Department of Microbiology

Faculty of Science

Khwaja Moinuddin Chishti Language University Lucknow, U.P. (India)

Syllabus of M.Sc. Microbiology as per

National Education Policy-2020

Abbreviations:

S. No.	Abbreviation	Full form
1	C	Credits
2	L	No. of Lectures/periods (One hour Lecture for theory & two hours lab for practical)
3	CIE	Continuous Internal Evaluation
4	UE	University Exam.
5	Th.	Theory paper
6	Prac.	Practical paper
7	UG	Under Graduation
8	PG	Post Graduation
9	MM	Maximum marks
10	POs	Program Outcomes
11	PSOs	Program Specific Outcomes
12	COs	Course Outcome

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DEPARTMENT OF MICROBIOLOGY

M.Sc. Microbiology

PROGRAMME OUTCOMES (POs)

PO1: Scientific Knowledge

Apply advanced knowledge of microbiology, biochemistry, immunology, molecular biology, and related life sciences to understand and solve complex microbiological problems.

PO2: Technical Proficiency

Demonstrate proficiency in core and advanced microbiological techniques including microbial culturing, staining, microscopy, molecular diagnostics, immunological assays, antimicrobial testing, fermentation, and bioinformatics tools.

PO3: Research Aptitude

Design, conduct, and execute microbiological research experiments; analyze and interpret experimental data using appropriate statistical and analytical methods; and contribute to scientific inquiry and innovation.

PO4: Critical Thinking and Problem-Solving

Apply critical thinking, logical reasoning, and scientific methodologies to identify, formulate, and solve problems related to microbial physiology, pathogenesis, industrial microbiology, and environmental microbiology.

PO5: Ethics, Biosafety, and Professional Responsibility

Understand and practice ethical principles, biosafety regulations, laboratory safety guidelines, and intellectual property rights relevant to microbiological research, clinical diagnostics, and industrial applications.

PO6: Communication Skills

Communicate microbiological concepts, research findings, and technical information effectively through laboratory records, scientific reports, oral presentations, and scholarly writing.

PO7: Lifelong Learning

Demonstrate readiness for continuous professional development by keeping pace with emerging trends, technologies, and interdisciplinary advancements in microbiology and allied sciences.

PO8: Professional, Environmental, and Societal Contribution

Apply microbiological knowledge to address challenges in public health, clinical diagnostics, food safety, agriculture, environmental sustainability, and industrial processes for societal benefit.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSOs for Semester I

PSO1.1: Understand the diversity, structure, and classification of microorganisms, including bacteria, fungi, viruses, and protozoa.

PSO1.2: Analyze the biochemical composition of microbial cells, enzyme functions, and major metabolic pathways involved in microbial growth and survival.

PSO1.3: Understand the Research Methodology, principles of intellectual property rights, patenting, and regulatory frameworks, and apply bioinformatics tools for sequence retrieval, analysis, and interpretation of biological data.

PSO1.4: Demonstrate proficiency in basic microbiological laboratory techniques such as aseptic handling, microbial culture, staining, microscopy, and biochemical testing while adhering to biosafety guidelines.

PSOs for Semester II

PSO2.1: Understand principles of applied and industrial microbiology, including large-scale microbial cultivation, fermentation processes, and production of industrially important biomolecules.

PSO2.2: Analyze the role of microorganisms in food production, preservation, spoilage, and safety, including foodborne pathogens and quality control measures.

PSO2.3: Apply analytical techniques and biostatistical tools for experimental design, data collection, analysis, interpretation, and validation of microbiological and molecular biology research data.

PSO2.4: Apply nanobiotechnology concepts and laboratory techniques, including nanoparticle synthesis, characterization, and their applications in diagnostics, therapeutics, and environmental systems, using appropriate laboratory and biosafety practices.

PSOs for Semester III

PSO3.1: Understand the principles of recombinant DNA technology and microbial genetics, including gene organization, regulation, mutation, and mechanisms of genetic exchange in microorganisms.

PSO3.2: Analyze the molecular basis of DNA replication, transcription, translation, gene expression, and regulation using concepts of modern molecular biology.

PSO3.3: Evaluate microbial interactions in the environment and their applications in biogeochemical cycles, bioremediation, wastewater treatment, and environmental sustainability.

PSO3.4: Demonstrate competence in advanced laboratory practices, molecular biology techniques, and independent research skills through hands-on practical training and execution of a supervised research project while adhering to biosafety and ethical standards.

PSOs for Semester IV

PSO4.1: Apply principles of microbial physiology and metabolism to explain energy generation, biosynthesis, and regulatory mechanisms under different environmental conditions.

PSO4.2: Analyze microbiological aspects of pharmaceutical production, including sterility testing, quality control, validation, and microbial safety of drugs and biologics.

PSO4.3: Explain advanced immunological concepts and apply immunotechniques such as ELISA, immunoblotting, flow cytometry, and antigen–antibody-based assays in research and diagnostics.

PSO4.4: Demonstrate advanced practical and research competence through immunological, pharmaceutical, and bioinformatics laboratory techniques, along with independent execution and documentation of a research dissertation in accordance with biosafety, ethical, and IPR guidelines.

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SEMESTER-WISE MAPPING OF POs & PSOs

Semester	Course	POs Addressed	PSOs Addressed
I	General microbiology	PO1, PO2, PO4	PSO1.1
I	Biochemistry	PO1, PO2, PO4	PSO1.2
I	Research Methodology, IPR & Bioinformatics	PO2, PO3, PO6	PSO1.4
I	Microbial pathogenicity	PO1, PO2, PO8	PSO1.3
I	Practical - LAB 1	PO2, PO3, PO6	PSO1.1–1.4
II	Applied & Industrial microbiology	PO1, PO2, PO4	PSO2.1
II	Food microbiology	PO2, PO3, PO4	PSO2.2
II	Analytical Techniques & Biostatistics	PO5, PO6, PO7	PSO2.3
II	Nanobiotechnology	PO4, PO5, PO8	PSO2.4
II	Practical - LAB 2	PO2, PO3, PO6	PSO2.1–2.4
III	RDT & Microbial Genetics	PO1, PO2, PO8	PSO3.1
III	Fundamentals of Molecular Biology	PO2, PO3, PO4	PSO3.2
III	Environmental microbiology	PO2, PO3, PO4	PSO3.3
III	Practical - LAB 3	PO1, PO2, PO4	PSO3.1- PSO3.3
III	Research Project / Dissertation I	PO1, PO2, PO4	PSO3.4
IV	Microbial physiology and Metabolism	PO1, PO2, PO8	PSO4.1
IV	Pharmaceutical Microbiology	PO2, PO3, PO4	PSO4.2
IV	Advanced Immunology and Immunotechniques	PO1, PO2, PO8	PSO4.3
IV	Practical - LAB 4	PO2, PO3, PO4	PSO4.1- PSO4.3
IV	Research Project / Dissertation II	PO1, PO2, PO4	PSO4.4

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Year Wise Course Structure M.Sc. Microbiology

M.Sc. I Year (Semester I) Microbiology
Paper 1: GENERAL MICROBIOLOGY (MB10101T)

Programme/Class: Degree/M.Sc.	Year: 1st year	M.Sc. 1st Semester
Subject: Microbiology		
Course Code: MB10101T	Course Title: GENERAL MICROBIOLOGY	

Course outcomes	Bloom's taxonomy
CO1: Explain the historical development and major scientific contributions that shaped microbiology and analyze their impact on modern interdisciplinary applications.	K2, K4
CO2: Compare microbial classification systems and explain the structural and biological characteristics of major groups of microorganisms.	K2, K4
CO3: Explain microbial nutritional strategies and evaluate the adaptive mechanisms that enable extremophiles to survive in extreme environments.	K2, K5
CO4: Apply appropriate cultivation and microbial control methods and evaluate their effectiveness in laboratory and applied microbiology settings.	K3, K5

Credits:4	Core Compulsory
Max. Marks:25+75	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L- 4/w

Unit	Topics	No. of Lectures= 60
I	**Introduction, History, and Scope of Microbiology** Introduction to microbiology and its scope; ancient microbiology; refutation of abiogenesis; discovery of penicillin; discovery of vaccination; proposal of the one gene–one enzyme hypothesis; major contributions of scientists to the development of microbiology. Modern microbiology and landmark achievements of the 20th century; emergence of interdisciplinary fields and applications of microbiology.	15

II	**Microbial Taxonomy, Diversity, and Biology of Microorganisms** Microbial Taxonomy and Systematics: Definition of taxonomy and systematics; nomenclatural rules and microbial identification. Haeckel's three-kingdom classification; Whittaker's five-kingdom classification; Woese's three-domain system. Major characteristics used in taxonomy: morphological, physiological, metabolic, genetic, and molecular approaches. Bergey's classification of bacteria. Concepts of microbiome and synthetic biology. Biology of Microorganisms: Differences between prokaryotic and eukaryotic cells. Biology of bacteria: cell structure, size, shape, arrangement; membrane and cell wall; cytoplasmic inclusions; mesosomes; flagella and motility; slime layer, capsule, pili; chemotaxis; endospores. Biology of fungi: structure, physiology, and classification; yeast biology and reproduction. Viruses and bacteriophages: structure and life cycles (lytic and lysogenic). Biology of algae; Mycoplasma; prions.	15
III	**Microbial Nutrition, Extremophiles, and Environmental Adaptations** Microbial Nutrition: Microbial nutrient requirements: macronutrients, micronutrients, and growth factors; sources of nutrients. Nutritional classification of bacteria: phototrophs, chemotrophs, autotrophs (lithotrophs), heterotrophs (organotrophs), photoautotrophs, photoheterotrophs, chemoautotrophs, and chemoheterotrophs. Nutritional patterns of pathogens; saprophytes and auxotrophs. Extremophiles and Adaptations: Diversity of microorganisms from Arctic, Antarctic, and hydrothermal vent ecosystems. Archaeal biology. Acidophiles, alkaliphiles, anaerobes, cryptoendoliths, halophiles, hyperthermophiles, hypoliths, lithoautotrophs, metal-tolerant microbes, oligotrophs, osmophiles, piezophiles, polyextremophiles, psychrophiles/cryophiles, radioresistant microorganisms (*Deinococcus radiodurans*), thermophiles, thermoacidophiles, xerophiles, and mechanisms of extremophile survival	15

IV	**Cultivation, Automation, and Control of Microorganisms** Cultivation of Microorganisms: Types of growth media: natural, synthetic, complex, enriched, and selective media (definitions with examples). Pure culture techniques: streak plate, spread plate, pour plate, stab culture, slant culture. Automation in microbiology. Special Cultivation Techniques: Anaerobic cultivation methods: thioglycolate medium, anaerobic chamber, Robertson's cooked meat medium, microaerophilic culture methods. Liquid shake culture for aerobic bacteria. Control of Microorganisms: Principles of microbial control; sterilization, disinfection, antisepsis, tyndallization, and pasteurization. Physical methods: dry heat, moist heat, ultraviolet radiation, ionizing radiation, filtration, HEPA filters. Chemical methods of microbial control.	15

Suggested Readings:

1. Tortora Gerard J., Funke, Berdell R. Case, Christine L. (2016). Microbiology: An Introduction, 12th Edition. Pearson, Boston.
2. Madigan M. T., Martinko J. M., Bender K. S., Buckley D. H., Stahl D. A. (2015). Brock biology of microorganisms, Fourteenth edition. Pearson, Boston.
3. Joanne M. Willey, Linda Sherwood, Christopher J. Woolverton, Lansing M. Prescott (2017). Prescott's microbiology, 10th edition. Mcgraw-Hill Education, New York.
4. John W. Foster. (2016). Microbiology: Human Experience, 16th edition. W.W. Norton & Co.
5. Jacquelyn G. Black, Laura J. Black. (2015). Microbiology: Principles and explorations, 9th edition. Wiley, Hoboken, New Jersey.
6. Ananthanarayanan R., Jayaram Paniker C.K. (2017). Textbook of Microbiology, 10th edition. Orient Lomgman.

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M.Sc. I Year (Semester I) Microbiology
Paper 2: BIOCHEMISTRY (MB10102T)

Programme/Class: Degree/M.Sc.	Year: 1st year	M.Sc. 1st Semester
Subject: Microbiology		
Course Code: MB10102T	Course Title: **BIOCHEMISTRY**	

Course outcomes	Bloom's taxonomy
CO1: Explain the chemical principles governing biological systems and apply bioenergetic concepts to determine free-energy changes and the role of ATP in cellular processes.	K2, K3
CO2: Describe the structure and organization of proteins and nucleic acids and analyze their functional significance in biological systems and microbial adaptations.	K2, K4
CO3: Explain carbohydrate and lipid metabolism and analyze central metabolic pathways involved in energy production and biosynthesis.	K2, K4
CO4: Explain the mechanisms of electron transport and oxidative phosphorylation and evaluate their role in cellular energy conservation and regulation.	K2, K5

Credits:4	Core Compulsory
Max. Marks:25+75	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L- 4/w

Unit	Topics	No. of Lectures= 60

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I	**Chemistry of Life, Bioenergetics, and Cellular Energy** Chemistry of Life: Chemical bonds and interactions in biological systems: ionic bonding, covalent bonds, hydrogen bonds, Van der Waals interactions, London forces, and hydrophobic interactions. Water as a biological solvent and its role in biological processes. Concept of pH, Henderson–Hasselbalch equation, buffers—strength and range of buffers, important biological buffers, and pH indicator dyes. Bioenergetics: Laws of thermodynamics; entropy, enthalpy, free energy; spontaneous reactions and equilibrium constants. Gibbs free energy equation, coupled reactions, feasibility of biochemical reactions; ATP and other high-energy phosphate compounds; calculations of ΔG and ΔH; ATP as the energy currency of the cell.	15
II	**Proteins, Nucleic Acids, and Special Microbial Molecules** Proteins: Structural features of amino acids; classification based on polarity and charge; peptide bond and its partial double-bond nature. Structural classification of proteins; primary, secondary, tertiary, and quaternary structures; Ramachandran plot. Nucleic Acids: Structure of purines, pyrimidines, nucleosides, and nucleotides; RNA capping; hyperchromic effect and melting temperature (Tm); Chargaff's rule. Secondary structure of DNA (Watson–Crick model); secondary structure of tRNA (cloverleaf model). De novo biosynthesis of purines and pyrimidines. Special Microbial Molecules: Bacteriorhodopsin; biphytanyl chains and unique lipids in archaeal membranes; molecular adaptations in extremophiles such as thermophiles and halophiles.	15
III	**Carbohydrates, Lipids, and Central Metabolic Pathways** Carbohydrates: Monosaccharides, disaccharides (nomenclature), oligosaccharides, polysaccharides; concepts of epimer, isomer, and anomer. Glycolysis, pentose phosphate pathway (HMP), Entner–Doudoroff pathway. Fermentative pathways: lactic acid fermentation (LDH), alcoholic fermentation (ADH); glycogen catabolism. Lipids: Saturated and unsaturated fatty acids; nomenclature and shorthand notation. Fatty acid oxidation: β-oxidation and α-oxidation. Biosynthesis of saturated fatty acids; structure of yeast fatty acid synthase; triacylglycerols and phospholipids. Central Metabolism: Pyruvate dehydrogenase (PDH) multienzyme complex; tricarboxylic acid (TCA) cycle; amphibolic nature of TCA.	15

IV	**Electron Transport, Oxidative Phosphorylation, and Energy Conservation** Electron transport chain (ETC); components and organization; generation and maintenance of proton motive force (PMF). Chemiosmotic theory; Q cycle; role of ubiquinone and cytochrome c. Substrate-level phosphorylation and oxidative phosphorylation. ATP synthase structure and function; shuttle systems. Inhibitors and uncouplers of the electron transport chain.	15

Suggested Readings:

1. Nelson D. L. and Cox, M. (2008) M. Lehninger‘s Principle of Biochemistry. 5th edition. W. H. Freeman and company, U.S.A.
2. Voet D. and Voet J.G. (2011) Biochemistry 4th Edition. John Wiley and Sons
3. Berg J.M., Tymoczko J.L., and Stryer L. (2012) Biochemistry 7th Edition. W.H. Freeman,U.S.A.
4. Segel, I.H. (1975) Biochemical Calculations: How to solve mathematical problems in general biochemistry. Second Edn. John Wiley & Sons, U.S.A.
5. Wood W.B., Wilson J.H., Benbow R.M., Hood L.E. (1981) Biochemistry: A problems approach. Second Edn. Benjamin / Cummings publishing group, U.S.A.

M.Sc. I Year (Semester I) Microbiology
Paper 3: RESEARCH METHODOLOGY IPR and BIOINFORMATICS (MB10103T)

Programme/Class: Degree/M.Sc.	Year: 1st year	M.Sc.1st Semester
Subject: Microbiology		
Course Code: **MB10103T**	**Course Title: RESEARCH METHODOLOGY IPR and BIOINFORMATICS**	

Course outcomes	Bloom's taxonomy
CO1: Explain Research methods, biosafety principles, regulatory frameworks, GMO risk assessment, and international biosafety agreements.	K2, K4
CO2: Analyze intellectual property rights, patenting of biotechnological inventions, and the role of international treaties and agreements.	K2, K3
CO3: Apply bioinformatics databases and sequence analysis tools for gene annotation and evolutionary studies.	K2, K4
CO4: Evaluate structural bioinformatics approaches and omics data analysis tools for drug discovery and systems biology applications.	K2, K5

Credits:4	Core Compulsory
Max. Marks:25+75	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L- 4/w

Unit	Topics	No. of Lectures= 60

I	**Research Methodology, Biosafety, and Bioethics** Research Methodology: Research design and types of research, formulation of research problems and hypotheses, literature survey and scientific databases, experimental design, sampling techniques, data collection methods, basics of biostatistics, data analysis and interpretation, scientific writing, research ethics, plagiarism, and publication ethics. Biosafety and Bioethics: Biosafety guidelines, primary containment for biohazards, biosafety levels of microorganisms, national and international biosafety regulations, GMOs/LMOs—concerns and challenges, role of IBSC, RCGM, and GEAC in GMO applications, environmental release of GMOs, risk analysis, risk assessment, risk management, and risk communication, Cartagena Protocol and international biosafety agreements.	15
II	**Intellectual Property Rights** Introduction to intellectual property rights—patents and types, trademarks, copyright and related rights, industrial designs, traditional knowledge, geographical indications, importance of IPR, patentable and non-patentable inventions, legal protection of biotechnological inventions, WIPO. International agreements and treaties—GATT, TRIPS, Madrid Agreement, Hague Agreement, WIPO treaties, Budapest Treaty, UPOV and Berne Conventions.	15
III	**Biological Databases and Sequence Analysis** Biological databases—primary, secondary and specialized databases, sequence and structural databases, sequence analysis methods, pairwise and multiple sequence alignment, global and local alignment, heuristic database search methods, BLAST, amino acid substitution matrices (PAM and BLOSUM), gene annotation, molecular phylogeny and evolution, cladogram, dendrogram, rooted and unrooted trees, neighbor joining, maximum parsimony and maximum likelihood methods.	15

IV	**Structural Bioinformatics, Omics Data Analysis, and Drug Design** Secondary and RNA structure prediction, molecular modeling and protein structure prediction, homology modeling, structure validation, ligand design and molecular docking, structural comparison of proteins (DALI, CATH, SCOP), structure-based drug design, molecular dynamics simulation, energy minimization, QSAR, pharmainformatics. Microarray data analysis, 2-D gel data analysis, protein mass spectrometry data analysis, genome annotation, overview of NGS data analysis, gene interaction networks and metabolic pathway databases.	15

Suggested Readings:

1. **Satheesh Kumar B.** *Bioethics and Biosafety.* I.K. International Publishing House.
2. **David P. Clark and Nanette J. Pazdernik.** *Biotechnology: Applying the Genetic Revolution.* Academic Press.
3. **Gupta, P.K.** *Biotechnology and Genomics.* Rastogi Publications.
4. **Nair, M.D. and R. Kumar.** *Intellectual Property Rights in Biotechnology.* PHI Learning Pvt. Ltd.
5. **Ganguli, P.** *Intellectual Property Rights: Unleashing the Knowledge Economy.* Tata McGraw-Hill.
6. **Mount, D.W.** *Bioinformatics: Sequence and Genome Analysis.* Cold Spring Harbor Laboratory Press.
7. **Pevsner, J.** *Bioinformatics and Functional Genomics.* Wiley-Blackwell.

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M.Sc. I Year (Semester I) Microbiology
Paper 4: MICROBIAL PATHOGENICITY (MB10104T)

Programme/Class: Degree/M.Sc.	Year: 1st year	M.Sc. 1st Semester
Subject: Microbiology		
Course Code: MB10104T	Course Title: **MICROBIAL PATHOGENICITY**	

Course outcomes:	Bloom's taxonomy
CO1: Explain the concepts of pathogenicity and virulence and analyze molecular mechanisms and regulatory systems involved in microbial pathogenesis.	K2, K4
CO2: Explain the emergence of new and opportunistic pathogens and analyze the genetic and environmental factors contributing to their spread.	K2, K4
CO3: Explain principles of microbial epidemiology and apply biochemical and molecular typing tools to track disease transmission.	K2, K3
CO4:- Explain the impact of environmental change on infectious diseases and evaluate strategies for antimicrobial resistance control, vaccination, and rapid diagnosis	K2, K5

Credits:4	Core Compulsory
Max. Marks:25+75	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L- 4/w

Unit	Topics	No. of Lectures= 60
I	**Classical and Molecular Basis of Microbial Pathogenicity** Concepts of pathogenicity and virulence; quantitative measures of pathogenicity including minimal lethal dose (MLD), LD_{50}, ID_{50}, and $TCID_{50}$. Virulence determinants: colonization, toxins, enzymes, invasiveness; facultative and obligate intracellular pathogens. Molecular aspects of microbial pathogenicity: molecular Koch's postulates; multiplicity of virulence determinants; coordinated regulation of virulence genes; environmental regulation of virulence determinants via two-component signal transduction systems; antigenic variation; clonal and panmictic nature of microbial pathogens; type III secretion systems (TTSS/T3SS); role of biofilms and quorum sensing in pathogenicity.	15

II	Emerging, Re-Emerging, and Opportunistic Pathogens Emerging and re-emerging pathogens with illustrations including *Vibrio cholerae* O139, X-MDR *Mycobacterium tuberculosis*, *Helicobacter pylori*, enterohaemorrhagic *Escherichia coli* (EHEC), *Cryptosporidium parvum*, bird and swine flu, AIDS, dengue hemorrhagic fever, and opportunistic fungal pathogens. Mechanisms of emergence of new pathogens including horizontal gene transfer (HGT) and pathogenicity islands (PAIs).	15
III	**Molecular Microbial Epidemiology and Disease Dynamics** Objectives and scope of microbial epidemiology. Biochemical and immunological tools for epidemiological investigations: biotyping, serotyping, phage typing, and multilocus enzyme electrophoresis (MLEE). Molecular typing methods: RAPD, repetitive sequence-based PCR (REP, ERIC, BOX), insertion sequence-based typing, PFGE, AFLP, MLST, VNTR, and whole-genome sequencing. Application of geographical information systems (GIS) in microbial epidemiology.	15
IV	**Environmental Change, Antimicrobial Resistance, Vaccines, and Rapid Diagnostics** Impact of environmental changes on infectious diseases: global warming-associated increase in vector-borne and water-borne diseases; effects of urbanization, international travel, and trade on disease transmission. Antimicrobial resistance (AMR): multidrug efflux pumps, extended-spectrum β-lactamases (ESBLs), X-MDR *M. tuberculosis*, methicillin-resistant *Staphylococcus aureus* (MRSA), and the role of integrons. Vaccines: recombinant vaccines, subunit vaccines, DNA vaccines, and vector-based vaccines including vaccinia-, BCG-, and HIV-based vectors. Rapid diagnostic principles: nucleic acid probes, nucleic acid amplification techniques, real-time PCR, lateral flow assays, diagnostic sequencing and mutation detection; automated diagnostic systems such as BACTEC, VITEK-2, and GeneXpert.	15

Suggested Readings:

1. Jawetz, Melnick, &Adelberg's Medical Microbiology by Carroll KC, Hobdon JA, Miller S, Morse SA, Mietzner TA. 27th edition. Lange Publication, 2016.

2. Beginner's guide to comparative genome analysis using next generation sequence data by Edward DJ and Holt KE in Microbial Informatics and Experimentation, 3:2, https://doi.org/10.1186/2042-5783-3-2, 2013.

3. Bacterial Pathogenesis: A molecular approach by Wilson BA, Salyers AA, Whitt DD, Winkler ME. 3rd edition. American Society for Microbiology Press, Washington, DC USA, 2011.

4. Bacterial Pathogenesis: Molecular and Cellular Mechanisms by Locht C, Simonet M, Caister Academic Press, 2012.

5. Molecular Microbiology: Diagnostic Principles and Practice by Persing DH, Tenover FC, Hayden R, Leven M, Miller MB, Nolte FS, Tang YW, Belkum AAV. 3rd edition. Washington, American Society for Microbiology Press, 2016

6. Infectious Disease Epidemiology: Theory and Practice by Nelson KE, Williams CM. 4th edition. Jones and Bartlett, 2019.

M.Sc. I Year (Semester I) Microbiology
Paper 5: Lab 1 (MB10105P)

Programme/Class: Degree/M.Sc.	Year: 1st year	M.Sc. 1st Semester
Subject: Microbiology		
Course Code: MB10105P	Course Title: **LAB 1**	

Course outcomes:	Bloom's taxonomy
CO1: Demonstrate good laboratory practices (GLP) and biosafety procedures, including appropriate handling of microbial cultures, laboratory equipment, and waste disposal in compliance with biosafety levels.	K2, K3
CO2: Prepare culture media, buffers, and reagents, and perform aseptic techniques such as plate pouring, smear preparation, fixation, and staining to study microbial morphology and growth characteristics.	K3
CO3: Analyze microbial populations and growth by conducting soil and water sample analysis, serial dilution, CFU enumeration, isolation techniques, and plotting bacterial growth curves.	K4
CO4: Estimate biochemical components such as proteins using standard quantitative methods (Biuret, Lowry, Bradford) and interpret experimental results using pH measurement and appropriate calculations.	K4, K5

Credits:4	Core Compulsory
Max. Marks:25+75	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L- 4/w

Unit	Topics	No. of Lectures= 60

	1. Good laboratory practices (GLP) and biosafety levels 2. Preparation of culture media 3. Collection and analysis of soil/water samples, serial dilution, CFU, soil microflora 4. Preparation of bacterial smear, fixation of suspension and simple staining for study of bacterial morphology 5. Bacterial growth curve 6. Staining techniques (simple, Gram, spore, capsule) 7. Preparation of nutrient agar and pouring of plates 8. To perform serial dilution and isolation of micro-organisms using spread plate technique 9. Preparation of buffers and pH measurement 10. Protein estimation (Biuret/Lowry/Bradford)	60

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M.Sc. I Year (Semester II) Microbiology
Paper 1: APPLIED & INDUSTRIAL MICROBIOLOGY (MB10201T)

Programme/Class: Degree/M.Sc.	Year: 1st year	M.Sc. 2nd Semester
Subject: Microbiology		
Course Code: MB10201T	**Course Title: APPLIED & INDUSTRIAL MICROBIOLOGY**	

Course outcomes:	Bloom's taxonomy
CO1: Explain the principles of industrial microbiology and fermentation processes and analyze strategies for strain selection, improvement, and fermentation kinetics.	K2, K4
CO2: Explain the production of microbial metabolites and recombinant products and apply metabolic engineering principles for large-scale bioprocess development.	K2, K3
CO3: Explain the industrial production of fermented products and microbial enzymes and analyze their roles in biocatalysis and industrial applications.	K2, K4
CO4: Explain microbial production of biofuels and bioproducts and evaluate their potential in sustainable and emerging industrial applications.	K2, K5

Credits:4	Core Compulsory
Max. Marks:25+75	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L- 4/w

Unit	Topics	No. of Lectures= 60
I	**Fundamentals of Industrial Microbiology and Fermentation Technology** Historical account of the use of microorganisms in industrial microbiology; sources and characteristics of industrially important microorganisms; isolation, purification, preservation, and maintenance of industrial strains. Screening of useful strains including primary and secondary screening methods; strain improvement through random mutagenesis and genetic engineering approaches. Types of fermentation processes and fermenters; microbial growth kinetics in batch, continuous, and fed-batch fermentation systems.	15

II	**Microbial Metabolites and Recombinant Products** Microbial production of primary and secondary metabolites; principles of metabolic engineering; biosynthetic pathways involved in secondary metabolite production. Commercial production of antibiotics with special reference to penicillin, streptomycin, and their derivatives. Microbial biotransformations including steroid and alkaloid production. Large-scale production of recombinant molecules such as interferons, human therapeutic proteins (insulin, somatostatin), vaccines, and anticancer agents.	15
III	**Fermented Products, Enzymes, and Biocatalysis** Fermented Microbial Products: Microbiology and industrial production of alcoholic beverages including malt beverages, distilled beverages, wine, and champagne; metabolic pathways involved in primary metabolite production. Microbial Enzymes: Production of industrial enzymes; immobilization of microbial enzymes and whole cells; applications in industries. Enzymes including cellulases, xylanases, pectinases, amylases, lipases, and proteases; enzymes involved in microbial biocatalysis and biotransformations.	15
IV	**Biofuels, Biopolymers, and Emerging Microbial Products** Production of biofuels such as ethanol and methane from organic residues; fuels derived from algae; microbial fuel cells. Mushroom cultivation and its industrial significance. Other microbial products including biopolymers and exopolysaccharides (EPS), bioplastics, and biosurfactants; applications and future prospects of microbial products in sustainable industries.	15

Suggested Readings:

1. W. Crueger & A. Crueger (2017). Cruegers Biotechnology: A Text Book of Industrial Microbiology. Edited by K.R. Aneja. Panima Publishing Corporation.
2. Reed. G. (1999). Prescott and Dunn‘s Industrial Microbiology. CBS Publishers.
3. Demain, A. L. (2001). Industrial Microbiology and Biotechnology IInd Edition. ASM Press, Washington.
4. P.F. Stanbury, W. Whitaker & S.J. Hall (2016). Principles of Fermentation Technology. 3rd edition. Elsevier publication.
3. Richard H. Baltz, Julian E. Davies, and Arnold L. Demain (2010). Manual of Industrial Microbiology and Biotechnology. 3rd Edition, ASM Press.
4. Daniel Forciniti (2008). Industrial Bioseparations: Principles and Practice. 1st Edition, Wiley-Blackwell.
5. Nduka Okafor, Benedict C. Okeke (2017). *Modern Industrial Microbiology and Biotechnology*. 2nd Edition: CRC Press Publishers.

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M.Sc. I Year (Semester II) Microbiology
Paper 2: FOOD MICROBIOLOGY (MB10202T)

Programme/Class: Degree/M.Sc.	Year: 1st year	M.Sc. 2nd Semester
Subject: Microbiology		
Course Code: MB10202T	**Course Title: FOOD MICROBIOLOGY**	

Course outcomes:	Bloom's taxonomy
CO1: Explain the role of microorganisms in foods and analyze intrinsic and extrinsic factors affecting microbial growth and survival in food systems.	K2, K4
CO2: Explain the etiology of food-borne diseases and analyze the characteristics of bacterial, fungal, viral, and parasitic food-borne pathogens.	K2, K4
CO3: Explain methods for detection of food-borne microorganisms and apply preservation techniques to control food spoilage and ensure food safety.	K2, K3
CO4: Explain the microbiology of food fermentations and evaluate food safety and quality management systems for safe food production.	K2, K5

Credits:4	Core Compulsory
Max. Marks:25+75	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L- 4/w

Unit	Topics	No. of Lectures= 60
I	**Fundamentals of Food Microbiology and Microbial Growth in Foods** Historical perspective and scope of microbiology in relation to food; importance and significance of microorganisms in foods. Factors affecting growth and survival of microorganisms in food: intrinsic parameters (pH, water activity, nutrient content, redox potential, natural antimicrobials, biological structures) and extrinsic parameters (temperature, relative humidity, gaseous environment, storage conditions).	15

II	**Food-Borne Diseases and Pathogens** Bacterial Food-Borne Diseases: Staphylococcal intoxication, botulism, salmonellosis, shigellosis, EPEC diarrhoea, *Clostridium perfringens* gastroenteritis, *Bacillus cereus* gastroenteritis. Food-Borne Fungi and Mycotoxins: Aflatoxicosis, deoxynivalenol, mycotoxicosis, ergotism. Food-Borne Viral Pathogens: Norwalk virus, reovirus, rotavirus, adenovirus, parvovirus, hepatitis A virus. Food-Borne Animal Parasites: Protozoa—giardiasis, amebiasis, toxoplasmosis, cryptosporidiosis; Helminths—cysticercosis/taeniasis, roundworms (*Trichinosis*, *Anisakiasis*).	15
III	**Detection, Spoilage, and Preservation of Foods** Detection of Food-Borne Pathogens: Detection and enumeration of microorganisms and their products in food; culture-dependent methods including sample collection and processing, surface testing, direct microscopic observation, enumeration and isolation; animal and cell culture models to study food-borne pathogen interactions. Food Spoilage: Microorganisms involved, characteristics, dynamics, and significance of spoilage of cereals and cereal products, fruits and vegetables, meat, poultry and seafood, milk and milk products, packed and canned foods; spoilage and defects of fermented foods. Food Preservation Methods: High-temperature processing, low-temperature preservation (role of psychrophilic microorganisms in cold-stored and frozen foods), drying, chemical preservatives, modified atmosphere packaging, radiation, other food protection methods, and microbial resistance.	15
IV	**Food Fermentation, Safety, and Quality Management** Microbiology of Food Fermentations: Milk fermentation; fermented and non-fermented dairy products; manufacture of fermented foods including meat and fishery products, plant-based fermentations (sauerkraut, fermented olives), breads, and beverages. Food Safety and Quality Management Systems: Principles of food safety risk management; recent concerns in food safety; safe food alternatives including organic foods; Good Agricultural Practices (GAP); indicators of water and food safety and quality; microbiological criteria of foods and their significance; HACCP and ISO systems for food safety management.	15

Suggested Readings:

1. Adams M. R. and Moss M. O. (1996). Food Microbiology, New Age International (Rt) Ltd., New Delhi.
2. Frazier W.C. and Westhoff D.C. (1995). Food Microbiology, Tata McGraw Hill Publishing Ltd., New Delhi.
3. Jay J. M., Loessner M. J. and Golden D. A. (2005). Modern Food Microbiology, Seventh edition.
4. Verma L. K. and Joshi V. K. (2000). Post Harvest Technology of Fruits and Vegetables, Tata McGraw Hill Publication.
5. Doyle M. P. and Beuchat L. R. (2007). Food Microbiology- Fundamentals and Frontiers, ASM Press.
6. Bhunia A. K. (2008). Food-borne Microbial Pathogens- Mechanisms and Pathogenesis, Food Science text Series, Springer International, New York, USA.

DEPARTMENT OF MICROBIOLOGY

M.Sc. I Year (Semester II) Microbiology
Paper 3: ANALYTICAL TECHNIQUES AND BIOSTATISTICS (MB10203T)

Programme/Class: Degree/M.Sc.	Year: 1st year	M.Sc. 2nd Semester
Subject: Microbiology		
Course Code: **MB10203T**	Course Title: ANALYTICAL TECHNIQUES AND BIOSTATISTICS	

Course outcomes	Bloom's taxonomy
CO1: Explain electrophoretic and chromatographic techniques and their applications in biological analysis.	K2, K4
CO2: Explain principles, instrumentation, and applications of centrifugation and spectroscopic techniques in biological systems.	K2, K3
CO3: Explain principles, detection methods, and applications of radioactivity and radioisotopes in biological and clinical studies.	K2, K4
CO4: Apply basic statistical tools and tests for analysis and interpretation of biological data.	K2, K5

Credits:4	Core Compulsory
Max. Marks:25+75	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L- 4/w

Unit	Topics	No. of Lectures= 60
I	**Contributions of Indian Scientists and Separation Techniques** Contribution of Indian scientists in various techniques. Electrophoretic Techniques – Theory and application of polyacrylamide and agarose gel electrophoresis, native and SDS PAGE, IEF, Chromatography techniques – TLC, paper, column chromatography, gel filtration, ion exchange, HPLC, GLC, partition, affinity, adsorption chromatography	15

II	**Centrifugation and Spectroscopic Techniques** Centrifugation techniques – basic principle, type of centrifuge, micro-centrifuge, high speed, ultracentrifuge, preparative centrifugation (differential and density gradient), analytical centrifugation, Spectroscopy techniques – basic principle, instrumentation and biological application of UV-visible spectroscopy, spectrofluorometry, CD, ORD, atomic spectroscopy (absorption and emission), NMR, ESR	15
III	**Radioisotopes and Their Applications** Radioactivity, Radioactivity and Isotopes: radioactive and stable isotopes, radioactive decay, unit of radioactivity, measurement of radioactivity – Geiger Mueller, solid and liquid scintillation counting, SPA, autoradiography; application of radioisotopes in biochemistry, clinical and diagnostic application	15
IV	**Biostatistics and Data Analysis** Introduction to statistics – Measures of Central Tendency: mean, median, mode; Measures of Dispersion: standard deviation, standard error, probability distribution; Tests of Significance: chi-square test, t-test, f-test, analysis of Variance, **ANOVA**	15

Suggested Readings:

1. **K. Wilson & J. Walker.** *Principles and Techniques of Biochemistry and Molecular Biology.* Cambridge University Press.
2. **S. V. S. Rana.** *Biotechniques: Theory & Practice.* Rastogi Publications.
3. **Abhilasha Shourie & Shilpa S. Chapadgaonkar.** *Bioanalytical Techniques.* TERI Publications.
4. **Mahin Basha.** *Analytical Techniques in Biochemistry.* Springer Protocols Handbooks.
5. **L. Ghatak.** *Techniques and Methods in Biology.* PHI Learning (covers electrophoresis, chromatography, spectroscopy, radioactivity, and stats).
6. **Rodney Boyer.** *Modern Experimental Biochemistry.* Pearson Education (covers practical biochemical techniques including spectrophotometry and electrophoresis).
7. **J.M. Walker & R. Rapley (Eds).** *Molecular Biomethods Handbook.* Human Press / Springer (good reference for separation and detection techniques).

M.Sc. I Year (Semester II) Microbiology
Paper 4: NANOBIOTECHNOLOGY (MB10204T)

Programme/Class: Degree/M.Sc.	Year: 1st year	M.Sc. 2nd Semester
Subject: Microbiology		
Course Code: MB10204T	**Course Title: NANOBIOTECHNOLOGY**	

Course outcomes:	Bloom's taxonomy
CO1: Explain the principles of industrial microbiology and fermentation processes and analyze strategies for strain selection, improvement, and fermentation kinetics.	K2, K4
CO2: Explain the production of microbial metabolites and recombinant products and apply metabolic engineering principles for large-scale bioprocess development.	K2, K3
CO3: Explain the industrial production of fermented products and microbial enzymes and analyze their roles in biocatalysis and industrial applications.	K2, K4
CO4: Explain microbial production of biofuels and bioproducts and evaluate their potential in sustainable and emerging industrial applications.	K2, K5

Credits:4	Core Compulsory
Max. Marks:25+75	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L- 4/w

Unit	Topics	No. of Lectures= 60

I	**Fundamentals and Classification of Nanotechnology** Introduction to Nanotechnology and Nanoscience. Definition and scope of nanotechnology, nanobiotechnology, and nanomaterials; evolution of nanoscience; need for nanotechnology and challenges in its development; factors affecting nanomaterial manufacturing processes; interdisciplinary contributions of physicists, chemists, engineers, biologists, medical doctors, and computer scientists; ethical, societal, and regulatory aspects of nanotechnology. Classification of Nanostructures, Nanospheres, nanotubes, nanorods, nanowires, nanosheets, quantum dots; effects of nanometer length scale; changes in system structure at nanoscale; influence of nanoscale dimensions on physical, chemical, and biological properties; nanocomposites including graphene, carbon nanotubes, fullerenes, natural nanomaterials, and bio-inspired nanomaterials.	15
II	**Synthesis and Fabrication of Nanomaterials** Physical Methods: Ball milling, electrodeposition, spray pyrolysis, thermal evaporation. Chemical Methods: Sol–gel process, synthesis of metal nanocrystals by chemical reduction, solvothermal synthesis. Biological and Green Synthesis Approaches: Protein-based nanostructure formation, DNA-templated nanostructure formation, protein self-assembly; advantages and limitations of biological synthesis methods.	15
III	**Nanobiotechnology and Protein-Based Nanostructures** Protein-based nanostructures and their functional properties; biomolecular nanomotors (E. coli flagellar motors, myosin-based mammalian nanostructures); self-assembly of biomolecules; nanobiosensors; nano-printing of DNA, RNA, and proteins; biochips; applications in nanoscale detection; lab-on-a-chip (LOC) and microfluidic devices.	15

IV	**Applications of Nanotechnology in Medicine and Environment** Medical and Pharmaceutical Applications: Nanotechnology for drug solubilization and targeted drug delivery; diagnostic applications using nanomaterials; nanotherapy for cancer treatment; interior artery expansion; joint replacement using nanomaterials; radioactive fullerene/tuberene cages in nuclear medicine. Environmental Applications and Safety Aspects: Nanotechnology for air purification and water treatment; microbial nanoparticles; nanocarbon balls as deodorizers in fermentation processes; biomotors for engineered devices; environmental fate and potential harm of nanomaterials; cytotoxicity and ecotoxicity models and assays; life cycle assessment (LCA) of nanomaterials.	15

Suggested Readings:

1. *Nanoscale Science and Technology* – Robert W. Kelsall, Ian W. Hamley, and Mark Geoghegan, John Wiley & Sons, Ltd., UK, 2005.
2. *Nano: The Essentials – Understanding Nanoscience and Nanotechnology* – T. Pradeep, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008.
3. *Nanostructures & Nanomaterials: Synthesis, Properties & Applications* – Guozhong Gao, Imperial College Press, 2004.
4. *Encyclopedia of Materials Characterization* – C. Richard Brundle, Charles A. Evans Jr., Shaun Wilson, Butterworth-Heinemann Publishers, 1992.
5. *Nanotechnology: Basic Science and Emerging Technologies* – Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Overseas Press, 2005.
6. *Nanoparticles as Drug Carriers* – Vladimir P. Torchilin, Imperial College Press, USA, 2006.

DEPARTMENT OF MICROBIOLOGY

M.Sc. I Year (Semester II) Microbiology
Paper 5: LAB 2 (MB10205P)

Programme/Class: Degree/M.Sc.	Year: 1st year	M.Sc. 2nd Semester
Subject: Microbiology		
Course Code: MB10205P	**Course Title: LAB 2**	

Course outcomes	Bloom's taxonomy
CO1: Apply standard microbiological techniques to cultivate, isolate, characterize, and analyze microorganisms involved in fermentation, soil processes, water quality assessment, and food safety..	K3
CO2: Analyze microbial growth, metabolic activities, and enzymatic functions by performing experiments such as ethanol production, catalase activity, nitrate reduction, and growth rate determination under different conditions.	K4
CO3: Demonstrate the synthesis, preparation, and stability testing of nanomaterials using chemical and biological approaches, and assess their antimicrobial activity using appropriate bioassays.	K3, K4
CO4: Evaluate experimental results related to microbial load in food and beverages, water quality (MPN), plant growth–promoting bacteria, and nanoparticle applications, and interpret their significance in health, agriculture, and industry.	K5

Credits:4	Core Compulsory
Max. Marks:25+75	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L- 4/w

Unit	Topics	No. of Lectures= 60

	1. Production of Ethanol by Yeast. 2. Isolation and characterization of plant growth promoting bacteria. 3. Bacteriological Examination of water quality (MPN) 4. Examination of microbial load in soft drinks, ice creams, packaged and canned foods. 5. To determine catalase activity of given microbial culture. 6. To determine the nitrate reduction in soil by microorganisms 7. To determine the specific growth rate of E. coli in different media. 8. Synthesis of nanoparticles (chemical/biological) 9. Antimicrobial activity of nanoparticles 10. Preparation of nanomaterials and stability testing	60