ed.). Notion Press, India.

3. Singh, K. K. (2016). *Biotechnology and intellectual property rights: Legal and social implications* (1st ed.). Springer India.

4. Goel, D., & Parashar, S. (2022). *IPR, biosafety and bioethic* (1st ed.). Pearson Education, India.

5. Kankanala, C. (2021). *Genetic patent law and strategy* (1st ed.). Manupatra Information Solutions Pvt. Ltd., India.

6. Wadehra, B. L. (2020). *Law relating to patents, trade marks, copyright, designs and geographical indications* (latest ed.). Universal Law Publishing, India.

7. Murray, T. M., & Mehlman, M. J. (2019). *Encyclopedia of ethical, legal and policy issues in biotechnology*. John Wiley & Sons, UK.

Session: 2025-26			
Part A – Introduction			
Name of Programme	**M.Sc. Microbiology**		
Semester	**4**		
Name of the Course	**Clinical and Pharmaceutical Microbiology**		
Course Code	**M24-MIC-406**		
Course Type	**DEC-4**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**NA**		
Course Learning Outcomes (CLO)	CO1. The student will be Apply key antimicrobial susceptibility testing methods to guide chemotherapy decisions. CO2. The student will be Utilize modern vaccine technologies and transgenic models, considering ethical research practices. CO3. The student will be Implement sterilization and disinfection protocols for pharmaceutical microbiological quality control. CO4. The student will be Ensure compliance with GMP and regulatory standards in sterile product manufacturing and testing.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Laboratory tests in chemotherapy: Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Susceptibility tests: Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests. Transgenic animals:-Development, applications. Ethics in Research:-Ethical issues pertaining to animal study, handling and disposal of 10 radioactive waste and pathogenic micro-organisms.	15
II	Modern approaches to live virus vaccines, live bacterial vaccines and their application against tumor antigens immune modifiers in vaccines. AIDS : HIV testing: product development strategies, approaches to HIV, vaccine design. Idiotype vaccines and immune toxins Recombinant DNA vaccines. Adjuvants & their future development. Commercial & regulatory aspects of vaccines production and distribution	15
III	Classification and mode of action of disinfectants Factors influencing disinfection, antiseptics and their evaluation. For bacteriostatic and bactericidal actions Evaluation of bactericidal & Bacteriostatic. Evaluation of the efficiency of sterilization methods. Equipments employed in large scale sterilization. Sterility indicators. Designing of aseptic area, laminar flow equipments; study of different sources of contamination in an aseptic area and methods of prevention, clean area classification	15

IV	**Microbiological Quality Control of Pharmaceuticals:** Total viable count (TVC); Test for specified microorganisms (*E. coli, Salmonella*); Sterility testing (membrane filtration, direct inoculation); Pyrogen testing (Rabbit test, LAL assay). **Good Manufacturing Practices (GMP):** Aseptic techniques; Documentation and SOPs; Validation and calibration. Sterility testing of products (solids, liquids, ophthalmic and other sterile products) according to IP, BP and USP.	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- **Riedel, S., Hobden, J. A., Miller, S., Morse, S. A., Mietzner, T. A., Detrick, B., … Mejia, R.** (2019). *Jawetz, Melnick & Adelberg's medical microbiology* (28th ed.). McGraw Hill Professional.
- **Edward, D. J., & Holt, K. E.** (2013). Beginner's guide to comparative genome analysis using next generation sequence data. *Microbial Informatics and Experimentation, 3*(2), Article 2.
- **Wilson, B. A., Salyers, A. A., Whitt, D. D., & Winkler, M. E.** (2019). *Bacterial pathogenesis: A molecular approach* (4th ed.). ASM Press. t
- **Locht, C., & Simonet, M.** (2012). *Bacterial pathogenesis: Molecular and cellular mechanisms*. Caister Academic Press.
- **Persing, D. H., Tenover, F. C., Hayden, R. T., Leven, M., Miller, M. B., Nolte, F. S., Tang, Y. W., & van Belkum, A.** (2016). *Molecular microbiology: Diagnostic principles and practice* (3rd ed.). ASM Press.

Session: 2025-26			
Part A – Introduction			
Name of the Programme	**M.Sc. Microbiology**		
Semester	**4**		
Name of the Course	**Practical based on Papers M24-MIC-401 to M24-MIC-402**		
Course Code	**M24-MIC-407**		
Course Type	**PC-7**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**NA**		
Course Learning Outcomes (CLO)	CO1. Student will learn about different protein database and protein modeling tools. CO2. Student will be able to do sequence alignments using BLAST and able to construct phylogenetic tree. CO3. The student will be able to Apply fermentation techniques for the microbial production of industrially important compounds like alcohol, acids, and amino acids. CO4. The student will be able to Perform qualitative assays for microbial enzymes and screen soil microbes for antibiotic production.		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time	0	4 hours	

Part B- Contents of the Course

	Practicals	**Contact Hours**
Course Contents	1. Introduction to various protein databases. 2. To perform protein modeling using SWISS-MODEL. 3. Visualization of 3D structures of proteins. 4. Sequence retrieval using BLAST. 5. Sequence alignment & phylogenetic analysis using clustal omega & phylip. 6. To analyze the given 16srRNA sequences by using BLAST and construct a phylogenetic tree based on the comparison results. 7. Alcoholic Fermentation of Grape Juice for Wine Production Using Yeast 8. Production of Citric Acid Using Aspergillus niger in Submerged Fermentation 9. Qualitative Assay of cellulase Activity from Fungal or Bacterial Isolates 10. Screening of Soil Microorganisms for Antibiotic Production by Cross streak method 11. Production of Lactic Acid by Lactobacillus sp. in Glucose Broth 12. Qualitative Assay of Protease from Bacterial Isolates 13. Production of Glutamic Acid Using Fermentation of Sugar-Based Media	120

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Cappuccino, J. G., & Welsh, C. T. (2023). *Microbiology: A laboratory manual* (12th ed.). Pearson Education.
- Thompson, D. A. (2018). *Biochemistry lab manual* (3rd ed.). Independently published.
- Segel, I. H. (1976). *Biochemical calculations: How to solve mathematical problems in general biochemistry* (2nd ed.). John Wiley & Sons.
- Collee, J. G., Fraser, A. G., Marmion, B. P., & Simmons, A. (Eds.). (1996). *Mackie & McCartney practical medical microbiology* (14th ed.). Churchill Livingstone.
- Atlas, R. M., Parks, L. C., & Brown, A. E. (1995). *Laboratory manual of experimental microbiology* (1st ed.). Mosby-Year Book, Inc..

Session: 2025-26			
Part A – Introduction			
Name of the Programme	**M.Sc. Microbiology**		
Semester	**4**		
Name of the Course	**Practical based on Papers M24-MIC 403/404 to M24-MIC-405/406**		
Course Code	**M24-MIC-408**		
Course Type	**PC-8**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**NA**		
Course Learning Outcomes (CLO)	CO1. Will be acquainted with bioinformatics and its relation with molecular biology, genetics and genomics, various modes of data transfer and simultaneously learning the advantages of encrypted data transfer, gained an in-depth knowledge of primary, secondary and composite databases, organization of diverse types of biological databases. CO2. Will understand the details of domains, motifs and folds, homology modelling for protein structure prediction, proteomics, computer aided drug designing and discovery. OR CO1- The student will be able to Assess environmental samples for pollutants and isolate microorganisms capable of biodegradation. CO2- The student will be able to Demonstrate microbial applications in waste management, including composting, dye biosorption, and pesticide degradation. AND CO3. The student Will obtain information on IPR, its main components, various types of application for filing the patent. CO4. The student will be able to study and have the basic understanding of patent application. OR CO3. Student will be able to isolate rhizospheric and non rhizospheric microorganism for different PGPR attributes. CO4. The student will be able to isolate the microorganism for cellulose degradation and will be able to identify pathogenic fungi from plants		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time	0	4 hours	

Part B- Contents of the Course

Practicals		Contact Hours
Course Contents	**Based on M24-MIC-403** 1. Picking out a given gene from genomes using Genscan or other software's (promoter region identification, repeat in genome, ORF prediction). 2. Gene finding tools (Glimmer, GENSCAN), Primer designing, Genscan/Genetool. 3. Virtual screening of drugs. **Based on M24-MIC-404** 1. Water Quality Assessment: pH, Turbidity, and Temperature of Sewage/Drain Water 2. Isolation of Hydrocarbon-Degrading Bacteria from Oil-Contaminated 3. Soil Composting of Organic Kitchen Waste and Observation of Microbial Growth 4. Screening of Pesticide-Tolerant Soil Microorganisms 5. Demonstration of Pesticide Degradation by Soil Bacteria 6. Biosorption of Dyes using fungal mycelium 7. Detection of Coliforms in sewage water	120

	AND **Based on M24-MIC-405** 1. Study of steps of a patenting process and different forms of filing the patent. 2. Design a suitable strategy to protect a genetically modified organism. 3. Case studies related to patenting of biological material OR **Based on M24-MIC-406** 1. Perform broth microdilution and macrodilution to determine Minimum Inhibitory Concentration (MIC). 2. Test the efficacy of disinfectants using phenol coefficient and use-dilution methods. 3. Conduct membrane filtration and direct inoculation methods on sterile products (e.g., ophthalmic solutions). 4. Perform Total Viable Count (TVC) and test for specified microorganisms (e.g., E. coli, Salmonella). 5. Practice documentation, SOP writing, and validation protocols for aseptic processing as per ISO.	

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Cappuccino, J. G., & Welsh, C. T. (2023). *Microbiology: A laboratory manual* (12th ed.). Pearson Education.
- Thompson, D. A. (2018). *Biochemistry lab manual* (3rd ed.). Independently published.
- Segel, I. H. (1976). *Biochemical calculations: How to solve mathematical problems in general biochemistry* (2nd ed.). John Wiley & Sons.
- Collee, J. G., Fraser, A. G., Marmion, B. P., & Simmons, A. (Eds.). (1996). *Mackie & McCartney practical medical microbiology* (14th ed.). Churchill Livingstone.
- Atlas, R. M., Parks, L. C., & Brown, A. E. (1995). *Laboratory manual of experimental microbiology* (1st ed.). Mosby-Year Book, Inc..

Session: 2025-26			
Part A – Introduction			
Name of Programme	**M.Sc. Microbiology**		
Semester	**4**		
Name of the Course	**Entrepreneurship and employability in microbiology**		
Course Code	**M24-MIC-409**		
Course Type	**EEC**		
Level of the course	**500-599**		
Pre-requisite for the course (if any)	**NA**		
Course Learning Outcomes (CLO)	• CO1. To develop entrepreneurial thinking and identify microbiology-based business opportunities. • CO2. To equip students with career skills relevant to microbiology-based industries and research. • CO3 To understand the regulatory, ethical, and financial considerations in setting up a microbiology enterprise. • CO4. To enhance soft skills, communication, and workplace readiness for better employability.		
Credits	Theory	Practical	Total
	2	0	2
Teaching Hours per week	2	0	2
Internal Assessment Marks	15	0	15
End Term Exam Marks	35	0	35
Max. Marks	50	0	50
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Entrepreneurship: Entrepreneurship and principles of entrepreneurial development, Qualities of an entrepreneur, Functions and types of entrepreneurs. Need for microbiology-based startups. Challenges of bioentrepreneurship in India and measures to promote bioentrepreneurship in India. Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Startup, Make In India),	8
II	Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests, Complement fixation, PCR, DNA probes). An overview of cancer biomarkers: types, tests and importance in management of cancer disease	7
III	Innovations in Microbiology • Emerging trends: microbiome therapy, synthetic biology, CRISPR Biosensors for detecting biomolecules and use in physiological monitoring, advantages and limitations of biosensors.	8
IV	Technology Transfer and Commercialization • Incubation centers, technology licensing • Academia-industry collaborations Case studies: Successful biotech/microbiology entrepreneurs. Bioethics and biosafety issues,	7
	Total Contact Hours	30

Suggested Evaluation Methods			
Internal Assessment: 15		**End Term Examination: 35**	
➢ **Theory**	**15**	➢ **Theory:**	**35**
• Class Participation:	4	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	4		
• Mid-Term Exam:	7		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. S. N. Jogdand, Entrepreneurship and Business of Biotechnology, Himalaya Publishing Home, 2007.
2. Desai V, Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House (2007).
3. Gupta, Reena & Malhotra, Bharti & Huddone, et al. (2012). Indian entrepreneurship in biotechnology comes of age.
4. Sinha, Dwaipayan & Singh, Anjana. (2021). Introduction to Bioentrepreneurship. 10.4018/978-1-7998-7411-9.ch001.
5. A. K. Bhatt, R. K. Bhatia and T. C. Bhalla (2022) Basic Biotechniques for Bioprocess and Bioentrepreneurship. Elsevier Science Publishing Co Inc | Academic Press Inc.

Session: 2025-26		
Part A – Introduction		
Name of Programme	**M.Sc. Microbiology**	
Semester	**4**	
Name of the Course	**Dissertation/Project Work**	
Course Code	**M24-MIC-410**	
Course Type	**Dissertation/Project Work**	
Level of the course	**500-599**	
Pre-requisite for the course (if any)	**NA**	
Credits	Dissertation/Project Work	Total
	12	12
End Term Exam Marks	300	300
Max. Marks	300	300