Re-Accredited B++ 2.85 CGPA by NAAC
VEER NARMAD SOUTH GUJARAT UNIVERSITY
University Campus, Udhna-Magdalla Road, SURAT - 395 007, Gujarat, India.
વીર નર્મદ દક્ષિણ ગુજરાત યુનિવર્સિટી
યુનિવર્સિટી કેમ્પસ, ઉધના-મગદલ્લા રોડ, સુરત - ૩૯૫ ૦૦૭, ગુજરાત, ભારત.
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-:પરિપત્ર:-

યુનિવર્સિટીના વિજ્ઞાન વિદ્યાશાખા હેઠળના તમામ શૈક્ષણિક વિભાગોના વડાશ્રીઓ અને યુનિવર્સિટી સંલગ્ન વિજ્ઞાન વિદ્યાશાખા હેઠળની તમામ કોલેજોનાં આચાર્યશ્રીઓને જણાવવાનું કે, NEP-2020 અંતર્ગત શૈક્ષણિક વર્ષ ૨૦૨૬–૨૭ થી અમલમાં આવનાર 2 Year PG- M.Sc. Microbiology Sem.-1 & 2 નો પેટાસમિતિ દ્વારા તૈયાર કરવામાં આવેલ અભ્યાસક્રમ માઈક્રોબાયોલોજી વિષયની અભ્યાસ સમિતિની તા.૨૧/૦૫/૨૦૨૬ અને તા.૦૨/૦૬/૨૦૨૬ ની સભાના ઠરાવ ક્રમાંકઃ૦૩ થી મંજૂર કરી વિજ્ઞાન વિદ્યાશાખાને કરેલ ભલામણ વિજ્ઞાન વિદ્યાશાખાની તા.૦૪/૦૬/૨૦૨૬ની સભાના ઠરાવ ક્રમાંકઃ૨૪થી મંજૂર કરવા એકેડેમિક કાઉન્સિલને કરેલ ભલામણ એકેડેમિક કાઉન્સિલની તા.૧૮/૦૬/૨૦૨૬ની સભાના ઠરાવ ક્રમાંકઃ૨૨ થી મંજૂર કરેલ છે. જેનો અમલ કરવા આથી જાણ કરવામાં આવે છે.

(બિડાણઃઉપર મુજબ)

ક્રમાંકઃઓથો./પરિપત્ર/૧૩૬૫૦/૨૦૨૬
તા.૨૩/૦૬/૨૦૨૬

કુલસચિવ(ઇ.ચા.)

પ્રતિ,
(૧) યુનિવર્સિટીના વિજ્ઞાન વિદ્યાશાખા હેઠળના તમામ શૈક્ષણિક વિભાગોના વડાશ્રીઓ.
(૨) યુનિવર્સિટી સંલગ્ન વિજ્ઞાન વિદ્યાશાખા હેઠળની તમામ કોલેજોનાં આચાર્યશ્રીઓ.
... આપશ્રીના વિભાગ/કોલેજના સંબંધિત શિક્ષકો/વિદ્યાર્થીઓને જાણ કરી અમલ કરવા સારૂ.
(૩) અધ્યક્ષશ્રી, વિજ્ઞાન વિદ્યાશાખા.
(૪) પરીક્ષા નિયામકશ્રી,પરીક્ષા વિભાગ, વીર નર્મદ દ. ગુ. યુનિવર્સિટી, સુરત.

.....તરફ જાણ તેમજ અમલ સારૂ.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

Postgraduate Program

In

Microbiology

02 years (ONLY COURSE WORK)

M.Sc. SEM 1 & 2 SYLLABUS

PROGRAM TITLE	
Name of Program	Master of Science (Honors) Microbiology
Program Abbreviation	M.Sc. MB
Duration	2 Years
Eligibility Criteria	Successfully Completed Sem-6 in the subject of Microbiology
Pre-requisite	Basic concepts in the field of microbiology
Medium of Instruction	English
Objective of Program	To provide Fundamental and applied knowledge of Micro- organism to students. To develop Laboratory skills and to train the students in scientific thinking to prepare for carriers like health care, pharmaceutical, biotechnology, diagnostics, industry and academia and to promote awareness to students of microbial application in the field of diseases prevention, environmental sustainability and technological innovation.
Program Outcome (PO)	**PO-01: Scientific Knowledge & Conceptual Understanding** Develop a strong foundation in scientific principles, theories and concepts across disciplines, fostering interdisciplinary learning, advanced knowledge and problem-solving abilities. **PO-02: Analytical & Critical Thinking** Apply critical thinking and analytical reasoning to evaluate scientific data, hypotheses and real-world problems, leading to evidence-based conclusions. **PO-03: Research & Inquiry-based Learning** Develop investigative skills through experimentation, data analysis and scientific inquiry to contribute to research and innovation. **PO-04: Laboratory & Technical Skills** Gain hands-on experience with laboratory techniques, instrumentation and computational tools relevant to scientific research and industry applications. **PO-05: Digital & Computational Literacy** Utilize digital tools, computational techniques and emerging technologies such as AI, bioinformatics and statistical modelling to enhance scientific learning and problem-solving. **PO-06: Environmental & Societal Responsibility** Understand the role of science in addressing environmental, health and societal challenges, promoting sustainability and ethical responsibility. **PO-07: Effective Communication & Collaboration**

	Develop proficiency in scientific communication, both written and oral, for effective dissemination of knowledge while collaborating in multidisciplinary teams. **PO-08: Innovation & Entrepreneurship** Foster an entrepreneurial mindset by applying scientific knowledge for innovation, technology development and industry-oriented applications. Develop sustainable solutions to address real-world challenges in research and environmental management. **PO-09: Lifelong Learning & Professional Growth** Cultivate curiosity and adaptability for continuous learning, equipping students for higher education, research and professional careers. **PO-10: Ethical Leadership & Value-based Education** Develop leadership qualities, ethical values and a sense of responsibility in applying science for societal progress, aligning with Indian knowledge systems and global perspectives.
Program Specific Outcomes (PSO)	**PSO1** Demonstrate advanced understanding of microbial diversity, taxonomy, genetics, physiology, metabolism, molecular biology, immunology, virology and host–microbe interactions. **PSO2** Apply microbiological principles for identification, characterization and utilization of microorganisms in healthcare, agriculture, food, pharmaceutical, industrial and environmental sectors. **PSO3** Integrate knowledge of microbial biotechnology, fermentation technology, bioprocess engineering and microbial products for development of sustainable technologies and industrial applications. **PSO4** Utilize advanced bioanalytical techniques, biophysical instrumentation, omics technologies, bioinformatics and artificial intelligence tools for biological data generation and interpretation. **PSO5** Analyze microbial communities, biodiversity, ecological interactions, evolutionary processes and microbiomes for environmental sustainability and resource management. **PSO6** Apply concepts of medical microbiology, public health microbiology, antimicrobial resistance, epidemiology and immunology for understanding disease processes and their control. **PSO7** Employ microbial resources and technologies for agricultural productivity, bioinoculant development, bioremediation, bioleaching, biomining and other environmental applications.

	PSO8 Demonstrate competency in research, innovation, intellectual property management, regulatory compliance and entrepreneurship for professional careers, higher studies and technology-driven enterprises. **PSO9** Apply research methodologies, experimental design and analytical approaches to investigate microbiological problems through an independent research project. **PSO10** Analyze, interpret and communicate research findings through dissertations, scientific reports and presentations.
Mapping between P0s and PSOs	

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
PSO1	■	■				■			■	
PSO2	■	■	■	■		■				
PSO3	■	■	■	■		■		■		
PSO4	■	■	■	■	■			■	■	
PSO5	■	■	■			■			■	■
PSO6	■	■	■	■		■				■
PSO7	■	■	■	■		■		■		■
PSO8		■	■	■	■		■	■	■	■
PSO9		■	■		■		■		■	■
PSO10		■	■	■	■		■	■	■	■

STRUCTURE FOR ERP – M.Sc MICROBIOLOGY – SEM – 1 COURSE WORK AND ONE SEMESTER RESEARCH																
Course Category	**Course Code**	**Course Title**	**Mark sheet Title in English**	**Level of Course**	**Teaching Hours/Week**		**Exam Duration (Hours)**		**Credit**		**Internal Marks**		**External Marks**		**Total**	
					TH	**PR**	**TH**	**PR**	**TH**	**PR**	**TH**	**PR**	**TH**	**PR**	**TH**	**PR**
MAJOR 1	**MB – 1001**	**MICROBIAL GENETICS**	**MICROBIALGENETICS**	500-599	02	04	01.00	06.00	02	02	25	25	25	25	50	50
MAJOR 2	**MB – 1002**	**MICROBIAL METABOLISM & PHYSIOLOGICAL ADAPTATION**	**MICROBIAL METABOLISM & PHYSIOLOGICAL ADAPTATION**	500-599	02	04	01.00	06.00	02	02	25	25	25	25	50	50
MAJOR 3	**MB – 1003**	**MICROBIAL BIOTECHNOLOGY**	**MICROBIAL BIOTECHNOLOGY**	500-599	02	04	01.00	06.00	02	02	25	25	25	25	50	50
MAJOR 4	**MB-1004 BKS**	**TRADITIONAL PRACTICES IN MICROBIOLOGY**	**TRADITIONAL PRACTICES IN MICROBIOLOGY**	500-599	04	00	02.00	00	04	-	50	-	50	-	100	-
MDC	**MB-1005**	**BIONANOTECHNOLOGY/ FUNDAMENTALS OF CYBERSECURITY**	**BIONANOTECHNOLOGY/ FUNDAMENTALS OF CYBER SECURITY**	500-599	04	00	02.00	00	04	-	50	-	50	-	100	-
SEC	**MB-1006**	**EPIDEMIOLOGY/ SWAYAM MOOC/RESEARCH METHODOLOGY**	**EPIDEMIOLOGY/ SWAYAM MOOC/RESEARCH METHODOLOGY**	500-599	02	00	00	00	02	-	25	-	25	-	50	-

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M. Sc. Microbiology, Semester-I

MB-MJ-1001: MICROBIAL GENETICS

Program Name	**M.Sc.**
Semester	**M. Sc. SEM 1**
Credit Level	**6.0**
Course Type	**MAJOR**
Course Subtype	**MAJOR 1**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MB-MJ-1001**
Course Level	**500-599**
Course Title	**Microbial Genetics**
Credit	02 (30 Hours)
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	**Course Outcomes (COs)** Upon successful completion of this course, the students will be able to: **CO1:** Explain the molecular mechanisms of DNA replication, transcription, translation, protein processing and protein secretion involved in the flow of genetic information in microorganisms. **(K2 – Understand)** **CO2:** Apply the principles of microbial gene regulation, including transcriptional regulation, RNA-mediated regulation, enzyme regulation and DNA repair mechanisms, to understand cellular responses and genetic stability. **(K3 – Apply)** **CO3:** Analyze the structure, properties and biological significance of plasmids and other genetic elements in microbial systems. **(K4 – Analyze)** **CO4:** Evaluate the mechanisms and applications of gene transfer processes, including transformation, transduction, conjugation and gene transfer in archaea, in microbial genetics and biotechnology. **(K5 – Evaluate)** **CO5:** Assess the roles of recombination, transposition and genome rearrangements in microbial evolution, adaptation and genetic engineering. **(K5 – Evaluate)**
Mapping between COs and PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	■					■		
CO2	■					■		
CO3	■	■						
CO4	■	■	■					
CO5	■		■					■

Course Content	
UNIT 1: Nucleic acid structure and synthesis	
1.1	*Molecular Biology and Genetic Elements:* DNA and Genetic Information Flow, Genetic Elements: Chromosomes and Plasmids overview
1.2	*DNA Replication:* Templates, Enzymes, and Replication Fork, Bidirectional Replication, the Replisome, and Proofreading
1.3	*RNA Synthesis:* Transcription in Bacteria, in Archaea
1.4	*Protein Synthesis*: Translation, Amino Acids, Polypeptides, and Proteins, Transfer RNA, Genetic Code, Mechanism of Protein Synthesis
1.5	*Protein Processing, Secretion, and Targeting:* Assisted Protein Folding and Chaperones, Protein Secretion in Gram-Negative Systems
1.6	*DNA-Binding Proteins and Transcriptional Regulation*: DNA-Binding Proteins, Negative Control- Repression and Induction, Positive Control-Activation, Global Control and the *lac* Operon, Transcription Controls in Archaea
1.7	*RNA-Based Regulation*: Regulatory RNAs, Riboswitches, Attenuation
1.8	*Regulation of Enzymes and Other Proteins*: Feedback Inhibition, Post-Translational Regulation
UNIT 2: Mutation, Plasmids, Gene Transfer and Genome Rearrangement	
2.1	*Mutation and DNA repair:* The causes of mutations, Repair of mutations and other types of DNA damage
2.2	*Plasmid*: Functions Encoded, Structure, Properties of Plasmids
2.3	Transformation, Artificially Induced Competence- Chemical Induction, Electroporation and Protoplast Transformation
2.4	Transduction
2.5	Conjugation and Formation of Hfr Strains & Chromosome Mobilization, mapping genes by interrupted mating, Gene Transfer in Archaea,
2.6	*Recombination*: Homologous and site-specific recombination
2.7	*Transposition*: Transposition, Mechanisms of Transposition and General Properties of Transposons

References

1. Brown, T. A. (2023). *Genomes 5* (5th ed.). CRC Press. ISBN: 978-0-367-67866-1
2. Henkin, T. M., & Peters, J. E. (2020). *Snyder and Champness molecular genetics of bacteria* (5th ed.). ASM Press; John Wiley & Sons. ISBN 9781555819750
3. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2014). *Lewin's GENES XI* (11th ed.). Jones & Bartlett Learning. ISBN 9781449659851
4. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. (2018). *Brock biology of microorganisms* (15th ed.). Pearson. ISBN 13: 978-1-292-23510-3
5. Watson, J.D., Baker, T. A., Beil S. P., Gann, A., Levine, M., & Losick, R. (2017). *Molecular biology of gene* (7th ed.) Pearson India Education Services Pvt. Ltd.
6. Willey, J. M., Sandman, K. M., & Wood, D. H. (2023). *Prescott's microbiology* (12th ed.). McGraw-Hill Education. ISBN 978-1-265-12303-1

Online reference

1. https://swayam.gov.in/

2. https://swayam-plus.swayam2.ac.in/
Teaching Methodology The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.
Evaluation scheme 50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MBP-MJ-1001: MICROBIAL GENETICS PRACTICALS

Program Name	**M.Sc.**
Semester	**M. Sc SEM 1**
Credit Level	**6.0**
Course Type	**MAJOR**
Course Subtype	**MAJOR Practical 1**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MBP-MJ-1001**
Course Level	**500-599**
Course Title	**Microbial Genetics Practical**
Credit	02 (30 Hours)
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	**Course Outcomes (COs)** Upon successful completion of this practical course, the students will be able to: **CO1:** Perform the isolation, purification and quantitative estimation of genomic DNA, plasmid DNA and RNA from microbial cells using standard molecular biology techniques. **(K3 – Apply)** **CO2:** Execute microbial genetic experiments involving mutation induction, mutant isolation and gene expression analysis to understand microbial genetics and gene regulation. **(K3 – Apply)** **CO3:** Demonstrate bacterial transformation techniques and interpret the role of gene transfer mechanisms in microbial genetic exchange. **(K3 – Apply)** **CO4:** Apply bioinformatics tools for identification of open reading frames (ORFs) and analysis of gene sequences retrieved from biological databases. **(K3 – Apply)** **CO5:** Analyze experimental and computational data related to nucleic acids, gene expression, mutation and microbial genetics for scientific interpretation and problem-solving. **(K4 – Analyze)**
Mapping between COs and PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	■			■				
CO2	■	■				■		
CO3	■	■	■					
CO4	■			■				
CO5	■		■	■				■

Course Content

1. Extraction of bacterial genomic DNA from bacteria and Quantitative estimation of DNA
2. Extraction of RNA from yeast and Quantitative estimation of RNA
3. Isolation of Plasmid DNA.
4. Isolation of Auxotrophic Mutants by Replica Plating technique
5. Study of UV-Induced Mutation in Bacteria
6. Induction of β-Galactosidase Activity (lac Operon Demonstration)
7. Bacterial Transformation testing using agar plat methods
8. Open Reading Frame (ORF) Prediction
9. Retrieval and analysis of Gene Sequence from NCBI.

References

1. Patel, R. J., & Patel, R. K. Experimental Microbiology, Vol. 1, 10th Edition, Aditya, 2022
2. Patel, R.J., & Patel, R. K. Experimental Microbiology, Vol. 2, 10th Edition, Aditya, 2022.
3. Aneja, K. R., Experiments in Microbiology 4thed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.
4. Brown, T. A. (2020). *Gene Cloning and DNA Analysis: An Introduction* (8th ed.). Wiley-Blackwell.
5. Walker, J. M. (Ed.). (2009). *The Protein Protocols Handbook* (3rd ed.). Humana Press.
6. Cappuccino, J. G., & Welsh, C. (2018). Microbiology: A laboratory manual (11th global ed.). Pearson Education Limited.
7. Bossi, Camilli, Grundl, Experiments in Bacterial Genetics: A Laboratory Manual, Cold Spring Harbor Laboratory Press, 2023, ISBN 978-1621824497
8. Tiwari, R. P., Hoondal, G. S., & Tewari, R. (2004). Laboratory techniques in microbiology & biotechnology (1st ed.). Abhishek Publications ISBN 81-8247-077-3
9. Bisen, P. S. (2014). *Laboratory protocols in applied life sciences*. CRC Press.
10. Alexander, S. K., Strete, D., & Niles, M. J. (2003). *Laboratory exercises in organismal and molecular microbiology*. McGraw-Hill Higher Education
11. Saxena, J., Baunthiyal, M., & Ravi, I. (2015). *Laboratory manual of microbiology, biochemistry and molecular biology,* Scientific Publishers.

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive
Discussion, seminars, assignments, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MB-MJ-1002: MICROBIAL METABOLISM AND PHYSIOLOGICAL ADAPTATION

Program Name	**M.Sc.**
Semester	**M. Sc. SEM 1**
Credit Level	**6.0**
Course Type	**MAJOR**
Course Subtype	**MAJOR 2**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MB-MJ-1002**
Course Level	**500-599**
Course Title	**Microbial Metabolism and Physiological Adaptation**
Credit	Theory: 02 (30 Hours)
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	**Course Outcomes (COs)** Upon successful completion of this course, the students will be able to: **CO1:** Explain the principles of microbial metabolism, bioenergetics, ATP generation, redox reactions, metabolic pathways and cellular energy conservation mechanisms in microorganisms. **(K2 – Understand)** **CO2:** Apply the concepts of respiratory metabolism, fermentation, autotrophy, lithotrophy, methanogenesis, methanotrophy and phototrophy to understand microbial metabolic diversity and ecological adaptation. **(K3 – Apply)** **CO3:** Analyze anabolic pathways, biosynthetic processes and inorganic metabolism involved in the synthesis of cellular components and nutrient assimilation in microorganisms. **(K4 – Analyze)** **CO4:** Evaluate microbial regulatory mechanisms, including two-component regulatory systems, stress responses, sporulation and germination, in relation to microbial survival and physiological adaptation. **(K5 – Evaluate)** **CO5:** Assess the roles of biofilm formation, quorum sensing and metabolic engineering in microbial ecology, biotechnology and industrial applications. **(K5 – Evaluate)**
Mapping between COs and PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	■							
CO2	■	■			■			
CO3	■	■	■				■	
CO4	■					■		■
CO5		■	■		■		■	■

Course content	
UNIT 1: Metabolism and Bioenergetics	
1.1	Introduction to Microbial Metabolism, Important Principles and Concepts, ATP- the Major Energy Currency
1.2	Redox Reactions, Sequential Redox Reactions, Biochemical Pathways- Sets of Linked Chemical Reactions, Enzymes and Ribozymes, Metabolism regulation to maintain Homeostasis
1.3	Cellular Mechanisms for ATP Synthesis, Chemiosmotic Theory, ATP Synthase, The Proton Motive Force (PMF) Quantifying PMF,
1.4	Environmental Impacts on PMF
1.5	Oxidative decarboxylation of pyruvate, TCA cycle, Glyoxylate cycle, Anaplerotic reactions
1.6	Electron Transport and Oxidative Phosphorylation, Aerobic respiration, Anaerobic respiration, Energy yield comparison Fermentation Pathways: Propionate, Acetate, Lactate, Mixed-Acid and Butanediol Fermentation, and Butyrate Fermentation, Syntrophy Autotrophic Pathways: Concept of autotrophy, Calvin cycle, Reverse TCA cycle
1.7	C1 Metabolism: Acetogenesis, Methanogenesis, Methanotrophy Phototrophy (Light Reactions in Oxygenic Photosynthesis and in Anoxygenic Photosynthesis, Rhodopsin-Based Phototrophy
UNIT 2: Microbial Anabolism and Physiological Adaptation	
2.1	Lithotrophy: hydrogen-oxidizing bacteria, Ammonia-oxidizing bacteria, Nitrite-oxidizing bacteria, Sulfur-oxidizing prokaryotes, Iron-oxidizing bacteria
2.2	Inorganic metabolisms: Assimilation and Dissimilation of Nitrate and Sulfate, Nitrogen fixation: nitrogen-fixing systems and nitrogenase
2.3	Anabolism and Biosynthesis: concept of biosynthesis, Precursor Metabolites for Biosynthesis
2.4	Lipid Synthesis: Fatty Acids and Phospholipids, Sterols and Isoprenoid Lipids, Lipopolysaccharides, Synthesis of Peptidoglycan
2.5	Two component regulatory system
2.6	Microbial stress responses: oxidative stress, physiological response to oxidative stress in *E. coli*, heat shock response, sporulation, stages of sporulation, germination and regulation in *Bacillus subtilis*, resistance properties of endospores
2.7	Prevalence, Importance, Properties, and Regulation of Biofilm Formation, Quorum Sensing, Metabolic engineering of bacteria

References

1. Kim, B. H., & Gadd, G. M. (2008). Bacterial physiology and metabolism (2nd ed.). Cambridge University Press. ISBN-13 978-0-511-39322-8
2. Kumar, R. R., & Prasad, S. (2011). Metabolic engineering of bacteria. Indian Journal of Microbiology, 51(3), 403–409. https://doi.org/10.1007/s12088-011-0172-8

3. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., Stahl, D. A. (2018). Brock biology of microorganisms (15th ed.). Pearson.
4. Moat, A. G., Foster, J. W., & Spector, M. P. (2002). Microbial physiology (4th ed.). Wiley-Liss.
5. Stevens, A. M., Ditty, J. L., Parales, R. E., & Merkel, S. M. (2023). Microbial physiology: Unity and diversity. ASM Books / Wiley. ISBN: 978-1683673675
6. Stevens, A. M., Ditty, J. L., Parales, R. E., & Merkel, S. M. (2023). Microbial physiology: Unity and diversity. ASM Books / Wiley. ISBN: 978-1683673675
7. White, D., Drummond, J., & Fuqua, C. (2012). The physiology and biochemistry of prokaryotes (4th ed.). Oxford University Press.
8. Willey, J. M., Sandman, K. M., & Wood, D. H. (2023). Prescott's microbiology (12th ed.). McGraw-Hill Education. ISBN 978-1-265-12303-1

Online reference

https://swayam.gov.in/
https://swayam-plus.swayam2.ac.in/

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Evaluation scheme

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MBP-MJ-1002: MICROBIAL METABOLISM AND PHYSIOLOGICAL ADAPTATION PRACTICALS

Program Name	**M.Sc.**
Semester	**M. Sc SEM 1**
Credit Level	**6.0**
Course Type	**MAJOR**
Course Subtype	**MAJOR Practical 2**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MBP-MJ-1002**
Course Level	**500-599**
Course Title	**Microbial Metabolism and Physiological Adaptation Practical**
Credit	Theory: 02 (30 Hours)
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	**Course Outcomes (COs)** Upon successful completion of this practical course, the students will be able to: **CO1:** Perform experiments to evaluate the effects of environmental factors such as temperature, pH and bile salts on microbial growth, metabolism and physiological adaptation. **(K3 – Apply)** **CO2:** Demonstrate microbial metabolic activities, including carbohydrate utilization, sporulation and photosynthetic growth, using standard microbiological techniques. **(K3 – Apply)** **CO3:** Investigate microbial adaptive mechanisms such as biofilm formation and stress tolerance and interpret their ecological and physiological significance. **(K4 – Analyze)** **CO4:** Apply bioinformatics tools and biological databases to retrieve, analyze and interpret microbial metabolic pathways and stress response genes. **(K3 – Apply)** **CO5:** Analyze experimental and computational data related to microbial metabolism, physiological adaptation and environmental responses for scientific interpretation and problem-solving. **(K4 – Analyze)**
Mapping between COs and PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	■	■			■		■	
CO2	■	■			■			
CO3	■				■		■	
CO4	■			■	■			
CO5	■		■	■	■			■

Course Content

1. Study of Bacterial Growth Curve under stress conditions of temperature
2. Study of Bacterial Growth Curve under stress conditions of pH
3. Estimation of sugar utilization by yeast by DNSA method
4. Study of Sporulation by Endospore Staining
5. Study of Biofilm formation by tube method using crystal violet staining
6. Determination of sensitivity of gram positive and gram-negative bacteria to bile salts
7. Enrichment and Microscopic Observation of Photosynthetic Bacteria
8. Retrieval and Analysis of different Microbial Metabolic Pathways using KEGG Database

9 Retrieval and Analysis of Stress Response Genes in Microorganisms

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1. Patel, R. J., & Patel, R. K. Experimental Microbiology, Vol. 1, 10th Edition, Aditya, 2022
2. Patel, R.J., & Patel, R. K. Experimental Microbiology, Vol. 2, 10th Edition, Aditya, 2022.
3. Aneja, K. R., Experiments in Microbiology 4thed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.
4. Cappuccino, J. G., Microbiology: A Laboratory Manual, 6Ed., Singapore Pearson Education Pvt. Ltd., 2005.
5. Cappuccino, J. G., & Welsh, C. (2018). Microbiology: A laboratory manual (11th global ed.). Pearson Education Limited.
6. Tiwari, R. P., Hoondal, G. S.,; Tewari, R. (2004). Laboratory techniques in microbiology; biotechnology (1st ed.). Abhishek Publications ISBN 81-8247-077-3
7. Saxena, J., Baunthiyal, M., & Ravi, I. (2015). *Laboratory manual of microbiology, biochemistry and molecular biology,* Scientific Publishers.

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive Discussions, seminars, assignments, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MB-MJ-1003: MICROBIAL BIOTECHNOLOGY

<table>
<tr><td>Program Name</td><td>M.Sc.</td></tr>
<tr><td>Semester</td><td>M. Sc SEM 1</td></tr>
<tr><td>Credit Level</td><td>6.0</td></tr>
<tr><td>Course Type</td><td>MAJOR</td></tr>
<tr><td>Course Subtype</td><td>MAJOR 3</td></tr>
<tr><td>Subject Type</td><td>Faculty of Science- Microbiology</td></tr>
<tr><td>Course Code</td><td>MB-MJ-1003</td></tr>
<tr><td>Course Level</td><td>500-599</td></tr>
<tr><td>Course Title</td><td>Microbial Biotechnology</td></tr>
<tr><td>Credit</td><td>Theory: 02 (30 Hours)</td></tr>
<tr><td>Effective From</td><td>Academic year: 2026-27</td></tr>
<tr><td>Course Outcomes (COs)</td><td>Course Outcomes (COs)
Upon successful completion of this course, the students will be able to:
CO1: Explain the principles of industrial microbiology, fermentation technology and microbial production processes involved in the manufacture of primary metabolites, enzymes and industrial bioproducts. (K2 – Understand)
CO2: Apply the concepts of microbial biotechnology for the production of organic acids, solvents, amino acids, vitamins, biofuels and other value-added microbial products. (K3 – Apply)
CO3: Analyze the production technologies, industrial applications and economic significance of secondary metabolites, biopolymers, biofertilizers, biopesticides, fermented beverages and therapeutic biomolecules. (K4 – Analyze)
CO4: Evaluate modern metabolic engineering strategies, including glycoengineering, gas fermentation and microbial electrosynthesis, for the development of sustainable bioprocesses and novel microbial products. (K5 – Evaluate)
CO5: Assess the applications of artificial intelligence, process analytical technology and machine learning in optimizing microbial production systems and industrial biotechnology processes. (K5 – Evaluate)</td></tr>
<tr><td>Mapping between COs and PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th><th>PSO7</th><th>PSO8</th></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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Course content

UNIT 1: Industrial Microbial Products and Fermentation Technologies	
1.1	Important microbes used in industrial microbiology and biotechnology: High throughput screening
1.2	Range of fermentation processes
1.3	Organic acids: Citric acid and Lactic acid
1.4	Amino acid: L-lysine; Vitamin: B12 & Riboflavin
1.5	Solvents: Ethanol and Bio-butanol
1.6	Biopolymers: PHAs and Exopolysaccharides: Xanthan.
1.7	Agricultural bioproducts: Microbial biopesticides, Siderophores and mycorrhizal biofertilizer
1.8	Alcohol-based fermented beverages: Beer and Wine
1.9	Therapeutics: mAbs, Insulin, Interferons, Antibiotics: Cephalosporins
UNIT 2: Metabolic Engineering and Intelligent Production Technologies	
2.1	Industrially important enzymes
2.2	Next generation biofuels from cyanobacteria and yeasts
2.3	AI-driven enzyme design: enzymes with tailored specificities
2.4	Glycoengineered microbes: humanized glycoproteins production
2.5	Gas fermentation by C1 pathway: industrial waste gases to bioplastics and SCPs
2.6	Microbial Electrosynthesis Systems: reduction of CO_2 into value-added chemicals
2.7	Process Analytical Technology: real-time monitoring of microbial product formation
2.8	Machine learning: reinforcement learning algorithms to maximize product yield

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1. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2016). Principles of fermentation technology (3rd ed.). Elsevier.
2. Okafor, Nduka, and Benedict C. Okeke. *Modern Industrial Microbiology and Biotechnology*. Boca Raton, CRC Press, 2017.
3. Waites, M. J., N. L. Morgan, et al. *Industrial Microbiology: An Introduction*. Oxford, Blackwell Science, 2001.
4. Aehle, Wolfgang, editor. *Enzymes in Industry: Production and Applications*. 3rd ed., Weinheim, Wiley-VCH, 2007.
5. Stephanopoulos, Gregory, Aristos A. Aristidou, and Jens Nielsen. *Metabolic Engineering: Principles and Methodologies*. San Diego, Academic Press, 1998.
6. Crommelin, D. J. A., R. D. Sindelar, and Bernd Meibohm, editors.
7. Pharmaceutical Biotechnology: Fundamentals and Applications. 5th ed., Cham, Springer, 2019.
8. Kaplan, David L., editor. Biopolymers from Renewable Resources. Berlin, Springer, 1998
9. Pandey, Ashok, D. J. Lee, et al., editors. Biofuels from Algae. Amsterdam, Elsevier, 2014.

10. White, Chris, and Jamil Zainasheff. Yeast: The Practical Guide to Beer Fermentation. Boulder, Brewers Publications, 2010.
11. Guo, Peixuan, and Fazlul Haque, editors. RNA Nanotechnology and Therapeutics. Boca Raton, CRC Press, 2020.
12. Köpke, Michael, and Sean Simpson, editors. Gas Fermentation: Carbon Capture and Utilization. Cham, Springer, 2022.
13. Raghavan, P., and S. Ghosh. Machine Learning and Data Science in the Power Generation and Process Industries. Amsterdam, Elsevier, 2022.
14. Smolke, Christina D., editor. The Metabolic Pathway Engineering Handbook: Fundamentals and Applications. Boca Raton, CRC Press, 2010.

Online reference

1 https://swayam.gov.in/

2 https://swayam-plus.swayam2.ac.in/

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Evaluation scheme

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MBP-MJ-1003: MICROBIAL BIOTECHNOLOGY PRACTICALS

Program Name	**M.Sc.**		
Semester	**M. Sc SEM 1**		
Credit Level	**6**		
Course Type	**MAJOR**		
Course Subtype	**MAJOR Practical 3**		
Subject Type	**Faculty of Science- Microbiology**		
Course Code	**MBP-MJ-1003**		
Course Level	**500-599**		
Course Title	**Microbial Biotechnology Practical**		
Credit	Theory: 02	Practical: 02	Total: 04 (30 Hours)
Effective From	**Academic year: 2026-27**		
Course Outcomes (COs)	**Course Outcomes (COs)** Upon successful completion of this practical course, the students will be able to: **CO1:** Perform isolation, screening and characterization of industrially important microorganisms for the production of organic acids, exopolysaccharides and industrial enzymes. **(K3 – Apply)** **CO2:** Demonstrate microbial fermentation processes and evaluate the production of industrially important metabolites, enzymes and vitamins using standard biotechnological techniques. **(K3 – Apply)** **CO3:** Apply downstream processing techniques for purification and assessment of enzyme preparations, including determination of specific activity and fold purification. **(K3 – Apply)** **CO4:** Analyze microbial traits of industrial significance, including siderophore production and metabolite biosynthesis, and interpret their applications in biotechnology. **(K4 – Analyze)** **CO5:** Utilize biological databases and culture collection repositories to retrieve, analyze and evaluate industrially important microbial strains and their physiological and fermentation characteristics. **(K4 – Analyze)**		

Mapping between Cos and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	■	■	■				■	
CO2	■	■	■				■	■
CO3	■	■	■	■				■
CO4	■	■	■		■		■	■
CO5	■	■		■				■

Course Content

1. Isolation and screening of citric acid & lactic acid producing fungi
2. Isolation and screening of EPS producing bacteria
3. Screening of amylase- and cellulase-producing microorganisms
4. Production of amylase/ cellulase enzyme under solid State & submerged fermentation
5. Purification of amylase/ cellulase by ammonium sulphate and dialysis to determine specific activity and fold purification
6. CAS assay for siderophore production
7. Spectrophotometric estimation of Riboflavin /Vitamin B12
8. Exploration of National and International Microbial Culture Collection Databases for Retrieval and Analysis of Industrially Important Microbial Strains
9. Exploration of BacDive Database for Physiological and Fermentation Characteristics of Industrial Microorganisms

References

1. Patel, R. J., & Patel, R. K. Experimental Microbiology, Vol. 1, 10th Edition, Aditya, 2022
2. Patel, R.J., & Patel, R. K. Experimental Microbiology, Vol. 2, 10th Edition, Aditya, 2022.
3. Aneja, K. R., Experiments in Microbiology 4th ed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.
4. Cappuccino, J. G., & Welsh, C. (2018). Microbiology: A laboratory manual (11th global ed.). Pearson Education Limited.
5. Bisen, P. S. (2014). *Laboratory protocols in applied life sciences*. CRC Press.
6. Saxena, J., Baunthiyal, M., & Ravi, I. (2015). *Laboratory manual of microbiology, biochemistry and molecular biology,* Scientific Publishers.
7. Bartzatt, R., & Wol, T. (2014). Detection and assay of vitamin B-12 (riboflavin) in alkaline borate buffer with UV/visible spectrophotometry. International Scholarly Research Notices, 2014, Article 453085.

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive Discussions, seminars, assignments, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MB-MJ-1004 (BKS): TRADITIONAL PRACTICES IN MICROBIOLOGY

<table>
<tr><td>Program Name</td><td>M.Sc.</td></tr>
<tr><td>Semester</td><td>M. Sc. SEM 1</td></tr>
<tr><td>Credit Level</td><td>6.0</td></tr>
<tr><td>Course Type</td><td>MAJOR</td></tr>
<tr><td>Course Subtype</td><td>MAJOR 4</td></tr>
<tr><td>Subject Type</td><td>Faculty of Science- Microbiology</td></tr>
<tr><td>Course Code</td><td>MB-MJ-1004</td></tr>
<tr><td>Course Level</td><td>500-599</td></tr>
<tr><td>Course Title</td><td>Traditional practices in Microbiology</td></tr>
<tr><td>Credit</td><td>04 (60 Hours)</td></tr>
<tr><td>Effective From</td><td>Academic year: 2026-27</td></tr>
<tr><td>Course Outcomes (COs)</td><td>Course Outcomes (COs)
Upon successful completion of this course, the students will be able to:
CO1: Explain the historical development of microbiology, traditional knowledge systems and the contributions of ancient civilizations and Indian scholars to microbiological sciences. (K2 – Understand)
CO2: Apply the principles of microbial fermentation to understand the scientific basis of traditional fermented foods, beverages and indigenous fermentation practices. (K3 – Apply)
CO3: Analyze traditional food preservation methods, ethnomedicinal practices and natural antimicrobial agents in relation to microbial growth control, food safety and human health. (K4 – Analyze)
CO4: Evaluate traditional agricultural microbiological practices, including biofertilizers, biopesticides, composting and Panchagavya, for sustainable agriculture and environmental management. (K5 – Evaluate)
CO5: Assess the relevance of traditional microbiological knowledge in modern biotechnology, microbiome research, bioprospecting, intellectual property rights and ethical applications. (K5 – Evaluate)</td></tr>
<tr><td>Mapping between COs and PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th><th>PSO7</th><th>PSO8</th></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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Course content	
UNIT 1: HISTORICAL PERSPECTIVES & INDIGENOUS KNOWLEDGE IN MICROBIOLOGY	
1.1	History of microbiology: from ancient traditional practices to modern science
1.2	Role of microorganisms in ancient civilizations: Vedic, Egyptian, Mesopotamian perspectives
1.3	Traditional Indian practices and their microbial connections (Ayurveda, Siddha, Unani)
1.4	Contributions of Indian scholars (Jagadish Chandra Bose, Birbal Sahni) to microbiology
1.5	Ethnomicrobiology: definition, scope, and significance and Documentation and preservation of traditional microbiological knowledge
UNIT 2: TRADITIONAL FERMENTATION PRACTICES	
2.1	Principles of fermentation: aerobic vs. anaerobic, homo- and hetero-fermentation
2.2	Traditional fermented foods of India: Idli, Dosa, Dhokla, Jalebi, Kanji, Ambali, and Fermented dairy products: Dahi (curd), Lassi, Shrikhand, Paneer, Buttermilk
2.3	Traditional beverages: Toddy, Rice beer (Handia), Mahua wine, Neera, and Traditional fermented foods of tribal communities in Gujarat and India
2.4	Vinegar production: traditional methods
2.5	Quality, safety, and nutritional aspects of traditionally fermented products and Comparison of traditional vs. industrial fermentation processes
UNIT 3: TRADITIONAL FOOD PRESERVATION, NATURAL ANTIMICROBIALS	
3.1	Ancient and traditional methods of food preservation: sun-drying, salting, pickling and smoking
3.2	Microbiological basis of food spoilage and preservation techniques; Traditional Indian pickles (Achaar), Murabba and Papad: microbiology and role of spices
3.3	Ethnomedicinal plants with antimicrobial properties: Aloe vera, Garlic, Neem and Tulsi
3.4	Traditional wound-healing practices and antimicrobial significance; Use of honey, ghee and herbal oils as traditional antimicrobial agents
3.5	Phytochemicals and their mode of antimicrobial action;
3.6	Modern scientific validation of traditional antimicrobial agents (evidence-based approach)
UNIT 4: TRADITIONAL AGRICULTURAL MICROBIOLOGY & MODERN RELEVANCE	
4.1	Traditional soil enrichment practices: green manuring, crop rotation, mixed cropping and Traditional composting: Nadep, Vermicomposting, Pit composting – microbiological basis
4.2	Indigenous biofertilizer knowledge: Rhizobium inoculation, Azolla-Anabaena, Blue-Green Algae, and Traditional biopesticide practices: Panchagavya, Dashparni Ark, Brahmastra

4.3	Cow-based microbiological practices (Panchagavya): scientific validation and applications
4.4	Role of traditional practices in sustainable agriculture and organic farming
4.5	Integration of traditional microbiological knowledge into modern biotechnology, Bioprospecting of traditional practices: IPR issues and ethical considerations, Future perspectives: blending ethnomicrobiology with modern microbiome research

References

1. Pelczar, M.J., Chan, E.C.S. and Krieg, N.R. (2010). Microbiology: An Application Based Approach. Tata McGraw-Hill, New Delhi.
2. Prescott, L.M., Harley, J.P. and Klein, D.A. (2008). Microbiology (7th Ed.). McGraw-Hill Higher Education, New York.
3. Madigan, M.T., Martinko, J.M. and Brock, T.D. (2015). Brock Biology of Microorganisms (14th Ed.). Pearson Education.
4. Tortora, G.J., Funke, B.R. and Case, C.L. (2013). Microbiology: An Introduction (11th Ed.) Benjamin Cummings.
5. Campbell, I. and Plumbly, H. (2009). Fermentation Biotechnology: Principles, Processes and Products. Elsevier.
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7. Steinkraus, K.H. (1995). Handbook of Indigenous Fermented Foods (2nd Ed.). Marcel Dekker, New York.
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12. Science History and Culture, Editor Jyoti Prakash Tamang, Springer, ISBN 978-981-15-1485-2, ISBN 978-981-15-1486-9 (eBook)
13. Fermented Foods and Beverages of the World, edited by Jyoti Prakash Tamang and Kasipathy Kailasapathy, CRC Press, ISBN 978-1-4200-9495-4

Online reference

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https://niscair.res.in
https://www.icmr.gov.in
https://www.tkdl.res.in
https://www.youtube.com/watch?v=HnQE80P4OaY
https://www.youtube.com/watch?v=RzGd1uFMYb Y

Ethnobiology: Unveiling Indigenous Wisdom of Nature | Science Pulse
What Is Fermentation and How Does It Work? |
Successful Fermentation Tips | Esco Lifesciences
Traditional fermented foods of India (Cereal and Legume Based)
The Science of Fermentation - 9 Minutes Microlearning
Lactic Acid Bacteria and Fermented Foods: Benefits– Dr.Berg
The Science of Dahi: How Lactobacillus Transforms Milk into Curd
Ancient Food Preservation Methods: How People Kept Food Safe in 4000 BC |
History Pulse – YouTube Which Spices Kill Bacteria?
Ayurvedic Medicinal Plants and Uses | Medicinal Plants Name | Ancient Medicinal Plants in India
Maybelline New York Colossal Bubble | 20s
Kheti और Pashupalan में उपयोगी Panchagavya (पंचगव्य) | कैसे बनाते है Panchagavya (पंचगव्य) ?
Sustainable Agriculture, Organic Farming, Biofertilizer, Vermicomposting |Kinjal Choudhary

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Evaluation scheme

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MB-MDC- 1005 BIONANOTECHNOLOGY

<table>
<tr><td>Program Name</td><td>M. Sc.</td></tr>
<tr><td>Semester</td><td>M. Sc. SEM 1</td></tr>
<tr><td>Credit Level</td><td>6</td></tr>
<tr><td>Course Type</td><td>Multidisciplinary Course (MDC)</td></tr>
<tr><td>Course Subtype</td><td>MDC 1</td></tr>
<tr><td>Subject Type</td><td>Faculty of Science- Microbiology</td></tr>
<tr><td>Course Code</td><td>MB 1005</td></tr>
<tr><td>Course Level</td><td>500-599</td></tr>
<tr><td>Course Title</td><td>Bionanotechnology</td></tr>
<tr><td>Credit</td><td>04 (60 Hours)</td></tr>
<tr><td>Effective From</td><td>Academic year: 2026-27</td></tr>
<tr><td>Course Outcomes (COs)</td><td>Course Outcomes (COs)
Upon successful completion of this course, the students will be able to:
CO1: Explain the fundamental concepts of nanoscience, nanotechnology, nanomaterials and biological nanomachines, including their structure, properties and significance in biological systems. (K2 – Understand)
CO2: Apply the principles of nanoparticle synthesis, self-assembly and nanomaterial fabrication through physical, chemical and biological approaches. (K3 – Apply)
CO3: Analyze the working principles and applications of advanced characterization techniques used for nanomaterial analysis, including microscopy, diffraction and spectroscopic methods. (K4 – Analyze)
CO4: Evaluate the design, structure and functions of molecular nanodevices, DNA nanostructures and protein-based nanomachines for nanotechnological applications. (K5 – Evaluate)
CO5: Assess the applications of bionanotechnology in medicine, drug delivery, diagnostics, tissue engineering, agriculture, food technology and other emerging interdisciplinary fields. (K5 – Evaluate)</td></tr>
<tr><td>Mapping between COs and PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th><th>PSO7</th><th>PSO8</th></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>CO5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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Course Content	
Unit 1: Fundamentals of Nanoscience and Biological Nanomachines	
1.1	Introduction to Nano-word: Nano, Nanometer; Nanoscience, Nanotechnology and Historical perspectives of nanotechnology
1.2	Types of Nanomaterials and Properties of Nanomaterials
1.3	Some Special Nanomaterials: Carbon Nanomaterials, Porous Material, Aerogels, Metamaterials and Bioinspired Materials
1.4	Introduction to Fundamentals of Bio Nanotechnology and In the Dominion of Biological machines
1.5	Nanomotors of Biological Systems: ATP Synthase and Flagellar Motors in Bacteria
Unit 2: Synthesis and Self-Assembly of Nanomaterials	
2.1	Approaches for Synthesis of Nanoparticles: Bottom-up & Top-down, Techniques for Synthesis of Nanostructures: Gas-, liquid- and solid-phase synthesis
2.2	Physical methods for nanomaterials synthesis
2.3	Chemical methods for nanomaterials synthesis
2.4	Biological methods for nanomaterials synthesis
2.5	Self-Assembly of Nanomaterials
Unit 3: Characterization Techniques in Nanotechnology	
3.1	Electron Microscopes: SEM and TEM
3.2	Scanning Probe Microscopes: STM and AFM
3.3	Diffraction Techniques: XRD and DLS
3.4	Spectroscopies: Optical Absorption, UV-Vis-NIR, Infra-Red & Dispersive Infra-Red, FTIR, Raman Spectroscopy
3.5	Magnetic Measurements and Mechanical Measurements
Unit 4: Molecular Nanotechnology and Applications of Bionanotechnology (15 Hours)	
4.1	Application of DNA Nanostructures in Molecular Nanotechnology: DNA-Based nanodevices i.e, B-Z Transition, Tweezers, Actuators, Scissors
4.2	Protein Nanomachines and protein nanoarchitectures i.e. Protein Cages, Rings, Tubes, Protein Nanostructure application i.e. as a data storage, FETs, VLP motors
4.3	Biomimicry at the nanoscale - nanomaterials inspired by nature
4.4	Applications of Carbon nanotubes in Diagnostic equipment; Surgical Supplements; Tissue Engineering; Gene Delivery, and Anticarcinogenic Activity; Drug Delivery; Neurodegenerative Disorder Therapy using Carbon Nanomaterials
4.5	Nanosizing Approaches in Drug Delivery (Bawa) and application of nanotechnology in Food, Agriculture and cosmetics

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1. Sharon, M., Sharon, M., & Pandey 2013, Bionanotechnology concept and application, Ane Books, Pvt. Ltd. ISBN: 978-93-8116-236-1
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3. Kulkarni, S. K. (2015). *Nanotechnology: Principles and practices* (3rd ed.). Springer. ISBN 978-3-319-09170-9
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https://www.youtube.com/watch?v=evE08ycZfnM
https://www.youtube.com/watch?v=YhuUFLzJSsg
https://www.youtube.com/watch?v=tfn7Nn4jPxo
https://www.youtube.com/watch?v=Z51R49OOqAA
https://en.wikipedia.org/wiki/Characterization_of_nanoparticles

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Evaluation scheme

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MB-SEC-1006: EPIDEMIOLOGY

Program Name	**M. Sc.**
Semester	**M. Sc SEM 1**
Credit Level	**6.5**
Course Type	**Skill Enhancement Course (SEC)**
Course Subtype	**MB-SEC-1006**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MB-SEC-1006**
Course Level	**500-599**
Course Title	**Epidemiology**
Credit	02 (30 Hours)
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	**Course Outcomes (COs)** Upon successful completion of this course, the students will be able to: **CO1:** Explain the fundamental principles, concepts and methodologies of epidemiology, including disease causation, transmission dynamics, epidemiological triad, chain of infection and disease surveillance. **(K2 – Understand)** **CO2:** Apply epidemiological measures, study designs and screening approaches to investigate disease occurrence, distribution and determinants in populations. **(K3 – Apply)** **CO3:** Analyze epidemiological data related to incidence, prevalence, morbidity, mortality, outbreaks and epidemics for evidence-based public health decision-making. **(K4 – Analyze)** **CO4:** Evaluate the epidemiology of emerging and re-emerging infectious diseases, public health interventions and risk assessment strategies for disease prevention and control. **(K5 – Evaluate)** **CO5:** Assess the roles of national and international health organizations, surveillance systems and public health infrastructure in strengthening community health and disease management. **(K5 – Evaluate)**
Mapping between COs and PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	■					■		
CO2	■			■		■		
CO3	■		■	■		■		■
CO4	■	■			■	■		■
CO5		■				■	■	■

Course Content	
Unit 1: Principles of Epidemiology and Disease Dynamics	
1.1	Introduction to Epidemiology: Definition, scope objectives, historical development of epidemiology, epidemiological triad
1.2	Epidemiological Concepts: Chain of infection, Natural History, Iceberg Concept
1.3	Epidemiological Study Designs: Descriptive epidemiology, analytical epidemiology, experimental/interventional studies
1.4	Screening and Surveillance: Screening methods, sensitivity and specificity, predictive values, surveillance systems, disease prevention strategies
1.5	Immunoepidemiology: Herd immunity and basic immunoepidemiology
UNIT 2: Public Health Epidemiology and Disease Investigation	
2.1	Disease Occurrence and Frequency: Incidence and prevalence, morbidity and mortality indicators, attack rate and case fatality rate
2.2	Outbreak Investigation and Epidemic Analysis: Outbreaks and epidemics, outbreak investigation, epidemic curves, transmission dynamics, evidence for causation, and risk assessment.
2.3	Emerging and Re-emerging Infectious Diseases: Emerging pathogens, pandemic outbreaks
2.4	Emerging Challenges and Opportunities in Infectious Disease Epidemiology
2.5	Public Health and Community Health: Definition and scope of public health, origin and development, community health programs and public health functions
2.6	Public Health Interventions: Public health, epidemiology and ecological constrains
2.7	Health Organizations and Public Health Infrastructure: WHO, CDC, ICMR, NCDC, IDSP and public health infrastructure in India

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1. Bonita R, Beaglehole R., & Kjellstrom T. (2006). Basic Epidemiology, 2nd edition, Geneva: World Health Organization.
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3. David Celentano & Moyses Szklo. Gordis Epidemiology, 6th edition, Elseveir.
4. Principles of Epidemiology in public health practice, 3rd edition. U.S. Department of health and human services. Centers for disease control and prevention.
5. Bhopal, RS. (2002). Concepts of Epidemiology: An Integrated Introduction to the Ideas, Theories, Principles and Methods of Epidemiology. Oxford: Oxford University Press
6. R. & Ranganathan, P. (2009). Study designs: Part 4–Interventional studies. Perspect Clin Res, 10:137-139.
7. Park, K. (2013) Park's textbook of Preventive and Social Medicine. Jabalpur: Bhanot Publishers.
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9. Willey J., Sandman K., and Wood D., (2023), Prescott's Microbiology, 12th edition, Mc Graw Hill Publishers
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13. Park, K. (2013) Park's textbook of Preventive and Social Medicine. Jabalpur: Bhanot Publishers.
14. Chokshi, M., Patil, B., Khanna, R., Neogi, S. B., Sharma, J., Paul, V. K., & Zodpey, S. (2016). Health systems in India. Journal of Perinatology, 36(3), S9-S12.

Online reference

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https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_hs82
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https://www.who.int/teams/global-hiv-hepatitis-and-stis-programmes/covid-19
https://www.youtube.com/watch?v=CM5mJKqWLxc
https://www.youtube.com/watch?v=4oaQUAnA6nY
https://www.youtube.com/watch?v=82_gxpFx9xk

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Evaluation scheme

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MB-SEC-1006: SWAYAM MOOC: Provided from the SWAYAM/ NPTEL of 2 credits

This course requirement is fulfilled through a 2-credit Massive Open Online Course (MOOC) provided via the SWAYAM/NPTEL platform. Students will complete the designated online curriculum and earn academic credits upon successful assessment.

STRUCTURE FOR ERP – M.Sc. MICROBIOLOGY – SEM – 2 ONLY COURSE WORK AND ONE SEMESTER RESEARCH																	
Course Category	Course Code	Course Title	Mark sheet Title in English	Level of Course	Teaching Hours/Week		Exam Duration (Hours)		Credit		Internal Marks		External Marks		Total	
					TH	PR	TH	PR	TH	PR	TH	PR	TH	PR	TH	PR
MAJOR 1	MB – 2001	MOLECULAR BIOLOGY AND GENOME ENGINEERING	MOLECULAR BIOLOGY AND GENOME ENGINEERING	500-599	02	04	01.00	06.00	02	02	25	25	25	25	50	50
MAJOR 2	MB – 2002	ENVIRONMENTAL MICROBIOLOGY	ENVIRONMENTAL MICROBIOLOGY	500-599	02	04	01.00	06.00	02	02	25	25	25	25	50	50
MAJOR 3	MB – 2003	BIOPROCESS AND FERMENTATION TECHNOLOGY	BIOPROCESS AND FERMENTATION TECHNOLOGY	500-599	02	04	01.00	06.00	02	02	25	25	25	25	50	50
MAJOR 4	MB-2004 BKS	BIOPHYSICS ANALYTICAL BIOCHEMISTRY AND INSTRUMENTATION	BIOPHYSICS ANALYTICAL BIOCHEMISTRY AND INSTRUMENTATION	500-599	04	00	02.00	00	04	-	50	-	50	-	100	-
ME	MB-ME-2005	MICROBIAL BIOINFORMATICS AND OMICS TECHNOLOGIES/ENTERPRENEURSHIP	MICROBIAL BIOINFORMATICS AND OMICS TECHNOLOGIES/ ENTERPRENEURSHIP	500-599	04	00	02.00	00	04	-	50	-	50	-	100	-
SEC	MB-2006	BIOINOCULANTS AND ORGANIC FARMING/ SWAYAM MOOC/RESEARCH METHODOLOGY -2	BIOINOCULANTS AND ORGANIC FARMING/ SWAYAM MOOC/ RESEARCH METHODOLOGY -2	500-599	02	00	00	00	02	-	25	-	25	-	50	-

MB-MJ- 2001: MOLECULAR BIOLOGY AND GENOME ENGINEERING

Program Name	**M.Sc.**
Semester	**M. Sc SEM 2**
NCrF Credit Level	**6.0**
Course Type	**MAJOR**
Course Subtype	**MAJOR 1**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MB-MJ- 2001**
Course Level	**500–599**
Course Title	**Molecular Biology And Genome Engineering**
Credit	**02 (30 Hours)**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs):	Upon successful completion of this course, the students will be able to: **CO1:** Explain the principles of DNA isolation, DNA manipulation, restriction enzymes, ligation, gene transfer techniques and recombinant DNA technology used in genetic engineering. (K2 – Understand) **CO2:** Apply cloning strategies using plasmid, bacteriophage, cosmid, phasmid and expression vectors for construction, screening and expression of recombinant DNA libraries. (K3 – Apply) **CO3:** Analyse methods for gene expression regulation, recombinant selection and library screening in prokaryotic and eukaryotic systems. (K4 – Analyse) **CO4:** Evaluate protein-engineering approaches including directed evolution, site-directed mutagenesis, molecular simulations and protein microarray technologies for modifying protein structure and function. (K5 – Evaluate) **CO5:** Assess the applications of genome editing technologies, particularly CRISPR-Cas systems, in microbial biotechnology, healthcare, agriculture and industrial research. (K5 – Evaluate)
Mapping between COs and PSOs	

	PSO1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO-1	■	■	■					
CO-2	■	■	■					■
CO-3	■		■					■
CO-4	■		■	■				■
CO-5		■	■	■				■

Course Content	
Unit 1 Genetic Engineering	
1.1	Preparation of total cell DNA, plasmid and bacteriophage DNA
1.2	DNA manipulative enzymes and restriction endonucleases, Ligation - joining DNA molecules
1.3	Uptake of DNA by bacterial cells and Identification of recombinants
1.4	Introduction of phage DNA into bacterial cells and non-bacterial cells
1.5	Cloning vectors based on E. coli plasmids, λ bacteriophage, vectors for synthesis of single-stranded DNA
1.6	Vectors for yeast, fungi, higher plants and for animals
1.7	Cosmids, phasmids, other advanced vectors, Expression vectors
1.8	Screening and differential screening strategies available for library screening, Manipulation of Gene Expression in Prokaryotes
Unit 2 : Protein Engineering and Genome Editing Technologies	
2.1	Introduction of Protein Structure and function
2.2	Concepts for Protein Engineering
2.3	Computer Simulations: A Tool for Investigating the Function of Complex Biological Macromolecules
2.4	Evolutionary Methods for Protein Engineering (Methods for the directed evolution of proteins)
2.5	Directed Mutagenesis Procedures and Protein Engineering in various enzymes
2.6	DNA and Protein Microarray technology
2.7	CRISPR-Cas9 genome editing

Reference

1. Brown, T. A. (2021). *Gene cloning and DNA analysis: An introduction* (8th ed.). Wiley-Blackwell. ISBN 9781119640783
2. Reece, R. J. (2004). *Analysis of genes and genomes*. John Wiley & Sons.
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11. Li, T., Yang, Y., Qi, H., Cui, W., Zhang, L., Fu, X., He, X., Liu, M., Li, P.-F., & Yu, T. (2023). CRISPR/Cas9 therapeutics: Progress and prospects. *Signal Transduction and Targeted Therapy*, *8*(1), Article 36. https://doi.org/10.1038/s41392-023-01309-7
12. Rastogi, S., & Pathak, N. (2009). *Genetic engineering*. Oxford University Press, ISBN: 978-0195696578

Online Resources

1. NCBI – https://www.ncbi.nlm.nih.gov
2. Addgene – https://www.addgene.org
3. DNA Learning Center (CSHL) – https://dnalc.cshl.edu
4. EMBL-EBI – https://www.ebi.ac.uk
5. Protein Data Bank (PDB) – https://www.rcsb.org
6. UniProt – https://www.uniprot.org
7. AlphaFold Protein Structure Database – https://alphafold.ebi.ac.uk
8. Broad Institute CRISPR Resources – https://www.broadinstitute.org/what-broad/areas-focus/project-spotlight/crispr
9. NPTEL – https://nptel.ac.in
10. SWAYAM – https://swayam.gov.in
11. SWAYAM Plus- https://swayam-plus.swayam2.ac.in/

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MBP-MJ- 2001 Molecular Biology and Genome Engineering (Practical)

<table>
<tr><td>Program Name</td><td>M.Sc.</td></tr>
<tr><td>Semester</td><td>M. Sc SEM 2</td></tr>
<tr><td>Credit Level</td><td>6.0</td></tr>
<tr><td>Course Type</td><td>MAJOR</td></tr>
<tr><td>Course Subtype</td><td>MAJOR PRACTICAL 1</td></tr>
<tr><td>Subject Type</td><td>Faculty of Science- Microbiology</td></tr>
<tr><td>Course Code</td><td>MBP-MJ- 2001</td></tr>
<tr><td>Course Level</td><td>500–599</td></tr>
<tr><td>Course Title</td><td>Molecular Biology and Genome Engineering (Practical)</td></tr>
<tr><td>Credit</td><td>02 (30 Hours)</td></tr>
<tr><td>Effective From</td><td>Academic year: 2026-27</td></tr>
<tr><td>Course Outcomes (COs)</td><td>Upon completion of this practical course, the students will be able to
CO1: Perform fundamental molecular biology techniques including restriction digestion, DNA ligation, PCR amplification, and site-directed mutagenesis for genetic manipulation. (K3 – Apply)
CO2: Execute protein extraction, quantification, folding, and denaturation and renaturation experiments and interpret the relationship between protein structure and function. (K3 – Apply)
CO3: Apply bioinformatics tools for primer design, open reading frame identification, protein structure prediction and homology modelling. (K3 – Apply)
CO4: Analyze and visualize protein structures and evaluate computational approaches for protein engineering and functional prediction. (K4 – Analyze)
CO5: Utilize genome editing and computational biology tools including CRISPR-Cas9 guide RNA design for solving biological and biotechnological problems. (K4 – Analyze)</td></tr>
<tr><td>Mapping between COs and PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO 2</th><th>PSO 3</th><th>PSO 4</th><th>PSO 5</th><th>PSO 6</th><th>PSO 7</th><th>PSO 8</th></tr>
<tr><td>CO-1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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Course Content

I. Wet Lab. Exercise

1. Restriction digestion of DNA/ plasmid using restriction endonuclease
2. Ligation of DNA molecules
3. In vitro amplification of DNA by PCR
4. PCR Mediated Site Directed mutagenesis
5. Protein extraction from bacterial cells and estimation by Bradford/Lowry assay
6. Protein folding- denaturation and renaturation by Urea method

II. Dry Lab. Exercise

7. Primer Designing for PCR
8. Protein secondary structure prediction.
9. Homology modelling
10. Retrieval, analysis and visualization of protein structure
11. Open Reading Frame Finder
12. CRISPR-Cas9 Guide RNA Design by CHOPCHOP

Reference

1. Sambrook, J., & Russell, D. W. (2001). *Molecular cloning: A laboratory manual* (3rd ed.). Cold Spring Harbor Laboratory Press.
2. Green, M. R., & Sambrook, J. (2019). *Molecular Cloning: A Laboratory Manual* (4th ed.). Cold Spring Harbor Laboratory Press.
3. Brown, T. A. (2020). *Gene Cloning and DNA Analysis: An Introduction* (8th ed.). Wiley-Blackwell.
4. Walker, J. M. (Ed.). (2009). *The Protein Protocols Handbook* (3rd ed.). Humana Press.
5. Cappuccino, J. G., & Welsh, C. (2018). Microbiology: A laboratory manual (11th global ed.). Pearson Education Limited.
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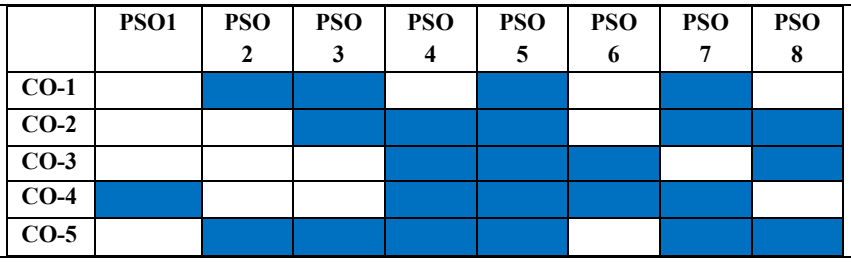
8. Aneja, K. R., Experiments in Microbiology 4thed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.
9. Saxena, J., Baunthiyal, M., & Ravi, I. (2015). *Laboratory manual of microbiology, biochemistry and molecular biology,* Scientific Publishers.
10. Bossi, Camilli, Grundl, Experiments in Bacterial Genetics: A Laboratory Manual, Cold Spring Harbor Laboratory Press, 2023, ISBN 978-1621824497
11. Tiwari, R. P., Hoondal, G. S., & Tewari, R. (2004). *Laboratory techniques in microbiology & biotechnology* (1st ed.). Abhishek Publications ISBN 81-8247-077-3
12. Baxevanis, A. D., & Ouellette, B. F. F. (Eds.). (2005). Bioinformatics: A practical guide to the analysis of genes and proteins (3rd ed.). Wiley-Interscience.
13. Mount, D. W. (2021). *Bioinformatics: Sequence and Genome Analysis* (5th ed.). Cold Spring Harbor Laboratory Press.
14. Lesk, A. M. (2019). *Introduction to Bioinformatics* (5th ed.). Oxford University Press.

Online Resources

1. Addgene Protocols – https://www.addgene.org/protocols/
2. New England Biolabs (NEB) Protocols and Tools – https://www.neb.com
3. Benchling Molecular Biology Platform – https://www.benchling.com
4. SnapGene Molecular Biology Resources – https://www.snapgene.com
5. NCBI BLAST and ORF Finder – https://www.ncbi.nlm.nih.gov
6. Primer3 for Primer Design – https://primer3.ut.ee
7. ExPASy Bioinformatics Resource Portal – https://www.expasy.org

8. SWISS-MODEL Homology Modelling Server – https://swissmodel.expasy.org 9. RCSB Protein Data Bank (PDB) – https://www.rcsb.org 10. AlphaFold Protein Structure Database – https://alphafold.ebi.ac.uk 11. CHOPCHOP CRISPR Design Tool – https://chopchop.cbu.uib.no 12. EMBL-EBI Training Portal – https://www.ebi.ac.uk/training
Teaching Methodology
The teaching methodology will involve laboratory experiments, and practical demonstrations to facilitate comprehensive experimental understanding of the subject.
Distribution of Marks
50% CCE: Internal assessment based on internal examination 50% SEE: External assessment based on semester-end university examination.

MB-MJ-2002: Environmental Microbiology

Program Name	**M.Sc.**
Semester	**M. Sc. SEM 2**
Credit Level	**6.0**
Course Type	**MAJOR**
Course Subtype	**MAJOR 2**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MB-MJ-2002**
Course Level	**500-599**
Course Title	**Environmental Microbiology**
Credit	**02 (30 Hours)**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	Upon completion of this practical course, the students will be able to **CO1:** Explain the principles and mechanisms involved in microbial degradation of organic and inorganic pollutants, waste treatment processes and environmental bioremediation technologies for sustainable environmental management. (K2) **CO2:** Analyze microbial processes involved in biofuel production, waste valorization, renewable bioenergy generation and circular bioeconomy applications. (K4) **CO3:** Evaluate environmental risks associated with GMOs, biosafety issues, environmental regulations and microbial threats in relation to environmental protection and public health. (K5) **CO4:** Assess the role of microorganisms in climate change mitigation, antimicrobial resistance dissemination, One Health approaches and ecosystem sustainability. (K5) **CO5:** Apply microbiological and biotechnological approaches for resource recovery, environmental restoration, sustainable agriculture and innovative environmental solutions. (K3)
Mapping between COs and PSOs	

Course Content	
Unit 1 : Bioremediation and Environmental Waste Management Technologies	
1.1	Degradation of hydrocarbons, Chlorinated Hydrocarbons and Aromatics, and Dioxins
1.2	Degradation of Xenobiotics Pesticides, Polymer and dye
1.3	Bioremediation with Inorganic Pollutants
1.4	Treatment of Waste from Organic Chemical Industries
1.5	Treatment of Waste from Food and Dairy Industries, Sugar and Distillery
1.6	Waste, Paper and Pulp industries
1.7	Pharmaceuticals and Hospital Waste Treatment
1.8	Treatment and management of Solid Waste, Treatment of Municipal Waste Insight of biofuel prospects From microalgae as Renewable energy source for Environmental sustainability
Unit 2 : Bioenergy, One Health and Sustainable Environmental Biotechnology	
2.1	Biodiesel, Transesterification for biodiesel, Biomethane and Biohydrogen
2.2	Conversion of Waste to Biofuels, Bioproducts, and Bioenergy
2.3	Cellulosic Ethanol Technology
2.4	Microbial Solutions for Climate Change Toward an Economically Resilient
2.5	Future, An Introduction to Sustainable Circular Bioeconomy,
2.6	Environmental risk assessment, biosafety, GMO release and environmental regulations. Microorganisms and Bioterrorism
2.7	A One-Health Perspective of Antimicrobial Resistance: Human, Animals and Environmental Health, The One Health resistome Microbially Induced Calcium Carbonate Precipitation (MICP) and Its Potential in Bioconcrete: Microbiological and Molecular Concepts

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1. Barton, L. L., & Northup, D. E. (2011). Microbial ecology. John Wiley & Sons.
2. Doble, M. & Anil kumar. (2005). Biotreatment of industrial effluents. Butterworth Heinemannan imprint of Elsevier. (ISBN; 9780080456218)
3. Maddela, N. R., Eller, L. K. W., & Prasad, R. (Eds.). (2023). Microbiology for cleaner production and environmental sustainability. CRC Press.
4. Patwardhan, A. D. (2008). Industrial waste water treatment. PHI Learning.
5. Sangeetha, J., Thangadurai, D., David, M., & Abdullah, M. A. (Eds.). (2016). Environmental biotechnology: Biodegradation, bioremediation, and bioconversion of xenobiotics for sustainable development. Apple Academic Press.
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8. Evans, G. M., & Furlong, J. C. (2010). Environmental biotechnology: Theory and application (2nd ed.). Wiley-Blackwell.
9. Singh, V. (Ed.). (2025). Sustainable waste management towards circular bioeconomy: Components, design innovation and impact. Springer.

10. American Society for Microbiology, & International Union for Microbiological Societies. (2025). Microbial solutions for climate change: Toward an economically resilient future. ASM Reports. https://asm.org/reports/microbial-solutions-for-climate-change
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13. Al-Khalaifah, H.; Rahman, M.H.; Al-Surrayai, T.; Al-Dhumair, A.; Al-Hasan, M. A One-Health Perspective of Antimicrobial Resistance (AMR): Human, Animals and Environmental Health. Life 2025, 15, 1598. https://doi.org/10.3390/ life15101598
14. Majumdar, A., Bagchi, D., Kotta-Loizou, I., & Buck, M. (2026). The One Health resistome: Integrating environmental, microbial, and human antimicrobial resistance surveillance and risk analysis in the digital age. Journal of Hazardous Materials, 513, Article 142431.
15. Castro-Alonso, M. J., Montañez-Hernandez, L. E., Sanchez-Muñoz, M. A., Macias Franco, M. R., Narayanasamy, R., & Balagurusamy, N. (2019). Microbially induced calcium carbonate precipitation (MICP) and its potential in bioconcrete: Microbiological and molecular concepts. Frontiers in Materials, 6, Article 126.

Online resources

1. SWAYAM https://swayam.gov.in
2. NPTEL https://nptel.ac.in
3. World Health Organization (WHO) https://www.who.int
4. Food and Agriculture Organization (FAO) https://www.fao.org
5. United Nations Environment Programme (UNEP) https://www.unep.org
6. Bioremediation and biodegradation [https://youtu.be/OskyBh4MDy4?si=i-mD149KV2FdpOw0]
7. Biodegradation of pesticides [https://youtu.be/tffTDCnuvwY?si=rqeiVGzYOIhKo5wB]
8. Biodegradation of heavy metals [https://youtu.be/nO21I-UvA9I?si=Po7mWIuCxOZPj5Js]
9. Biodegradation[https://youtu.be/qhqlLZKhsYQ?si=UKsVtqnvCwnFtzZD]
10. https://frtr.gov/matrix/documents/Monitored-Natural-Attenuation/2006-In-Situ-and-Ex-Situ-Biodegradation-Technologies-for-Remediation-of-Contaminated-Sites.PDF

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MBP-MJ-2002: Environmental Microbiology Practical

<table>
<tr><td>Program Name</td><td>M.Sc.</td></tr>
<tr><td>Semester</td><td>M. Sc. SEM 2</td></tr>
<tr><td>Credit Level</td><td>6.0</td></tr>
<tr><td>Course Type</td><td>MAJOR</td></tr>
<tr><td>Course Subtype</td><td>MAJOR Practical 2</td></tr>
<tr><td>Subject Type</td><td>Faculty of Science- Microbiology</td></tr>
<tr><td>Course Code</td><td>MBP-MJ-2002</td></tr>
<tr><td>Course Level</td><td>500-599</td></tr>
<tr><td>Course Title</td><td>Environmental Microbiology Practical</td></tr>
<tr><td>Credit</td><td>02 (30 Hours)</td></tr>
<tr><td>Effective From</td><td>Academic year: 2026-27</td></tr>
<tr><td>Course Outcomes (COs)</td><td>Upon completion of this practical course, the students will be able to
CO1: Perform laboratory techniques for assessment of microbial tolerance to environmental pollutants, biodegradation of xenobiotics and evaluation of microbial remediation potential. (K3)
CO2: Analyze environmental quality parameters and microbial indicators using BOD, COD and antimicrobial susceptibility testing for environmental monitoring and public health assessment. (K4)
CO3: Isolate, characterize and evaluate environmentally significant microorganisms including microalgae and pollutant-degrading microbial communities. (K4)
CO4: Apply computational tools for community metagenomic analysis to assess microbial diversity, community structure and ecological functions in environmental samples. (K3)
CO5: Interpret functional metagenomic datasets to identify metabolic pathways, biodegradation potential and environmental applications of microbial communities. (K5)</td></tr>
<tr><td>Mapping between COs and PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO 2</th><th>PSO 3</th><th>PSO 4</th><th>PSO 5</th><th>PSO 6</th><th>PSO 7</th><th>PSO 8</th></tr>
<tr><td>CO-1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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</td></tr>
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Course Content

1. Study of heavy metal tolerance by environmental microorganisms.
2. Pesticide tolerance assay of environmental microorganisms.
3. Biodegradation of pesticide by microbial isolates.
4. Microbial degradation of synthetic dyes (methylene blue/crystal violet) and evaluation of decolourization efficiency.
5. Estimation of Biochemical Oxygen Demand (BOD).
6. Estimation of Chemical Oxygen Demand (COD).
7. Isolation and characterization of microalgae from environmental samples.
8. Antibiotic susceptibility testing of environmental isolates
9. Computational analysis of Community metagenomics
10. Computational analysis of Functional metagenomics

References:

1. Ian L. Pepper, Charles P. Gerba, Terry J. Gentry, Environmental Microbiology: A Laboratory Manual, 2nd Ed. Academic Press
2. Glazer Alexander N., Nikaido Hiroshi, Microbial Biotechnology: Fundamentals of Applied Microbiology, 2nd Edition, Cambridge University Press
3. Agathos Spiros and Reineke Walter, Biotechnology for the Environment: Strategy and Fundamentals, Series: Advances in Biochemical Engineering/Biotechnology, Vol. 81, Springer.
4. Cappuccino, J. G., & Welsh, C. (2018). Microbiology: A laboratory manual (11th global ed.). Pearson Education Limited.
5. Bisen, P. S. (2014). *Laboratory protocols in applied life sciences*. CRC Press.
6. Alexander, S. K., Strete, D., & Niles, M. J. (2003). *Laboratory exercises in organismal and molecular microbiology*. McGraw-Hill Higher Education
7. Aneja, K. R., Experiments in Microbiology 4thed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.
8. Saxena, J., Baunthiyal, M., & Ravi, I. (2015). *Laboratory manual of microbiology, biochemistry and molecular biology,* Scientific Publishers.
9. Bossi, Camilli, Grundl, Experiments in Bacterial Genetics: A Laboratory Manual, Cold Spring Harbor Laboratory Press, 2023, ISBN 978-1621824497
10. Tiwari, R. P., Hoondal, G. S., & Tewari, R. (2004). *Laboratory techniques in microbiology & biotechnology* (1st ed.). Abhishek Publications ISBN 81-8247-077-3

Online resources

1. National Center for Biotechnology Information (NCBI) https://www.ncbi.nlm.nih.gov
2. PubMed https://pubmed.ncbi.nlm.nih.gov
3. United Nations Environment Programme (UNEP) https://www.unep.org

4. World Health Organization (WHO) – One Health & Antimicrobial Resistance Resources
   https://www.who.int
5. Food and Agriculture Organization (FAO)
   https://www.fao.org
6. Intergovernmental Panel on Climate Change (IPCC)
   https://www.ipcc.ch
7. Department of Biotechnology (DBT), Government of India
   https://dbtindia.gov.in
8. Genetic Engineering Appraisal Committee (GEAC), Government of India
   https://geacindia.gov.in

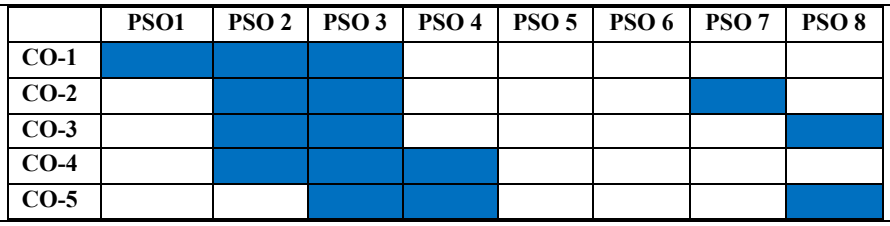
Teaching Methodology

The teaching methodology will involve laboratory experiments, and practical demonstrations to facilitate comprehensive experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on internal examination 50% SEE: External assessment based on semester-end university examination.

MB-MJ-2003: Bioprocess and Fermentation Technology

Program Name	**M.Sc.**
Semester	**M. Sc. SEM 2**
Credit Level	**6**
Course Type	**MAJOR**
Course Subtype	**MAJOR 3**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MB-MJ-2003**
Course Level	**500-599**
Course Title	**Bioprocess and Fermentation Technology**
Credit	**02 (30 Hours)**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	Upon successful completion of this course, the students will be able to: **CO1:** Explain the principles of industrial microbiology, strain improvement, culture preservation, inoculum development, fermentation media formulation and microbial growth kinetics used in bioprocess industries. (K2 – Understand) **CO2:** Apply concepts of submerged and solid-state fermentation, media optimization and process parameters for efficient microbial cultivation and product formation. (K3 – Apply) **CO3:** Analyze aeration, agitation, oxygen transfer, scale-up and scale-down strategies for the design and operation of industrial bioprocesses. (K4 – Analyze) **CO4:** Evaluate downstream processing techniques including filtration, centrifugation, cell disruption, extraction and purification methods for recovery of bioproducts. (K5 – Evaluate) **CO5:** Assess modern bioprocess technologies including heterologous protein production, synthetic biology platforms and Bioprocessing 4.0 for industrial and biotechnological applications. (K5 – Evaluate)
Mapping between COs and PSOs	

Course Content	
Unit 1 : Upstream Processing and Fermentation Technology	
1.1	Isolation of suitable microorganisms from the environment, Culture collections, Improvement of industrial microorganisms, Strain stability,
1.2	Culture preservation: Storage at reduced temperature, storage in a dehydrated form and quality control of preserved stock cultures
1.3	Fermentation media, formulation, Carbon sources Nitrogen source Minerals & others growth factor, precursors, inducers inhibitors, Oxygen requirement, Antifoam and Statistical media Optimization
1.4	Microbial growth kinetics: Batch culture, Continuous culture, Fed-batch culture
1.5	Inoculum development, inoculum transfer, Development of inocula for yeast processes and bacteria
1.6	Introduction to Solid-state fermentation, Suitability of Microorganisms for SSF Processes Biomass Measurement, Factors Affecting SSF, Scale-Up, Modeling in SSF, Types of SSF Bioreactors
1.7	Sterilization and Contamination Control: Sterilization of media, air and equipment; filtration systems; contamination sources; aseptic operation; biosafety and GMP considerations.
1.8	Process Monitoring and Control**:** Measurement and control of temperature, pH, dissolved oxygen, foam, pressure and biomass; sensors, biosensors and process automation
Unit 2 : Downstream Processing and Modern Bioprocess Engineering	
2.1	Aeration and agitation: Introduction, Oxygen requirements of industrial fermentations, Oxygen supply, Determination of KLa values, Fluid rheology, Factors affecting KLa values in fermentation vessels,
2.2	Scale-Up and Scale-Down
2.3	Downstream Processing: Cell harvesting, filtration, centrifugation, cell disruption, extraction, precipitation, membrane separation, chromatography and product formulation.
2.4	Cell disruption by Physico-mechanical methods, Chemical and biological methods
2.5	Products purification: Liquid–liquid extraction, Solvent recovery, Two-phase aqueous extraction, Reversed micelle extraction, Supercritical fluid extraction, Adsorption, Removal of volatile products, Drying, Crystallization
2.6	Recent Advances and Impacts of Microtiter Plate-Based Fermentations in Synthetic Biology and Bioprocess Development
2.7	Emerging trends in bioprocess technology: microbiome microbiome-based biotechnology, omics-guided bioprocessing, AI-assisted fermentation, continuous biomanufacturing and Industry applications.
References:	
1. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2016). *Principles of fermentation technology* (3rd ed.). Elsevier Science & Technology.	

2. Waites, M. J., Morgan, N. L., Rockey, J. S., & Higton, G. (2001). *Industrial microbiology: An introduction*. Blackwell Science.
3. Okafor, N., & Okeke, B. C. (2017). *Modern industrial microbiology and biotechnology* (2nd ed.). CRC Press.
4. El-Mansi, E. M. T., Nielsen, J., Mousdale, D., Allman, T., & Carlson, R. (Eds.). (2019). *Fermentation microbiology and biotechnology* (4th ed.). CRC Press.
5. Isoko, K., Cordiner, J. L., Kis, Z., & Moghadam, P. Z. (2024). Bioprocessing 4.0: A pragmatic review and future perspectives. *Digital Discovery*, *3*(9), 1662–1681. https://doi.org/10.1039/d4dd00127c

Online Resources

1. Addgene – https://www.addgene.org
2. New England Biolabs (NEB) Protocols and Technical Resources – https://www.neb.com/tools-and-resources
3. Thermo Fisher Scientific Learning Center – https://www.thermofisher.com
4. Cytiva Bioprocess Resource Center – https://www.cytivalifesciences.com
5. BioProcess International – https://www.bioprocessintl.com
6. EMBL-EBI Training Portal – https://www.ebi.ac.uk/training
7. NPTEL – https://nptel.ac.in
8. SWAYAM – https://swayam.gov.in

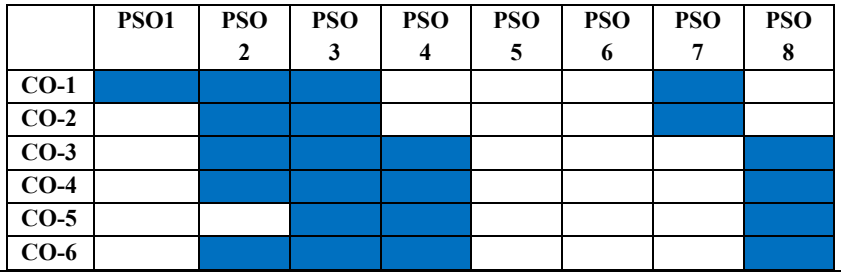
Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning and demonstrations to facilitate comprehensive theoretical understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination

MBP-MJ-2003: Bioprocess and Fermentation Technology Practical

Program Name	**M.Sc.**
Semester	**M. Sc. SEM 2**
Credit Level	**6.0**
Course Type	**MAJOR**
Course Subtype	**MAJOR Practical 3**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MBP-MJ-2003**
Course Level	**500-599**
Course Title	**Bioprocess and Fermentation Technology Practical**
Credit	**02 (30 Hours)**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	Upon successful completion of this practical course, the students will be able to: **CO1**: Prepare and optimize fermentation media, develop inocula, cultivate industrial microorganisms and evaluate microbial growth and biomass production using standard bioprocess techniques. (K3 – Apply) **CO2:** Perform fermentation processes for the production of organic acids and industrially important enzymes under submerged and solid-state fermentation systems. (K3 – Apply) **CO3:** Analyze bioprocess parameters including oxygen transfer, biomass formation and fermentation performance using appropriate analytical methods. (K4 – Analyze) **CO4:** Operate laboratory-scale bioreactors and perform downstream processing techniques including cell harvesting, product recovery and partial purification. (K3 – Apply) **CO5:** Apply statistical experimental design tools for media optimization and process improvement in bioprocess development. (K4 – Analyze) **CO6:** Evaluate fermentation products using chromatographic, spectrophotometric and other analytical techniques for quality assessment and process optimization. (K5 – Evaluate)
Mapping between COs and PSOs	

Course content

1. Preparation and optimization of fermentation media for microbial growth and product formation.
2. Cell harvesting by centrifugation and filtration techniques and Estimation of biomass concentration by spectrophotometric and dry cell weight methods.
3. Production and quantification of citric acid by Aspergillus niger fermentation.
4. Production and assay of industrially important enzymes (protease/cellulase) under submerged fermentation.
5. Production of microbial enzymes under solid-state fermentation using agro-industrial substrates.
6. Determination of oxygen transfer characteristics and estimation of volumetric oxygen transfer coefficient (kLa).
7. Recovery and partial purification of fermentation products by precipitation and membrane filtration methods.
8. Demonstration and operation of laboratory-scale fermenter/bioreactor and study of its components.
9. Analysis of fermentation products using chromatographic or spectrophotometric methods.
10. Use of Plackett-Burman-design-calculator for screening
11. Use of Optimization design using Box-Behnken Design or Central Composite Design

References:

1. Walker, J. M. (Ed.). (2009). *The Protein Protocols Handbook* (3rd ed.). Humana Press.
2. Cappuccino, J. G., & Welsh, C. (2018). Microbiology: A laboratory manual (11th global ed.). Pearson Education Limited.
3. Bisen, P. S. (2014). *Laboratory protocols in applied life sciences*. CRC Press.
4. Alexander, S. K., Strete, D., & Niles, M. J. (2003). *Laboratory exercises in organismal and molecular microbiology*. McGraw-Hill Higher Education
5. Aneja, K. R., Experiments in Microbiology 4thed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.
6. Saxena, J., Baunthiyal, M., & Ravi, I. (2015). *Laboratory manual of microbiology, biochemistry and molecular biology,* Scientific Publishers.
7. Bossi, Camilli, Grundl, Experiments in Bacterial Genetics: A Laboratory Manual, Cold Spring Harbor Laboratory Press, 2023, ISBN 978-1621824497
8. Tiwari, R. P., Hoondal, G. S., & Tewari, R. (2004). *Laboratory techniques in microbiology & biotechnology* (1st ed.). Abhishek Publications ISBN 81-8247-077-3

Online Resources

1. Addgene Protocols – https://www.addgene.org/protocols
2. New England Biolabs (NEB) Protocols – https://www.neb.com/protocols

3. Thermo Fisher Scientific Learning Center – https://www.thermofisher.com
4. Cytiva Bioprocess Resource Center – https://www.cytivalifesciences.com
5. EMBL-EBI Training Portal – https://www.ebi.ac.uk/training
6. BioProcess International – https://www.bioprocessintl.com
7. NPTEL Biotechnology Courses – https://nptel.ac.in
8. SWAYAM – https://swayam.gov.in
9. JMP Learning Library – https://www.jmp.com/en_us/learning-library.html

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, Laboratory exercises and practical, demonstrations to facilitate comprehensive theoretical understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, practical test, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination

MB-MJ-2004: Biophysics, Analytical Biochemistry and Instrumentation

Program Name	**M.Sc.**
Semester	**M. Sc. SEM 2**
Credit Level	**6.0**
Course Type	**MAJOR**
Course Subtype	**MAJOR 4**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MB-MJ-2004**
Course Level	**500-599**
Course Title	**Biophysics, Analytical Biochemistry and Instrumentation**
Credit	**04 (60 Hours)**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	Upon successful completion of this practical course, the students will be able to: **CO1:** Explain the principles of biophysical chemistry, chromatography, electrophoresis and their applications in biological and biochemical investigations. (K2 – Understand) **CO2:** Apply the principles of spectroscopic, microscopic and centrifugation techniques for analysis and characterization of biomolecules and biological systems. (K3 – Apply) **CO3:** Analyze molecular structure determination methods, advanced analytical techniques and nucleic acid quantification approaches used in modern biological research. (K4 – Analyze) **CO4:** Evaluate the applications of mass spectrometry, PCR variants, flow cytometry, biosensors and imaging technologies in microbiology, biotechnology and biomedical sciences. (K5 – Evaluate) **CO5:** Assess immunological, radiolabeling and electrophysiological techniques and their significance in diagnostics, research and healthcare applications. (K5 – Evaluate)

Mapping between COs and PSOs	

	PSO1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO-1								
CO-2								
CO-3								
CO-4								
CO-5								

Course content	
Unit 1: Biophysical Chemistry, Chromatographic and Electrophoretic Techniques	
1.1	Principles of biophysical chemistry: pH, buffer, reaction kinetics, thermodynamics, colligative properties
1.2	An Introduction to Chromatographic Separations, Principle, instrumentation and applications of Paper chromatography, Thin Layer Chromatography (TLC),
1.3	Principle, instrumentation and applications of Adsorption chromatography, Partition chromatography, Ion Exchange Chromatography, Size Exclusion (Gel Filtration) Chromatography, Affinity Chromatography,
1.4	Principle, instrumentation and applications of Gas Chromatography (GC) and High-Performance Liquid Chromatography (HPLC)
1.5	Electrophoresis: General principles, support media and buffers, electrophoresis of proteins, electrophoresis of nucleic acids, capillary electrophoresis and microchip electrophoresis.
Unit 2: Spectroscopy, Structural Biology and Advanced Analytical Techniques	
2.1	Spectroscopic Techniques for Biomolecular Analysis**:** UV–Visible Spectroscopy, Fluorescence Spectroscopy, Circular Dichroism (CD) Spectroscopy, Electron Spin Resonance (ESR/EPR) Spectroscopy
2.2	Structural Biology and Molecular Structure Determination: X-ray Diffraction (X-ray Crystallography), Cryo-Electron Microscopy (Cryo-EM), Nuclear Magnetic Resonance (NMR) Spectroscopy in Structure Determination
2.3	Advanced Molecular Characterization and Interaction Analysis: Light Scattering Techniques, Mass Spectrometry and its Types, Surface Plasmon Resonance (SPR)
2.4	Advanced Analytical Techniques: MALDI-TOF Mass Spectrometry, Liquid Chromatography–Mass Spectrometry (LC-MS) and Liquid Chromatography–Tandem Mass Spectrometry (LC-MS/MS)
2.5	Principle of Centrifugation, Differential centrifugation, density-gradient centrifugation, ultracentrifugation
Unit 3: Molecular Analysis, Quantification and Imaging Technologies	

3.1	Infrared and Raman Spectroscopy and Atomic Spectroscopy, Fluorescence Spectroscopy
3.2	PCR, Q-PCR, ddPCR and other variants of PCR,
3.3	Spectrophotometric and fluorometric nucleic acid quantification (Nanodrop and Qubit), Nucleic acid hybridization,
3.4	Protein Sequencing: Significance, Methods, and Applications
3.5	Confocal microscopy, fluorescence imaging, transmission electron microscopy (TEM), scanning electron microscopy (SEM), cryo-electron microscopy (Cryo-EM), Atomic Force Microscopy (AFM)
Unit 4: Cellular Analysis, Immunotechniques and Biomedical Instrumentation	
4.1	Principles, instrumentation and application of flow cytometry
4.2	Radiolabeling techniques: Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines
4.3	Histochemical and Immunotechniques: ELISA, RIA, blotting techniques, immunofluorescence, immunoprecipitation, FISH and GISH techniques.
4.4	Concept, types and application biosensors
4.5	Electrophysiological methods: Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT

Reference

1. Nelson, D. L., Cox, M. M., Hoskins, A. A., & Lehninger, A. L. (2021). *Lehninger principles of biochemistry* (8th ed.). W. H. Freeman and Company
2. Kumar, P. (2024). *Biophysics and molecular biology: Tools and techniques* (5th ed.). Pearson India.
3. Kumar, P. (2018). *Fundamentals and techniques of biophysics and molecular biology* (2nd ed.). Pathfinder Publication.
4. Kalidas, C., & Sangaranarayanan, M. V. (2023). *Biophysical Chemistry: Techniques and Applications* (1st ed.). Springer International Publishing.
5. Hofmann, A., & Clokie, S. J. (Eds.). (2018). *Wilson and Walker's principles and techniques of biochemistry and molecular biology* (8th ed.). Cambridge University Press.
6. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2018). *Principles of instrumental analysis* (7th ed.). Cengage Learning.
7. Mekonen, A. A., & Ali, A. (2023). A review on principles of FISH and GISH and its role in cytogenetic study. *Global Research in Environment and Sustainability*, *1*(4), 15–26.
8. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. (2021). *Brock biology of microorganisms* (16th ed.). Pearson
9. Chatwal, G. R., & Anand, S. K. (2019). *Instrumental methods of chemical analysis* (5th ed.). Himalaya Publishing House.
10. https://www.metwarebio.com/what-is-protein-sequencing/

Online Resources

1. https://www.metwarebio.com/what-is-protein-sequencing/

2. National Center for Biotechnology Information (NCBI) – https://www.ncbi.nlm.nih.gov
3. EMBL-European Bioinformatics Institute (EMBL-EBI) – https://www.ebi.ac.uk
4. ExPASy Bioinformatics Resource Portal – https://www.expasy.org
5. Protein Data Bank (PDB) – https://www.rcsb.org
6. UniProt Protein Knowledgebase – https://www.uniprot.org
7. PubChem Chemical Database – https://pubchem.ncbi.nlm.nih.gov
8. NIST Chemistry WebBook – https://webbook.nist.gov
9. MicroscopyU (Nikon Microscopy Education) – https://www.microscopyu.com
10. Thermo Fisher Learning Center – https://www.thermofisher.com/in/en/home/global/forms/life-science/learning-center.html
11. NPTEL Courses – https://nptel.ac.in
12. SWAYAM – https://swayam.gov.in

Teaching Methodology
The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning and demonstrations to facilitate comprehensive theoretical understanding of the subject.
Distribution of Marks
50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination

MB-ME-2005: Microbial Bioinformatics and Omics Technologies

Program Name	**M.Sc.**
Semester	**M. Sc. SEM 2**
Credit Level	**6**
Course Type	**MAJOR**
Course Subtype	**MAJOR 4 Pracricals**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MB-MDC-2005**
Course Level	**500–599**
Course Title	**Microbial Bioinformatics and Omics Technologies**
Credit	**04 (60 Hours)**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	Upon successful completion of this course, the students will be able to: **CO1:** Explain the fundamental concepts of bioinformatics, biological databases, sequence alignment methods, phylogenetic analysis and their applications in microbiological research. (K2 – Understand) **CO2:** Apply genome sequencing technologies, quality control methods, genome assembly, annotation tools and comparative genomics approaches for microbial genome analysis. (K3 – Apply) **CO3:** Analyze microbial genomes, metagenomes, transcriptomes and metabolomic datasets for classification, identification and functional interpretation of microorganisms. (K4 – Analyze) **CO4:** Evaluate protein structure, protein function, molecular interactions and computational approaches including AI-assisted structural prediction and molecular modelling. (K5 – Evaluate) **CO5:** Assess the applications of bioinformatics, systems biology and computer-aided drug design in solving contemporary problems in microbiology, biotechnology and healthcare. (K5 – Evaluate)
Mapping between COs and PSOs	

	PSO1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO-1	■			■	■			
CO-2	■			■				■
CO-3	■			■	■			
CO-4				■		■		■
CO-5		■		■		■		■

Course Content	
Unit 1: Fundamentals of Bioinformatics and Sequence Alignment	
1.1	Introduction, Overview, Definition, Applications of Bioinformatics, Molecular Biology and Bioinformatics, Molecular Biology and Bioinformatics, Central Dogma of Molecular Biology. Computers and Operating Systems Required for Bioinformatics,
1.2	Major Databases in Bioinformatics: Sequence databases, gene expression databases, 3D structure database, pattern sequence databases, Data Retrieval
1.3	Definitions of homologues, orthologues, paralogues, repeat finding, sequence identity and similarity, pairwise sequence alignments, scoring matrix
1.4	Database searches, BLAST and FASTA
1.5	Multiple sequence alignments (MSA), application in taxonomy and phylogeny, Phylogenetics
Unit 2: Genome Sequencing, Quality Control, and Comparative Genomics	
2.1	DNA Sequencing: Sanger sequencing, Next Generation Sequencing (NGS) and Third Generation Sequencing technologies; Illumina, Ion Torrent, PacBio and Oxford Nanopore platforms
2.2	Raw Sequence Data Quality Control, DNA Sequence Assembly and Annotation of Genes
2.3	Prediction of gene function using homology, context, structures, networks; Genetic variation polymorphism, deleterious mutations;
2.4	Computational Approaches in Comparative Genomics
2.5	Sequenced-Based Typing of Prokaryotes
Unit 3: Microbial Genomics and Multi-Omics Technologies	
3.1	Sequence-Based Classification and Identification of Prokaryotes
3.2	16S rRNA Amplicon Sequencing for Metagenomics
3.3	Full Shotgun DNA Metagenomics
3.4	Transcriptomics
3.5	Metabolomics
Unit 4: Proteomics, Structural Biology, and Computer-Aided Drug Design	
4.1	Proteomics and Protein Identification
4.2	Protein stability and folding, Classifications of protein structures,
4.3	Protein structure prediction and modelling, AI-based methods of structure prediction (AlphaFold), Molecular Modelling and Dynamics
4.4	Chemical databases like NCI /PUBCHEM, Fundamentals of Receptor-ligand interactions, Structure-based drug design, Ligand based drug design: Structure-Activity Relationship, QSARs and pharmacophores, in silico predictions of drug activity and ADMET
4.5	Systems biology: Concept and application

References

1. Ismail, H. D. (2023). Bioinformatics: A Practical Guide to Next Generation Sequencing Data Analysis. CRC Press.
2. Christensen, H. (Ed.). (2018). Introduction to Bioinformatics in Microbiology. Springer.
3. Rastogi, S. C., Mendiratta, N., & Rastogi, P. (2013). Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery (4th ed.). PHI Learning.
4. Lesk, A. M. (2014). Introduction to Bioinformatics (4th ed.). Oxford University Press.
5. Baxevanis, A. D., & Ouellette, B. F. F. (Eds.). (2005). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (3rd ed.). Wiley.
6. Choudhuri, S. (2014). Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools. Academic Press.
7. Higgs, P. G., & Attwood, T. K. (2005). Bioinformatics and Molecular Evolution. Blackwell Publishing.
8. Hollingsworth, S. A., & Dror, R. O. (2018). Molecular dynamics simulation for all. Neuron, 99(6), 1129–1143. https://pmc.ncbi.nlm.nih.gov/articles/PMC6209097/
9. Wehrens, R., & Salek, R. (Eds.). (2019). Metabolomics: Practical guide to design and analysis. CRC Press.
10. Selzer, P. M., Marhöfer, R. J., & Rohwer, A. (2008). Applied bioinformatics: An introduction. Springer
11. Krawetz, S. A. (Ed.). (2009). Bioinformatics for systems biology. Humana Press.
12. Bard, J. (2013). Systems biology — the broader perspective. Cells, 2(2), 414–431. https://doi.org/10.3390/cells2020414
13. Marcus, F. B. (2008). Bioinformatics and systems biology: Collaborative research and resources. Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-540-78353-4

Online Resources

1. National Center for Biotechnology Information (NCBI): https://www.ncbi.nlm.nih.gov
2. European Bioinformatics Institute (EMBL-EBI): https://www.ebi.ac.uk
3. DNA Learning Center (Cold Spring Harbor Laboratory): https://dnalc.cshl.edu
4. National Programme on Technology Enhanced Learning (NPTEL): https://nptel.ac.in
5. SWAYAM: https://swayam.gov.in
6. Protein Data Bank (PDB): https://www.rcsb.org
7. UniProt Knowledgebase: https://www.uniprot.org
8. AlphaFold Protein Structure Database: https://alphafold.ebi.ac.uk
9. Galaxy Project for Bioinformatics Analysis: https://usegalaxy.org
10. PubChem Database: https://pubchem.ncbi.nlm.nih.gov

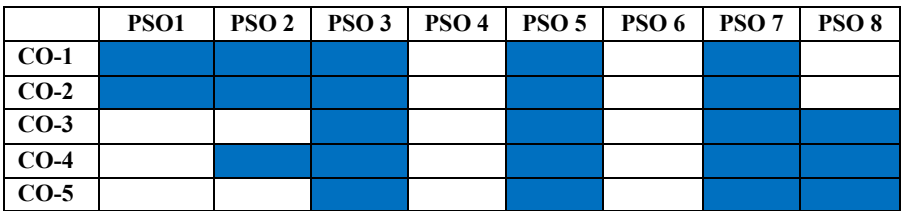
Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, seminars, assignments, case studies, scientific literature review, problem-solving exercises, and lecture-based demonstrations of bioinformatics tools and databases to facilitate comprehensive theoretical understanding of bioinformatics, genomics, omics technologies, and computational biology.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MB-SEC-2006: Bioinoculants and Organic Farming

Program Name	**M.Sc.**
Semester	**M. Sc. SEM 2**
Credit Level	**6.0**
Course Type	**SEC**
Course Subtype	**SEC 1**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MB-SEC-2006**
Course Level	**500-599**
Course Title	**Bioinoculants and Organic Farming**
Credit	**02 (30 Hours)**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	Upon successful completion of this course, the students will be able to: **CO1:** Explain the principles, importance and applications of bioinoculants in sustainable agriculture, including their role in nutrient management, plant health promotion and stress mitigation. (K2) **CO2:** Analyze the diversity, characteristics and agricultural significance of major bioinoculants such as bacterial inoculants, cyanobacteria, Azolla, mycorrhizae and phosphate-solubilizing microorganisms. (K4) **CO3:** Describe the concepts, principles, advantages, limitations and practices of organic farming for environmentally sustainable agricultural production. (K2) **CO4:** Evaluate the role of biofertilizers in sustainable agriculture, their economic and environmental benefits, commercial production and contribution to soil fertility management. (K5) **CO5:** Assess the current status, industrial development, challenges and future prospects of bioinoculant and biofertilizer technologies in India. (K5)
Mapping between COs and PSOs	

Course Content	
Unit 1 : Fundamentals and Applications of Bioinoculants	
1.1	Introduction of Bioinoculants
1.2	Role of Bioinoculants in Green Agriculture: Nutrient Assimilation and Biofortification, Management of Pests and Pathogens, Abiotic Stress Management
1.3	Method of application and recommended doses
1.4	Current market scenario in India and Challenges and future prospects
1.5	Bacterial Inoculants, Green Manuring
1.6	Cyanobacterial Inoculants, Azolla as Biofertilizer
1.7	Mycorrhizal fungi as Biofertilizer
1.8	Phosphate solubilizing microorganisms
Unit 2 : Organic Farming and Biofertilizers	
2.1	Definition and Concepts of organic farming
2.2	Importance and Characteristics of organic farming
2.3	Advantages and Disadvantages of organic farming
2.4	Introduction of Biofertilizers, Biofertilizer for sustainable Agricultures
2.5	Economic and Environmental Benefits of Biofertilizer
2.6	Commercial Producers of Biofertilizers, Works Done on Biofertilizers in India
2.7	Development of Microbial Biofertilizer Industry

References

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2. Aman Raj and Adesh Kumar, A sustainable alternative to agrochemicals, Bioinoculants ***Indian*** *Farming 75* (05): 21-24.
3. Aneja, K. R., (2003). Experiments in Microbiology 4thed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers DOI http://dx.doi.org/10.18174/375218
4. Dubey, R. C. (1993). A Textbook of Biotechnology. (Multicolor Illustrative revised Edition) S. Chand Publishing. (ISBN: 81-219-2608-4).
5. Dubey, R. C. (2000). Textbook of Microbiology. (4th Edition) S. Chand, Limited.(ISBN: 978-8121926201).
6. Handbook for composting and compost use in organic horticulture. André W.G. van der Wurff, Jacques G. Fuchs, Michael Raviv and Aad J. Termorshuizen, (ISBN:978-94-6257-749-7),
7. Jnana Bharati Palai M, Mostafizur Rahman Shah, Viliam Barek, Peter Ondrisik, Milan Skalický and Akbar Hossain. Bioinoculants: Natural Biological Resources for Sustainable plant production. Microorganisms https://doi.org/10.3390/10010051, 10 (51) 1-35.
8. Motsara, M. R., Bhattacharyya, P., & Srivastava, B. (1995). Biofertilizer: Technology, marketing and usage. A sourcebook-cum-glossary.
9. Patel, R. J., & Patel, R. K., (2022). Experimental Microbiology, Vol. 1, 10th Edition,

Aditya.
10. Purohit, S. S. (2006). Microbiology: Fundamentals and Applications. (7th Edition) Agrobios. (ISBN:978-81-7754-259-1).
11. Sagar Maitra, Marian Brestic, Preetha Bhadra, Tanmoy Shankar, Subhashisa Praharaj,
12. Santanu Kundu, Ashay D Souza, Lalta Prasad Verma, Tushar Ghosh, Debarati Seal (2024). Organic Farming Cultivating Sustainable Agriculture, National Press Associates, New Delhi, (ISBN: 978-81-19674-42-8)
13. Somasundaram, E., Nandhini, D. U., & Meyyappan, M. (2019). Principles of Organic Farming: (With Theory and Practicals). New India Publishing Agency.(ISBN:9781003260844)
14. Subba Rao, N. S. (1993). Biofertilizers in agriculture and forestry (3rd rev. ed). International Science Publisher. (ISBN: 1881570290)

Online resources

1. https://www.youtube.com/watch?v=LvqMMfa8ysM
2. https://www.youtube.com/watch?v=ExqbV5Ol1FU
3. https://www.youtube.com/watch?v=3YxE9kEXv3I
4. https://www.youtube.com/watch?v=RpHms71b4m4
5. https://www.youtube.com/watch?v=Cm8MyVq8er8
6. https://www.youtube.com/watch?v=WhOrIUlrnPo
7. https://www.youtube.com/watch?v=_AM2fX24vtQ
8. https://www.youtube.com/watch?v=yCDTXI1l6D4
9. SWAYAM (https://swayam.gov.in)
10. SWAYAM Plus (https://swayam-plus.swayam2.ac.in)
11. https://share.google/nqkdslVo2iRT8gfQE
12. https://share.google/qBUjyvmWUau3amgN4
13. https://share.google/91VpjqU25ZxulCFRN

Teaching Methodology
The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning and demonstrations to facilitate comprehensive theoretical understanding of the subject.
Distribution of Marks
50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination

MB-SEC-2006: SWAYAM MOOC: Provided from the SWAYAM/ NPTEL of 2 credits

This course requirement is fulfilled through a 2-credit Massive Open Online Course (MOOC) provided via the SWAYAM/NPTEL platform. Students will complete the designated online curriculum and earn academic credits upon successful assessment.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

Postgraduate Program

In

Microbiology

2 years

(COURSE WORK AND ONE SEMESTER RESEARCH)

M.Sc. SEM 1 & 2 SYLLABUS

PROGRAM TITLE	
Name of Program	Master of Science (Honors) Microbiology
Program Abbreviation	M.Sc. MB
Duration	2 Years
Eligibility Criteria	Successfully Completed Sem-6 in the subject of Microbiology
Pre-requisite	Basic concepts in the field of microbiology
Medium of Instruction	English
Objective of Program	To provide Fundamental and applied knowledge of Micro- organism to students. To develop Laboratory skills and to train the students in scientific thinking to prepare for carriers like health care, pharmaceutical, biotechnology, diagnostics, industry and academia and to promote awareness to students of microbial application in the field of diseases prevention, environmental sustainability and technological innovation.
Program Outcome (PO)	**PO-01: Scientific Knowledge & Conceptual Understanding** Develop a strong foundation in scientific principles, theories and concepts across disciplines, fostering interdisciplinary learning, advanced knowledge and problem-solving abilities. **PO-02: Analytical & Critical Thinking** Apply critical thinking and analytical reasoning to evaluate scientific data, hypotheses and real-world problems, leading to evidence-based conclusions. **PO-03: Research & Inquiry-based Learning** Develop investigative skills through experimentation, data analysis and scientific inquiry to contribute to research and innovation. **PO-04: Laboratory & Technical Skills** Gain hands-on experience with laboratory techniques, instrumentation and computational tools relevant to scientific research and industry applications. **PO-05: Digital & Computational Literacy** Utilize digital tools, computational techniques and emerging technologies such as AI, bioinformatics and statistical modelling to enhance scientific learning and problem-solving. **PO-06: Environmental & Societal Responsibility** Understand the role of science in addressing environmental, health and societal challenges, promoting sustainability and ethical responsibility. **PO-07: Effective Communication & Collaboration**

	Develop proficiency in scientific communication, both written and oral, for effective dissemination of knowledge while collaborating in multidisciplinary teams. **PO-08: Innovation & Entrepreneurship** Foster an entrepreneurial mindset by applying scientific knowledge for innovation, technology development and industry-oriented applications. Develop sustainable solutions to address real-world challenges in research and environmental management. **PO-09: Lifelong Learning & Professional Growth** Cultivate curiosity and adaptability for continuous learning, equipping students for higher education, research and professional careers. **PO-10: Ethical Leadership & Value-based Education** Develop leadership qualities, ethical values and a sense of responsibility in applying science for societal progress, aligning with Indian knowledge systems and global perspectives.
Program Specific Outcomes (PSO)	**PSO1** Demonstrate advanced understanding of microbial diversity, taxonomy, genetics, physiology, metabolism, molecular biology, immunology, virology and host–microbe interactions. **PSO2** Apply microbiological principles for identification, characterization and utilization of microorganisms in healthcare, agriculture, food, pharmaceutical, industrial and environmental sectors. **PSO3** Integrate knowledge of microbial biotechnology, fermentation technology, bioprocess engineering and microbial products for development of sustainable technologies and industrial applications. **PSO4** Utilize advanced bioanalytical techniques, biophysical instrumentation, omics technologies, bioinformatics and artificial intelligence tools for biological data generation and interpretation. **PSO5** Analyze microbial communities, biodiversity, ecological interactions, evolutionary processes and microbiomes for environmental sustainability and resource management. **PSO6** Apply concepts of medical microbiology, public health microbiology, antimicrobial resistance, epidemiology and immunology for understanding disease processes and their control. **PSO7** Employ microbial resources and technologies for agricultural productivity, bioinoculant development, bioremediation, bioleaching, biomining and other environmental applications.

	PSO8 Demonstrate competency in research, innovation, intellectual property management, regulatory compliance and entrepreneurship for professional careers, higher studies and technology-driven enterprises. **PSO9** Apply research methodologies, experimental design and analytical approaches to investigate microbiological problems through an independent research project. **PSO10** Analyze, interpret and communicate research findings through dissertations, scientific reports and presentations.
Mapping between Pos and PSOs	

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
PSO1	■	■				■			■	
PSO2	■	■	■	■		■				
PSO3	■	■	■	■		■		■		
PSO4	■	■	■	■	■			■	■	
PSO5	■	■	■			■			■	■
PSO6	■	■	■	■		■				■
PSO7	■	■	■	■		■		■		■
PSO8		■	■	■	■		■	■	■	■
PSO9		■	■		■		■		■	■
PSO10		■	■	■	■		■	■	■	■

STRUCTURE FOR ERP – M.Sc MICROBIOLOGY – SEM – 1 COURSE WORK AND ONE SEMESTER RESEARCH																
Course Category	**Course Code**	**Course Title**	**Mark sheet Title in English**	**Level of Course**	**Teaching Hours/Week**		**Exam Duration (Hours)**		**Credit**		**Internal Marks**		**External Marks**		**Total**	
					TH	**PR**	**TH**	**PR**	**TH**	**PR**	**TH**	**PR**	**TH**	**PR**	**TH**	**PR**
MAJOR 1	**MB – 1001**	**MICROBIAL GENETICS**	**MICROBIALGENETICS**	500-599	02	04	01.00	06.00	02	02	25	25	25	25	50	50
MAJOR 2	**MB – 1002**	**MICROBIAL METABOLISM & PHYSIOLOGICAL ADAPTATION**	**MICROBIAL METABOLISM & PHYSIOLOGICAL ADAPTATION**	500-599	02	04	01.00	06.00	02	02	25	25	25	25	50	50
MAJOR 3	**MB – 1003**	**MICROBIAL BIOTECHNOLOGY**	**MICROBIAL BIOTECHNOLOGY**	500-599	02	04	01.00	06.00	02	02	25	25	25	25	50	50
MAJOR 4	**MB-1004 BKS**	**TRADITIONAL PRACTICES IN MICROBIOLOGY**	**TRADITIONAL PRACTICES IN MICROBIOLOGY**	500-599	04	00	02.00	00	04	-	50	-	50	-	100	-
MDC	**MB-1005**	**BIONANOTECHNOLOGY/ FUNDAMENTALS OF CYBERSECURITY**	**BIONANOTECHNOLOGY/ FUNDAMENTALS OF CYBER SECURITY**	500-599	04	00	02.00	00	04	-	50	-	50	-	100	-
SEC	**MB-1006**	**EPIDEMIOLOGY/ SWAYAM MOOC/RESEARCH METHODOLOGY**	**EPIDEMIOLOGY/ SWAYAM MOOC/RESEARCH METHODOLOGY**	500-599	02	00	00	00	02	-	25	-	25	-	50	-

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M. Sc. Microbiology, Semester-I

MB-MJ-1001: MICROBIAL GENETICS

Program Name	**M.Sc.**
Semester	**M. Sc SEM 1**
Credit Level	**6.0**
Course Type	**MAJOR**
Course Subtype	**MAJOR 1**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MB-MJ-1001**
Course Level	**500-599**
Course Title	**Microbial Genetics**
Credit	02 (30 Hours)
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	**Course Outcomes (COs)** Upon successful completion of this course, the students will be able to: **CO1:** Explain the molecular mechanisms of DNA replication, transcription, translation, protein processing and protein secretion involved in the flow of genetic information in microorganisms. **(K2 – Understand)** **CO2:** Apply the principles of microbial gene regulation, including transcriptional regulation, RNA-mediated regulation, enzyme regulation and DNA repair mechanisms, to understand cellular responses and genetic stability. **(K3 – Apply)** **CO3:** Analyze the structure, properties and biological significance of plasmids and other genetic elements in microbial systems. **(K4 – Analyze)** **CO4:** Evaluate the mechanisms and applications of gene transfer processes, including transformation, transduction, conjugation and gene transfer in archaea, in microbial genetics and biotechnology. **(K5 – Evaluate)** **CO5:** Assess the roles of recombination, transposition and genome rearrangements in microbial evolution, adaptation and genetic engineering. **(K5 – Evaluate)**
Mapping between COs and PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	■					■		
CO2	■					■		
CO3	■	■						
CO4	■	■	■					
CO5	■		■					■

Course Content	
UNIT 1: Nucleic acid structure and synthesis	
1.1	*Molecular Biology and Genetic Elements:* DNA and Genetic Information Flow, Genetic Elements: Chromosomes and Plasmids overview
1.2	*DNA Replication:* Templates, Enzymes, and Replication Fork, Bidirectional Replication, the Replisome, and Proofreading
1.3	*RNA Synthesis:* Transcription in Bacteria, in Archaea
1.4	*Protein Synthesis*: Translation, Amino Acids, Polypeptides, and Proteins, Transfer RNA, Genetic Code, Mechanism of Protein Synthesis
1.5	*Protein Processing, Secretion, and Targeting:* Assisted Protein Folding and Chaperones, Protein Secretion in Gram-Negative Systems
1.6	*DNA-Binding Proteins and Transcriptional Regulation*: DNA-Binding Proteins, Negative Control- Repression and Induction, Positive Control-Activation, Global Control and the *lac* Operon, Transcription Controls in Archaea
1.7	*RNA-Based Regulation*: Regulatory RNAs, Riboswitches, Attenuation
1.8	*Regulation of Enzymes and Other Proteins*: Feedback Inhibition, Post-Translational Regulation
UNIT 2: Mutation, Plasmids, Gene Transfer and Genome Rearrangement	
2.1	*Mutation and DNA repair:* The causes of mutations, Repair of mutations and other types of DNA damage
2.2	*Plasmid*: Functions Encoded, Structure, Properties of Plasmids
2.3	Transformation, Artificially Induced Competence- Chemical Induction, Electroporation and Protoplast Transformation
2.4	Transduction
2.5	Conjugation and Formation of Hfr Strains & Chromosome Mobilization, mapping genes by interrupted mating, Gene Transfer in Archaea,
2.6	*Recombination*: Homologous and site-specific recombination
2.7	*Transposition*: Transposition, Mechanisms of Transposition and General Properties of Transposons

References

1. Brown, T. A. (2023). *Genomes 5* (5th ed.). CRC Press. ISBN: 978-0-367-67866-1
2. Henkin, T. M., & Peters, J. E. (2020). *Snyder and Champness molecular genetics of bacteria* (5th ed.). ASM Press; John Wiley & Sons. ISBN 9781555819750
3. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2014). *Lewin's GENES XI* (11th ed.). Jones & Bartlett Learning. ISBN 9781449659851
4. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. (2018). *Brock biology of microorganisms* (15th ed.). Pearson. ISBN 13: 978-1-292-23510-3
5. Watson, J.D., Baker, T. A., Beil S. P., Gann, A., Levine, M., & Losick, R. (2017). *Molecular biology of gene* (7th ed.) Pearson India Education Services Pvt. Ltd.
6. Willey, J. M., Sandman, K. M., & Wood, D. H. (2023). *Prescott's microbiology* (12th ed.). McGraw-Hill Education. ISBN 978-1-265-12303-1

Online reference

1. https://swayam.gov.in/

2. https://swayam-plus.swayam2.ac.in/
Teaching Methodology The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.
Evaluation scheme 50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MBP-MJ-1001: MICROBIAL GENETICS PRACTICALS

Program Name	**M.Sc.**
Semester	**M. Sc SEM 1**
Credit Level	**6.0**
Course Type	**MAJOR**
Course Subtype	**MAJOR Practical 1**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MBP-MJ-1001**
Course Level	**500-599**
Course Title	**Microbial Genetics Practical**
Credit	02 (30 Hours)
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	**Course Outcomes (COs)** Upon successful completion of this practical course, the students will be able to: **CO1:** Perform the isolation, purification and quantitative estimation of genomic DNA, plasmid DNA and RNA from microbial cells using standard molecular biology techniques. **(K3 – Apply)** **CO2:** Execute microbial genetic experiments involving mutation induction, mutant isolation and gene expression analysis to understand microbial genetics and gene regulation. **(K3 – Apply)** **CO3:** Demonstrate bacterial transformation techniques and interpret the role of gene transfer mechanisms in microbial genetic exchange. **(K3 – Apply)** **CO4:** Apply bioinformatics tools for identification of open reading frames (ORFs) and analysis of gene sequences retrieved from biological databases. **(K3 – Apply)** **CO5:** Analyze experimental and computational data related to nucleic acids, gene expression, mutation and microbial genetics for scientific interpretation and problem-solving. **(K4 – Analyze)**
Mapping between COs and PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	■			■				
CO2	■	■				■		
CO3	■	■	■					
CO4	■			■				
CO5	■		■	■				■

Course Content

1. Extraction of bacterial genomic DNA from bacteria and Quantitative estimation of DNA
2. Extraction of RNA from yeast and Quantitative estimation of RNA
3. Isolation of Plasmid DNA.
4. Isolation of Auxotrophic Mutants by Replica Plating technique
5. Study of UV-Induced Mutation in Bacteria
6. Induction of β-Galactosidase Activity (lac Operon Demonstration)
7. Bacterial Transformation testing using agar plat methods
8. Open Reading Frame (ORF) Prediction
9. Retrieval and analysis of Gene Sequence from NCBI.

References

1. Patel, R. J., & Patel, R. K. Experimental Microbiology, Vol. 1, 10th Edition, Aditya, 2022
2. Patel, R.J., & Patel, R. K. Experimental Microbiology, Vol. 2, 10th Edition, Aditya, 2022.
3. Aneja, K. R., Experiments in Microbiology 4thed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.
4. Brown, T. A. (2020). *Gene Cloning and DNA Analysis: An Introduction* (8th ed.). Wiley-Blackwell.
5. Walker, J. M. (Ed.). (2009). *The Protein Protocols Handbook* (3rd ed.). Humana Press.
6. Cappuccino, J. G., & Welsh, C. (2018). Microbiology: A laboratory manual (11th global ed.). Pearson Education Limited.
7. Bossi, Camilli, Grundl, Experiments in Bacterial Genetics: A Laboratory Manual, Cold Spring Harbor Laboratory Press, 2023, ISBN 978-1621824497
8. Tiwari, R. P., Hoondal, G. S., & Tewari, R. (2004). Laboratory techniques in microbiology & biotechnology (1st ed.). Abhishek Publications ISBN 81-8247-077-3
9. Bisen, P. S. (2014). *Laboratory protocols in applied life sciences*. CRC Press.
10. Alexander, S. K., Strete, D., & Niles, M. J. (2003). *Laboratory exercises in organismal and molecular microbiology*. McGraw-Hill Higher Education
11. Saxena, J., Baunthiyal, M., & Ravi, I. (2015). *Laboratory manual of microbiology, biochemistry and molecular biology,* Scientific Publishers.

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive
Discussion, seminars, assignments, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MB-MJ-1002: MICROBIAL METABOLISM AND PHYSIOLOGICAL ADAPTATION

Program Name	**M.Sc.**
Semester	**M. Sc. SEM 1**
Credit Level	**6.0**
Course Type	**MAJOR**
Course Subtype	**MAJOR 2**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MB-MJ-1002**
Course Level	**500-599**
Course Title	**Microbial Metabolism and Physiological Adaptation**
Credit	Theory: 02 (30 Hours)
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	**Course Outcomes (COs)** Upon successful completion of this course, the students will be able to: **CO1:** Explain the principles of microbial metabolism, bioenergetics, ATP generation, redox reactions, metabolic pathways and cellular energy conservation mechanisms in microorganisms. **(K2 – Understand)** **CO2:** Apply the concepts of respiratory metabolism, fermentation, autotrophy, lithotrophy, methanogenesis, methanotrophy and phototrophy to understand microbial metabolic diversity and ecological adaptation. **(K3 – Apply)** **CO3:** Analyze anabolic pathways, biosynthetic processes and inorganic metabolism involved in the synthesis of cellular components and nutrient assimilation in microorganisms. **(K4 – Analyze)** **CO4:** Evaluate microbial regulatory mechanisms, including two-component regulatory systems, stress responses, sporulation and germination, in relation to microbial survival and physiological adaptation. **(K5 – Evaluate)** **CO5:** Assess the roles of biofilm formation, quorum sensing and metabolic engineering in microbial ecology, biotechnology and industrial applications. **(K5 – Evaluate)**
Mapping between COs and PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	■							
CO2	■	■			■			
CO3	■	■	■				■	
CO4	■					■		■
CO5		■	■		■		■	■

Course content	
UNIT 1: Metabolism and Bioenergetics	
1.1	Introduction to Microbial Metabolism, Important Principles and Concepts, ATP- the Major Energy Currency
1.2	Redox Reactions, Sequential Redox Reactions, Biochemical Pathways- Sets of Linked Chemical Reactions, Enzymes and Ribozymes, Metabolism regulation to maintain Homeostasis
1.3	Cellular Mechanisms for ATP Synthesis, Chemiosmotic Theory, ATP Synthase, The Proton Motive Force (PMF) Quantifying PMF,
1.4	Environmental Impacts on PMF
1.5	Oxidative decarboxylation of pyruvate, TCA cycle, Glyoxylate cycle, Anaplerotic reactions
1.6	Electron Transport and Oxidative Phosphorylation, Aerobic respiration, Anaerobic respiration, Energy yield comparison Fermentation Pathways: Propionate, Acetate, Lactate, Mixed-Acid and Butanediol Fermentation, and Butyrate Fermentation, Syntrophy Autotrophic Pathways: Concept of autotrophy, Calvin cycle, Reverse TCA cycle
1.7	C1 Metabolism: Acetogenesis, Methanogenesis, Methanotrophy Phototrophy (Light Reactions in Oxygenic Photosynthesis and in Anoxygenic Photosynthesis, Rhodopsin-Based Phototrophy
UNIT 2: Microbial Anabolism and Physiological Adaptation	
2.1	Lithotrophy: hydrogen-oxidizing bacteria, Ammonia-oxidizing bacteria, Nitrite-oxidizing bacteria, Sulfur-oxidizing prokaryotes, Iron-oxidizing bacteria
2.2	Inorganic metabolisms: Assimilation and Dissimilation of Nitrate and Sulfate, Nitrogen fixation: nitrogen-fixing systems and nitrogenase
2.3	Anabolism and Biosynthesis: concept of biosynthesis, Precursor Metabolites for Biosynthesis
2.4	Lipid Synthesis: Fatty Acids and Phospholipids, Sterols and Isoprenoid Lipids, Lipopolysaccharides, Synthesis of Peptidoglycan
2.5	Two component regulatory system
2.6	Microbial stress responses: oxidative stress, physiological response to oxidative stress in *E. coli*, heat shock response, sporulation, stages of sporulation, germination and regulation in *Bacillus subtilis*, resistance properties of endospores
2.7	Prevalence, Importance, Properties, and Regulation of Biofilm Formation, Quorum Sensing, Metabolic engineering of bacteria

References

1. Kim, B. H., & Gadd, G. M. (2008). Bacterial physiology and metabolism (2nd ed.). Cambridge University Press. ISBN-13 978-0-511-39322-8
2. Kumar, R. R., & Prasad, S. (2011). Metabolic engineering of bacteria. Indian Journal of Microbiology, 51(3), 403–409. https://doi.org/10.1007/s12088-011-0172-8

3. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., Stahl, D. A. (2018). Brock biology of microorganisms (15th ed.). Pearson.
4. Moat, A. G., Foster, J. W., & Spector, M. P. (2002). Microbial physiology (4th ed.). Wiley-Liss.
5. Stevens, A. M., Ditty, J. L., Parales, R. E., & Merkel, S. M. (2023). Microbial physiology: Unity and diversity. ASM Books / Wiley. ISBN: 978-1683673675
6. Stevens, A. M., Ditty, J. L., Parales, R. E., & Merkel, S. M. (2023). Microbial physiology: Unity and diversity. ASM Books / Wiley. ISBN: 978-1683673675
7. White, D., Drummond, J., & Fuqua, C. (2012). The physiology and biochemistry of prokaryotes (4th ed.). Oxford University Press.
8. Willey, J. M., Sandman, K. M., & Wood, D. H. (2023). Prescott's microbiology (12th ed.). McGraw-Hill Education. ISBN 978-1-265-12303-1

Online reference

https://swayam.gov.in/
https://swayam-plus.swayam2.ac.in/

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Evaluation scheme

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MBP-MJ-1002: MICROBIAL METABOLISM AND PHYSIOLOGICAL ADAPTATION PRACTICALS

Program Name	**M.Sc.**
Semester	**M. Sc SEM 1**
Credit Level	**6.0**
Course Type	**MAJOR**
Course Subtype	**MAJOR Practical 2**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MBP-MJ-1002**
Course Level	**500-599**
Course Title	**Microbial Metabolism and Physiological Adaptation Practical**
Credit	Theory: 02 (30 Hours)
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	**Course Outcomes (COs)** Upon successful completion of this practical course, the students will be able to: **CO1:** Perform experiments to evaluate the effects of environmental factors such as temperature, pH and bile salts on microbial growth, metabolism and physiological adaptation. **(K3 – Apply)** **CO2:** Demonstrate microbial metabolic activities, including carbohydrate utilization, sporulation and photosynthetic growth, using standard microbiological techniques. **(K3 – Apply)** **CO3:** Investigate microbial adaptive mechanisms such as biofilm formation and stress tolerance and interpret their ecological and physiological significance. **(K4 – Analyze)** **CO4:** Apply bioinformatics tools and biological databases to retrieve, analyze and interpret microbial metabolic pathways and stress response genes. **(K3 – Apply)** **CO5:** Analyze experimental and computational data related to microbial metabolism, physiological adaptation and environmental responses for scientific interpretation and problem-solving. **(K4 – Analyze)**
Mapping between COs and PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	■	■			■		■	
CO2	■	■			■			
CO3	■				■		■	
CO4	■			■	■			
CO5	■		■	■	■			■

Course Content

1. Study of Bacterial Growth Curve under stress conditions of temperature
2. Study of Bacterial Growth Curve under stress conditions of pH
3. Estimation of sugar utilization by yeast by DNSA method
4. Study of Sporulation by Endospore Staining
5. Study of Biofilm formation by tube method using crystal violet staining
6. Determination of sensitivity of gram positive and gram-negative bacteria to bile salts
7. Enrichment and Microscopic Observation of Photosynthetic Bacteria
8. Retrieval and Analysis of different Microbial Metabolic Pathways using KEGG Database

9 Retrieval and Analysis of Stress Response Genes in Microorganisms

References

1. Patel, R. J., & Patel, R. K. Experimental Microbiology, Vol. 1, 10th Edition, Aditya, 2022
2. Patel, R.J., & Patel, R. K. Experimental Microbiology, Vol. 2, 10th Edition, Aditya, 2022.
3. Aneja, K. R., Experiments in Microbiology 4thed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.
4. Cappuccino, J. G., Microbiology: A Laboratory Manual, 6Ed., Singapore Pearson Education Pvt. Ltd., 2005.
5. Cappuccino, J. G., & Welsh, C. (2018). Microbiology: A laboratory manual (11th global ed.). Pearson Education Limited.
6. Tiwari, R. P., Hoondal, G. S.,; Tewari, R. (2004). Laboratory techniques in microbiology; biotechnology (1st ed.). Abhishek Publications ISBN 81-8247-077-3
7. Saxena, J., Baunthiyal, M., & Ravi, I. (2015). *Laboratory manual of microbiology, biochemistry and molecular biology,* Scientific Publishers.

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive Discussions, seminars, assignments, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MB-MJ-1003: MICROBIAL BIOTECHNOLOGY

<table>
<tr><td>Program Name</td><td>M.Sc.</td></tr>
<tr><td>Semester</td><td>M. Sc SEM 1</td></tr>
<tr><td>Credit Level</td><td>6.0</td></tr>
<tr><td>Course Type</td><td>MAJOR</td></tr>
<tr><td>Course Subtype</td><td>MAJOR 3</td></tr>
<tr><td>Subject Type</td><td>Faculty of Science- Microbiology</td></tr>
<tr><td>Course Code</td><td>MB-MJ-1003</td></tr>
<tr><td>Course Level</td><td>500-599</td></tr>
<tr><td>Course Title</td><td>Microbial Biotechnology</td></tr>
<tr><td>Credit</td><td>Theory: 02 (30 Hours)</td></tr>
<tr><td>Effective From</td><td>Academic year: 2026-27</td></tr>
<tr><td>Course Outcomes (COs)</td><td>Course Outcomes (COs)
Upon successful completion of this course, the students will be able to:
CO1: Explain the principles of industrial microbiology, fermentation technology and microbial production processes involved in the manufacture of primary metabolites, enzymes and industrial bioproducts. (K2 – Understand)
CO2: Apply the concepts of microbial biotechnology for the production of organic acids, solvents, amino acids, vitamins, biofuels and other value-added microbial products. (K3 – Apply)
CO3: Analyze the production technologies, industrial applications and economic significance of secondary metabolites, biopolymers, biofertilizers, biopesticides, fermented beverages and therapeutic biomolecules. (K4 – Analyze)
CO4: Evaluate modern metabolic engineering strategies, including glycoengineering, gas fermentation and microbial electrosynthesis, for the development of sustainable bioprocesses and novel microbial products. (K5 – Evaluate)
CO5: Assess the applications of artificial intelligence, process analytical technology and machine learning in optimizing microbial production systems and industrial biotechnology processes. (K5 – Evaluate)</td></tr>
<tr><td>Mapping between COs and PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th><th>PSO7</th><th>PSO8</th></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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Course content

UNIT 1: Industrial Microbial Products and Fermentation Technologies	
1.1	Important microbes used in industrial microbiology and biotechnology: High throughput screening
1.2	Range of fermentation processes
1.3	Organic acids: Citric acid and Lactic acid
1.4	Amino acid: L-lysine; Vitamin: B12 & Riboflavin
1.5	Solvents: Ethanol and Bio-butanol
1.6	Biopolymers: PHAs and Exopolysaccharides: Xanthan.
1.7	Agricultural bioproducts: Microbial biopesticides, Siderophores and mycorrhizal biofertilizer
1.8	Alcohol-based fermented beverages: Beer and Wine
1.9	Therapeutics: mAbs, Insulin, Interferons, Antibiotics: Cephalosporins
UNIT 2: Metabolic Engineering and Intelligent Production Technologies	
2.1	Industrially important enzymes
2.2	Next generation biofuels from cyanobacteria and yeasts
2.3	AI-driven enzyme design: enzymes with tailored specificities
2.4	Glycoengineered microbes: humanized glycoproteins production
2.5	Gas fermentation by C1 pathway: industrial waste gases to bioplastics and SCPs
2.6	Microbial Electrosynthesis Systems: reduction of CO_2 into value-added chemicals
2.7	Process Analytical Technology: real-time monitoring of microbial product formation
2.8	Machine learning: reinforcement learning algorithms to maximize product yield

References

1. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2016). Principles of fermentation technology (3rd ed.). Elsevier.
2. Okafor, Nduka, and Benedict C. Okeke. *Modern Industrial Microbiology and Biotechnology*. Boca Raton, CRC Press, 2017.
3. Waites, M. J., N. L. Morgan, et al. *Industrial Microbiology: An Introduction*. Oxford, Blackwell Science, 2001.
4. Aehle, Wolfgang, editor. *Enzymes in Industry: Production and Applications*. 3rd ed., Weinheim, Wiley-VCH, 2007.
5. Stephanopoulos, Gregory, Aristos A. Aristidou, and Jens Nielsen. *Metabolic Engineering: Principles and Methodologies*. San Diego, Academic Press, 1998.
6. Crommelin, D. J. A., R. D. Sindelar, and Bernd Meibohm, editors.
7. Pharmaceutical Biotechnology: Fundamentals and Applications. 5th ed., Cham, Springer, 2019.
8. Kaplan, David L., editor. Biopolymers from Renewable Resources. Berlin, Springer, 1998
9. Pandey, Ashok, D. J. Lee, et al., editors. Biofuels from Algae. Amsterdam, Elsevier, 2014.

10. White, Chris, and Jamil Zainasheff. Yeast: The Practical Guide to Beer Fermentation. Boulder, Brewers Publications, 2010.
11. Guo, Peixuan, and Fazlul Haque, editors. RNA Nanotechnology and Therapeutics. Boca Raton, CRC Press, 2020.
12. Köpke, Michael, and Sean Simpson, editors. Gas Fermentation: Carbon Capture and Utilization. Cham, Springer, 2022.
13. Raghavan, P., and S. Ghosh. Machine Learning and Data Science in the Power Generation and Process Industries. Amsterdam, Elsevier, 2022.
14. Smolke, Christina D., editor. The Metabolic Pathway Engineering Handbook: Fundamentals and Applications. Boca Raton, CRC Press, 2010.

Online reference

1 https://swayam.gov.in/

2 https://swayam-plus.swayam2.ac.in/

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Evaluation scheme

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MBP-MJ-1003: MICROBIAL BIOTECHNOLOGY PRACTICALS

Program Name	**M.Sc.**		
Semester	**M. Sc SEM 1**		
Credit Level	**6**		
Course Type	**MAJOR**		
Course Subtype	**MAJOR Practical 3**		
Subject Type	**Faculty of Science- Microbiology**		
Course Code	**MBP-MJ-1003**		
Course Level	**500-599**		
Course Title	**Microbial Biotechnology Practical**		
Credit	Theory: 02	Practical: 02	Total: 04 (30 Hours)
Effective From	**Academic year: 2026-27**		
Course Outcomes (COs)	**Course Outcomes (COs)** Upon successful completion of this practical course, the students will be able to: **CO1:** Perform isolation, screening and characterization of industrially important microorganisms for the production of organic acids, exopolysaccharides and industrial enzymes. **(K3 – Apply)** **CO2:** Demonstrate microbial fermentation processes and evaluate the production of industrially important metabolites, enzymes and vitamins using standard biotechnological techniques. **(K3 – Apply)** **CO3:** Apply downstream processing techniques for purification and assessment of enzyme preparations, including determination of specific activity and fold purification. **(K3 – Apply)** **CO4:** Analyze microbial traits of industrial significance, including siderophore production and metabolite biosynthesis, and interpret their applications in biotechnology. **(K4 – Analyze)** **CO5:** Utilize biological databases and culture collection repositories to retrieve, analyze and evaluate industrially important microbial strains and their physiological and fermentation characteristics. **(K4 – Analyze)**		

Mapping between Cos and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	■	■	■				■	
CO2	■	■	■				■	■
CO3	■	■	■	■				■
CO4	■	■	■		■		■	■
CO5	■	■		■				■

Course Content

1. Isolation and screening of citric acid & lactic acid producing fungi
2. Isolation and screening of EPS producing bacteria
3. Screening of amylase- and cellulase-producing microorganisms
4. Production of amylase/ cellulase enzyme under solid State & submerged fermentation
5. Purification of amylase/ cellulase by ammonium sulphate and dialysis to determine specific activity and fold purification
6. CAS assay for siderophore production
7. Spectrophotometric estimation of Riboflavin /Vitamin B12
8. Exploration of National and International Microbial Culture Collection Databases for Retrieval and Analysis of Industrially Important Microbial Strains
9. Exploration of BacDive Database for Physiological and Fermentation Characteristics of Industrial Microorganisms

References

1. Patel, R. J., & Patel, R. K. Experimental Microbiology, Vol. 1, 10th Edition, Aditya, 2022
2. Patel, R.J., & Patel, R. K. Experimental Microbiology, Vol. 2, 10th Edition, Aditya, 2022.
3. Aneja, K. R., Experiments in Microbiology 4th ed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.
4. Cappuccino, J. G., & Welsh, C. (2018). Microbiology: A laboratory manual (11th global ed.). Pearson Education Limited.
5. Bisen, P. S. (2014). *Laboratory protocols in applied life sciences*. CRC Press.
6. Saxena, J., Baunthiyal, M., & Ravi, I. (2015). *Laboratory manual of microbiology, biochemistry and molecular biology,* Scientific Publishers.
7. Bartzatt, R., & Wol, T. (2014). Detection and assay of vitamin B-12 (riboflavin) in alkaline borate buffer with UV/visible spectrophotometry. International Scholarly Research Notices, 2014, Article 453085.

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive Discussions, seminars, assignments, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MB-MJ-1004 (BKS): TRADITIONAL PRACTICES IN MICROBIOLOGY

<table>
<tr><td>Program Name</td><td>M.Sc.</td></tr>
<tr><td>Semester</td><td>M. Sc. SEM 1</td></tr>
<tr><td>Credit Level</td><td>6.0</td></tr>
<tr><td>Course Type</td><td>MAJOR</td></tr>
<tr><td>Course Subtype</td><td>MAJOR 4</td></tr>
<tr><td>Subject Type</td><td>Faculty of Science- Microbiology</td></tr>
<tr><td>Course Code</td><td>MB-MJ-1004</td></tr>
<tr><td>Course Level</td><td>500-599</td></tr>
<tr><td>Course Title</td><td>Traditional practices in Microbiology</td></tr>
<tr><td>Credit</td><td>04 (60 Hours)</td></tr>
<tr><td>Effective From</td><td>Academic year: 2026-27</td></tr>
<tr><td>Course Outcomes (COs)</td><td>Course Outcomes (COs)
Upon successful completion of this course, the students will be able to:
CO1: Explain the historical development of microbiology, traditional knowledge systems and the contributions of ancient civilizations and Indian scholars to microbiological sciences. (K2 – Understand)
CO2: Apply the principles of microbial fermentation to understand the scientific basis of traditional fermented foods, beverages and indigenous fermentation practices. (K3 – Apply)
CO3: Analyze traditional food preservation methods, ethnomedicinal practices and natural antimicrobial agents in relation to microbial growth control, food safety and human health. (K4 – Analyze)
CO4: Evaluate traditional agricultural microbiological practices, including biofertilizers, biopesticides, composting and Panchagavya, for sustainable agriculture and environmental management. (K5 – Evaluate)
CO5: Assess the relevance of traditional microbiological knowledge in modern biotechnology, microbiome research, bioprospecting, intellectual property rights and ethical applications. (K5 – Evaluate)</td></tr>
<tr><td>Mapping between COs and PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th><th>PSO7</th><th>PSO8</th></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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Course content	
UNIT 1: HISTORICAL PERSPECTIVES & INDIGENOUS KNOWLEDGE IN MICROBIOLOGY	
1.1	History of microbiology: from ancient traditional practices to modern science
1.2	Role of microorganisms in ancient civilizations: Vedic, Egyptian, Mesopotamian perspectives
1.3	Traditional Indian practices and their microbial connections (Ayurveda, Siddha, Unani)
1.4	Contributions of Indian scholars (Jagadish Chandra Bose, Birbal Sahni) to microbiology
1.5	Ethnomicrobiology: definition, scope, and significance and Documentation and preservation of traditional microbiological knowledge
UNIT 2: TRADITIONAL FERMENTATION PRACTICES	
2.1	Principles of fermentation: aerobic vs. anaerobic, homo- and hetero-fermentation
2.2	Traditional fermented foods of India: Idli, Dosa, Dhokla, Jalebi, Kanji, Ambali, and Fermented dairy products: Dahi (curd), Lassi, Shrikhand, Paneer, Buttermilk
2.3	Traditional beverages: Toddy, Rice beer (Handia), Mahua wine, Neera, and Traditional fermented foods of tribal communities in Gujarat and India
2.4	Vinegar production: traditional methods
2.5	Quality, safety, and nutritional aspects of traditionally fermented products and Comparison of traditional vs. industrial fermentation processes
UNIT 3: TRADITIONAL FOOD PRESERVATION, NATURAL ANTIMICROBIALS	
3.1	Ancient and traditional methods of food preservation: sun-drying, salting, pickling and smoking
3.2	Microbiological basis of food spoilage and preservation techniques; Traditional Indian pickles (Achaar), Murabba and Papad: microbiology and role of spices
3.3	Ethnomedicinal plants with antimicrobial properties: Aloe vera, Garlic, Neem and Tulsi
3.4	Traditional wound-healing practices and antimicrobial significance; Use of honey, ghee and herbal oils as traditional antimicrobial agents
3.5	Phytochemicals and their mode of antimicrobial action;
3.6	Modern scientific validation of traditional antimicrobial agents (evidence-based approach)
UNIT 4: TRADITIONAL AGRICULTURAL MICROBIOLOGY & MODERN RELEVANCE	
4.1	Traditional soil enrichment practices: green manuring, crop rotation, mixed cropping and Traditional composting: Nadep, Vermicomposting, Pit composting – microbiological basis
4.2	Indigenous biofertilizer knowledge: Rhizobium inoculation, Azolla-Anabaena, Blue-Green Algae, and Traditional biopesticide practices: Panchagavya, Dashparni Ark, Brahmastra

4.3	Cow-based microbiological practices (Panchagavya): scientific validation and applications
4.4	Role of traditional practices in sustainable agriculture and organic farming
4.5	Integration of traditional microbiological knowledge into modern biotechnology, Bioprospecting of traditional practices: IPR issues and ethical considerations, Future perspectives: blending ethnomicrobiology with modern microbiome research

References

1. Pelczar, M.J., Chan, E.C.S. and Krieg, N.R. (2010). Microbiology: An Application Based Approach. Tata McGraw-Hill, New Delhi.
2. Prescott, L.M., Harley, J.P. and Klein, D.A. (2008). Microbiology (7th Ed.). McGraw-Hill Higher Education, New York.
3. Madigan, M.T., Martinko, J.M. and Brock, T.D. (2015). Brock Biology of Microorganisms (14th Ed.). Pearson Education.
4. Tortora, G.J., Funke, B.R. and Case, C.L. (2013). Microbiology: An Introduction (11th Ed.) Benjamin Cummings.
5. Campbell, I. and Plumbly, H. (2009). Fermentation Biotechnology: Principles, Processes and Products. Elsevier.
6. Prajapati, J.B. and Nair, B.M. (2008). The History of Fermented Foods. In: Farnworth, E.R. (Ed.), Handbook of Fermented Functional Foods. CRC Press.
7. Steinkraus, K.H. (1995). Handbook of Indigenous Fermented Foods (2nd Ed.). Marcel Dekker, New York.
8. Sathe, S.K. and Reddy, N.R. (2013). Traditional Foods: Status, Challenges and Opportunities. Springer.
9. Mukherjee, P.K. (2012). Quality Control and Evaluation of Herbal Drugs. Elsevier.
10. Chopra, R.N., Nayar, S.L. and Chopra, I.C. (1956). Glossary of Indian Medicinal Plants. CSIR, New Delhi.
11. Krishnamurthy, K.H. (2003). Bioresources of the Western Ghats: Ancient Traditions and Current Practices of the Nilgiri Biosphere Reserve People. Biosphere Reserve Information System. MSSRF.
12. Science History and Culture, Editor Jyoti Prakash Tamang, Springer, ISBN 978-981-15-1485-2, ISBN 978-981-15-1486-9 (eBook)
13. Fermented Foods and Beverages of the World, edited by Jyoti Prakash Tamang and Kasipathy Kailasapathy, CRC Press, ISBN 978-1-4200-9495-4

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https://niscair.res.in
https://www.icmr.gov.in
https://www.tkdl.res.in
https://www.youtube.com/watch?v=HnQE80P4OaY
https://www.youtube.com/watch?v=RzGd1uFMYb Y

Ethnobiology: Unveiling Indigenous Wisdom of Nature | Science Pulse
What Is Fermentation and How Does It Work? |
Successful Fermentation Tips | Esco Lifesciences
Traditional fermented foods of India (Cereal and Legume Based)
The Science of Fermentation - 9 Minutes Microlearning
Lactic Acid Bacteria and Fermented Foods: Benefits– Dr.Berg
The Science of Dahi: How Lactobacillus Transforms Milk into Curd
Ancient Food Preservation Methods: How People Kept Food Safe in 4000 BC |
History Pulse – YouTube Which Spices Kill Bacteria?
Ayurvedic Medicinal Plants and Uses | Medicinal Plants Name | Ancient Medicinal Plants in India
Maybelline New York Colossal Bubble | 20s
Kheti और Pashupalan में उपयोगी Panchagavya (पंचगव्य) | कैसे बनाते है Panchagavya (पंचगव्य) ?
Sustainable Agriculture, Organic Farming, Biofertilizer, Vermicomposting |Kinjal Choudhary

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Evaluation scheme

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MB-MDC- 1005 BIONANOTECHNOLOGY

<table>
<tr><td>Program Name</td><td>M. Sc.</td></tr>
<tr><td>Semester</td><td>M. Sc. SEM 1</td></tr>
<tr><td>Credit Level</td><td>6</td></tr>
<tr><td>Course Type</td><td>Multidisciplinary Course (MDC)</td></tr>
<tr><td>Course Subtype</td><td>MDC 1</td></tr>
<tr><td>Subject Type</td><td>Faculty of Science- Microbiology</td></tr>
<tr><td>Course Code</td><td>MB 1005</td></tr>
<tr><td>Course Level</td><td>500-599</td></tr>
<tr><td>Course Title</td><td>Bionanotechnology</td></tr>
<tr><td>Credit</td><td>04 (60 Hours)</td></tr>
<tr><td>Effective From</td><td>Academic year: 2026-27</td></tr>
<tr><td>Course Outcomes (COs)</td><td>Course Outcomes (COs)
Upon successful completion of this course, the students will be able to:
CO1: Explain the fundamental concepts of nanoscience, nanotechnology, nanomaterials and biological nanomachines, including their structure, properties and significance in biological systems. (K2 – Understand)
CO2: Apply the principles of nanoparticle synthesis, self-assembly and nanomaterial fabrication through physical, chemical and biological approaches. (K3 – Apply)
CO3: Analyze the working principles and applications of advanced characterization techniques used for nanomaterial analysis, including microscopy, diffraction and spectroscopic methods. (K4 – Analyze)
CO4: Evaluate the design, structure and functions of molecular nanodevices, DNA nanostructures and protein-based nanomachines for nanotechnological applications. (K5 – Evaluate)
CO5: Assess the applications of bionanotechnology in medicine, drug delivery, diagnostics, tissue engineering, agriculture, food technology and other emerging interdisciplinary fields. (K5 – Evaluate)</td></tr>
<tr><td>Mapping between COs and PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th><th>PSO7</th><th>PSO8</th></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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Course Content	
Unit 1: Fundamentals of Nanoscience and Biological Nanomachines	
1.1	Introduction to Nano-word: Nano, Nanometer; Nanoscience, Nanotechnology and Historical perspectives of nanotechnology
1.2	Types of Nanomaterials and Properties of Nanomaterials
1.3	Some Special Nanomaterials: Carbon Nanomaterials, Porous Material, Aerogels, Metamaterials and Bioinspired Materials
1.4	Introduction to Fundamentals of Bio Nanotechnology and In the Dominion of Biological machines
1.5	Nanomotors of Biological Systems: ATP Synthase and Flagellar Motors in Bacteria
Unit 2: Synthesis and Self-Assembly of Nanomaterials	
2.1	Approaches for Synthesis of Nanoparticles: Bottom-up & Top-down, Techniques for Synthesis of Nanostructures: Gas-, liquid- and solid-phase synthesis
2.2	Physical methods for nanomaterials synthesis
2.3	Chemical methods for nanomaterials synthesis
2.4	Biological methods for nanomaterials synthesis
2.5	Self-Assembly of Nanomaterials
Unit 3: Characterization Techniques in Nanotechnology	
3.1	Electron Microscopes: SEM and TEM
3.2	Scanning Probe Microscopes: STM and AFM
3.3	Diffraction Techniques: XRD and DLS
3.4	Spectroscopies: Optical Absorption, UV-Vis-NIR, Infra-Red & Dispersive Infra-Red, FTIR, Raman Spectroscopy
3.5	Magnetic Measurements and Mechanical Measurements
Unit 4: Molecular Nanotechnology and Applications of Bionanotechnology (15 Hours)	
4.1	Application of DNA Nanostructures in Molecular Nanotechnology: DNA-Based nanodevices i.e, B-Z Transition, Tweezers, Actuators, Scissors
4.2	Protein Nanomachines and protein nanoarchitectures i.e. Protein Cages, Rings, Tubes, Protein Nanostructure application i.e. as a data storage, FETs, VLP motors
4.3	Biomimicry at the nanoscale - nanomaterials inspired by nature
4.4	Applications of Carbon nanotubes in Diagnostic equipment; Surgical Supplements; Tissue Engineering; Gene Delivery, and Anticarcinogenic Activity; Drug Delivery; Neurodegenerative Disorder Therapy using Carbon Nanomaterials
4.5	Nanosizing Approaches in Drug Delivery (Bawa) and application of nanotechnology in Food, Agriculture and cosmetics

References

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3. Kulkarni, S. K. (2015). *Nanotechnology: Principles and practices* (3rd ed.). Springer. ISBN 978-3-319-09170-9
4. Rathinasamy, C. Parameswari and V. Ponnuswami, An introduction to Nanotechnology, New India Publishing Agency, ISBN: 978-93-81450-41-3
5. Bawa, R., Audette, G. F., & Rubinstein, I. (Eds.). (2016). *Handbook of clinical nanomedicine: Nanoparticles, imaging, therapy, and clinical applications*. Pan Stanford Publishing. ISBN 978-981-4669-21-4
6. Mundekkad, D., & Mallya, A. R. (2025). *Biomimicry at the nanoscale: A review of nanomaterials inspired by nature*. *Nano Trends, 10*, 100119.

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https://swayam-plus.swayam2.ac.in/
https://www.youtube.com/watch?v=clg0EQGRyOM
https://www.youtube.com/watch?v=evE08ycZfnM
https://www.youtube.com/watch?v=YhuUFLzJSsg
https://www.youtube.com/watch?v=tfn7Nn4jPxo
https://www.youtube.com/watch?v=Z51R49OOqAA
https://en.wikipedia.org/wiki/Characterization_of_nanoparticles

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Evaluation scheme

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MB-SEC-1006: EPIDEMIOLOGY

Program Name	**M. Sc.**
Semester	**M. Sc SEM 1**
Credit Level	**6**
Course Type	**Skill Enhancement Course (SEC)**
Course Subtype	**MB-SEC-1006**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MB-SEC-1006**
Course Level	**500-599**
Course Title	**Epidemiology**
Credit	02 (30 Hours)
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	**Course Outcomes (COs)** Upon successful completion of this course, the students will be able to: **CO1:** Explain the fundamental principles, concepts and methodologies of epidemiology, including disease causation, transmission dynamics, epidemiological triad, chain of infection and disease surveillance. **(K2 – Understand)** **CO2:** Apply epidemiological measures, study designs and screening approaches to investigate disease occurrence, distribution and determinants in populations. **(K3 – Apply)** **CO3:** Analyze epidemiological data related to incidence, prevalence, morbidity, mortality, outbreaks and epidemics for evidence-based public health decision-making. **(K4 – Analyze)** **CO4:** Evaluate the epidemiology of emerging and re-emerging infectious diseases, public health interventions and risk assessment strategies for disease prevention and control. **(K5 – Evaluate)** **CO5:** Assess the roles of national and international health organizations, surveillance systems and public health infrastructure in strengthening community health and disease management. **(K5 – Evaluate)**
Mapping between COs and PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	■					■		
CO2	■			■		■		
CO3	■		■	■		■		■
CO4	■	■			■	■		■
CO5		■				■	■	■

Course Content	
Unit 1: Principles of Epidemiology and Disease Dynamics	
1.1	Introduction to Epidemiology: Definition, scope objectives, historical development of epidemiology, epidemiological triad
1.2	Epidemiological Concepts: Chain of infection, Natural History, Iceberg Concept
1.3	Epidemiological Study Designs: Descriptive epidemiology, analytical epidemiology, experimental/interventional studies
1.4	Screening and Surveillance: Screening methods, sensitivity and specificity, predictive values, surveillance systems, disease prevention strategies
1.5	Immunoepidemiology: Herd immunity and basic immunoepidemiology
UNIT 2: Public Health Epidemiology and Disease Investigation	
2.1	Disease Occurrence and Frequency: Incidence and prevalence, morbidity and mortality indicators, attack rate and case fatality rate
2.2	Outbreak Investigation and Epidemic Analysis: Outbreaks and epidemics, outbreak investigation, epidemic curves, transmission dynamics, evidence for causation, and risk assessment.
2.3	Emerging and Re-emerging Infectious Diseases: Emerging pathogens, pandemic outbreaks
2.4	Emerging Challenges and Opportunities in Infectious Disease Epidemiology
2.5	Public Health and Community Health: Definition and scope of public health, origin and development, community health programs and public health functions
2.6	Public Health Interventions: Public health, epidemiology and ecological constrains
2.7	Health Organizations and Public Health Infrastructure: WHO, CDC, ICMR, NCDC, IDSP and public health infrastructure in India

References

1. Bonita R, Beaglehole R., & Kjellstrom T. (2006). Basic Epidemiology, 2nd edition, Geneva: World Health Organization.
2. Frérot, M., Lefebvre, A., Aho, S., Callier, P., Astruc, K., & Aho Glélé, L. S. (2018). What is epidemiology? Changing definitions of epidemiology 1978-2017. PLoS one, 13(12), e0208442.https://doi.org/10.1371/journal.pone.0208442
3. David Celentano & Moyses Szklo. Gordis Epidemiology, 6th edition, Elseveir.
4. Principles of Epidemiology in public health practice, 3rd edition. U.S. Department of health and human services. Centers for disease control and prevention.
5. Bhopal, RS. (2002). Concepts of Epidemiology: An Integrated Introduction to the Ideas, Theories, Principles and Methods of Epidemiology. Oxford: Oxford University Press
6. R. & Ranganathan, P. (2009). Study designs: Part 4–Interventional studies. Perspect Clin Res, 10:137-139.
7. Park, K. (2013) Park's textbook of Preventive and Social Medicine. Jabalpur: Bhanot Publishers.
8. Anderson B., Beins M. Auman A. and Walker J., (2024), Nester's Microbiology: A Human Perspective, Mc Graw Hill Publishers

9. Willey J., Sandman K., and Wood D., (2023), Prescott's Microbiology, 12th edition, Mc Graw Hill Publishers
10. Penny web, Chris Bain, & Andrew page (2017). Essential Epidemiology, An introduction for students and healthcare professional, 3rd edition, Cambridge University Press.
11. DeSalvo, K. B., Wang, Y. C., Harris, A., Auerbach, J., Koo, D., & O'Carroll, P. (2017). Public health 3.0: a call to action for public health to meet the challenges of the 21st century. Preventing chronic disease, 14, E78.
12. Goodman, R. A., Bunnell, R., & Posner, S. F. (2014). What is "community health"? Examining the meaning of an evolving field in public health. Preventive medicine, 67, S58-S61.
13. Park, K. (2013) Park's textbook of Preventive and Social Medicine. Jabalpur: Bhanot Publishers.
14. Chokshi, M., Patil, B., Khanna, R., Neogi, S. B., Sharma, J., Paul, V. K., & Zodpey, S. (2016). Health systems in India. Journal of Perinatology, 36(3), S9-S12.

Online reference

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https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_hs82
https://onlinecourses.swayam2.ac.in/e-learning/preview/ini25_hc04
https://www.who.int/teams/global-hiv-hepatitis-and-stis-programmes/covid-19
https://www.youtube.com/watch?v=CM5mJKqWLxc
https://www.youtube.com/watch?v=4oaQUAnA6nY
https://www.youtube.com/watch?v=82_gxpFx9xk

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Evaluation scheme

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MB-SEC-1006: SWAYAM MOOC: Provided from the SWAYAM/ NPTEL of 2 credits

This course requirement is fulfilled through a 2-credit Massive Open Online Course (MOOC) provided via the SWAYAM/NPTEL platform. Students will complete the designated online curriculum and earn academic credits upon successful assessment.

STRUCTURE FOR ERP – M.Sc. MICROBIOLOGY – SEM – 2 ONLY COURSE WORK AND ONE SEMESTER RESEARCH																	
Course Category	Course Code	Course Title	Mark sheet Title in English	Level of Course	Teaching Hours/Week		Exam Duration (Hours)		Credit		Internal Marks		External Marks		Total	
					TH	PR	TH	PR	TH	PR	TH	PR	TH	PR	TH	PR
MAJOR 1	MB – 2001	MOLECULAR BIOLOGY AND GENOME ENGINEERING	MOLECULAR BIOLOGY AND GENOME ENGINEERING	500-599	02	04	01.00	06.00	02	02	25	25	25	25	50	50
MAJOR 2	MB – 2002	ENVIRONMENTAL MICROBIOLOGY	ENVIRONMENTAL MICROBIOLOGY	500-599	02	04	01.00	06.00	02	02	25	25	25	25	50	50
MAJOR 3	MB – 2003	BIOPROCESS AND FERMENTATION TECHNOLOGY	BIOPROCESS AND FERMENTATION TECHNOLOGY	500-599	02	04	01.00	06.00	02	02	25	25	25	25	50	50
MAJOR 4	MB-2004 BKS	BIOPHYSICS ANALYTICAL BIOCHEMISTRY AND INSTRUMENTATION	BIOPHYSICS ANALYTICAL BIOCHEMISTRY AND INSTRUMENTATION	500-599	04	00	02.00	00	04	-	50	-	50	-	100	-
ME	MB-ME-2005	MICROBIAL BIOINFORMATICS AND OMICS TECHNOLOGIES/ENTERPRENEURSHIP	MICROBIAL BIOINFORMATICS AND OMICS TECHNOLOGIES/ ENTERPRENEURSHIP	500-599	04	00	02.00	00	04	-	50	-	50	-	100	-
SEC	MB-2006	BIOINOCULANTS AND ORGANIC FARMING/ SWAYAM MOOC/RESEARCH METHODOLOGY -2	BIOINOCULANTS AND ORGANIC FARMING/ SWAYAM MOOC/ RESEARCH METHODOLOGY -2	500-599	02	00	00	00	02	-	25	-	25	-	50	-

MB-MJ- 2001: MOLECULAR BIOLOGY AND GENOME ENGINEERING

Program Name	**M.Sc.**
Semester	**M. Sc SEM 2**
NCrF Credit Level	**6.0**
Course Type	**MAJOR**
Course Subtype	**MAJOR 1**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MB-MJ- 2001**
Course Level	**500–599**
Course Title	**Molecular Biology And Genome Engineering**
Credit	**02 (30 Hours)**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs):	Upon successful completion of this course, the students will be able to: **CO1:** Explain the principles of DNA isolation, DNA manipulation, restriction enzymes, ligation, gene transfer techniques and recombinant DNA technology used in genetic engineering. (K2 – Understand) **CO2:** Apply cloning strategies using plasmid, bacteriophage, cosmid, phasmid and expression vectors for construction, screening and expression of recombinant DNA libraries. (K3 – Apply) **CO3:** Analyse methods for gene expression regulation, recombinant selection and library screening in prokaryotic and eukaryotic systems. (K4 – Analyse) **CO4:** Evaluate protein-engineering approaches including directed evolution, site-directed mutagenesis, molecular simulations and protein microarray technologies for modifying protein structure and function. (K5 – Evaluate) **CO5:** Assess the applications of genome editing technologies, particularly CRISPR-Cas systems, in microbial biotechnology, healthcare, agriculture and industrial research. (K5 – Evaluate)
Mapping between COs and PSOs	

	PSO1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO-1	■	■	■					
CO-2	■	■	■					■
CO-3	■		■					■
CO-4	■		■	■				■
CO-5		■	■	■				■

Course Content	
Unit 1 Genetic Engineering	
1.1	Preparation of total cell DNA, plasmid and bacteriophage DNA
1.2	DNA manipulative enzymes and restriction endonucleases, Ligation - joining DNA molecules
1.3	Uptake of DNA by bacterial cells and Identification of recombinants
1.4	Introduction of phage DNA into bacterial cells and non-bacterial cells
1.5	Cloning vectors based on E. coli plasmids, λ bacteriophage, vectors for synthesis of single-stranded DNA
1.6	Vectors for yeast, fungi, higher plants and for animals
1.7	Cosmids, phasmids, other advanced vectors, Expression vectors
1.8	Screening and differential screening strategies available for library screening, Manipulation of Gene Expression in Prokaryotes
Unit 2 : Protein Engineering and Genome Editing Technologies	
2.1	Introduction of Protein Structure and function
2.2	Concepts for Protein Engineering
2.3	Computer Simulations: A Tool for Investigating the Function of Complex Biological Macromolecules
2.4	Evolutionary Methods for Protein Engineering (Methods for the directed evolution of proteins)
2.5	Directed Mutagenesis Procedures and Protein Engineering in various enzymes
2.6	DNA and Protein Microarray technology
2.7	CRISPR-Cas9 genome editing

Reference

1. Brown, T. A. (2021). *Gene cloning and DNA analysis: An introduction* (8th ed.). Wiley-Blackwell. ISBN 9781119640783
2. Reece, R. J. (2004). *Analysis of genes and genomes*. John Wiley & Sons.
3. Brown, T. A. (2021). Gene cloning and DNA analysis: An introduction (8th ed.). Wiley-Blackwell. ISBN 9781119640783
4. Primrose, S. B., & Twyman, R. M. (2006). *Principles of gene manipulation and genomics* (7th ed.). Blackwell Publishing.
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10. Pacesa, M., Pelea, O., & Jinek, M. (2024). Past, present, and future of CRISPR genome editing technologies. Cell, 187(5), 1076–1100. https://doi.org/10.1016/j.cell.2024.01.042

11. Li, T., Yang, Y., Qi, H., Cui, W., Zhang, L., Fu, X., He, X., Liu, M., Li, P.-F., & Yu, T. (2023). CRISPR/Cas9 therapeutics: Progress and prospects. *Signal Transduction and Targeted Therapy*, *8*(1), Article 36. https://doi.org/10.1038/s41392-023-01309-7
12. Rastogi, S., & Pathak, N. (2009). *Genetic engineering*. Oxford University Press, ISBN: 978-0195696578

Online Resources

1. NCBI – https://www.ncbi.nlm.nih.gov
2. Addgene – https://www.addgene.org
3. DNA Learning Center (CSHL) – https://dnalc.cshl.edu
4. EMBL-EBI – https://www.ebi.ac.uk
5. Protein Data Bank (PDB) – https://www.rcsb.org
6. UniProt – https://www.uniprot.org
7. AlphaFold Protein Structure Database – https://alphafold.ebi.ac.uk
8. Broad Institute CRISPR Resources – https://www.broadinstitute.org/what-broad/areas-focus/project-spotlight/crispr
9. NPTEL – https://nptel.ac.in
10. SWAYAM – https://swayam.gov.in
11. SWAYAM Plus- https://swayam-plus.swayam2.ac.in/

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MBP-MJ- 2001 Molecular Biology and Genome Engineering (Practical)

<table>
<tr><td>Program Name</td><td>M.Sc.</td></tr>
<tr><td>Semester</td><td>M. Sc SEM 2</td></tr>
<tr><td>Credit Level</td><td>6.0</td></tr>
<tr><td>Course Type</td><td>MAJOR</td></tr>
<tr><td>Course Subtype</td><td>MAJOR PRACTICAL 1</td></tr>
<tr><td>Subject Type</td><td>Faculty of Science- Microbiology</td></tr>
<tr><td>Course Code</td><td>MBP-MJ- 2001</td></tr>
<tr><td>Course Level</td><td>500–599</td></tr>
<tr><td>Course Title</td><td>Molecular Biology and Genome Engineering (Practical)</td></tr>
<tr><td>Credit</td><td>02 (30 Hours)</td></tr>
<tr><td>Effective From</td><td>Academic year: 2026-27</td></tr>
<tr><td>Course Outcomes (COs)</td><td>Upon completion of this practical course, the students will be able to
CO1: Perform fundamental molecular biology techniques including restriction digestion, DNA ligation, PCR amplification, and site-directed mutagenesis for genetic manipulation. (K3 – Apply)
CO2: Execute protein extraction, quantification, folding, and denaturation and renaturation experiments and interpret the relationship between protein structure and function. (K3 – Apply)
CO3: Apply bioinformatics tools for primer design, open reading frame identification, protein structure prediction and homology modelling. (K3 – Apply)
CO4: Analyze and visualize protein structures and evaluate computational approaches for protein engineering and functional prediction. (K4 – Analyze)
CO5: Utilize genome editing and computational biology tools including CRISPR-Cas9 guide RNA design for solving biological and biotechnological problems. (K4 – Analyze)</td></tr>
<tr><td>Mapping between COs and PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO 2</th><th>PSO 3</th><th>PSO 4</th><th>PSO 5</th><th>PSO 6</th><th>PSO 7</th><th>PSO 8</th></tr>
<tr><td>CO-1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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Course Content

I. Wet Lab. Exercise

1. Restriction digestion of DNA/ plasmid using restriction endonuclease
2. Ligation of DNA molecules
3. In vitro amplification of DNA by PCR
4. PCR Mediated Site Directed mutagenesis
5. Protein extraction from bacterial cells and estimation by Bradford/Lowry assay
6. Protein folding- denaturation and renaturation by Urea method

II. Dry Lab. Exercise

7. Primer Designing for PCR
8. Protein secondary structure prediction.
9. Homology modelling
10. Retrieval, analysis and visualization of protein structure
11. Open Reading Frame Finder
12. CRISPR-Cas9 Guide RNA Design by CHOPCHOP

Reference

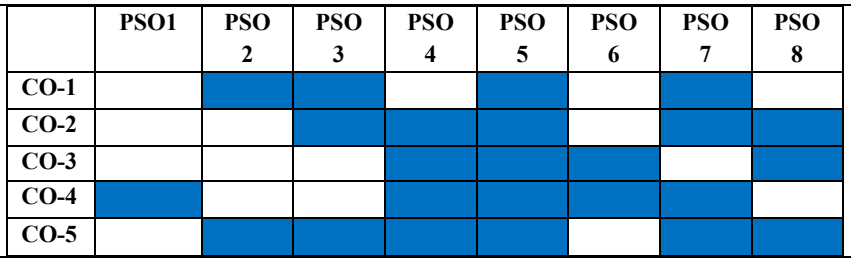
1. Sambrook, J., & Russell, D. W. (2001). *Molecular cloning: A laboratory manual* (3rd ed.). Cold Spring Harbor Laboratory Press.
2. Green, M. R., & Sambrook, J. (2019). *Molecular Cloning: A Laboratory Manual* (4th ed.). Cold Spring Harbor Laboratory Press.
3. Brown, T. A. (2020). *Gene Cloning and DNA Analysis: An Introduction* (8th ed.). Wiley-Blackwell.
4. Walker, J. M. (Ed.). (2009). *The Protein Protocols Handbook* (3rd ed.). Humana Press.
5. Cappuccino, J. G., & Welsh, C. (2018). Microbiology: A laboratory manual (11th global ed.). Pearson Education Limited.
6. Bisen, P. S. (2014). *Laboratory protocols in applied life sciences*. CRC Press.
7. Alexander, S. K., Strete, D., & Niles, M. J. (2003). *Laboratory exercises in organismal and molecular microbiology*. McGraw-Hill Higher Education
8. Aneja, K. R., Experiments in Microbiology 4thed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.
9. Saxena, J., Baunthiyal, M., & Ravi, I. (2015). *Laboratory manual of microbiology, biochemistry and molecular biology,* Scientific Publishers.
10. Bossi, Camilli, Grundl, Experiments in Bacterial Genetics: A Laboratory Manual, Cold Spring Harbor Laboratory Press, 2023, ISBN 978-1621824497
11. Tiwari, R. P., Hoondal, G. S., & Tewari, R. (2004). *Laboratory techniques in microbiology & biotechnology* (1st ed.). Abhishek Publications ISBN 81-8247-077-3
12. Baxevanis, A. D., & Ouellette, B. F. F. (Eds.). (2005). Bioinformatics: A practical guide to the analysis of genes and proteins (3rd ed.). Wiley-Interscience.
13. Mount, D. W. (2021). *Bioinformatics: Sequence and Genome Analysis* (5th ed.). Cold Spring Harbor Laboratory Press.
14. Lesk, A. M. (2019). *Introduction to Bioinformatics* (5th ed.). Oxford University Press.

Online Resources

1. Addgene Protocols – https://www.addgene.org/protocols/
2. New England Biolabs (NEB) Protocols and Tools – https://www.neb.com
3. Benchling Molecular Biology Platform – https://www.benchling.com
4. SnapGene Molecular Biology Resources – https://www.snapgene.com
5. NCBI BLAST and ORF Finder – https://www.ncbi.nlm.nih.gov
6. Primer3 for Primer Design – https://primer3.ut.ee
7. ExPASy Bioinformatics Resource Portal – https://www.expasy.org

8. SWISS-MODEL Homology Modelling Server – https://swissmodel.expasy.org 9. RCSB Protein Data Bank (PDB) – https://www.rcsb.org 10. AlphaFold Protein Structure Database – https://alphafold.ebi.ac.uk 11. CHOPCHOP CRISPR Design Tool – https://chopchop.cbu.uib.no 12. EMBL-EBI Training Portal – https://www.ebi.ac.uk/training
Teaching Methodology
The teaching methodology will involve laboratory experiments, and practical demonstrations to facilitate comprehensive experimental understanding of the subject.
Distribution of Marks
50% CCE: Internal assessment based on internal examination 50% SEE: External assessment based on semester-end university examination.

MB-MJ-2002: Environmental Microbiology

Program Name	**M.Sc.**
Semester	**M. Sc. SEM 2**
Credit Level	**6.0**
Course Type	**MAJOR**
Course Subtype	**MAJOR 2**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MB-MJ-2002**
Course Level	**500-599**
Course Title	**Environmental Microbiology**
Credit	**02 (30 Hours)**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	Upon completion of this practical course, the students will be able to **CO1:** Explain the principles and mechanisms involved in microbial degradation of organic and inorganic pollutants, waste treatment processes and environmental bioremediation technologies for sustainable environmental management. (K2) **CO2:** Analyze microbial processes involved in biofuel production, waste valorization, renewable bioenergy generation and circular bioeconomy applications. (K4) **CO3:** Evaluate environmental risks associated with GMOs, biosafety issues, environmental regulations and microbial threats in relation to environmental protection and public health. (K5) **CO4:** Assess the role of microorganisms in climate change mitigation, antimicrobial resistance dissemination, One Health approaches and ecosystem sustainability. (K5) **CO5:** Apply microbiological and biotechnological approaches for resource recovery, environmental restoration, sustainable agriculture and innovative environmental solutions. (K3)
Mapping between COs and PSOs	

Course Content	
Unit 1 : Bioremediation and Environmental Waste Management Technologies	
1.1	Degradation of hydrocarbons, Chlorinated Hydrocarbons and Aromatics, and Dioxins
1.2	Degradation of Xenobiotics Pesticides, Polymer and dye
1.3	Bioremediation with Inorganic Pollutants
1.4	Treatment of Waste from Organic Chemical Industries
1.5	Treatment of Waste from Food and Dairy Industries, Sugar and Distillery
1.6	Waste, Paper and Pulp industries
1.7	Pharmaceuticals and Hospital Waste Treatment
1.8	Treatment and management of Solid Waste, Treatment of Municipal Waste Insight of biofuel prospects From microalgae as Renewable energy source for Environmental sustainability
Unit 2 : Bioenergy, One Health and Sustainable Environmental Biotechnology	
2.1	Biodiesel, Transesterification for biodiesel, Biomethane and Biohydrogen
2.2	Conversion of Waste to Biofuels, Bioproducts, and Bioenergy
2.3	Cellulosic Ethanol Technology
2.4	Microbial Solutions for Climate Change Toward an Economically Resilient
2.5	Future, An Introduction to Sustainable Circular Bioeconomy,
2.6	Environmental risk assessment, biosafety, GMO release and environmental regulations. Microorganisms and Bioterrorism
2.7	A One-Health Perspective of Antimicrobial Resistance: Human, Animals and Environmental Health, The One Health resistome Microbially Induced Calcium Carbonate Precipitation (MICP) and Its Potential in Bioconcrete: Microbiological and Molecular Concepts

Reference

1. Barton, L. L., & Northup, D. E. (2011). Microbial ecology. John Wiley & Sons.
2. Doble, M. & Anil kumar. (2005). Biotreatment of industrial effluents. Butterworth Heinemannan imprint of Elsevier. (ISBN; 9780080456218)
3. Maddela, N. R., Eller, L. K. W., & Prasad, R. (Eds.). (2023). Microbiology for cleaner production and environmental sustainability. CRC Press.
4. Patwardhan, A. D. (2008). Industrial waste water treatment. PHI Learning.
5. Sangeetha, J., Thangadurai, D., David, M., & Abdullah, M. A. (Eds.). (2016). Environmental biotechnology: Biodegradation, bioremediation, and bioconversion of xenobiotics for sustainable development. Apple Academic Press.
6. Srinivas, T. (2008). Environmental biotechnology. New Age International Publishers.
7. Sukla, L. B., Pradhan, N., Panda, S., & Mishra, B. K. (Eds.). (2015). Environmental Microbial Biotechnology. Springer.
8. Evans, G. M., & Furlong, J. C. (2010). Environmental biotechnology: Theory and application (2nd ed.). Wiley-Blackwell.
9. Singh, V. (Ed.). (2025). Sustainable waste management towards circular bioeconomy: Components, design innovation and impact. Springer.

10. American Society for Microbiology, & International Union for Microbiological Societies. (2025). Microbial solutions for climate change: Toward an economically resilient future. ASM Reports. https://asm.org/reports/microbial-solutions-for-climate-change
11. Sungyu Lee and Shah Y.T., (2013). Biofuels and Bioenergy Processes and Technologies, CRC Press. (ISBN 978-1-4200-8955-4)
12. Maier, R. M., Pepper, I. L., & Gerba, C. P. (Eds.). (2009). Environmental microbiology (2nd ed.). Academic Press.
13. Al-Khalaifah, H.; Rahman, M.H.; Al-Surrayai, T.; Al-Dhumair, A.; Al-Hasan, M. A One-Health Perspective of Antimicrobial Resistance (AMR): Human, Animals and Environmental Health. Life 2025, 15, 1598. https://doi.org/10.3390/ life15101598
14. Majumdar, A., Bagchi, D., Kotta-Loizou, I., & Buck, M. (2026). The One Health resistome: Integrating environmental, microbial, and human antimicrobial resistance surveillance and risk analysis in the digital age. Journal of Hazardous Materials, 513, Article 142431.
15. Castro-Alonso, M. J., Montañez-Hernandez, L. E., Sanchez-Muñoz, M. A., Macias Franco, M. R., Narayanasamy, R., & Balagurusamy, N. (2019). Microbially induced calcium carbonate precipitation (MICP) and its potential in bioconcrete: Microbiological and molecular concepts. Frontiers in Materials, 6, Article 126.

Online resources

1. SWAYAM https://swayam.gov.in
2. NPTEL https://nptel.ac.in
3. World Health Organization (WHO) https://www.who.int
4. Food and Agriculture Organization (FAO) https://www.fao.org
5. United Nations Environment Programme (UNEP) https://www.unep.org
6. Bioremediation and biodegradation [https://youtu.be/OskyBh4MDy4?si=i-mD149KV2FdpOw0]
7. Biodegradation of pesticides [https://youtu.be/tffTDCnuvwY?si=rqeiVGzYOIhKo5wB]
8. Biodegradation of heavy metals [https://youtu.be/nO21I-UvA9I?si=Po7mWIuCxOZPj5Js]
9. Biodegradation[https://youtu.be/qhqlLZKhsYQ?si=UKsVtqnvCwnFtzZD]
10. https://frtr.gov/matrix/documents/Monitored-Natural-Attenuation/2006-In-Situ-and-Ex-Situ-Biodegradation-Technologies-for-Remediation-of-Contaminated-Sites.PDF

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MBP-MJ-2002: Environmental Microbiology Practical

<table>
<tr><td>Program Name</td><td>M.Sc.</td></tr>
<tr><td>Semester</td><td>M. Sc. SEM 2</td></tr>
<tr><td>Credit Level</td><td>6.0</td></tr>
<tr><td>Course Type</td><td>MAJOR</td></tr>
<tr><td>Course Subtype</td><td>MAJOR Practical 2</td></tr>
<tr><td>Subject Type</td><td>Faculty of Science- Microbiology</td></tr>
<tr><td>Course Code</td><td>MBP-MJ-2002</td></tr>
<tr><td>Course Level</td><td>500-599</td></tr>
<tr><td>Course Title</td><td>Environmental Microbiology Practical</td></tr>
<tr><td>Credit</td><td>02 (30 Hours)</td></tr>
<tr><td>Effective From</td><td>Academic year: 2026-27</td></tr>
<tr><td>Course Outcomes (COs)</td><td>Upon completion of this practical course, the students will be able to
CO1: Perform laboratory techniques for assessment of microbial tolerance to environmental pollutants, biodegradation of xenobiotics and evaluation of microbial remediation potential. (K3)
CO2: Analyze environmental quality parameters and microbial indicators using BOD, COD and antimicrobial susceptibility testing for environmental monitoring and public health assessment. (K4)
CO3: Isolate, characterize and evaluate environmentally significant microorganisms including microalgae and pollutant-degrading microbial communities. (K4)
CO4: Apply computational tools for community metagenomic analysis to assess microbial diversity, community structure and ecological functions in environmental samples. (K3)
CO5: Interpret functional metagenomic datasets to identify metabolic pathways, biodegradation potential and environmental applications of microbial communities. (K5)</td></tr>
<tr><td>Mapping between COs and PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO 2</th><th>PSO 3</th><th>PSO 4</th><th>PSO 5</th><th>PSO 6</th><th>PSO 7</th><th>PSO 8</th></tr>
<tr><td>CO-1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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Course Content

1. Study of heavy metal tolerance by environmental microorganisms.
2. Pesticide tolerance assay of environmental microorganisms.
3. Biodegradation of pesticide by microbial isolates.
4. Microbial degradation of synthetic dyes (methylene blue/crystal violet) and evaluation of decolourization efficiency.
5. Estimation of Biochemical Oxygen Demand (BOD).
6. Estimation of Chemical Oxygen Demand (COD).
7. Isolation and characterization of microalgae from environmental samples.
8. Antibiotic susceptibility testing of environmental isolates
9. Computational analysis of Community metagenomics
10. Computational analysis of Functional metagenomics

References:

1. Ian L. Pepper, Charles P. Gerba, Terry J. Gentry, Environmental Microbiology: A Laboratory Manual, 2nd Ed. Academic Press
2. Glazer Alexander N., Nikaido Hiroshi, Microbial Biotechnology: Fundamentals of Applied Microbiology, 2nd Edition, Cambridge University Press
3. Agathos Spiros and Reineke Walter, Biotechnology for the Environment: Strategy and Fundamentals, Series: Advances in Biochemical Engineering/Biotechnology, Vol. 81, Springer.
4. Cappuccino, J. G., & Welsh, C. (2018). Microbiology: A laboratory manual (11th global ed.). Pearson Education Limited.
5. Bisen, P. S. (2014). *Laboratory protocols in applied life sciences*. CRC Press.
6. Alexander, S. K., Strete, D., & Niles, M. J. (2003). *Laboratory exercises in organismal and molecular microbiology*. McGraw-Hill Higher Education
7. Aneja, K. R., Experiments in Microbiology 4thed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.
8. Saxena, J., Baunthiyal, M., & Ravi, I. (2015). *Laboratory manual of microbiology, biochemistry and molecular biology,* Scientific Publishers.
9. Bossi, Camilli, Grundl, Experiments in Bacterial Genetics: A Laboratory Manual, Cold Spring Harbor Laboratory Press, 2023, ISBN 978-1621824497
10. Tiwari, R. P., Hoondal, G. S., & Tewari, R. (2004). *Laboratory techniques in microbiology & biotechnology* (1st ed.). Abhishek Publications ISBN 81-8247-077-3

Online resources

1. National Center for Biotechnology Information (NCBI) https://www.ncbi.nlm.nih.gov
2. PubMed https://pubmed.ncbi.nlm.nih.gov
3. United Nations Environment Programme (UNEP) https://www.unep.org

4. World Health Organization (WHO) – One Health & Antimicrobial Resistance Resources
   https://www.who.int
5. Food and Agriculture Organization (FAO)
   https://www.fao.org
6. Intergovernmental Panel on Climate Change (IPCC)
   https://www.ipcc.ch
7. Department of Biotechnology (DBT), Government of India
   https://dbtindia.gov.in
8. Genetic Engineering Appraisal Committee (GEAC), Government of India
   https://geacindia.gov.in

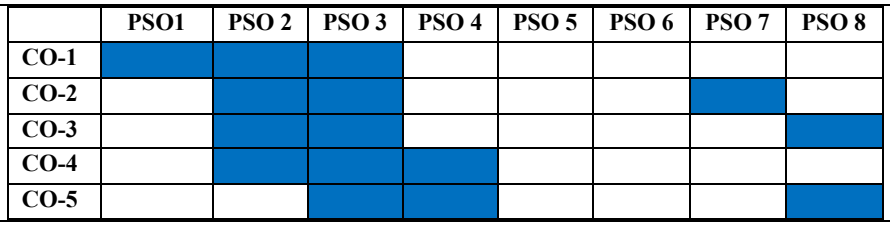
Teaching Methodology

The teaching methodology will involve laboratory experiments, and practical demonstrations to facilitate comprehensive experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on internal examination 50% SEE: External assessment based on semester-end university examination.

MB-MJ-2003: Bioprocess and Fermentation Technology

Program Name	**M.Sc.**
Semester	**M. Sc. SEM 2**
Credit Level	**6**
Course Type	**MAJOR**
Course Subtype	**MAJOR 3**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MB-MJ-2003**
Course Level	**500-599**
Course Title	**Bioprocess and Fermentation Technology**
Credit	**02 (30 Hours)**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	Upon successful completion of this course, the students will be able to: **CO1:** Explain the principles of industrial microbiology, strain improvement, culture preservation, inoculum development, fermentation media formulation and microbial growth kinetics used in bioprocess industries. (K2 – Understand) **CO2:** Apply concepts of submerged and solid-state fermentation, media optimization and process parameters for efficient microbial cultivation and product formation. (K3 – Apply) **CO3:** Analyze aeration, agitation, oxygen transfer, scale-up and scale-down strategies for the design and operation of industrial bioprocesses. (K4 – Analyze) **CO4:** Evaluate downstream processing techniques including filtration, centrifugation, cell disruption, extraction and purification methods for recovery of bioproducts. (K5 – Evaluate) **CO5:** Assess modern bioprocess technologies including heterologous protein production, synthetic biology platforms and Bioprocessing 4.0 for industrial and biotechnological applications. (K5 – Evaluate)
Mapping between COs and PSOs	

Course Content	
Unit 1 : Upstream Processing and Fermentation Technology	
1.1	Isolation of suitable microorganisms from the environment, Culture collections, Improvement of industrial microorganisms, Strain stability,
1.2	Culture preservation: Storage at reduced temperature, storage in a dehydrated form and quality control of preserved stock cultures
1.3	Fermentation media, formulation, Carbon sources Nitrogen source Minerals & others growth factor, precursors, inducers inhibitors, Oxygen requirement, Antifoam and Statistical media Optimization
1.4	Microbial growth kinetics: Batch culture, Continuous culture, Fed-batch culture
1.5	Inoculum development, inoculum transfer, Development of inocula for yeast processes and bacteria
1.6	Introduction to Solid-state fermentation, Suitability of Microorganisms for SSF Processes Biomass Measurement, Factors Affecting SSF, Scale-Up, Modeling in SSF, Types of SSF Bioreactors
1.7	Sterilization and Contamination Control: Sterilization of media, air and equipment; filtration systems; contamination sources; aseptic operation; biosafety and GMP considerations.
1.8	Process Monitoring and Control**:** Measurement and control of temperature, pH, dissolved oxygen, foam, pressure and biomass; sensors, biosensors and process automation
Unit 2 : Downstream Processing and Modern Bioprocess Engineering	
2.1	Aeration and agitation: Introduction, Oxygen requirements of industrial fermentations, Oxygen supply, Determination of KLa values, Fluid rheology, Factors affecting KLa values in fermentation vessels,
2.2	Scale-Up and Scale-Down
2.3	Downstream Processing: Cell harvesting, filtration, centrifugation, cell disruption, extraction, precipitation, membrane separation, chromatography and product formulation.
2.4	Cell disruption by Physico-mechanical methods, Chemical and biological methods
2.5	Products purification: Liquid–liquid extraction, Solvent recovery, Two-phase aqueous extraction, Reversed micelle extraction, Supercritical fluid extraction, Adsorption, Removal of volatile products, Drying, Crystallization
2.6	Recent Advances and Impacts of Microtiter Plate-Based Fermentations in Synthetic Biology and Bioprocess Development
2.7	Emerging trends in bioprocess technology: microbiome microbiome-based biotechnology, omics-guided bioprocessing, AI-assisted fermentation, continuous biomanufacturing and Industry applications.
References:	
1. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2016). *Principles of fermentation technology* (3rd ed.). Elsevier Science & Technology.	

2. Waites, M. J., Morgan, N. L., Rockey, J. S., & Higton, G. (2001). *Industrial microbiology: An introduction*. Blackwell Science.
3. Okafor, N., & Okeke, B. C. (2017). *Modern industrial microbiology and biotechnology* (2nd ed.). CRC Press.
4. El-Mansi, E. M. T., Nielsen, J., Mousdale, D., Allman, T., & Carlson, R. (Eds.). (2019). *Fermentation microbiology and biotechnology* (4th ed.). CRC Press.
5. Isoko, K., Cordiner, J. L., Kis, Z., & Moghadam, P. Z. (2024). Bioprocessing 4.0: A pragmatic review and future perspectives. *Digital Discovery*, *3*(9), 1662–1681. https://doi.org/10.1039/d4dd00127c

Online Resources

1. Addgene – https://www.addgene.org
2. New England Biolabs (NEB) Protocols and Technical Resources – https://www.neb.com/tools-and-resources
3. Thermo Fisher Scientific Learning Center – https://www.thermofisher.com
4. Cytiva Bioprocess Resource Center – https://www.cytivalifesciences.com
5. BioProcess International – https://www.bioprocessintl.com
6. EMBL-EBI Training Portal – https://www.ebi.ac.uk/training
7. NPTEL – https://nptel.ac.in
8. SWAYAM – https://swayam.gov.in

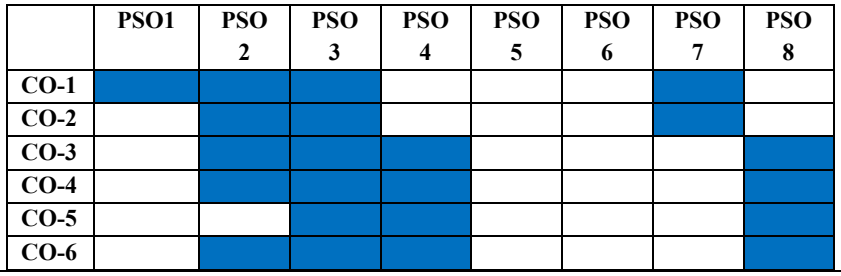
Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning and demonstrations to facilitate comprehensive theoretical understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination

MBP-MJ-2003: Bioprocess and Fermentation Technology Practical

Program Name	**M.Sc.**
Semester	**M. Sc. SEM 2**
Credit Level	**6.0**
Course Type	**MAJOR**
Course Subtype	**MAJOR Practical 3**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MBP-MJ-2003**
Course Level	**500-599**
Course Title	**Bioprocess and Fermentation Technology Practical**
Credit	**02 (30 Hours)**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	Upon successful completion of this practical course, the students will be able to: **CO1**: Prepare and optimize fermentation media, develop inocula, cultivate industrial microorganisms and evaluate microbial growth and biomass production using standard bioprocess techniques. (K3 – Apply) **CO2:** Perform fermentation processes for the production of organic acids and industrially important enzymes under submerged and solid-state fermentation systems. (K3 – Apply) **CO3:** Analyze bioprocess parameters including oxygen transfer, biomass formation and fermentation performance using appropriate analytical methods. (K4 – Analyze) **CO4:** Operate laboratory-scale bioreactors and perform downstream processing techniques including cell harvesting, product recovery and partial purification. (K3 – Apply) **CO5:** Apply statistical experimental design tools for media optimization and process improvement in bioprocess development. (K4 – Analyze) **CO6:** Evaluate fermentation products using chromatographic, spectrophotometric and other analytical techniques for quality assessment and process optimization. (K5 – Evaluate)
Mapping between COs and PSOs	

Course content

1. Preparation and optimization of fermentation media for microbial growth and product formation.
2. Cell harvesting by centrifugation and filtration techniques and Estimation of biomass concentration by spectrophotometric and dry cell weight methods.
3. Production and quantification of citric acid by Aspergillus niger fermentation.
4. Production and assay of industrially important enzymes (protease/cellulase) under submerged fermentation.
5. Production of microbial enzymes under solid-state fermentation using agro-industrial substrates.
6. Determination of oxygen transfer characteristics and estimation of volumetric oxygen transfer coefficient (kLa).
7. Recovery and partial purification of fermentation products by precipitation and membrane filtration methods.
8. Demonstration and operation of laboratory-scale fermenter/bioreactor and study of its components.
9. Analysis of fermentation products using chromatographic or spectrophotometric methods.
10. Use of Plackett-Burman-design-calculator for screening
11. Use of Optimization design using Box-Behnken Design or Central Composite Design

References:

1. Walker, J. M. (Ed.). (2009). *The Protein Protocols Handbook* (3rd ed.). Humana Press.
2. Cappuccino, J. G., & Welsh, C. (2018). Microbiology: A laboratory manual (11th global ed.). Pearson Education Limited.
3. Bisen, P. S. (2014). *Laboratory protocols in applied life sciences*. CRC Press.
4. Alexander, S. K., Strete, D., & Niles, M. J. (2003). *Laboratory exercises in organismal and molecular microbiology*. McGraw-Hill Higher Education
5. Aneja, K. R., Experiments in Microbiology 4thed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.
6. Saxena, J., Baunthiyal, M., & Ravi, I. (2015). *Laboratory manual of microbiology, biochemistry and molecular biology,* Scientific Publishers.
7. Bossi, Camilli, Grundl, Experiments in Bacterial Genetics: A Laboratory Manual, Cold Spring Harbor Laboratory Press, 2023, ISBN 978-1621824497
8. Tiwari, R. P., Hoondal, G. S., & Tewari, R. (2004). *Laboratory techniques in microbiology & biotechnology* (1st ed.). Abhishek Publications ISBN 81-8247-077-3

Online Resources

1. Addgene Protocols – https://www.addgene.org/protocols
2. New England Biolabs (NEB) Protocols – https://www.neb.com/protocols

3. Thermo Fisher Scientific Learning Center – https://www.thermofisher.com
4. Cytiva Bioprocess Resource Center – https://www.cytivalifesciences.com
5. EMBL-EBI Training Portal – https://www.ebi.ac.uk/training
6. BioProcess International – https://www.bioprocessintl.com
7. NPTEL Biotechnology Courses – https://nptel.ac.in
8. SWAYAM – https://swayam.gov.in
9. JMP Learning Library – https://www.jmp.com/en_us/learning-library.html

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, Laboratory exercises and practical, demonstrations to facilitate comprehensive theoretical understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, practical test, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination

MB-MJ-2004: Biophysics, Analytical Biochemistry and Instrumentation

<table>
<tr><td>Program Name</td><td>M.Sc.</td></tr>
<tr><td>Semester</td><td>M. Sc. SEM 2</td></tr>
<tr><td>Credit Level</td><td>6.0</td></tr>
<tr><td>Course Type</td><td>MAJOR</td></tr>
<tr><td>Course Subtype</td><td>MAJOR 4</td></tr>
<tr><td>Subject Type</td><td>Faculty of Science- Microbiology</td></tr>
<tr><td>Course Code</td><td>MB-MJ-2004</td></tr>
<tr><td>Course Level</td><td>500-599</td></tr>
<tr><td>Course Title</td><td>Biophysics, Analytical Biochemistry and Instrumentation</td></tr>
<tr><td>Credit</td><td>04 (60 Hours)</td></tr>
<tr><td>Effective From</td><td>Academic year: 2026-27</td></tr>
<tr><td>Course Outcomes (COs)</td><td>Upon successful completion of this practical course, the students will be able to:
CO1: Explain the principles of biophysical chemistry, chromatography, electrophoresis and their applications in biological and biochemical investigations. (K2 – Understand)
CO2: Apply the principles of spectroscopic, microscopic and centrifugation techniques for analysis and characterization of biomolecules and biological systems. (K3 – Apply)
CO3: Analyze molecular structure determination methods, advanced analytical techniques and nucleic acid quantification approaches used in modern biological research. (K4 – Analyze)
CO4: Evaluate the applications of mass spectrometry, PCR variants, flow cytometry, biosensors and imaging technologies in microbiology, biotechnology and biomedical sciences. (K5 – Evaluate)
CO5: Assess immunological, radiolabeling and electrophysiological techniques and their significance in diagnostics, research and healthcare applications. (K5 – Evaluate)</td></tr>
<tr><td>Mapping between COs and PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO 2</th><th>PSO 3</th><th>PSO 4</th><th>PSO 5</th><th>PSO 6</th><th>PSO 7</th><th>PSO 8</th></tr>
<tr><td>CO-1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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Course content	
Unit 1: Biophysical Chemistry, Chromatographic and Electrophoretic Techniques	
1.1	Principles of biophysical chemistry: pH, buffer, reaction kinetics, thermodynamics, colligative properties
1.2	An Introduction to Chromatographic Separations, Principle, instrumentation and applications of Paper chromatography, Thin Layer Chromatography (TLC),
1.3	Principle, instrumentation and applications of Adsorption chromatography, Partition chromatography, Ion Exchange Chromatography, Size Exclusion (Gel Filtration) Chromatography, Affinity Chromatography,
1.4	Principle, instrumentation and applications of Gas Chromatography (GC) and High-Performance Liquid Chromatography (HPLC)
1.5	Electrophoresis: General principles, support media and buffers, electrophoresis of proteins, electrophoresis of nucleic acids, capillary electrophoresis and microchip electrophoresis.
Unit 2: Spectroscopy, Structural Biology and Advanced Analytical Techniques	
2.1	Spectroscopic Techniques for Biomolecular Analysis**:** UV–Visible Spectroscopy, Fluorescence Spectroscopy, Circular Dichroism (CD) Spectroscopy, Electron Spin Resonance (ESR/EPR) Spectroscopy
2.2	Structural Biology and Molecular Structure Determination: X-ray Diffraction (X-ray Crystallography), Cryo-Electron Microscopy (Cryo-EM), Nuclear Magnetic Resonance (NMR) Spectroscopy in Structure Determination
2.3	Advanced Molecular Characterization and Interaction Analysis: Light Scattering Techniques, Mass Spectrometry and its Types, Surface Plasmon Resonance (SPR)
2.4	Advanced Analytical Techniques: MALDI-TOF Mass Spectrometry, Liquid Chromatography–Mass Spectrometry (LC-MS) and Liquid Chromatography–Tandem Mass Spectrometry (LC-MS/MS)
2.5	Principle of Centrifugation, Differential centrifugation, density-gradient centrifugation, ultracentrifugation
Unit 3: Molecular Analysis, Quantification and Imaging Technologies	
3.1	Infrared and Raman Spectroscopy and Atomic Spectroscopy, Fluorescence Spectroscopy
3.2	PCR, Q-PCR, ddPCR and other variants of PCR,
3.3	Spectrophotometric and fluorometric nucleic acid quantification (Nanodrop and Qubit), Nucleic acid hybridization,
3.4	Protein Sequencing: Significance, Methods, and Applications
3.5	Confocal microscopy, fluorescence imaging, transmission electron microscopy (TEM), scanning electron microscopy (SEM), cryo-electron microscopy (Cryo-EM), Atomic Force Microscopy (AFM)

Unit 4: Cellular Analysis, Immunotechniques and Biomedical Instrumentation	
4.1	Principles, instrumentation and application of flow cytometry
4.2	Radiolabeling techniques: Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines
4.3	Histochemical and Immunotechniques: ELISA, RIA, blotting techniques, immunofluorescence, immunoprecipitation, FISH and GISH techniques.
4.4	Concept, types and application biosensors
4.5	Electrophysiological methods: Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT

Reference

1. Nelson, D. L., Cox, M. M., Hoskins, A. A., & Lehninger, A. L. (2021). *Lehninger principles of biochemistry* (8th ed.). W. H. Freeman and Company
2. Kumar, P. (2024). *Biophysics and molecular biology: Tools and techniques* (5th ed.). Pearson India.
3. Kumar, P. (2018). *Fundamentals and techniques of biophysics and molecular biology* (2nd ed.). Pathfinder Publication.
4. Kalidas, C., & Sangaranarayanan, M. V. (2023). *Biophysical Chemistry: Techniques and Applications* (1st ed.). Springer International Publishing.
5. Hofmann, A., & Clokie, S. J. (Eds.). (2018). *Wilson and Walker's principles and techniques of biochemistry and molecular biology* (8th ed.). Cambridge University Press.
6. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2018). *Principles of instrumental analysis* (7th ed.). Cengage Learning.
7. Mekonen, A. A., & Ali, A. (2023). A review on principles of FISH and GISH and its role in cytogenetic study. *Global Research in Environment and Sustainability*, *1*(4), 15–26.
8. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. (2021). *Brock biology of microorganisms* (16th ed.). Pearson
9. Chatwal, G. R., & Anand, S. K. (2019). *Instrumental methods of chemical analysis* (5th ed.). Himalaya Publishing House.
10. https://www.metwarebio.com/what-is-protein-sequencing/

Online Resources

1. https://www.metwarebio.com/what-is-protein-sequencing/
2. National Center for Biotechnology Information (NCBI) – https://www.ncbi.nlm.nih.gov
3. EMBL-European Bioinformatics Institute (EMBL-EBI) – https://www.ebi.ac.uk
4. ExPASy Bioinformatics Resource Portal – https://www.expasy.org
5. Protein Data Bank (PDB) – https://www.rcsb.org
6. UniProt Protein Knowledgebase – https://www.uniprot.org
7. PubChem Chemical Database – https://pubchem.ncbi.nlm.nih.gov
8. NIST Chemistry WebBook – https://webbook.nist.gov
9. MicroscopyU (Nikon Microscopy Education) – https://www.microscopyu.com
10. Thermo Fisher Learning Center – https://www.thermofisher.com/in/en/home/global/forms/life-science/learning-center.html

11. NPTEL Courses – https://nptel.ac.in
12. SWAYAM – https://swayam.gov.in

Teaching Methodology
The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning and demonstrations to facilitate comprehensive theoretical understanding of the subject.
Distribution of Marks
50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination

MB-ME-2005: Microbial Bioinformatics and Omics Technologies

Program Name	**M.Sc.**
Semester	**M. Sc. SEM 2**
Credit Level	**6**
Course Type	**MAJOR**
Course Subtype	**MAJOR 4 Pracricals**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MB-MDC-2005**
Course Level	**500–599**
Course Title	**Microbial Bioinformatics and Omics Technologies**
Credit	**04 (60 Hours)**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	Upon successful completion of this course, the students will be able to: **CO1:** Explain the fundamental concepts of bioinformatics, biological databases, sequence alignment methods, phylogenetic analysis and their applications in microbiological research. (K2 – Understand) **CO2:** Apply genome sequencing technologies, quality control methods, genome assembly, annotation tools and comparative genomics approaches for microbial genome analysis. (K3 – Apply) **CO3:** Analyze microbial genomes, metagenomes, transcriptomes and metabolomic datasets for classification, identification and functional interpretation of microorganisms. (K4 – Analyze) **CO4:** Evaluate protein structure, protein function, molecular interactions and computational approaches including AI-assisted structural prediction and molecular modelling. (K5 – Evaluate) **CO5:** Assess the applications of bioinformatics, systems biology and computer-aided drug design in solving contemporary problems in microbiology, biotechnology and healthcare. (K5 – Evaluate)
Mapping between COs and PSOs	

	PSO1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO-1	■			■	■			
CO-2	■			■				■
CO-3	■			■	■			
CO-4				■		■		■
CO-5		■		■		■		■

Course Content	
Unit 1: Fundamentals of Bioinformatics and Sequence Alignment	
1.1	Introduction, Overview, Definition, Applications of Bioinformatics, Molecular Biology and Bioinformatics, Molecular Biology and Bioinformatics, Central Dogma of Molecular Biology. Computers and Operating Systems Required for Bioinformatics,
1.2	Major Databases in Bioinformatics: Sequence databases, gene expression databases, 3D structure database, pattern sequence databases, Data Retrieval
1.3	Definitions of homologues, orthologues, paralogues, repeat finding, sequence identity and similarity, pairwise sequence alignments, scoring matrix
1.4	Database searches, BLAST and FASTA
1.5	Multiple sequence alignments (MSA), application in taxonomy and phylogeny, Phylogenetics
Unit 2: Genome Sequencing, Quality Control, and Comparative Genomics	
2.1	DNA Sequencing: Sanger sequencing, Next Generation Sequencing (NGS) and Third Generation Sequencing technologies; Illumina, Ion Torrent, PacBio and Oxford Nanopore platforms
2.2	Raw Sequence Data Quality Control, DNA Sequence Assembly and Annotation of Genes
2.3	Prediction of gene function using homology, context, structures, networks; Genetic variation polymorphism, deleterious mutations;
2.4	Computational Approaches in Comparative Genomics
2.5	Sequenced-Based Typing of Prokaryotes
Unit 3: Microbial Genomics and Multi-Omics Technologies	
3.1	Sequence-Based Classification and Identification of Prokaryotes
3.2	16S rRNA Amplicon Sequencing for Metagenomics
3.3	Full Shotgun DNA Metagenomics
3.4	Transcriptomics
3.5	Metabolomics
Unit 4: Proteomics, Structural Biology, and Computer-Aided Drug Design	
4.1	Proteomics and Protein Identification
4.2	Protein stability and folding, Classifications of protein structures,
4.3	Protein structure prediction and modelling, AI-based methods of structure prediction (AlphaFold), Molecular Modelling and Dynamics
4.4	Chemical databases like NCI /PUBCHEM, Fundamentals of Receptor-ligand interactions, Structure-based drug design, Ligand based drug design: Structure-Activity Relationship, QSARs and pharmacophores, in silico predictions of drug activity and ADMET
4.5	Systems biology: Concept and application

References

1. Ismail, H. D. (2023). Bioinformatics: A Practical Guide to Next Generation Sequencing Data Analysis. CRC Press.
2. Christensen, H. (Ed.). (2018). Introduction to Bioinformatics in Microbiology. Springer.
3. Rastogi, S. C., Mendiratta, N., & Rastogi, P. (2013). Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery (4th ed.). PHI Learning.
4. Lesk, A. M. (2014). Introduction to Bioinformatics (4th ed.). Oxford University Press.
5. Baxevanis, A. D., & Ouellette, B. F. F. (Eds.). (2005). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (3rd ed.). Wiley.
6. Choudhuri, S. (2014). Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools. Academic Press.
7. Higgs, P. G., & Attwood, T. K. (2005). Bioinformatics and Molecular Evolution. Blackwell Publishing.
8. Hollingsworth, S. A., & Dror, R. O. (2018). Molecular dynamics simulation for all. Neuron, 99(6), 1129–1143. https://pmc.ncbi.nlm.nih.gov/articles/PMC6209097/
9. Wehrens, R., & Salek, R. (Eds.). (2019). Metabolomics: Practical guide to design and analysis. CRC Press.
10. Selzer, P. M., Marhöfer, R. J., & Rohwer, A. (2008). Applied bioinformatics: An introduction. Springer
11. Krawetz, S. A. (Ed.). (2009). Bioinformatics for systems biology. Humana Press.
12. Bard, J. (2013). Systems biology — the broader perspective. Cells, 2(2), 414–431. https://doi.org/10.3390/cells2020414
13. Marcus, F. B. (2008). Bioinformatics and systems biology: Collaborative research and resources. Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-540-78353-4

Online Resources

1. National Center for Biotechnology Information (NCBI): https://www.ncbi.nlm.nih.gov
2. European Bioinformatics Institute (EMBL-EBI): https://www.ebi.ac.uk
3. DNA Learning Center (Cold Spring Harbor Laboratory): https://dnalc.cshl.edu
4. National Programme on Technology Enhanced Learning (NPTEL): https://nptel.ac.in
5. SWAYAM: https://swayam.gov.in
6. Protein Data Bank (PDB): https://www.rcsb.org
7. UniProt Knowledgebase: https://www.uniprot.org
8. AlphaFold Protein Structure Database: https://alphafold.ebi.ac.uk
9. Galaxy Project for Bioinformatics Analysis: https://usegalaxy.org
10. PubChem Database: https://pubchem.ncbi.nlm.nih.gov

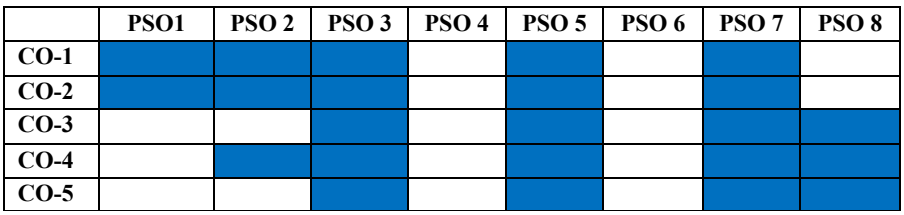
Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, seminars, assignments, case studies, scientific literature review, problem-solving exercises, and lecture-based demonstrations of bioinformatics tools and databases to facilitate comprehensive theoretical understanding of bioinformatics, genomics, omics technologies, and computational biology.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MB-SEC-2006: Bioinoculants and Organic Farming

Program Name	**M.Sc.**
Semester	**M. Sc. SEM 2**
Credit Level	**6.0**
Course Type	**SEC**
Course Subtype	**SEC 1**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MB-SEC-2006**
Course Level	**500-599**
Course Title	**Bioinoculants and Organic Farming**
Credit	**02 (30 Hours)**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	Upon successful completion of this course, the students will be able to: **CO1:** Explain the principles, importance and applications of bioinoculants in sustainable agriculture, including their role in nutrient management, plant health promotion and stress mitigation. (K2) **CO2:** Analyze the diversity, characteristics and agricultural significance of major bioinoculants such as bacterial inoculants, cyanobacteria, Azolla, mycorrhizae and phosphate-solubilizing microorganisms. (K4) **CO3:** Describe the concepts, principles, advantages, limitations and practices of organic farming for environmentally sustainable agricultural production. (K2) **CO4:** Evaluate the role of biofertilizers in sustainable agriculture, their economic and environmental benefits, commercial production and contribution to soil fertility management. (K5) **CO5:** Assess the current status, industrial development, challenges and future prospects of bioinoculant and biofertilizer technologies in India. (K5)
Mapping between COs and PSOs	

Course Content	
Unit 1 : Fundamentals and Applications of Bioinoculants	
1.1	Introduction of Bioinoculants
1.2	Role of Bioinoculants in Green Agriculture: Nutrient Assimilation and Biofortification, Management of Pests and Pathogens, Abiotic Stress Management
1.3	Method of application and recommended doses
1.4	Current market scenario in India and Challenges and future prospects
1.5	Bacterial Inoculants, Green Manuring
1.6	Cyanobacterial Inoculants, Azolla as Biofertilizer
1.7	Mycorrhizal fungi as Biofertilizer
1.8	Phosphate solubilizing microorganisms
Unit 2 : Organic Farming and Biofertilizers	
2.1	Definition and Concepts of organic farming
2.2	Importance and Characteristics of organic farming
2.3	Advantages and Disadvantages of organic farming
2.4	Introduction of Biofertilizers, Biofertilizer for sustainable Agricultures
2.5	Economic and Environmental Benefits of Biofertilizer
2.6	Commercial Producers of Biofertilizers, Works Done on Biofertilizers in India
2.7	Development of Microbial Biofertilizer Industry

References

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2. Aman Raj and Adesh Kumar, A sustainable alternative to agrochemicals, Bioinoculants ***Indian*** *Farming 75* (05): 21-24.
3. Aneja, K. R., (2003). Experiments in Microbiology 4thed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers DOI http://dx.doi.org/10.18174/375218
4. Dubey, R. C. (1993). A Textbook of Biotechnology. (Multicolor Illustrative revised Edition) S. Chand Publishing. (ISBN: 81-219-2608-4).
5. Dubey, R. C. (2000). Textbook of Microbiology. (4th Edition) S. Chand, Limited.(ISBN: 978-8121926201).
6. Handbook for composting and compost use in organic horticulture. André W.G. van der Wurff, Jacques G. Fuchs, Michael Raviv and Aad J. Termorshuizen, (ISBN:978-94-6257-749-7),
7. Jnana Bharati Palai M, Mostafizur Rahman Shah, Viliam Barek, Peter Ondrisik, Milan Skalický and Akbar Hossain. Bioinoculants: Natural Biological Resources for Sustainable plant production. Microorganisms https://doi.org/10.3390/10010051, 10 (51) 1-35.
8. Motsara, M. R., Bhattacharyya, P., & Srivastava, B. (1995). Biofertilizer: Technology, marketing and usage. A sourcebook-cum-glossary.
9. Patel, R. J., & Patel, R. K., (2022). Experimental Microbiology, Vol. 1, 10th Edition,

Aditya.
10. Purohit, S. S. (2006). Microbiology: Fundamentals and Applications. (7th Edition) Agrobios. (ISBN:978-81-7754-259-1).
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12. Santanu Kundu, Ashay D Souza, Lalta Prasad Verma, Tushar Ghosh, Debarati Seal (2024). Organic Farming Cultivating Sustainable Agriculture, National Press Associates, New Delhi, (ISBN: 978-81-19674-42-8)
13. Somasundaram, E., Nandhini, D. U., & Meyyappan, M. (2019). Principles of Organic Farming: (With Theory and Practicals). New India Publishing Agency.(ISBN:9781003260844)
14. Subba Rao, N. S. (1993). Biofertilizers in agriculture and forestry (3rd rev. ed). International Science Publisher. (ISBN: 1881570290)

Online resources

1. https://www.youtube.com/watch?v=LvqMMfa8ysM
2. https://www.youtube.com/watch?v=ExqbV5Ol1FU
3. https://www.youtube.com/watch?v=3YxE9kEXv3I
4. https://www.youtube.com/watch?v=RpHms71b4m4
5. https://www.youtube.com/watch?v=Cm8MyVq8er8
6. https://www.youtube.com/watch?v=WhOrIUlrnPo
7. https://www.youtube.com/watch?v=_AM2fX24vtQ
8. https://www.youtube.com/watch?v=yCDTXI1l6D4
9. SWAYAM (https://swayam.gov.in)
10. SWAYAM Plus (https://swayam-plus.swayam2.ac.in)
11. https://share.google/nqkdslVo2iRT8gfQE
12. https://share.google/qBUjyvmWUau3amgN4
13. https://share.google/91VpjqU25ZxulCFRN

Teaching Methodology
The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning and demonstrations to facilitate comprehensive theoretical understanding of the subject.
Distribution of Marks
50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination

MB-SEC-2006: SWAYAM MOOC: Provided from the SWAYAM/ NPTEL of 2 credits

This course requirement is fulfilled through a 2-credit Massive Open Online Course (MOOC) provided via the SWAYAM/NPTEL platform. Students will complete the designated online curriculum and earn academic credits upon successful assessment.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

Postgraduate Program

In

Microbiology

02 years

(COURSE WORK AND TWO SEMESTER RESEARCH)

M.Sc. SEM 1 & 2 SYLLABUS

PROGRAM TITLE	
Name of Program	Master of Science (Honors) Microbiology
Program Abbreviation	M.Sc. MB
Duration	2 Years
Eligibility Criteria	Successfully Completed Sem-6 in the subject of Microbiology
Pre-requisite	Basic concepts in the field of microbiology
Medium of Instruction	English
Objective of Program	To provide Fundamental and applied knowledge of Micro- organism to students. To develop Laboratory skills and to train the students in scientific thinking to prepare for carriers like health care, pharmaceutical, biotechnology, diagnostics, industry and academia and to promote awareness to students of microbial application in the field of diseases prevention, environmental sustainability and technological innovation.
Program Outcome (PO)	**PO-01: Scientific Knowledge & Conceptual Understanding** Develop a strong foundation in scientific principles, theories and concepts across disciplines, fostering interdisciplinary learning, advanced knowledge and problem-solving abilities. **PO-02: Analytical & Critical Thinking** Apply critical thinking and analytical reasoning to evaluate scientific data, hypotheses and real-world problems, leading to evidence-based conclusions. **PO-03: Research & Inquiry-based Learning** Develop investigative skills through experimentation, data analysis and scientific inquiry to contribute to research and innovation. **PO-04: Laboratory & Technical Skills** Gain hands-on experience with laboratory techniques, instrumentation and computational tools relevant to scientific research and industry applications. **PO-05: Digital & Computational Literacy** Utilize digital tools, computational techniques and emerging technologies such as AI, bioinformatics and statistical modelling to enhance scientific learning and problem-solving. **PO-06: Environmental & Societal Responsibility** Understand the role of science in addressing environmental, health and societal challenges, promoting sustainability and ethical responsibility. **PO-07: Effective Communication & Collaboration**

	Develop proficiency in scientific communication, both written and oral, for effective dissemination of knowledge while collaborating in multidisciplinary teams. **PO-08: Innovation & Entrepreneurship** Foster an entrepreneurial mindset by applying scientific knowledge for innovation, technology development and industry-oriented applications. Develop sustainable solutions to address real-world challenges in research and environmental management. **PO-09: Lifelong Learning & Professional Growth** Cultivate curiosity and adaptability for continuous learning, equipping students for higher education, research and professional careers. **PO-10: Ethical Leadership & Value-based Education** Develop leadership qualities, ethical values and a sense of responsibility in applying science for societal progress, aligning with Indian knowledge systems and global perspectives.
Program Specific Outcomes (PSO)	**PSO1** Demonstrate advanced understanding of microbial diversity, taxonomy, genetics, physiology, metabolism, molecular biology, immunology, virology and host–microbe interactions. **PSO2** Apply microbiological principles for identification, characterization and utilization of microorganisms in healthcare, agriculture, food, pharmaceutical, industrial and environmental sectors. **PSO3** Integrate knowledge of microbial biotechnology, fermentation technology, bioprocess engineering and microbial products for development of sustainable technologies and industrial applications. **PSO4** Utilize advanced bioanalytical techniques, biophysical instrumentation, omics technologies, bioinformatics and artificial intelligence tools for biological data generation and interpretation. **PSO5** Analyze microbial communities, biodiversity, ecological interactions, evolutionary processes and microbiomes for environmental sustainability and resource management. **PSO6** Apply concepts of medical microbiology, public health microbiology, antimicrobial resistance, epidemiology and immunology for understanding disease processes and their control. **PSO7** Employ microbial resources and technologies for agricultural productivity, bioinoculant development, bioremediation, bioleaching, biomining and other environmental applications.

	PSO8 Demonstrate competency in research, innovation, intellectual property management, regulatory compliance and entrepreneurship for professional careers, higher studies and technology-driven enterprises. **PSO9** Apply research methodologies, experimental design and analytical approaches to investigate microbiological problems through an independent research project. **PSO10** Analyze, interpret and communicate research findings through dissertations, scientific reports and presentations.
Mapping between Pos and PSOs	

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
PSO1	■	■				■			■	
PSO2	■	■	■	■		■				
PSO3	■	■	■	■		■		■		
PSO4	■	■	■	■	■			■	■	
PSO5	■	■	■			■			■	■
PSO6	■	■	■	■		■				■
PSO7	■	■	■	■		■		■		■
PSO8		■	■	■	■		■	■	■	■
PSO9		■	■		■		■		■	■
PSO10		■	■	■	■		■	■	■	■

STRUCTURE FOR ERP – M.Sc MICROBIOLOGY – SEM – 1 COURSE WORK AND ONE SEMESTER RESEARCH																
Course Category	**Course Code**	**Course Title**	**Mark sheet Title in English**	**Level of Course**	**Teaching Hours/Week**		**Exam Duration (Hours)**		**Credit**		**Internal Marks**		**External Marks**		**Total**	
					TH	**PR**	**TH**	**PR**	**TH**	**PR**	**TH**	**PR**	**TH**	**PR**	**TH**	**PR**
MAJOR 1	**MB – 1001**	**MICROBIAL GENETICS**	**MICROBIALGENETICS**	500-599	02	04	01.00	06.00	02	02	25	25	25	25	50	50
MAJOR 2	**MB – 1002**	**MICROBIAL METABOLISM & PHYSIOLOGICAL ADAPTATION**	**MICROBIAL METABOLISM & PHYSIOLOGICAL ADAPTATION**	500-599	02	04	01.00	06.00	02	02	25	25	25	25	50	50
MAJOR 3	**MB – 1003**	**MICROBIAL BIOTECHNOLOGY**	**MICROBIAL BIOTECHNOLOGY**	500-599	02	04	01.00	06.00	02	02	25	25	25	25	50	50
MAJOR 4	**MB-1004 BKS**	**TRADITIONAL PRACTICES IN MICROBIOLOGY**	**TRADITIONAL PRACTICES IN MICROBIOLOGY**	500-599	04	00	02.00	00	04	-	50	-	50	-	100	-
MDC	**MB-1005**	**BIONANOTECHNOLOGY/ FUNDAMENTALS OF CYBERSECURITY**	**BIONANOTECHNOLOGY/ FUNDAMENTALS OF CYBER SECURITY**	500-599	04	00	02.00	00	04	-	50	-	50	-	100	-
SEC	**MB-1006**	**EPIDEMIOLOGY/ SWAYAM MOOC/RESEARCH METHODOLOGY**	**EPIDEMIOLOGY/ SWAYAM MOOC/RESEARCH METHODOLOGY**	500-599	02	00	00	00	02	-	25	-	25	-	50	-

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M. Sc. Microbiology, Semester-I

MB-MJ-1001: MICROBIAL GENETICS

Program Name	**M.Sc.**
Semester	**M. Sc SEM 1**
Credit Level	**6.0**
Course Type	**MAJOR**
Course Subtype	**MAJOR 1**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MB-MJ-1001**
Course Level	**500-599**
Course Title	**Microbial Genetics**
Credit	02 (30 Hours)
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	**Course Outcomes (COs)** Upon successful completion of this course, the students will be able to: **CO1:** Explain the molecular mechanisms of DNA replication, transcription, translation, protein processing and protein secretion involved in the flow of genetic information in microorganisms. **(K2 – Understand)** **CO2:** Apply the principles of microbial gene regulation, including transcriptional regulation, RNA-mediated regulation, enzyme regulation and DNA repair mechanisms, to understand cellular responses and genetic stability. **(K3 – Apply)** **CO3:** Analyze the structure, properties and biological significance of plasmids and other genetic elements in microbial systems. **(K4 – Analyze)** **CO4:** Evaluate the mechanisms and applications of gene transfer processes, including transformation, transduction, conjugation and gene transfer in archaea, in microbial genetics and biotechnology. **(K5 – Evaluate)** **CO5:** Assess the roles of recombination, transposition and genome rearrangements in microbial evolution, adaptation and genetic engineering. **(K5 – Evaluate)**
Mapping between COs and PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	■					■		
CO2	■					■		
CO3	■	■						
CO4	■	■	■					
CO5	■		■					■

Course Content	
UNIT 1: Nucleic acid structure and synthesis	
1.1	*Molecular Biology and Genetic Elements:* DNA and Genetic Information Flow, Genetic Elements: Chromosomes and Plasmids overview
1.2	*DNA Replication:* Templates, Enzymes, and Replication Fork, Bidirectional Replication, the Replisome, and Proofreading
1.3	*RNA Synthesis:* Transcription in Bacteria, in Archaea
1.4	*Protein Synthesis*: Translation, Amino Acids, Polypeptides, and Proteins, Transfer RNA, Genetic Code, Mechanism of Protein Synthesis
1.5	*Protein Processing, Secretion, and Targeting:* Assisted Protein Folding and Chaperones, Protein Secretion in Gram-Negative Systems
1.6	*DNA-Binding Proteins and Transcriptional Regulation*: DNA-Binding Proteins, Negative Control- Repression and Induction, Positive Control-Activation, Global Control and the *lac* Operon, Transcription Controls in Archaea
1.7	*RNA-Based Regulation*: Regulatory RNAs, Riboswitches, Attenuation
1.8	*Regulation of Enzymes and Other Proteins*: Feedback Inhibition, Post-Translational Regulation
UNIT 2: Mutation, Plasmids, Gene Transfer and Genome Rearrangement	
2.1	*Mutation and DNA repair:* The causes of mutations, Repair of mutations and other types of DNA damage
2.2	*Plasmid*: Functions Encoded, Structure, Properties of Plasmids
2.3	Transformation, Artificially Induced Competence- Chemical Induction, Electroporation and Protoplast Transformation
2.4	Transduction
2.5	Conjugation and Formation of Hfr Strains & Chromosome Mobilization, mapping genes by interrupted mating, Gene Transfer in Archaea,
2.6	*Recombination*: Homologous and site-specific recombination
2.7	*Transposition*: Transposition, Mechanisms of Transposition and General Properties of Transposons

References

1. Brown, T. A. (2023). *Genomes 5* (5th ed.). CRC Press. ISBN: 978-0-367-67866-1
2. Henkin, T. M., & Peters, J. E. (2020). *Snyder and Champness molecular genetics of bacteria* (5th ed.). ASM Press; John Wiley & Sons. ISBN 9781555819750
3. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2014). *Lewin's GENES XI* (11th ed.). Jones & Bartlett Learning. ISBN 9781449659851
4. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. (2018). *Brock biology of microorganisms* (15th ed.). Pearson. ISBN 13: 978-1-292-23510-3
5. Watson, J.D., Baker, T. A., Beil S. P., Gann, A., Levine, M., & Losick, R. (2017). *Molecular biology of gene* (7th ed.) Pearson India Education Services Pvt. Ltd.
6. Willey, J. M., Sandman, K. M., & Wood, D. H. (2023). *Prescott's microbiology* (12th ed.). McGraw-Hill Education. ISBN 978-1-265-12303-1

Online reference

1. https://swayam.gov.in/

2. https://swayam-plus.swayam2.ac.in/
Teaching Methodology The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.
Evaluation scheme 50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MBP-MJ-1001: MICROBIAL GENETICS PRACTICALS

Program Name	**M.Sc.**
Semester	**M. Sc SEM 1**
Credit Level	**6.0**
Course Type	**MAJOR**
Course Subtype	**MAJOR Practical 1**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MBP-MJ-1001**
Course Level	**500-599**
Course Title	**Microbial Genetics Practical**
Credit	02 (30 Hours)
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	**Course Outcomes (COs)** Upon successful completion of this practical course, the students will be able to: **CO1:** Perform the isolation, purification and quantitative estimation of genomic DNA, plasmid DNA and RNA from microbial cells using standard molecular biology techniques. **(K3 – Apply)** **CO2:** Execute microbial genetic experiments involving mutation induction, mutant isolation and gene expression analysis to understand microbial genetics and gene regulation. **(K3 – Apply)** **CO3:** Demonstrate bacterial transformation techniques and interpret the role of gene transfer mechanisms in microbial genetic exchange. **(K3 – Apply)** **CO4:** Apply bioinformatics tools for identification of open reading frames (ORFs) and analysis of gene sequences retrieved from biological databases. **(K3 – Apply)** **CO5:** Analyze experimental and computational data related to nucleic acids, gene expression, mutation and microbial genetics for scientific interpretation and problem-solving. **(K4 – Analyze)**
Mapping between COs and PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	■			■				
CO2	■	■				■		
CO3	■	■	■					
CO4	■			■				
CO5	■		■	■				■

Course Content

1. Extraction of bacterial genomic DNA from bacteria and Quantitative estimation of DNA
2. Extraction of RNA from yeast and Quantitative estimation of RNA
3. Isolation of Plasmid DNA.
4. Isolation of Auxotrophic Mutants by Replica Plating technique
5. Study of UV-Induced Mutation in Bacteria
6. Induction of β-Galactosidase Activity (lac Operon Demonstration)
7. Bacterial Transformation testing using agar plat methods
8. Open Reading Frame (ORF) Prediction
9. Retrieval and analysis of Gene Sequence from NCBI.

References

1. Patel, R. J., & Patel, R. K. Experimental Microbiology, Vol. 1, 10th Edition, Aditya, 2022
2. Patel, R.J., & Patel, R. K. Experimental Microbiology, Vol. 2, 10th Edition, Aditya, 2022.
3. Aneja, K. R., Experiments in Microbiology 4thed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.
4. Brown, T. A. (2020). *Gene Cloning and DNA Analysis: An Introduction* (8th ed.). Wiley-Blackwell.
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6. Cappuccino, J. G., & Welsh, C. (2018). Microbiology: A laboratory manual (11th global ed.). Pearson Education Limited.
7. Bossi, Camilli, Grundl, Experiments in Bacterial Genetics: A Laboratory Manual, Cold Spring Harbor Laboratory Press, 2023, ISBN 978-1621824497
8. Tiwari, R. P., Hoondal, G. S., & Tewari, R. (2004). Laboratory techniques in microbiology & biotechnology (1st ed.). Abhishek Publications ISBN 81-8247-077-3
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10. Alexander, S. K., Strete, D., & Niles, M. J. (2003). *Laboratory exercises in organismal and molecular microbiology*. McGraw-Hill Higher Education
11. Saxena, J., Baunthiyal, M., & Ravi, I. (2015). *Laboratory manual of microbiology, biochemistry and molecular biology,* Scientific Publishers.

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive
Discussion, seminars, assignments, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MB-MJ-1002: MICROBIAL METABOLISM AND PHYSIOLOGICAL ADAPTATION

Program Name	**M.Sc.**
Semester	**M. Sc. SEM 1**
Credit Level	**6.0**
Course Type	**MAJOR**
Course Subtype	**MAJOR 2**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MB-MJ-1002**
Course Level	**500-599**
Course Title	**Microbial Metabolism and Physiological Adaptation**
Credit	Theory: 02 (30 Hours)
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	**Course Outcomes (COs)** Upon successful completion of this course, the students will be able to: **CO1:** Explain the principles of microbial metabolism, bioenergetics, ATP generation, redox reactions, metabolic pathways and cellular energy conservation mechanisms in microorganisms. **(K2 – Understand)** **CO2:** Apply the concepts of respiratory metabolism, fermentation, autotrophy, lithotrophy, methanogenesis, methanotrophy and phototrophy to understand microbial metabolic diversity and ecological adaptation. **(K3 – Apply)** **CO3:** Analyze anabolic pathways, biosynthetic processes and inorganic metabolism involved in the synthesis of cellular components and nutrient assimilation in microorganisms. **(K4 – Analyze)** **CO4:** Evaluate microbial regulatory mechanisms, including two-component regulatory systems, stress responses, sporulation and germination, in relation to microbial survival and physiological adaptation. **(K5 – Evaluate)** **CO5:** Assess the roles of biofilm formation, quorum sensing and metabolic engineering in microbial ecology, biotechnology and industrial applications. **(K5 – Evaluate)**
Mapping between COs and PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	■							
CO2	■	■			■			
CO3	■	■	■				■	
CO4	■					■		■
CO5		■	■		■		■	■

Course content	
UNIT 1: Metabolism and Bioenergetics	
1.1	Introduction to Microbial Metabolism, Important Principles and Concepts, ATP- the Major Energy Currency
1.2	Redox Reactions, Sequential Redox Reactions, Biochemical Pathways- Sets of Linked Chemical Reactions, Enzymes and Ribozymes, Metabolism regulation to maintain Homeostasis
1.3	Cellular Mechanisms for ATP Synthesis, Chemiosmotic Theory, ATP Synthase, The Proton Motive Force (PMF) Quantifying PMF,
1.4	Environmental Impacts on PMF
1.5	Oxidative decarboxylation of pyruvate, TCA cycle, Glyoxylate cycle, Anaplerotic reactions
1.6	Electron Transport and Oxidative Phosphorylation, Aerobic respiration, Anaerobic respiration, Energy yield comparison Fermentation Pathways: Propionate, Acetate, Lactate, Mixed-Acid and Butanediol Fermentation, and Butyrate Fermentation, Syntrophy Autotrophic Pathways: Concept of autotrophy, Calvin cycle, Reverse TCA cycle
1.7	C1 Metabolism: Acetogenesis, Methanogenesis, Methanotrophy Phototrophy (Light Reactions in Oxygenic Photosynthesis and in Anoxygenic Photosynthesis, Rhodopsin-Based Phototrophy
UNIT 2: Microbial Anabolism and Physiological Adaptation	
2.1	Lithotrophy: hydrogen-oxidizing bacteria, Ammonia-oxidizing bacteria, Nitrite-oxidizing bacteria, Sulfur-oxidizing prokaryotes, Iron-oxidizing bacteria
2.2	Inorganic metabolisms: Assimilation and Dissimilation of Nitrate and Sulfate, Nitrogen fixation: nitrogen-fixing systems and nitrogenase
2.3	Anabolism and Biosynthesis: concept of biosynthesis, Precursor Metabolites for Biosynthesis
2.4	Lipid Synthesis: Fatty Acids and Phospholipids, Sterols and Isoprenoid Lipids, Lipopolysaccharides, Synthesis of Peptidoglycan
2.5	Two component regulatory system
2.6	Microbial stress responses: oxidative stress, physiological response to oxidative stress in *E. coli*, heat shock response, sporulation, stages of sporulation, germination and regulation in *Bacillus subtilis*, resistance properties of endospores
2.7	Prevalence, Importance, Properties, and Regulation of Biofilm Formation, Quorum Sensing, Metabolic engineering of bacteria

References

1. Kim, B. H., & Gadd, G. M. (2008). Bacterial physiology and metabolism (2nd ed.). Cambridge University Press. ISBN-13 978-0-511-39322-8
2. Kumar, R. R., & Prasad, S. (2011). Metabolic engineering of bacteria. Indian Journal of Microbiology, 51(3), 403–409. https://doi.org/10.1007/s12088-011-0172-8

3. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., Stahl, D. A. (2018). Brock biology of microorganisms (15th ed.). Pearson.
4. Moat, A. G., Foster, J. W., & Spector, M. P. (2002). Microbial physiology (4th ed.). Wiley-Liss.
5. Stevens, A. M., Ditty, J. L., Parales, R. E., & Merkel, S. M. (2023). Microbial physiology: Unity and diversity. ASM Books / Wiley. ISBN: 978-1683673675
6. Stevens, A. M., Ditty, J. L., Parales, R. E., & Merkel, S. M. (2023). Microbial physiology: Unity and diversity. ASM Books / Wiley. ISBN: 978-1683673675
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8. Willey, J. M., Sandman, K. M., & Wood, D. H. (2023). Prescott's microbiology (12th ed.). McGraw-Hill Education. ISBN 978-1-265-12303-1

Online reference

https://swayam.gov.in/
https://swayam-plus.swayam2.ac.in/

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Evaluation scheme

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MBP-MJ-1002: MICROBIAL METABOLISM AND PHYSIOLOGICAL ADAPTATION PRACTICALS

Program Name	**M.Sc.**
Semester	**M. Sc SEM 1**
Credit Level	**6.0**
Course Type	**MAJOR**
Course Subtype	**MAJOR Practical 2**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MBP-MJ-1002**
Course Level	**500-599**
Course Title	**Microbial Metabolism and Physiological Adaptation Practical**
Credit	Theory: 02 (30 Hours)
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	**Course Outcomes (COs)** Upon successful completion of this practical course, the students will be able to: **CO1:** Perform experiments to evaluate the effects of environmental factors such as temperature, pH and bile salts on microbial growth, metabolism and physiological adaptation. **(K3 – Apply)** **CO2:** Demonstrate microbial metabolic activities, including carbohydrate utilization, sporulation and photosynthetic growth, using standard microbiological techniques. **(K3 – Apply)** **CO3:** Investigate microbial adaptive mechanisms such as biofilm formation and stress tolerance and interpret their ecological and physiological significance. **(K4 – Analyze)** **CO4:** Apply bioinformatics tools and biological databases to retrieve, analyze and interpret microbial metabolic pathways and stress response genes. **(K3 – Apply)** **CO5:** Analyze experimental and computational data related to microbial metabolism, physiological adaptation and environmental responses for scientific interpretation and problem-solving. **(K4 – Analyze)**
Mapping between COs and PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	■	■			■		■	
CO2	■	■			■			
CO3	■				■		■	
CO4	■			■	■			
CO5	■		■	■	■			■

Course Content

1. Study of Bacterial Growth Curve under stress conditions of temperature
2. Study of Bacterial Growth Curve under stress conditions of pH
3. Estimation of sugar utilization by yeast by DNSA method
4. Study of Sporulation by Endospore Staining
5. Study of Biofilm formation by tube method using crystal violet staining
6. Determination of sensitivity of gram positive and gram-negative bacteria to bile salts
7. Enrichment and Microscopic Observation of Photosynthetic Bacteria
8. Retrieval and Analysis of different Microbial Metabolic Pathways using KEGG Database

9 Retrieval and Analysis of Stress Response Genes in Microorganisms

References

1. Patel, R. J., & Patel, R. K. Experimental Microbiology, Vol. 1, 10th Edition, Aditya, 2022
2. Patel, R.J., & Patel, R. K. Experimental Microbiology, Vol. 2, 10th Edition, Aditya, 2022.
3. Aneja, K. R., Experiments in Microbiology 4thed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.
4. Cappuccino, J. G., Microbiology: A Laboratory Manual, 6Ed., Singapore Pearson Education Pvt. Ltd., 2005.
5. Cappuccino, J. G., & Welsh, C. (2018). Microbiology: A laboratory manual (11th global ed.). Pearson Education Limited.
6. Tiwari, R. P., Hoondal, G. S.,; Tewari, R. (2004). Laboratory techniques in microbiology; biotechnology (1st ed.). Abhishek Publications ISBN 81-8247-077-3
7. Saxena, J., Baunthiyal, M., & Ravi, I. (2015). *Laboratory manual of microbiology, biochemistry and molecular biology,* Scientific Publishers.

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive Discussions, seminars, assignments, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MB-MJ-1003: MICROBIAL BIOTECHNOLOGY

<table>
<tr><td>Program Name</td><td>M.Sc.</td></tr>
<tr><td>Semester</td><td>M. Sc SEM 1</td></tr>
<tr><td>Credit Level</td><td>6.0</td></tr>
<tr><td>Course Type</td><td>MAJOR</td></tr>
<tr><td>Course Subtype</td><td>MAJOR 3</td></tr>
<tr><td>Subject Type</td><td>Faculty of Science- Microbiology</td></tr>
<tr><td>Course Code</td><td>MB-MJ-1003</td></tr>
<tr><td>Course Level</td><td>500-599</td></tr>
<tr><td>Course Title</td><td>Microbial Biotechnology</td></tr>
<tr><td>Credit</td><td>Theory: 02 (30 Hours)</td></tr>
<tr><td>Effective From</td><td>Academic year: 2026-27</td></tr>
<tr><td>Course Outcomes (COs)</td><td>Course Outcomes (COs)
Upon successful completion of this course, the students will be able to:
CO1: Explain the principles of industrial microbiology, fermentation technology and microbial production processes involved in the manufacture of primary metabolites, enzymes and industrial bioproducts. (K2 – Understand)
CO2: Apply the concepts of microbial biotechnology for the production of organic acids, solvents, amino acids, vitamins, biofuels and other value-added microbial products. (K3 – Apply)
CO3: Analyze the production technologies, industrial applications and economic significance of secondary metabolites, biopolymers, biofertilizers, biopesticides, fermented beverages and therapeutic biomolecules. (K4 – Analyze)
CO4: Evaluate modern metabolic engineering strategies, including glycoengineering, gas fermentation and microbial electrosynthesis, for the development of sustainable bioprocesses and novel microbial products. (K5 – Evaluate)
CO5: Assess the applications of artificial intelligence, process analytical technology and machine learning in optimizing microbial production systems and industrial biotechnology processes. (K5 – Evaluate)</td></tr>
<tr><td>Mapping between COs and PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th><th>PSO7</th><th>PSO8</th></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>CO5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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Course content

UNIT 1: Industrial Microbial Products and Fermentation Technologies	
1.1	Important microbes used in industrial microbiology and biotechnology: High throughput screening
1.2	Range of fermentation processes
1.3	Organic acids: Citric acid and Lactic acid
1.4	Amino acid: L-lysine; Vitamin: B12 & Riboflavin
1.5	Solvents: Ethanol and Bio-butanol
1.6	Biopolymers: PHAs and Exopolysaccharides: Xanthan.
1.7	Agricultural bioproducts: Microbial biopesticides, Siderophores and mycorrhizal biofertilizer
1.8	Alcohol-based fermented beverages: Beer and Wine
1.9	Therapeutics: mAbs, Insulin, Interferons, Antibiotics: Cephalosporins
UNIT 2: Metabolic Engineering and Intelligent Production Technologies	
2.1	Industrially important enzymes
2.2	Next generation biofuels from cyanobacteria and yeasts
2.3	AI-driven enzyme design: enzymes with tailored specificities
2.4	Glycoengineered microbes: humanized glycoproteins production
2.5	Gas fermentation by C1 pathway: industrial waste gases to bioplastics and SCPs
2.6	Microbial Electrosynthesis Systems: reduction of CO_2 into value-added chemicals
2.7	Process Analytical Technology: real-time monitoring of microbial product formation
2.8	Machine learning: reinforcement learning algorithms to maximize product yield

References

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5. Stephanopoulos, Gregory, Aristos A. Aristidou, and Jens Nielsen. *Metabolic Engineering: Principles and Methodologies*. San Diego, Academic Press, 1998.
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8. Kaplan, David L., editor. Biopolymers from Renewable Resources. Berlin, Springer, 1998
9. Pandey, Ashok, D. J. Lee, et al., editors. Biofuels from Algae. Amsterdam, Elsevier, 2014.

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11. Guo, Peixuan, and Fazlul Haque, editors. RNA Nanotechnology and Therapeutics. Boca Raton, CRC Press, 2020.
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13. Raghavan, P., and S. Ghosh. Machine Learning and Data Science in the Power Generation and Process Industries. Amsterdam, Elsevier, 2022.
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Online reference

1 https://swayam.gov.in/

2 https://swayam-plus.swayam2.ac.in/

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Evaluation scheme

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MBP-MJ-1003: MICROBIAL BIOTECHNOLOGY PRACTICALS

Program Name	**M.Sc.**		
Semester	**M. Sc SEM 1**		
Credit Level	**6**		
Course Type	**MAJOR**		
Course Subtype	**MAJOR Practical 3**		
Subject Type	**Faculty of Science- Microbiology**		
Course Code	**MBP-MJ-1003**		
Course Level	**500-599**		
Course Title	**Microbial Biotechnology Practical**		
Credit	Theory: 02	Practical: 02	Total: 04 (30 Hours)
Effective From	**Academic year: 2026-27**		
Course Outcomes (COs)	**Course Outcomes (COs)** Upon successful completion of this practical course, the students will be able to: **CO1:** Perform isolation, screening and characterization of industrially important microorganisms for the production of organic acids, exopolysaccharides and industrial enzymes. **(K3 – Apply)** **CO2:** Demonstrate microbial fermentation processes and evaluate the production of industrially important metabolites, enzymes and vitamins using standard biotechnological techniques. **(K3 – Apply)** **CO3:** Apply downstream processing techniques for purification and assessment of enzyme preparations, including determination of specific activity and fold purification. **(K3 – Apply)** **CO4:** Analyze microbial traits of industrial significance, including siderophore production and metabolite biosynthesis, and interpret their applications in biotechnology. **(K4 – Analyze)** **CO5:** Utilize biological databases and culture collection repositories to retrieve, analyze and evaluate industrially important microbial strains and their physiological and fermentation characteristics. **(K4 – Analyze)**		

Mapping between Cos and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	■	■	■				■	
CO2	■	■	■				■	■
CO3	■	■	■	■				■
CO4	■	■	■		■		■	■
CO5	■	■		■				■

Course Content

1. Isolation and screening of citric acid & lactic acid producing fungi
2. Isolation and screening of EPS producing bacteria
3. Screening of amylase- and cellulase-producing microorganisms
4. Production of amylase/ cellulase enzyme under solid State & submerged fermentation
5. Purification of amylase/ cellulase by ammonium sulphate and dialysis to determine specific activity and fold purification
6. CAS assay for siderophore production
7. Spectrophotometric estimation of Riboflavin /Vitamin B12
8. Exploration of National and International Microbial Culture Collection Databases for Retrieval and Analysis of Industrially Important Microbial Strains
9. Exploration of BacDive Database for Physiological and Fermentation Characteristics of Industrial Microorganisms

References

1. Patel, R. J., & Patel, R. K. Experimental Microbiology, Vol. 1, 10th Edition, Aditya, 2022
2. Patel, R.J., & Patel, R. K. Experimental Microbiology, Vol. 2, 10th Edition, Aditya, 2022.
3. Aneja, K. R., Experiments in Microbiology 4th ed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.
4. Cappuccino, J. G., & Welsh, C. (2018). Microbiology: A laboratory manual (11th global ed.). Pearson Education Limited.
5. Bisen, P. S. (2014). *Laboratory protocols in applied life sciences*. CRC Press.
6. Saxena, J., Baunthiyal, M., & Ravi, I. (2015). *Laboratory manual of microbiology, biochemistry and molecular biology,* Scientific Publishers.
7. Bartzatt, R., & Wol, T. (2014). Detection and assay of vitamin B-12 (riboflavin) in alkaline borate buffer with UV/visible spectrophotometry. International Scholarly Research Notices, 2014, Article 453085.

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive Discussions, seminars, assignments, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MB-MJ-1004 (BKS): TRADITIONAL PRACTICES IN MICROBIOLOGY

<table>
<tr><td>Program Name</td><td>M.Sc.</td></tr>
<tr><td>Semester</td><td>M. Sc. SEM 1</td></tr>
<tr><td>Credit Level</td><td>6.0</td></tr>
<tr><td>Course Type</td><td>MAJOR</td></tr>
<tr><td>Course Subtype</td><td>MAJOR 4</td></tr>
<tr><td>Subject Type</td><td>Faculty of Science- Microbiology</td></tr>
<tr><td>Course Code</td><td>MB-MJ-1004</td></tr>
<tr><td>Course Level</td><td>500-599</td></tr>
<tr><td>Course Title</td><td>Traditional practices in Microbiology</td></tr>
<tr><td>Credit</td><td>04 (60 Hours)</td></tr>
<tr><td>Effective From</td><td>Academic year: 2026-27</td></tr>
<tr><td>Course Outcomes (COs)</td><td>Course Outcomes (COs)
Upon successful completion of this course, the students will be able to:
CO1: Explain the historical development of microbiology, traditional knowledge systems and the contributions of ancient civilizations and Indian scholars to microbiological sciences. (K2 – Understand)
CO2: Apply the principles of microbial fermentation to understand the scientific basis of traditional fermented foods, beverages and indigenous fermentation practices. (K3 – Apply)
CO3: Analyze traditional food preservation methods, ethnomedicinal practices and natural antimicrobial agents in relation to microbial growth control, food safety and human health. (K4 – Analyze)
CO4: Evaluate traditional agricultural microbiological practices, including biofertilizers, biopesticides, composting and Panchagavya, for sustainable agriculture and environmental management. (K5 – Evaluate)
CO5: Assess the relevance of traditional microbiological knowledge in modern biotechnology, microbiome research, bioprospecting, intellectual property rights and ethical applications. (K5 – Evaluate)</td></tr>
<tr><td>Mapping between COs and PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th><th>PSO7</th><th>PSO8</th></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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Course content	
UNIT 1: HISTORICAL PERSPECTIVES & INDIGENOUS KNOWLEDGE IN MICROBIOLOGY	
1.1	History of microbiology: from ancient traditional practices to modern science
1.2	Role of microorganisms in ancient civilizations: Vedic, Egyptian, Mesopotamian perspectives
1.3	Traditional Indian practices and their microbial connections (Ayurveda, Siddha, Unani)
1.4	Contributions of Indian scholars (Jagadish Chandra Bose, Birbal Sahni) to microbiology
1.5	Ethnomicrobiology: definition, scope, and significance and Documentation and preservation of traditional microbiological knowledge
UNIT 2: TRADITIONAL FERMENTATION PRACTICES	
2.1	Principles of fermentation: aerobic vs. anaerobic, homo- and hetero-fermentation
2.2	Traditional fermented foods of India: Idli, Dosa, Dhokla, Jalebi, Kanji, Ambali, and Fermented dairy products: Dahi (curd), Lassi, Shrikhand, Paneer, Buttermilk
2.3	Traditional beverages: Toddy, Rice beer (Handia), Mahua wine, Neera, and Traditional fermented foods of tribal communities in Gujarat and India
2.4	Vinegar production: traditional methods
2.5	Quality, safety, and nutritional aspects of traditionally fermented products and Comparison of traditional vs. industrial fermentation processes
UNIT 3: TRADITIONAL FOOD PRESERVATION, NATURAL ANTIMICROBIALS	
3.1	Ancient and traditional methods of food preservation: sun-drying, salting, pickling and smoking
3.2	Microbiological basis of food spoilage and preservation techniques; Traditional Indian pickles (Achaar), Murabba and Papad: microbiology and role of spices
3.3	Ethnomedicinal plants with antimicrobial properties: Aloe vera, Garlic, Neem and Tulsi
3.4	Traditional wound-healing practices and antimicrobial significance; Use of honey, ghee and herbal oils as traditional antimicrobial agents
3.5	Phytochemicals and their mode of antimicrobial action;
3.6	Modern scientific validation of traditional antimicrobial agents (evidence-based approach)
UNIT 4: TRADITIONAL AGRICULTURAL MICROBIOLOGY & MODERN RELEVANCE	
4.1	Traditional soil enrichment practices: green manuring, crop rotation, mixed cropping and Traditional composting: Nadep, Vermicomposting, Pit composting – microbiological basis
4.2	Indigenous biofertilizer knowledge: Rhizobium inoculation, Azolla-Anabaena, Blue-Green Algae, and Traditional biopesticide practices: Panchagavya, Dashparni Ark, Brahmastra

4.3	Cow-based microbiological practices (Panchagavya): scientific validation and applications
4.4	Role of traditional practices in sustainable agriculture and organic farming
4.5	Integration of traditional microbiological knowledge into modern biotechnology, Bioprospecting of traditional practices: IPR issues and ethical considerations, Future perspectives: blending ethnomicrobiology with modern microbiome research

References

1. Pelczar, M.J., Chan, E.C.S. and Krieg, N.R. (2010). Microbiology: An Application Based Approach. Tata McGraw-Hill, New Delhi.
2. Prescott, L.M., Harley, J.P. and Klein, D.A. (2008). Microbiology (7th Ed.). McGraw-Hill Higher Education, New York.
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13. Fermented Foods and Beverages of the World, edited by Jyoti Prakash Tamang and Kasipathy Kailasapathy, CRC Press, ISBN 978-1-4200-9495-4

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https://swayam-plus.swayam2.ac.in/
https://nptel.ac.in
https://www.ncbi.nlm.nih.gov/pmc
https://niscair.res.in
https://www.icmr.gov.in
https://www.tkdl.res.in
https://www.youtube.com/watch?v=HnQE80P4OaY
https://www.youtube.com/watch?v=RzGd1uFMYb Y

Ethnobiology: Unveiling Indigenous Wisdom of Nature | Science Pulse
What Is Fermentation and How Does It Work? |
Successful Fermentation Tips | Esco Lifesciences
Traditional fermented foods of India (Cereal and Legume Based)
The Science of Fermentation - 9 Minutes Microlearning
Lactic Acid Bacteria and Fermented Foods: Benefits– Dr.Berg
The Science of Dahi: How Lactobacillus Transforms Milk into Curd
Ancient Food Preservation Methods: How People Kept Food Safe in 4000 BC |
History Pulse – YouTube Which Spices Kill Bacteria?
Ayurvedic Medicinal Plants and Uses | Medicinal Plants Name | Ancient Medicinal Plants in India
Maybelline New York Colossal Bubble | 20s
Kheti और Pashupalan में उपयोगी Panchagavya (पंचगव्य) | कैसे बनाते है Panchagavya (पंचगव्य) ?
Sustainable Agriculture, Organic Farming, Biofertilizer, Vermicomposting |Kinjal Choudhary

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Evaluation scheme

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MB-MDC- 1005 BIONANOTECHNOLOGY

<table>
<tr><td>Program Name</td><td>M. Sc.</td></tr>
<tr><td>Semester</td><td>M. Sc. SEM 1</td></tr>
<tr><td>Credit Level</td><td>6</td></tr>
<tr><td>Course Type</td><td>Multidisciplinary Course (MDC)</td></tr>
<tr><td>Course Subtype</td><td>MDC 1</td></tr>
<tr><td>Subject Type</td><td>Faculty of Science- Microbiology</td></tr>
<tr><td>Course Code</td><td>MB 1005</td></tr>
<tr><td>Course Level</td><td>500-599</td></tr>
<tr><td>Course Title</td><td>Bionanotechnology</td></tr>
<tr><td>Credit</td><td>04 (60 Hours)</td></tr>
<tr><td>Effective From</td><td>Academic year: 2026-27</td></tr>
<tr><td>Course Outcomes (COs)</td><td>Course Outcomes (COs)
Upon successful completion of this course, the students will be able to:
CO1: Explain the fundamental concepts of nanoscience, nanotechnology, nanomaterials and biological nanomachines, including their structure, properties and significance in biological systems. (K2 – Understand)
CO2: Apply the principles of nanoparticle synthesis, self-assembly and nanomaterial fabrication through physical, chemical and biological approaches. (K3 – Apply)
CO3: Analyze the working principles and applications of advanced characterization techniques used for nanomaterial analysis, including microscopy, diffraction and spectroscopic methods. (K4 – Analyze)
CO4: Evaluate the design, structure and functions of molecular nanodevices, DNA nanostructures and protein-based nanomachines for nanotechnological applications. (K5 – Evaluate)
CO5: Assess the applications of bionanotechnology in medicine, drug delivery, diagnostics, tissue engineering, agriculture, food technology and other emerging interdisciplinary fields. (K5 – Evaluate)</td></tr>
<tr><td>Mapping between COs and PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th><th>PSO7</th><th>PSO8</th></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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</td></tr>
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Course Content	
Unit 1: Fundamentals of Nanoscience and Biological Nanomachines	
1.1	Introduction to Nano-word: Nano, Nanometer; Nanoscience, Nanotechnology and Historical perspectives of nanotechnology
1.2	Types of Nanomaterials and Properties of Nanomaterials
1.3	Some Special Nanomaterials: Carbon Nanomaterials, Porous Material, Aerogels, Metamaterials and Bioinspired Materials
1.4	Introduction to Fundamentals of Bio Nanotechnology and In the Dominion of Biological machines
1.5	Nanomotors of Biological Systems: ATP Synthase and Flagellar Motors in Bacteria
Unit 2: Synthesis and Self-Assembly of Nanomaterials	
2.1	Approaches for Synthesis of Nanoparticles: Bottom-up & Top-down, Techniques for Synthesis of Nanostructures: Gas-, liquid- and solid-phase synthesis
2.2	Physical methods for nanomaterials synthesis
2.3	Chemical methods for nanomaterials synthesis
2.4	Biological methods for nanomaterials synthesis
2.5	Self-Assembly of Nanomaterials
Unit 3: Characterization Techniques in Nanotechnology	
3.1	Electron Microscopes: SEM and TEM
3.2	Scanning Probe Microscopes: STM and AFM
3.3	Diffraction Techniques: XRD and DLS
3.4	Spectroscopies: Optical Absorption, UV-Vis-NIR, Infra-Red & Dispersive Infra-Red, FTIR, Raman Spectroscopy
3.5	Magnetic Measurements and Mechanical Measurements
Unit 4: Molecular Nanotechnology and Applications of Bionanotechnology (15 Hours)	
4.1	Application of DNA Nanostructures in Molecular Nanotechnology: DNA-Based nanodevices i.e, B-Z Transition, Tweezers, Actuators, Scissors
4.2	Protein Nanomachines and protein nanoarchitectures i.e. Protein Cages, Rings, Tubes, Protein Nanostructure application i.e. as a data storage, FETs, VLP motors
4.3	Biomimicry at the nanoscale - nanomaterials inspired by nature
4.4	Applications of Carbon nanotubes in Diagnostic equipment; Surgical Supplements; Tissue Engineering; Gene Delivery, and Anticarcinogenic Activity; Drug Delivery; Neurodegenerative Disorder Therapy using Carbon Nanomaterials
4.5	Nanosizing Approaches in Drug Delivery (Bawa) and application of nanotechnology in Food, Agriculture and cosmetics

References

1. Sharon, M., Sharon, M., & Pandey 2013, Bionanotechnology concept and application, Ane Books, Pvt. Ltd. ISBN: 978-93-8116-236-1
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3. Kulkarni, S. K. (2015). *Nanotechnology: Principles and practices* (3rd ed.). Springer. ISBN 978-3-319-09170-9
4. Rathinasamy, C. Parameswari and V. Ponnuswami, An introduction to Nanotechnology, New India Publishing Agency, ISBN: 978-93-81450-41-3
5. Bawa, R., Audette, G. F., & Rubinstein, I. (Eds.). (2016). *Handbook of clinical nanomedicine: Nanoparticles, imaging, therapy, and clinical applications*. Pan Stanford Publishing. ISBN 978-981-4669-21-4
6. Mundekkad, D., & Mallya, A. R. (2025). *Biomimicry at the nanoscale: A review of nanomaterials inspired by nature*. *Nano Trends, 10*, 100119.

Online reference

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https://swayam-plus.swayam2.ac.in/
https://www.youtube.com/watch?v=clg0EQGRyOM
https://www.youtube.com/watch?v=evE08ycZfnM
https://www.youtube.com/watch?v=YhuUFLzJSsg
https://www.youtube.com/watch?v=tfn7Nn4jPxo
https://www.youtube.com/watch?v=Z51R49OOqAA
https://en.wikipedia.org/wiki/Characterization_of_nanoparticles

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Evaluation scheme

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MB-SEC-1006: EPIDEMIOLOGY

Program Name	**M. Sc.**
Semester	**M. Sc SEM 1**
Credit Level	**6**
Course Type	**Skill Enhancement Course (SEC)**
Course Subtype	**MB-SEC-1006**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**M. Sc. MB-SEC-1006**
Course Level	**500-599**
Course Title	**Epidemiology**
Credit	02 (30 Hours)
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	**Course Outcomes (COs)** Upon successful completion of this course, the students will be able to: **CO1:** Explain the fundamental principles, concepts and methodologies of epidemiology, including disease causation, transmission dynamics, epidemiological triad, chain of infection and disease surveillance. **(K2 – Understand)** **CO2:** Apply epidemiological measures, study designs and screening approaches to investigate disease occurrence, distribution and determinants in populations. **(K3 – Apply)** **CO3:** Analyze epidemiological data related to incidence, prevalence, morbidity, mortality, outbreaks and epidemics for evidence-based public health decision-making. **(K4 – Analyze)** **CO4:** Evaluate the epidemiology of emerging and re-emerging infectious diseases, public health interventions and risk assessment strategies for disease prevention and control. **(K5 – Evaluate)** **CO5:** Assess the roles of national and international health organizations, surveillance systems and public health infrastructure in strengthening community health and disease management. **(K5 – Evaluate)**
Mapping between COs and PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	■					■		
CO2	■			■		■		
CO3	■		■	■		■		■
CO4	■	■			■	■		■
CO5		■				■	■	■

Course Content	
Unit 1: Principles of Epidemiology and Disease Dynamics	
1.1	Introduction to Epidemiology: Definition, scope objectives, historical development of epidemiology, epidemiological triad
1.2	Epidemiological Concepts: Chain of infection, Natural History, Iceberg Concept
1.3	Epidemiological Study Designs: Descriptive epidemiology, analytical epidemiology, experimental/interventional studies
1.4	Screening and Surveillance: Screening methods, sensitivity and specificity, predictive values, surveillance systems, disease prevention strategies
1.5	Immunoepidemiology: Herd immunity and basic immunoepidemiology
UNIT 2: Public Health Epidemiology and Disease Investigation	
2.1	Disease Occurrence and Frequency: Incidence and prevalence, morbidity and mortality indicators, attack rate and case fatality rate
2.2	Outbreak Investigation and Epidemic Analysis: Outbreaks and epidemics, outbreak investigation, epidemic curves, transmission dynamics, evidence for causation, and risk assessment.
2.3	Emerging and Re-emerging Infectious Diseases: Emerging pathogens, pandemic outbreaks
2.4	Emerging Challenges and Opportunities in Infectious Disease Epidemiology
2.5	Public Health and Community Health: Definition and scope of public health, origin and development, community health programs and public health functions
2.6	Public Health Interventions: Public health, epidemiology and ecological constrains
2.7	Health Organizations and Public Health Infrastructure: WHO, CDC, ICMR, NCDC, IDSP and public health infrastructure in India

References

1. Bonita R, Beaglehole R., & Kjellstrom T. (2006). Basic Epidemiology, 2nd edition, Geneva: World Health Organization.
2. Frérot, M., Lefebvre, A., Aho, S., Callier, P., Astruc, K., & Aho Glélé, L. S. (2018). What is epidemiology? Changing definitions of epidemiology 1978-2017. PLoS one, 13(12), e0208442.https://doi.org/10.1371/journal.pone.0208442
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5. Bhopal, RS. (2002). Concepts of Epidemiology: An Integrated Introduction to the Ideas, Theories, Principles and Methods of Epidemiology. Oxford: Oxford University Press
6. R. & Ranganathan, P. (2009). Study designs: Part 4–Interventional studies. Perspect Clin Res, 10:137-139.
7. Park, K. (2013) Park's textbook of Preventive and Social Medicine. Jabalpur: Bhanot Publishers.
8. Anderson B., Beins M. Auman A. and Walker J., (2024), Nester's Microbiology: A Human Perspective, Mc Graw Hill Publishers

9. Willey J., Sandman K., and Wood D., (2023), Prescott's Microbiology, 12th edition, Mc Graw Hill Publishers
10. Penny web, Chris Bain, & Andrew page (2017). Essential Epidemiology, An introduction for students and healthcare professional, 3rd edition, Cambridge University Press.
11. DeSalvo, K. B., Wang, Y. C., Harris, A., Auerbach, J., Koo, D., & O'Carroll, P. (2017). Public health 3.0: a call to action for public health to meet the challenges of the 21st century. Preventing chronic disease, 14, E78.
12. Goodman, R. A., Bunnell, R., & Posner, S. F. (2014). What is "community health"? Examining the meaning of an evolving field in public health. Preventive medicine, 67, S58-S61.
13. Park, K. (2013) Park's textbook of Preventive and Social Medicine. Jabalpur: Bhanot Publishers.
14. Chokshi, M., Patil, B., Khanna, R., Neogi, S. B., Sharma, J., Paul, V. K., & Zodpey, S. (2016). Health systems in India. Journal of Perinatology, 36(3), S9-S12.

Online reference

https://swayam.gov.in/
https://swayam-plus.swayam2.ac.in/
https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_hs82
https://onlinecourses.swayam2.ac.in/e-learning/preview/ini25_hc04
https://www.who.int/teams/global-hiv-hepatitis-and-stis-programmes/covid-19
https://www.youtube.com/watch?v=CM5mJKqWLxc
https://www.youtube.com/watch?v=4oaQUAnA6nY
https://www.youtube.com/watch?v=82_gxpFx9xk

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Evaluation scheme

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MB-SEC-1006: SWAYAM MOOC: Provided from the SWAYAM/ NPTEL of 2 credits

This course requirement is fulfilled through a 2-credit Massive Open Online Course (MOOC) provided via the SWAYAM/NPTEL platform. Students will complete the designated online curriculum and earn academic credits upon successful assessment.

STRUCTURE FOR ERP – M.Sc. MICROBIOLOGY – SEM – 2 ONLY COURSE WORK AND ONE SEMESTER RESEARCH																	
Course Category	Course Code	Course Title	Mark sheet Title in English	Level of Course	Teaching Hours/Week		Exam Duration (Hours)		Credit		Internal Marks		External Marks		Total	
					TH	PR	TH	PR	TH	PR	TH	PR	TH	PR	TH	PR
MAJOR 1	MB – 2001	MOLECULAR BIOLOGY AND GENOME ENGINEERING	MOLECULAR BIOLOGY AND GENOME ENGINEERING	500-599	02	04	01.00	06.00	02	02	25	25	25	25	50	50
MAJOR 2	MB – 2002	ENVIRONMENTAL MICROBIOLOGY	ENVIRONMENTAL MICROBIOLOGY	500-599	02	04	01.00	06.00	02	02	25	25	25	25	50	50
MAJOR 3	MB – 2003	BIOPROCESS AND FERMENTATION TECHNOLOGY	BIOPROCESS AND FERMENTATION TECHNOLOGY	500-599	02	04	01.00	06.00	02	02	25	25	25	25	50	50
MAJOR 4	MB-2004 BKS	BIOPHYSICS ANALYTICAL BIOCHEMISTRY AND INSTRUMENTATION	BIOPHYSICS ANALYTICAL BIOCHEMISTRY AND INSTRUMENTATION	500-599	04	00	02.00	00	04	-	50	-	50	-	100	-
ME	MB-ME-2005	MICROBIAL BIOINFORMATICS AND OMICS TECHNOLOGIES/ENTERPRENEURSHIP	MICROBIAL BIOINFORMATICS AND OMICS TECHNOLOGIES/ ENTERPRENEURSHIP	500-599	04	00	02.00	00	04	-	50	-	50	-	100	-
SEC	MB-2006	BIOINOCULANTS AND ORGANIC FARMING/ SWAYAM MOOC/RESEARCH METHODOLOGY -2	BIOINOCULANTS AND ORGANIC FARMING/ SWAYAM MOOC/ RESEARCH METHODOLOGY -2	500-599	02	00	00	00	02	-	25	-	25	-	50	-

MB-MJ- 2001: MOLECULAR BIOLOGY AND GENOME ENGINEERING

Program Name	**M.Sc.**
Semester	**M. Sc SEM 2**
NCrF Credit Level	**6.0**
Course Type	**MAJOR**
Course Subtype	**MAJOR 1**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MB-MJ- 2001**
Course Level	**500–599**
Course Title	**Molecular Biology And Genome Engineering**
Credit	**02 (30 Hours)**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs):	Upon successful completion of this course, the students will be able to: **CO1:** Explain the principles of DNA isolation, DNA manipulation, restriction enzymes, ligation, gene transfer techniques and recombinant DNA technology used in genetic engineering. (K2 – Understand) **CO2:** Apply cloning strategies using plasmid, bacteriophage, cosmid, phasmid and expression vectors for construction, screening and expression of recombinant DNA libraries. (K3 – Apply) **CO3:** Analyse methods for gene expression regulation, recombinant selection and library screening in prokaryotic and eukaryotic systems. (K4 – Analyse) **CO4:** Evaluate protein-engineering approaches including directed evolution, site-directed mutagenesis, molecular simulations and protein microarray technologies for modifying protein structure and function. (K5 – Evaluate) **CO5:** Assess the applications of genome editing technologies, particularly CRISPR-Cas systems, in microbial biotechnology, healthcare, agriculture and industrial research. (K5 – Evaluate)
Mapping between COs and PSOs	

	PSO1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO-1	■	■	■					
CO-2	■	■	■					■
CO-3	■		■					■
CO-4	■		■	■				■
CO-5		■	■	■				■

Course Content	
Unit 1 Genetic Engineering	
1.1	Preparation of total cell DNA, plasmid and bacteriophage DNA
1.2	DNA manipulative enzymes and restriction endonucleases, Ligation - joining DNA molecules
1.3	Uptake of DNA by bacterial cells and Identification of recombinants
1.4	Introduction of phage DNA into bacterial cells and non-bacterial cells
1.5	Cloning vectors based on E. coli plasmids, λ bacteriophage, vectors for synthesis of single-stranded DNA
1.6	Vectors for yeast, fungi, higher plants and for animals
1.7	Cosmids, phasmids, other advanced vectors, Expression vectors
1.8	Screening and differential screening strategies available for library screening, Manipulation of Gene Expression in Prokaryotes
Unit 2 : Protein Engineering and Genome Editing Technologies	
2.1	Introduction of Protein Structure and function
2.2	Concepts for Protein Engineering
2.3	Computer Simulations: A Tool for Investigating the Function of Complex Biological Macromolecules
2.4	Evolutionary Methods for Protein Engineering (Methods for the directed evolution of proteins)
2.5	Directed Mutagenesis Procedures and Protein Engineering in various enzymes
2.6	DNA and Protein Microarray technology
2.7	CRISPR-Cas9 genome editing

Reference

1. Brown, T. A. (2021). *Gene cloning and DNA analysis: An introduction* (8th ed.). Wiley-Blackwell. ISBN 9781119640783
2. Reece, R. J. (2004). *Analysis of genes and genomes*. John Wiley & Sons.
3. Brown, T. A. (2021). Gene cloning and DNA analysis: An introduction (8th ed.). Wiley-Blackwell. ISBN 9781119640783
4. Primrose, S. B., & Twyman, R. M. (2006). *Principles of gene manipulation and genomics* (7th ed.). Blackwell Publishing.
5. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). *Molecular biotechnology: Principles and applications of recombinant DNA* (4th ed.). ASM Press.
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8. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). *Molecular biotechnology: Principles and applications of recombinant DNA* (4th ed.). ASM Press.
9. Aparna, G. M., & Tetala, K. K. R. (2023). Recent progress in development and application of DNA, protein, peptide, glycan, antibody, and aptamer microarrays. *Biomolecules*, *13*(4), Article 602. https://doi.org/10.3390/biom13040602
10. Pacesa, M., Pelea, O., & Jinek, M. (2024). Past, present, and future of CRISPR genome editing technologies. Cell, 187(5), 1076–1100. https://doi.org/10.1016/j.cell.2024.01.042

11. Li, T., Yang, Y., Qi, H., Cui, W., Zhang, L., Fu, X., He, X., Liu, M., Li, P.-F., & Yu, T. (2023). CRISPR/Cas9 therapeutics: Progress and prospects. *Signal Transduction and Targeted Therapy*, *8*(1), Article 36. https://doi.org/10.1038/s41392-023-01309-7
12. Rastogi, S., & Pathak, N. (2009). *Genetic engineering*. Oxford University Press, ISBN: 978-0195696578

Online Resources

1. NCBI – https://www.ncbi.nlm.nih.gov
2. Addgene – https://www.addgene.org
3. DNA Learning Center (CSHL) – https://dnalc.cshl.edu
4. EMBL-EBI – https://www.ebi.ac.uk
5. Protein Data Bank (PDB) – https://www.rcsb.org
6. UniProt – https://www.uniprot.org
7. AlphaFold Protein Structure Database – https://alphafold.ebi.ac.uk
8. Broad Institute CRISPR Resources – https://www.broadinstitute.org/what-broad/areas-focus/project-spotlight/crispr
9. NPTEL – https://nptel.ac.in
10. SWAYAM – https://swayam.gov.in
11. SWAYAM Plus- https://swayam-plus.swayam2.ac.in/

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, laboratory experiments, and practical demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MBP-MJ- 2001 Molecular Biology and Genome Engineering (Practical)

<table>
<tr><td>Program Name</td><td>M.Sc.</td></tr>
<tr><td>Semester</td><td>M. Sc SEM 2</td></tr>
<tr><td>Credit Level</td><td>6.0</td></tr>
<tr><td>Course Type</td><td>MAJOR</td></tr>
<tr><td>Course Subtype</td><td>MAJOR PRACTICAL 1</td></tr>
<tr><td>Subject Type</td><td>Faculty of Science- Microbiology</td></tr>
<tr><td>Course Code</td><td>MBP-MJ- 2001</td></tr>
<tr><td>Course Level</td><td>500–599</td></tr>
<tr><td>Course Title</td><td>Molecular Biology and Genome Engineering (Practical)</td></tr>
<tr><td>Credit</td><td>02 (30 Hours)</td></tr>
<tr><td>Effective From</td><td>Academic year: 2026-27</td></tr>
<tr><td>Course Outcomes (COs)</td><td>Upon completion of this practical course, the students will be able to
CO1: Perform fundamental molecular biology techniques including restriction digestion, DNA ligation, PCR amplification, and site-directed mutagenesis for genetic manipulation. (K3 – Apply)
CO2: Execute protein extraction, quantification, folding, and denaturation and renaturation experiments and interpret the relationship between protein structure and function. (K3 – Apply)
CO3: Apply bioinformatics tools for primer design, open reading frame identification, protein structure prediction and homology modelling. (K3 – Apply)
CO4: Analyze and visualize protein structures and evaluate computational approaches for protein engineering and functional prediction. (K4 – Analyze)
CO5: Utilize genome editing and computational biology tools including CRISPR-Cas9 guide RNA design for solving biological and biotechnological problems. (K4 – Analyze)</td></tr>
<tr><td>Mapping between COs and PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO 2</th><th>PSO 3</th><th>PSO 4</th><th>PSO 5</th><th>PSO 6</th><th>PSO 7</th><th>PSO 8</th></tr>
<tr><td>CO-1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>CO-5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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Course Content

I. Wet Lab. Exercise

1. Restriction digestion of DNA/ plasmid using restriction endonuclease
2. Ligation of DNA molecules
3. In vitro amplification of DNA by PCR
4. PCR Mediated Site Directed mutagenesis
5. Protein extraction from bacterial cells and estimation by Bradford/Lowry assay
6. Protein folding- denaturation and renaturation by Urea method

II. Dry Lab. Exercise

7. Primer Designing for PCR
8. Protein secondary structure prediction.
9. Homology modelling
10. Retrieval, analysis and visualization of protein structure
11. Open Reading Frame Finder
12. CRISPR-Cas9 Guide RNA Design by CHOPCHOP

Reference

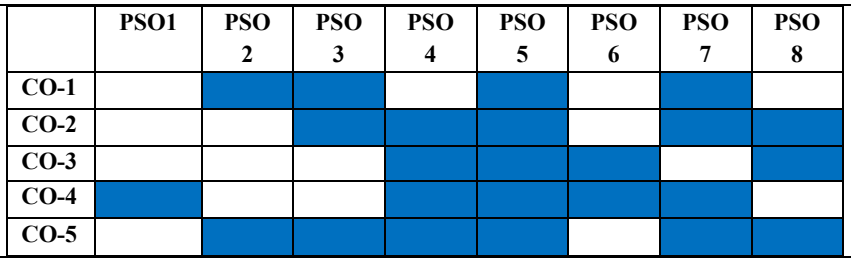
1. Sambrook, J., & Russell, D. W. (2001). *Molecular cloning: A laboratory manual* (3rd ed.). Cold Spring Harbor Laboratory Press.
2. Green, M. R., & Sambrook, J. (2019). *Molecular Cloning: A Laboratory Manual* (4th ed.). Cold Spring Harbor Laboratory Press.
3. Brown, T. A. (2020). *Gene Cloning and DNA Analysis: An Introduction* (8th ed.). Wiley-Blackwell.
4. Walker, J. M. (Ed.). (2009). *The Protein Protocols Handbook* (3rd ed.). Humana Press.
5. Cappuccino, J. G., & Welsh, C. (2018). Microbiology: A laboratory manual (11th global ed.). Pearson Education Limited.
6. Bisen, P. S. (2014). *Laboratory protocols in applied life sciences*. CRC Press.
7. Alexander, S. K., Strete, D., & Niles, M. J. (2003). *Laboratory exercises in organismal and molecular microbiology*. McGraw-Hill Higher Education
8. Aneja, K. R., Experiments in Microbiology 4thed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.
9. Saxena, J., Baunthiyal, M., & Ravi, I. (2015). *Laboratory manual of microbiology, biochemistry and molecular biology,* Scientific Publishers.
10. Bossi, Camilli, Grundl, Experiments in Bacterial Genetics: A Laboratory Manual, Cold Spring Harbor Laboratory Press, 2023, ISBN 978-1621824497
11. Tiwari, R. P., Hoondal, G. S., & Tewari, R. (2004). *Laboratory techniques in microbiology & biotechnology* (1st ed.). Abhishek Publications ISBN 81-8247-077-3
12. Baxevanis, A. D., & Ouellette, B. F. F. (Eds.). (2005). Bioinformatics: A practical guide to the analysis of genes and proteins (3rd ed.). Wiley-Interscience.
13. Mount, D. W. (2021). *Bioinformatics: Sequence and Genome Analysis* (5th ed.). Cold Spring Harbor Laboratory Press.
14. Lesk, A. M. (2019). *Introduction to Bioinformatics* (5th ed.). Oxford University Press.

Online Resources

1. Addgene Protocols – https://www.addgene.org/protocols/
2. New England Biolabs (NEB) Protocols and Tools – https://www.neb.com
3. Benchling Molecular Biology Platform – https://www.benchling.com
4. SnapGene Molecular Biology Resources – https://www.snapgene.com
5. NCBI BLAST and ORF Finder – https://www.ncbi.nlm.nih.gov
6. Primer3 for Primer Design – https://primer3.ut.ee
7. ExPASy Bioinformatics Resource Portal – https://www.expasy.org

8. SWISS-MODEL Homology Modelling Server – https://swissmodel.expasy.org 9. RCSB Protein Data Bank (PDB) – https://www.rcsb.org 10. AlphaFold Protein Structure Database – https://alphafold.ebi.ac.uk 11. CHOPCHOP CRISPR Design Tool – https://chopchop.cbu.uib.no 12. EMBL-EBI Training Portal – https://www.ebi.ac.uk/training
Teaching Methodology
The teaching methodology will involve laboratory experiments, and practical demonstrations to facilitate comprehensive experimental understanding of the subject.
Distribution of Marks
50% CCE: Internal assessment based on internal examination 50% SEE: External assessment based on semester-end university examination.

MB-MJ-2002: Environmental Microbiology

Program Name	**M.Sc.**
Semester	**M. Sc. SEM 2**
Credit Level	**6.0**
Course Type	**MAJOR**
Course Subtype	**MAJOR 2**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MB-MJ-2002**
Course Level	**500-599**
Course Title	**Environmental Microbiology**
Credit	**02 (30 Hours)**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	Upon completion of this practical course, the students will be able to **CO1:** Explain the principles and mechanisms involved in microbial degradation of organic and inorganic pollutants, waste treatment processes and environmental bioremediation technologies for sustainable environmental management. (K2) **CO2:** Analyze microbial processes involved in biofuel production, waste valorization, renewable bioenergy generation and circular bioeconomy applications. (K4) **CO3:** Evaluate environmental risks associated with GMOs, biosafety issues, environmental regulations and microbial threats in relation to environmental protection and public health. (K5) **CO4:** Assess the role of microorganisms in climate change mitigation, antimicrobial resistance dissemination, One Health approaches and ecosystem sustainability. (K5) **CO5:** Apply microbiological and biotechnological approaches for resource recovery, environmental restoration, sustainable agriculture and innovative environmental solutions. (K3)
Mapping between COs and PSOs	

Course Content	
Unit 1 : Bioremediation and Environmental Waste Management Technologies	
1.1	Degradation of hydrocarbons, Chlorinated Hydrocarbons and Aromatics, and Dioxins
1.2	Degradation of Xenobiotics Pesticides, Polymer and dye
1.3	Bioremediation with Inorganic Pollutants
1.4	Treatment of Waste from Organic Chemical Industries
1.5	Treatment of Waste from Food and Dairy Industries, Sugar and Distillery
1.6	Waste, Paper and Pulp industries
1.7	Pharmaceuticals and Hospital Waste Treatment
1.8	Treatment and management of Solid Waste, Treatment of Municipal Waste Insight of biofuel prospects From microalgae as Renewable energy source for Environmental sustainability
Unit 2 : Bioenergy, One Health and Sustainable Environmental Biotechnology	
2.1	Biodiesel, Transesterification for biodiesel, Biomethane and Biohydrogen
2.2	Conversion of Waste to Biofuels, Bioproducts, and Bioenergy
2.3	Cellulosic Ethanol Technology
2.4	Microbial Solutions for Climate Change Toward an Economically Resilient
2.5	Future, An Introduction to Sustainable Circular Bioeconomy,
2.6	Environmental risk assessment, biosafety, GMO release and environmental regulations. Microorganisms and Bioterrorism
2.7	A One-Health Perspective of Antimicrobial Resistance: Human, Animals and Environmental Health, The One Health resistome Microbially Induced Calcium Carbonate Precipitation (MICP) and Its Potential in Bioconcrete: Microbiological and Molecular Concepts

Reference

1. Barton, L. L., & Northup, D. E. (2011). Microbial ecology. John Wiley & Sons.
2. Doble, M. & Anil kumar. (2005). Biotreatment of industrial effluents. Butterworth Heinemannan imprint of Elsevier. (ISBN; 9780080456218)
3. Maddela, N. R., Eller, L. K. W., & Prasad, R. (Eds.). (2023). Microbiology for cleaner production and environmental sustainability. CRC Press.
4. Patwardhan, A. D. (2008). Industrial waste water treatment. PHI Learning.
5. Sangeetha, J., Thangadurai, D., David, M., & Abdullah, M. A. (Eds.). (2016). Environmental biotechnology: Biodegradation, bioremediation, and bioconversion of xenobiotics for sustainable development. Apple Academic Press.
6. Srinivas, T. (2008). Environmental biotechnology. New Age International Publishers.
7. Sukla, L. B., Pradhan, N., Panda, S., & Mishra, B. K. (Eds.). (2015). Environmental Microbial Biotechnology. Springer.
8. Evans, G. M., & Furlong, J. C. (2010). Environmental biotechnology: Theory and application (2nd ed.). Wiley-Blackwell.
9. Singh, V. (Ed.). (2025). Sustainable waste management towards circular bioeconomy: Components, design innovation and impact. Springer.

10. American Society for Microbiology, & International Union for Microbiological Societies. (2025). Microbial solutions for climate change: Toward an economically resilient future. ASM Reports. https://asm.org/reports/microbial-solutions-for-climate-change
11. Sungyu Lee and Shah Y.T., (2013). Biofuels and Bioenergy Processes and Technologies, CRC Press. (ISBN 978-1-4200-8955-4)
12. Maier, R. M., Pepper, I. L., & Gerba, C. P. (Eds.). (2009). Environmental microbiology (2nd ed.). Academic Press.
13. Al-Khalaifah, H.; Rahman, M.H.; Al-Surrayai, T.; Al-Dhumair, A.; Al-Hasan, M. A One-Health Perspective of Antimicrobial Resistance (AMR): Human, Animals and Environmental Health. Life 2025, 15, 1598. https://doi.org/10.3390/ life15101598
14. Majumdar, A., Bagchi, D., Kotta-Loizou, I., & Buck, M. (2026). The One Health resistome: Integrating environmental, microbial, and human antimicrobial resistance surveillance and risk analysis in the digital age. Journal of Hazardous Materials, 513, Article 142431.
15. Castro-Alonso, M. J., Montañez-Hernandez, L. E., Sanchez-Muñoz, M. A., Macias Franco, M. R., Narayanasamy, R., & Balagurusamy, N. (2019). Microbially induced calcium carbonate precipitation (MICP) and its potential in bioconcrete: Microbiological and molecular concepts. Frontiers in Materials, 6, Article 126.

Online resources

1. SWAYAM https://swayam.gov.in
2. NPTEL https://nptel.ac.in
3. World Health Organization (WHO) https://www.who.int
4. Food and Agriculture Organization (FAO) https://www.fao.org
5. United Nations Environment Programme (UNEP) https://www.unep.org
6. Bioremediation and biodegradation [https://youtu.be/OskyBh4MDy4?si=i-mD149KV2FdpOw0]
7. Biodegradation of pesticides [https://youtu.be/tffTDCnuvwY?si=rqeiVGzYOIhKo5wB]
8. Biodegradation of heavy metals [https://youtu.be/nO21I-UvA9I?si=Po7mWIuCxOZPj5Js]
9. Biodegradation[https://youtu.be/qhqlLZKhsYQ?si=UKsVtqnvCwnFtzZD]
10. https://frtr.gov/matrix/documents/Monitored-Natural-Attenuation/2006-In-Situ-and-Ex-Situ-Biodegradation-Technologies-for-Remediation-of-Contaminated-Sites.PDF

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, demonstrations to facilitate comprehensive theoretical and experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MBP-MJ-2002: Environmental Microbiology Practical

<table>
<tr><td>Program Name</td><td>M.Sc.</td></tr>
<tr><td>Semester</td><td>M. Sc. SEM 2</td></tr>
<tr><td>Credit Level</td><td>6.0</td></tr>
<tr><td>Course Type</td><td>MAJOR</td></tr>
<tr><td>Course Subtype</td><td>MAJOR Practical 2</td></tr>
<tr><td>Subject Type</td><td>Faculty of Science- Microbiology</td></tr>
<tr><td>Course Code</td><td>MBP-MJ-2002</td></tr>
<tr><td>Course Level</td><td>500-599</td></tr>
<tr><td>Course Title</td><td>Environmental Microbiology Practical</td></tr>
<tr><td>Credit</td><td>02 (30 Hours)</td></tr>
<tr><td>Effective From</td><td>Academic year: 2026-27</td></tr>
<tr><td>Course Outcomes (COs)</td><td>Upon completion of this practical course, the students will be able to
CO1: Perform laboratory techniques for assessment of microbial tolerance to environmental pollutants, biodegradation of xenobiotics and evaluation of microbial remediation potential. (K3)
CO2: Analyze environmental quality parameters and microbial indicators using BOD, COD and antimicrobial susceptibility testing for environmental monitoring and public health assessment. (K4)
CO3: Isolate, characterize and evaluate environmentally significant microorganisms including microalgae and pollutant-degrading microbial communities. (K4)
CO4: Apply computational tools for community metagenomic analysis to assess microbial diversity, community structure and ecological functions in environmental samples. (K3)
CO5: Interpret functional metagenomic datasets to identify metabolic pathways, biodegradation potential and environmental applications of microbial communities. (K5)</td></tr>
<tr><td>Mapping between COs and PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO 2</th><th>PSO 3</th><th>PSO 4</th><th>PSO 5</th><th>PSO 6</th><th>PSO 7</th><th>PSO 8</th></tr>
<tr><td>CO-1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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Course Content

1. Study of heavy metal tolerance by environmental microorganisms.
2. Pesticide tolerance assay of environmental microorganisms.
3. Biodegradation of pesticide by microbial isolates.
4. Microbial degradation of synthetic dyes (methylene blue/crystal violet) and evaluation of decolourization efficiency.
5. Estimation of Biochemical Oxygen Demand (BOD).
6. Estimation of Chemical Oxygen Demand (COD).
7. Isolation and characterization of microalgae from environmental samples.
8. Antibiotic susceptibility testing of environmental isolates
9. Computational analysis of Community metagenomics
10. Computational analysis of Functional metagenomics

References:

1. Ian L. Pepper, Charles P. Gerba, Terry J. Gentry, Environmental Microbiology: A Laboratory Manual, 2nd Ed. Academic Press
2. Glazer Alexander N., Nikaido Hiroshi, Microbial Biotechnology: Fundamentals of Applied Microbiology, 2nd Edition, Cambridge University Press
3. Agathos Spiros and Reineke Walter, Biotechnology for the Environment: Strategy and Fundamentals, Series: Advances in Biochemical Engineering/Biotechnology, Vol. 81, Springer.
4. Cappuccino, J. G., & Welsh, C. (2018). Microbiology: A laboratory manual (11th global ed.). Pearson Education Limited.
5. Bisen, P. S. (2014). *Laboratory protocols in applied life sciences*. CRC Press.
6. Alexander, S. K., Strete, D., & Niles, M. J. (2003). *Laboratory exercises in organismal and molecular microbiology*. McGraw-Hill Higher Education
7. Aneja, K. R., Experiments in Microbiology 4thed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.
8. Saxena, J., Baunthiyal, M., & Ravi, I. (2015). *Laboratory manual of microbiology, biochemistry and molecular biology,* Scientific Publishers.
9. Bossi, Camilli, Grundl, Experiments in Bacterial Genetics: A Laboratory Manual, Cold Spring Harbor Laboratory Press, 2023, ISBN 978-1621824497
10. Tiwari, R. P., Hoondal, G. S., & Tewari, R. (2004). *Laboratory techniques in microbiology & biotechnology* (1st ed.). Abhishek Publications ISBN 81-8247-077-3

Online resources

1. National Center for Biotechnology Information (NCBI) https://www.ncbi.nlm.nih.gov
2. PubMed https://pubmed.ncbi.nlm.nih.gov
3. United Nations Environment Programme (UNEP) https://www.unep.org

4. World Health Organization (WHO) – One Health & Antimicrobial Resistance Resources
   https://www.who.int
5. Food and Agriculture Organization (FAO)
   https://www.fao.org
6. Intergovernmental Panel on Climate Change (IPCC)
   https://www.ipcc.ch
7. Department of Biotechnology (DBT), Government of India
   https://dbtindia.gov.in
8. Genetic Engineering Appraisal Committee (GEAC), Government of India
   https://geacindia.gov.in

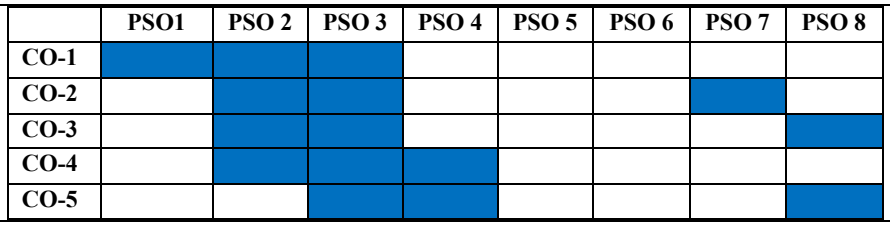
Teaching Methodology

The teaching methodology will involve laboratory experiments, and practical demonstrations to facilitate comprehensive experimental understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on internal examination 50% SEE: External assessment based on semester-end university examination.

MB-MJ-2003: Bioprocess and Fermentation Technology

Program Name	**M.Sc.**
Semester	**M. Sc. SEM 2**
Credit Level	**6**
Course Type	**MAJOR**
Course Subtype	**MAJOR 3**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MB-MJ-2003**
Course Level	**500-599**
Course Title	**Bioprocess and Fermentation Technology**
Credit	**02 (30 Hours)**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	Upon successful completion of this course, the students will be able to: **CO1:** Explain the principles of industrial microbiology, strain improvement, culture preservation, inoculum development, fermentation media formulation and microbial growth kinetics used in bioprocess industries. (K2 – Understand) **CO2:** Apply concepts of submerged and solid-state fermentation, media optimization and process parameters for efficient microbial cultivation and product formation. (K3 – Apply) **CO3:** Analyze aeration, agitation, oxygen transfer, scale-up and scale-down strategies for the design and operation of industrial bioprocesses. (K4 – Analyze) **CO4:** Evaluate downstream processing techniques including filtration, centrifugation, cell disruption, extraction and purification methods for recovery of bioproducts. (K5 – Evaluate) **CO5:** Assess modern bioprocess technologies including heterologous protein production, synthetic biology platforms and Bioprocessing 4.0 for industrial and biotechnological applications. (K5 – Evaluate)
Mapping between COs and PSOs	

Course Content	
Unit 1 : Upstream Processing and Fermentation Technology	
1.1	Isolation of suitable microorganisms from the environment, Culture collections, Improvement of industrial microorganisms, Strain stability,
1.2	Culture preservation: Storage at reduced temperature, storage in a dehydrated form and quality control of preserved stock cultures
1.3	Fermentation media, formulation, Carbon sources Nitrogen source Minerals & others growth factor, precursors, inducers inhibitors, Oxygen requirement, Antifoam and Statistical media Optimization
1.4	Microbial growth kinetics: Batch culture, Continuous culture, Fed-batch culture
1.5	Inoculum development, inoculum transfer, Development of inocula for yeast processes and bacteria
1.6	Introduction to Solid-state fermentation, Suitability of Microorganisms for SSF Processes Biomass Measurement, Factors Affecting SSF, Scale-Up, Modeling in SSF, Types of SSF Bioreactors
1.7	Sterilization and Contamination Control: Sterilization of media, air and equipment; filtration systems; contamination sources; aseptic operation; biosafety and GMP considerations.
1.8	Process Monitoring and Control**:** Measurement and control of temperature, pH, dissolved oxygen, foam, pressure and biomass; sensors, biosensors and process automation
Unit 2 : Downstream Processing and Modern Bioprocess Engineering	
2.1	Aeration and agitation: Introduction, Oxygen requirements of industrial fermentations, Oxygen supply, Determination of KLa values, Fluid rheology, Factors affecting KLa values in fermentation vessels,
2.2	Scale-Up and Scale-Down
2.3	Downstream Processing: Cell harvesting, filtration, centrifugation, cell disruption, extraction, precipitation, membrane separation, chromatography and product formulation.
2.4	Cell disruption by Physico-mechanical methods, Chemical and biological methods
2.5	Products purification: Liquid–liquid extraction, Solvent recovery, Two-phase aqueous extraction, Reversed micelle extraction, Supercritical fluid extraction, Adsorption, Removal of volatile products, Drying, Crystallization
2.6	Recent Advances and Impacts of Microtiter Plate-Based Fermentations in Synthetic Biology and Bioprocess Development
2.7	Emerging trends in bioprocess technology: microbiome microbiome-based biotechnology, omics-guided bioprocessing, AI-assisted fermentation, continuous biomanufacturing and Industry applications.
References:	
1. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2016). *Principles of fermentation technology* (3rd ed.). Elsevier Science & Technology.	

2. Waites, M. J., Morgan, N. L., Rockey, J. S., & Higton, G. (2001). *Industrial microbiology: An introduction*. Blackwell Science.
3. Okafor, N., & Okeke, B. C. (2017). *Modern industrial microbiology and biotechnology* (2nd ed.). CRC Press.
4. El-Mansi, E. M. T., Nielsen, J., Mousdale, D., Allman, T., & Carlson, R. (Eds.). (2019). *Fermentation microbiology and biotechnology* (4th ed.). CRC Press.
5. Isoko, K., Cordiner, J. L., Kis, Z., & Moghadam, P. Z. (2024). Bioprocessing 4.0: A pragmatic review and future perspectives. *Digital Discovery*, *3*(9), 1662–1681. https://doi.org/10.1039/d4dd00127c

Online Resources

1. Addgene – https://www.addgene.org
2. New England Biolabs (NEB) Protocols and Technical Resources – https://www.neb.com/tools-and-resources
3. Thermo Fisher Scientific Learning Center – https://www.thermofisher.com
4. Cytiva Bioprocess Resource Center – https://www.cytivalifesciences.com
5. BioProcess International – https://www.bioprocessintl.com
6. EMBL-EBI Training Portal – https://www.ebi.ac.uk/training
7. NPTEL – https://nptel.ac.in
8. SWAYAM – https://swayam.gov.in

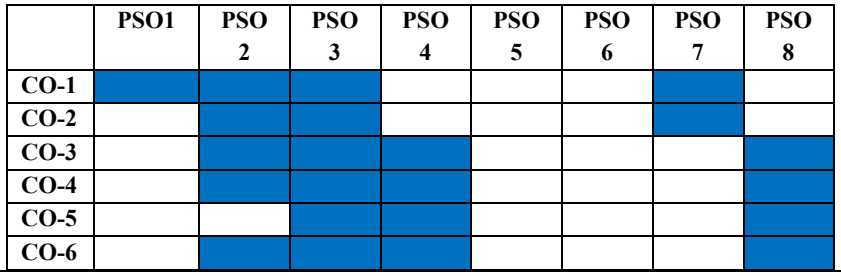
Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning and demonstrations to facilitate comprehensive theoretical understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination

MBP-MJ-2003: Bioprocess and Fermentation Technology Practical

Program Name	**M.Sc.**
Semester	**M. Sc. SEM 2**
Credit Level	**6.0**
Course Type	**MAJOR**
Course Subtype	**MAJOR Practical 3**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MBP-MJ-2003**
Course Level	**500-599**
Course Title	**Bioprocess and Fermentation Technology Practical**
Credit	**02 (30 Hours)**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	Upon successful completion of this practical course, the students will be able to: **CO1**: Prepare and optimize fermentation media, develop inocula, cultivate industrial microorganisms and evaluate microbial growth and biomass production using standard bioprocess techniques. (K3 – Apply) **CO2:** Perform fermentation processes for the production of organic acids and industrially important enzymes under submerged and solid-state fermentation systems. (K3 – Apply) **CO3:** Analyze bioprocess parameters including oxygen transfer, biomass formation and fermentation performance using appropriate analytical methods. (K4 – Analyze) **CO4:** Operate laboratory-scale bioreactors and perform downstream processing techniques including cell harvesting, product recovery and partial purification. (K3 – Apply) **CO5:** Apply statistical experimental design tools for media optimization and process improvement in bioprocess development. (K4 – Analyze) **CO6:** Evaluate fermentation products using chromatographic, spectrophotometric and other analytical techniques for quality assessment and process optimization. (K5 – Evaluate)
Mapping between COs and PSOs	

Course content

1. Preparation and optimization of fermentation media for microbial growth and product formation.
2. Cell harvesting by centrifugation and filtration techniques and Estimation of biomass concentration by spectrophotometric and dry cell weight methods.
3. Production and quantification of citric acid by Aspergillus niger fermentation.
4. Production and assay of industrially important enzymes (protease/cellulase) under submerged fermentation.
5. Production of microbial enzymes under solid-state fermentation using agro-industrial substrates.
6. Determination of oxygen transfer characteristics and estimation of volumetric oxygen transfer coefficient (kLa).
7. Recovery and partial purification of fermentation products by precipitation and membrane filtration methods.
8. Demonstration and operation of laboratory-scale fermenter/bioreactor and study of its components.
9. Analysis of fermentation products using chromatographic or spectrophotometric methods.
10. Use of Plackett-Burman-design-calculator for screening
11. Use of Optimization design using Box-Behnken Design or Central Composite Design

References:

1. Walker, J. M. (Ed.). (2009). *The Protein Protocols Handbook* (3rd ed.). Humana Press.
2. Cappuccino, J. G., & Welsh, C. (2018). Microbiology: A laboratory manual (11th global ed.). Pearson Education Limited.
3. Bisen, P. S. (2014). *Laboratory protocols in applied life sciences*. CRC Press.
4. Alexander, S. K., Strete, D., & Niles, M. J. (2003). *Laboratory exercises in organismal and molecular microbiology*. McGraw-Hill Higher Education
5. Aneja, K. R., Experiments in Microbiology 4thed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers, 2003.
6. Saxena, J., Baunthiyal, M., & Ravi, I. (2015). *Laboratory manual of microbiology, biochemistry and molecular biology,* Scientific Publishers.
7. Bossi, Camilli, Grundl, Experiments in Bacterial Genetics: A Laboratory Manual, Cold Spring Harbor Laboratory Press, 2023, ISBN 978-1621824497
8. Tiwari, R. P., Hoondal, G. S., & Tewari, R. (2004). *Laboratory techniques in microbiology & biotechnology* (1st ed.). Abhishek Publications ISBN 81-8247-077-3

Online Resources

1. Addgene Protocols – https://www.addgene.org/protocols
2. New England Biolabs (NEB) Protocols – https://www.neb.com/protocols

3. Thermo Fisher Scientific Learning Center – https://www.thermofisher.com
4. Cytiva Bioprocess Resource Center – https://www.cytivalifesciences.com
5. EMBL-EBI Training Portal – https://www.ebi.ac.uk/training
6. BioProcess International – https://www.bioprocessintl.com
7. NPTEL Biotechnology Courses – https://nptel.ac.in
8. SWAYAM – https://swayam.gov.in
9. JMP Learning Library – https://www.jmp.com/en_us/learning-library.html

Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning, Laboratory exercises and practical, demonstrations to facilitate comprehensive theoretical understanding of the subject.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, practical test, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination

MB-MJ-2004: Biophysics, Analytical Biochemistry and Instrumentation

<table>
<tr><td>Program Name</td><td>M.Sc.</td></tr>
<tr><td>Semester</td><td>M. Sc. SEM 2</td></tr>
<tr><td>Credit Level</td><td>6.0</td></tr>
<tr><td>Course Type</td><td>MAJOR</td></tr>
<tr><td>Course Subtype</td><td>MAJOR 4</td></tr>
<tr><td>Subject Type</td><td>Faculty of Science- Microbiology</td></tr>
<tr><td>Course Code</td><td>MB-MJ-2004</td></tr>
<tr><td>Course Level</td><td>500-599</td></tr>
<tr><td>Course Title</td><td>Biophysics, Analytical Biochemistry and Instrumentation</td></tr>
<tr><td>Credit</td><td>04 (60 Hours)</td></tr>
<tr><td>Effective From</td><td>Academic year: 2026-27</td></tr>
<tr><td>Course Outcomes (COs)</td><td>Upon successful completion of this practical course, the students will be able to:
CO1: Explain the principles of biophysical chemistry, chromatography, electrophoresis and their applications in biological and biochemical investigations. (K2 – Understand)
CO2: Apply the principles of spectroscopic, microscopic and centrifugation techniques for analysis and characterization of biomolecules and biological systems. (K3 – Apply)
CO3: Analyze molecular structure determination methods, advanced analytical techniques and nucleic acid quantification approaches used in modern biological research. (K4 – Analyze)
CO4: Evaluate the applications of mass spectrometry, PCR variants, flow cytometry, biosensors and imaging technologies in microbiology, biotechnology and biomedical sciences. (K5 – Evaluate)
CO5: Assess immunological, radiolabeling and electrophysiological techniques and their significance in diagnostics, research and healthcare applications. (K5 – Evaluate)</td></tr>
<tr><td>Mapping between COs and PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO 2</th><th>PSO 3</th><th>PSO 4</th><th>PSO 5</th><th>PSO 6</th><th>PSO 7</th><th>PSO 8</th></tr>
<tr><td>CO-1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO-3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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Course content	
Unit 1: Biophysical Chemistry, Chromatographic and Electrophoretic Techniques	
1.1	Principles of biophysical chemistry: pH, buffer, reaction kinetics, thermodynamics, colligative properties
1.2	An Introduction to Chromatographic Separations, Principle, instrumentation and applications of Paper chromatography, Thin Layer Chromatography (TLC),
1.3	Principle, instrumentation and applications of Adsorption chromatography, Partition chromatography, Ion Exchange Chromatography, Size Exclusion (Gel Filtration) Chromatography, Affinity Chromatography,
1.4	Principle, instrumentation and applications of Gas Chromatography (GC) and High-Performance Liquid Chromatography (HPLC)
1.5	Electrophoresis: General principles, support media and buffers, electrophoresis of proteins, electrophoresis of nucleic acids, capillary electrophoresis and microchip electrophoresis.
Unit 2: Spectroscopy, Structural Biology and Advanced Analytical Techniques	
2.1	Spectroscopic Techniques for Biomolecular Analysis**:** UV–Visible Spectroscopy, Fluorescence Spectroscopy, Circular Dichroism (CD) Spectroscopy, Electron Spin Resonance (ESR/EPR) Spectroscopy
2.2	Structural Biology and Molecular Structure Determination: X-ray Diffraction (X-ray Crystallography), Cryo-Electron Microscopy (Cryo-EM), Nuclear Magnetic Resonance (NMR) Spectroscopy in Structure Determination
2.3	Advanced Molecular Characterization and Interaction Analysis: Light Scattering Techniques, Mass Spectrometry and its Types, Surface Plasmon Resonance (SPR)
2.4	Advanced Analytical Techniques: MALDI-TOF Mass Spectrometry, Liquid Chromatography–Mass Spectrometry (LC-MS) and Liquid Chromatography–Tandem Mass Spectrometry (LC-MS/MS)
2.5	Principle of Centrifugation, Differential centrifugation, density-gradient centrifugation, ultracentrifugation
Unit 3: Molecular Analysis, Quantification and Imaging Technologies	
3.1	Infrared and Raman Spectroscopy and Atomic Spectroscopy, Fluorescence Spectroscopy
3.2	PCR, Q-PCR, ddPCR and other variants of PCR,
3.3	Spectrophotometric and fluorometric nucleic acid quantification (Nanodrop and Qubit), Nucleic acid hybridization,
3.4	Protein Sequencing: Significance, Methods, and Applications
3.5	Confocal microscopy, fluorescence imaging, transmission electron microscopy (TEM), scanning electron microscopy (SEM), cryo-electron microscopy (Cryo-EM), Atomic Force Microscopy (AFM)

Unit 4: Cellular Analysis, Immunotechniques and Biomedical Instrumentation	
4.1	Principles, instrumentation and application of flow cytometry
4.2	Radiolabeling techniques: Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines
4.3	Histochemical and Immunotechniques: ELISA, RIA, blotting techniques, immunofluorescence, immunoprecipitation, FISH and GISH techniques.
4.4	Concept, types and application biosensors
4.5	Electrophysiological methods: Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT

Reference

1. Nelson, D. L., Cox, M. M., Hoskins, A. A., & Lehninger, A. L. (2021). *Lehninger principles of biochemistry* (8th ed.). W. H. Freeman and Company
2. Kumar, P. (2024). *Biophysics and molecular biology: Tools and techniques* (5th ed.). Pearson India.
3. Kumar, P. (2018). *Fundamentals and techniques of biophysics and molecular biology* (2nd ed.). Pathfinder Publication.
4. Kalidas, C., & Sangaranarayanan, M. V. (2023). *Biophysical Chemistry: Techniques and Applications* (1st ed.). Springer International Publishing.
5. Hofmann, A., & Clokie, S. J. (Eds.). (2018). *Wilson and Walker's principles and techniques of biochemistry and molecular biology* (8th ed.). Cambridge University Press.
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9. Chatwal, G. R., & Anand, S. K. (2019). *Instrumental methods of chemical analysis* (5th ed.). Himalaya Publishing House.
10. https://www.metwarebio.com/what-is-protein-sequencing/

Online Resources

1. https://www.metwarebio.com/what-is-protein-sequencing/
2. National Center for Biotechnology Information (NCBI) – https://www.ncbi.nlm.nih.gov
3. EMBL-European Bioinformatics Institute (EMBL-EBI) – https://www.ebi.ac.uk
4. ExPASy Bioinformatics Resource Portal – https://www.expasy.org
5. Protein Data Bank (PDB) – https://www.rcsb.org
6. UniProt Protein Knowledgebase – https://www.uniprot.org
7. PubChem Chemical Database – https://pubchem.ncbi.nlm.nih.gov
8. NIST Chemistry WebBook – https://webbook.nist.gov
9. MicroscopyU (Nikon Microscopy Education) – https://www.microscopyu.com
10. Thermo Fisher Learning Center – https://www.thermofisher.com/in/en/home/global/forms/life-science/learning-center.html

11. NPTEL Courses – https://nptel.ac.in
12. SWAYAM – https://swayam.gov.in

Teaching Methodology
The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning and demonstrations to facilitate comprehensive theoretical understanding of the subject.
Distribution of Marks
50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination

MB-ME-2005: Microbial Bioinformatics and Omics Technologies

Program Name	**M.Sc.**
Semester	**M. Sc. SEM 2**
Credit Level	**6**
Course Type	**MAJOR**
Course Subtype	**MAJOR 4 Pracricals**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MB-MDC-2005**
Course Level	**500–599**
Course Title	**Microbial Bioinformatics and Omics Technologies**
Credit	**04 (60 Hours)**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	Upon successful completion of this course, the students will be able to: **CO1:** Explain the fundamental concepts of bioinformatics, biological databases, sequence alignment methods, phylogenetic analysis and their applications in microbiological research. (K2 – Understand) **CO2:** Apply genome sequencing technologies, quality control methods, genome assembly, annotation tools and comparative genomics approaches for microbial genome analysis. (K3 – Apply) **CO3:** Analyze microbial genomes, metagenomes, transcriptomes and metabolomic datasets for classification, identification and functional interpretation of microorganisms. (K4 – Analyze) **CO4:** Evaluate protein structure, protein function, molecular interactions and computational approaches including AI-assisted structural prediction and molecular modelling. (K5 – Evaluate) **CO5:** Assess the applications of bioinformatics, systems biology and computer-aided drug design in solving contemporary problems in microbiology, biotechnology and healthcare. (K5 – Evaluate)
Mapping between COs and PSOs	

	PSO1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO-1	■			■	■			
CO-2	■			■				■
CO-3	■			■	■			
CO-4				■		■		■
CO-5		■		■		■		■

Course Content	
Unit 1: Fundamentals of Bioinformatics and Sequence Alignment	
1.1	Introduction, Overview, Definition, Applications of Bioinformatics, Molecular Biology and Bioinformatics, Molecular Biology and Bioinformatics, Central Dogma of Molecular Biology. Computers and Operating Systems Required for Bioinformatics,
1.2	Major Databases in Bioinformatics: Sequence databases, gene expression databases, 3D structure database, pattern sequence databases, Data Retrieval
1.3	Definitions of homologues, orthologues, paralogues, repeat finding, sequence identity and similarity, pairwise sequence alignments, scoring matrix
1.4	Database searches, BLAST and FASTA
1.5	Multiple sequence alignments (MSA), application in taxonomy and phylogeny, Phylogenetics
Unit 2: Genome Sequencing, Quality Control, and Comparative Genomics	
2.1	DNA Sequencing: Sanger sequencing, Next Generation Sequencing (NGS) and Third Generation Sequencing technologies; Illumina, Ion Torrent, PacBio and Oxford Nanopore platforms
2.2	Raw Sequence Data Quality Control, DNA Sequence Assembly and Annotation of Genes
2.3	Prediction of gene function using homology, context, structures, networks; Genetic variation polymorphism, deleterious mutations;
2.4	Computational Approaches in Comparative Genomics
2.5	Sequenced-Based Typing of Prokaryotes
Unit 3: Microbial Genomics and Multi-Omics Technologies	
3.1	Sequence-Based Classification and Identification of Prokaryotes
3.2	16S rRNA Amplicon Sequencing for Metagenomics
3.3	Full Shotgun DNA Metagenomics
3.4	Transcriptomics
3.5	Metabolomics
Unit 4: Proteomics, Structural Biology, and Computer-Aided Drug Design	
4.1	Proteomics and Protein Identification
4.2	Protein stability and folding, Classifications of protein structures,
4.3	Protein structure prediction and modelling, AI-based methods of structure prediction (AlphaFold), Molecular Modelling and Dynamics
4.4	Chemical databases like NCI /PUBCHEM, Fundamentals of Receptor-ligand interactions, Structure-based drug design, Ligand based drug design: Structure-Activity Relationship, QSARs and pharmacophores, in silico predictions of drug activity and ADMET
4.5	Systems biology: Concept and application

References

1. Ismail, H. D. (2023). Bioinformatics: A Practical Guide to Next Generation Sequencing Data Analysis. CRC Press.
2. Christensen, H. (Ed.). (2018). Introduction to Bioinformatics in Microbiology. Springer.
3. Rastogi, S. C., Mendiratta, N., & Rastogi, P. (2013). Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery (4th ed.). PHI Learning.
4. Lesk, A. M. (2014). Introduction to Bioinformatics (4th ed.). Oxford University Press.
5. Baxevanis, A. D., & Ouellette, B. F. F. (Eds.). (2005). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (3rd ed.). Wiley.
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12. Bard, J. (2013). Systems biology — the broader perspective. Cells, 2(2), 414–431. https://doi.org/10.3390/cells2020414
13. Marcus, F. B. (2008). Bioinformatics and systems biology: Collaborative research and resources. Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-540-78353-4

Online Resources

1. National Center for Biotechnology Information (NCBI): https://www.ncbi.nlm.nih.gov
2. European Bioinformatics Institute (EMBL-EBI): https://www.ebi.ac.uk
3. DNA Learning Center (Cold Spring Harbor Laboratory): https://dnalc.cshl.edu
4. National Programme on Technology Enhanced Learning (NPTEL): https://nptel.ac.in
5. SWAYAM: https://swayam.gov.in
6. Protein Data Bank (PDB): https://www.rcsb.org
7. UniProt Knowledgebase: https://www.uniprot.org
8. AlphaFold Protein Structure Database: https://alphafold.ebi.ac.uk
9. Galaxy Project for Bioinformatics Analysis: https://usegalaxy.org
10. PubChem Database: https://pubchem.ncbi.nlm.nih.gov

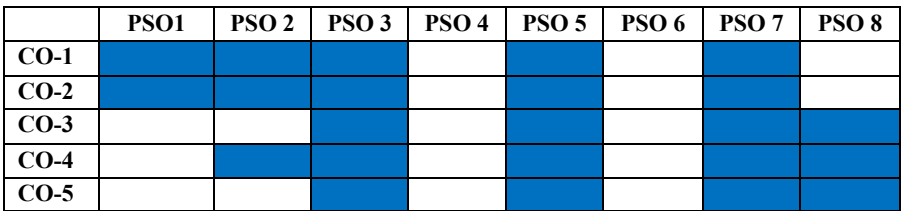
Teaching Methodology

The teaching methodology will involve classroom lectures, interactive discussions, seminars, assignments, case studies, scientific literature review, problem-solving exercises, and lecture-based demonstrations of bioinformatics tools and databases to facilitate comprehensive theoretical understanding of bioinformatics, genomics, omics technologies, and computational biology.

Distribution of Marks

50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination.

MB-SEC-2006: Bioinoculants and Organic Farming

Program Name	**M.Sc.**
Semester	**M. Sc. SEM 2**
Credit Level	**6.0**
Course Type	**SEC**
Course Subtype	**SEC 1**
Subject Type	**Faculty of Science- Microbiology**
Course Code	**MB-SEC-2006**
Course Level	**500-599**
Course Title	**Bioinoculants and Organic Farming**
Credit	**02 (30 Hours)**
Effective From	**Academic year: 2026-27**
Course Outcomes (COs)	Upon successful completion of this course, the students will be able to: **CO1:** Explain the principles, importance and applications of bioinoculants in sustainable agriculture, including their role in nutrient management, plant health promotion and stress mitigation. (K2) **CO2:** Analyze the diversity, characteristics and agricultural significance of major bioinoculants such as bacterial inoculants, cyanobacteria, Azolla, mycorrhizae and phosphate-solubilizing microorganisms. (K4) **CO3:** Describe the concepts, principles, advantages, limitations and practices of organic farming for environmentally sustainable agricultural production. (K2) **CO4:** Evaluate the role of biofertilizers in sustainable agriculture, their economic and environmental benefits, commercial production and contribution to soil fertility management. (K5) **CO5:** Assess the current status, industrial development, challenges and future prospects of bioinoculant and biofertilizer technologies in India. (K5)
Mapping between COs and PSOs	

Course Content	
Unit 1 : Fundamentals and Applications of Bioinoculants	
1.1	Introduction of Bioinoculants
1.2	Role of Bioinoculants in Green Agriculture: Nutrient Assimilation and Biofortification, Management of Pests and Pathogens, Abiotic Stress Management
1.3	Method of application and recommended doses
1.4	Current market scenario in India and Challenges and future prospects
1.5	Bacterial Inoculants, Green Manuring
1.6	Cyanobacterial Inoculants, Azolla as Biofertilizer
1.7	Mycorrhizal fungi as Biofertilizer
1.8	Phosphate solubilizing microorganisms
Unit 2 : Organic Farming and Biofertilizers	
2.1	Definition and Concepts of organic farming
2.2	Importance and Characteristics of organic farming
2.3	Advantages and Disadvantages of organic farming
2.4	Introduction of Biofertilizers, Biofertilizer for sustainable Agricultures
2.5	Economic and Environmental Benefits of Biofertilizer
2.6	Commercial Producers of Biofertilizers, Works Done on Biofertilizers in India
2.7	Development of Microbial Biofertilizer Industry

References

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2. Aman Raj and Adesh Kumar, A sustainable alternative to agrochemicals, Bioinoculants ***Indian*** *Farming 75* (05): 21-24.
3. Aneja, K. R., (2003). Experiments in Microbiology 4thed., Experiments in microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, New Age International Publishers DOI http://dx.doi.org/10.18174/375218
4. Dubey, R. C. (1993). A Textbook of Biotechnology. (Multicolor Illustrative revised Edition) S. Chand Publishing. (ISBN: 81-219-2608-4).
5. Dubey, R. C. (2000). Textbook of Microbiology. (4th Edition) S. Chand, Limited.(ISBN: 978-8121926201).
6. Handbook for composting and compost use in organic horticulture. André W.G. van der Wurff, Jacques G. Fuchs, Michael Raviv and Aad J. Termorshuizen, (ISBN:978-94-6257-749-7),
7. Jnana Bharati Palai M, Mostafizur Rahman Shah, Viliam Barek, Peter Ondrisik, Milan Skalický and Akbar Hossain. Bioinoculants: Natural Biological Resources for Sustainable plant production. Microorganisms https://doi.org/10.3390/10010051, 10 (51) 1-35.
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9. Patel, R. J., & Patel, R. K., (2022). Experimental Microbiology, Vol. 1, 10th Edition,

Aditya.
10. Purohit, S. S. (2006). Microbiology: Fundamentals and Applications. (7th Edition) Agrobios. (ISBN:978-81-7754-259-1).
11. Sagar Maitra, Marian Brestic, Preetha Bhadra, Tanmoy Shankar, Subhashisa Praharaj,
12. Santanu Kundu, Ashay D Souza, Lalta Prasad Verma, Tushar Ghosh, Debarati Seal (2024). Organic Farming Cultivating Sustainable Agriculture, National Press Associates, New Delhi, (ISBN: 978-81-19674-42-8)
13. Somasundaram, E., Nandhini, D. U., & Meyyappan, M. (2019). Principles of Organic Farming: (With Theory and Practicals). New India Publishing Agency.(ISBN:9781003260844)
14. Subba Rao, N. S. (1993). Biofertilizers in agriculture and forestry (3rd rev. ed). International Science Publisher. (ISBN: 1881570290)

Online resources

1. https://www.youtube.com/watch?v=LvqMMfa8ysM
2. https://www.youtube.com/watch?v=ExqbV5Ol1FU
3. https://www.youtube.com/watch?v=3YxE9kEXv3I
4. https://www.youtube.com/watch?v=RpHms71b4m4
5. https://www.youtube.com/watch?v=Cm8MyVq8er8
6. https://www.youtube.com/watch?v=WhOrIUlrnPo
7. https://www.youtube.com/watch?v=_AM2fX24vtQ
8. https://www.youtube.com/watch?v=yCDTXI1l6D4
9. SWAYAM (https://swayam.gov.in)
10. SWAYAM Plus (https://swayam-plus.swayam2.ac.in)
11. https://share.google/nqkdslVo2iRT8gfQE
12. https://share.google/qBUjyvmWUau3amgN4
13. https://share.google/91VpjqU25ZxulCFRN

Teaching Methodology
The teaching methodology will involve classroom lectures, interactive discussions, self-study, seminars, assignments, project-based learning and demonstrations to facilitate comprehensive theoretical understanding of the subject.
Distribution of Marks
50% CCE: Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination etc. 50% SEE: External assessment based on semester-end university examination

MB-SEC-2006: SWAYAM MOOC: Provided from the SWAYAM/ NPTEL of 2 credits

This course requirement is fulfilled through a 2-credit Massive Open Online Course (MOOC) provided via the SWAYAM/NPTEL platform. Students will complete the designated online curriculum and earn academic credits upon successful assessment.