Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

(Autonomous)

Two Year Degree Program in Microbiology (Faculty of Science & Technology)

Choice Based Credit System Syllabus (2023 Pattern)

(As Per NEP 2020)

M.Sc. Microbiology Part-I Semester -I

To be implemented from Academic Year 2023-2024

Title of the Programme: M.Sc. Microbiology

Preamble

Introduction:

Anekant Education Society's Tuljaram Chaturchand College has decided to change the syllabus of various faculties from June, 2023 by taking into consideration the guidelines and provisions given in the National Education Policy (NEP), 2020. The NEP envisions making education more holistic and effective and to lay emphasis on the integration of general (academic) education, vocational education and experiential learning. The NEP introduces holistic and multidisciplinary education that would help to develop intellectual, scientific, social, physical, emotional, ethical and moral capacities of the students. The NEP 2020 envisages flexible curricular structures and learning based outcomes for the development of the students. The credit structure and the courses framework provided in the NEP are nationally accepted and internationally comparable.

The rapid changes in science and technology and new approaches in different areas of Microbiology and related subjects, Board of Studies in Microbiology of Tuljaram Chaturchand College, Baramati - Pune has prepared the syllabus of M.Sc.-I Microbiology Semester - I under the Choice Based Credit System (CBCS) by following the guidelines of NEP 2020, NCrF, NHEQF, Prof. R.D. Kulkarni's Report, GR of Gov. of Maharashtra dated 20th April and 16th May 2023 and Circular of SPPU, Pune dated 31st May 2023.

A Master degree in Microbiology will provide students, the knowledge and skills to begin a variety of rewarding careers. The scope of an MSc in Microbiology is broad and offers a range of opportunities in various sectors like Research and Development in academic institutions, government research organizations, pharmaceutical companies, biotechnology firms, and other industries. They can work in industries such as pharmaceuticals, biotechnology, food and beverage, agriculture, environmental monitoring, and fermentation industries. Microbiologists are involved in quality control, process optimization, product development, microbial fermentation, and ensuring compliance with regulations and standards. Microbiologists play a vital role in public health and epidemiology, studying infectious diseases, investigating outbreaks, and developing strategies for disease prevention and control. They can work in government health agencies, public health laboratories, hospitals, and international organizations like the World Health Organization (WHO) or the Centers for Disease Control and Prevention (CDC).

Microbiology postgraduates can find opportunities in the pharmaceutical and biotechnology sectors, contributing to the development and production of vaccines, antibiotics, and other therapeutic products. They may work in areas such as drug discovery,

clinical trials, quality assurance, and regulatory affairs. With MSc in Microbiology, postgraduates can pursue academic careers and become researchers, lecturers, or professors in universities and colleges. They can conduct independent research, mentor students, and contribute to the advancement of scientific knowledge.

Programme Specific Outcomes (PSOs)

PSO1. Post Graduates should be able to demonstrate the acquisition of Comprehensive knowledge and coherent understanding of the separation and purification of Biomolecules.

PSO2. Post Graduates should be able to demonstrate the acquisition of Comprehensive knowledge and coherent understanding of Pharmaceutical, medical, industrial microbiology.

PSO3. Post Graduates should be able to demonstrate the acquisition of Comprehensive knowledge and coherent understanding of biochemistry, molecular biology, virology and immunology.

PSO4. Post Graduates should be able to demonstrate the acquisition of Practical, professional, and procedural knowledge required for carrying out professional or highly skilled work/tasks related to Microbiology, including knowledge required for undertaking self-employment.

PSO5. The post graduates should be able to demonstrate the ability to plan, execute and report the results of an experiment or investigation.

PSO6. The post graduates should be able to demonstrate the ability to acquire the understanding of basic research ethics and skills in practicing/doing ethics in the field/ in personal research work, regardless of the funding authority or field of study.

PSO7. The post graduates should be able to demonstrate the acquisition of and ability to apply the knowledge, skills, attitudes, and values required to take appropriate actions for: effective waste management, conservation of biological diversity, management of biological resources and biodiversity and sustainable development and living.

PSO8. The post graduates should be able to demonstrate the capability to analyze and synthesize data from a variety of sources; draw valid conclusions.

PSO9. The post graduates should be able to demonstrate the appropriate use of statistical and other analytical tools and techniques.

Anekant Education Society's

Tuljaram Chaturchand College, Baramati

(Autonomous)

Board of Studies (BOS) in Microbiology

From 2022-23 to 2024-25

Sr. No.	Name	Designation
1.	Prof .S.T,Pawar	Chairman
2.	Prof M.H.Gajbhiye	Member
3.	Prof..Y.R.Mulay	Member
4.	Mr.D.V.Doshi	Member
5.	Mrs K.R.Jagtap	Member
6	Miss.P.C.Bhosale	Member
7	Dr. Snehal Kulkarni	Expert from SPPU, Pune
8.	Dr. T. A. Kadam	Expert from other University
9.	Dr. A. V. Pethkar	Expert from other University
10.	Pradip Lonkar	Industry Expert
11	Miss Kiran Sonawane	Meritorious Alumni
12.	Miss .Pooja Jamdade	Student Representative

Credit distribution Structure
for M.Sc. I 2023-2024
(Microbiology)

Level	Sem	Major		Research Methodology (RM)	OJT/FP	RP	Cum. Cr.	Degree
		Mandatory	Elective					
6.0	Sem-I	MI-501-MJM: Instrumentation (Credit 04)	MI-511-MJE: A. Biochemistry B. Ecology C. Medical Microbiology (Credit 04)	MI-521-RM (Credit 04)	---	---	20	PG Diploma (after 3 year degree)
		MI-502-MJM: Microbial Technology (Credit 04)						
		MI-503-MJM: Practical course I (Credit 02)						
		MI-504-MJM: Practical Course II (Credit 02)						
	Sem-II	MI-551-MJM: Pharmaceutical Microbiology (Credit 04)	MI-561-MJE A. Virology B. Biophysical techniques C. Developmental Biology (Credit 04)	---	MI-581-OJT/FP Credit 04	---	20	
		MI-552-MJM: Industrial Waste Water treatment (Credit 04)						
		MI-553-MJM: Practical course III (Credit 02)						
		MI-554-MJM: Practical course IV (Credit 02)						
	Cum Cr.	24	8	4	4	---	40	

Anekant Education Society's
TuljaramChaturchand College of Arts, Science and Commerce, Baramati
(Autonomous)
Department of Microbiology

Course Structure for M.Sc. Microbiology Part I (2023 Pattern)

Semester	Course Type	Course Code	Title of Course	Theory/ Practical	No. of Credits
I	Major (Mandatory)	MI-501-MJM	Instrumentation	Theory	4
	Major (Mandatory)	MI-502-MJM	Microbial Technology	Theory	4
	Major (Mandatory)	MI-503-MJM	Practical Course I	Practical	2
	Major (Mandatory)	MI-504-MJM	Practical Course II	Practical	2
	Major (Elective)	MI-511-MJE(A)	Biochemistry	Theory	4
		MI-511-MJE(B)	Ecology		
		MI-511-MJE(C)	Medical Microbiology		
	RM	MI-521-RM	Research Methodology	Theory	4
	Total credits Semester I				20
II	Major (Mandatory)	MI-551-MJM	Pharmaceutical Microbiology	Theory	4
	Major (Mandatory)	MI-552-MJM	Industrial Waste water treatment	Theory	4
	Major (Mandatory)	MI-553-MJM	Practical Course III	Practical	2
	Major (Mandatory)	MI-554-MJM	Practical Course IV	Practical	2
	Major (Elective)	MI-561-MJE(A)	Virology	Theory	4
		MI-561-MJE(B)	Biophysical techniques		
		MI-561-MJE(C)	Developmental Biology		
	OJT/FP	MI-581-OJT/FP	On job training/Field projects	Training / Project	4
	Total credits Semester II				20
Cumulative Credits Semester I and II					40

SYLLABUS (CBCS as per NEP 2020) FOR M.Sc. I. Microbiology
(w. e. from June, 2023)

Name of the Programme : M.Sc. Microbiology
Program Code : PSMI
Class : M.Sc. I
Semester : I
Course Type : Major Mandatory
Course Name : Instrumentation
Course Code : MI-501-MJM
No. of Lectures : 60
No. of Credits : 04

Course Objective:

1. To understand the fundamental principles and concepts of instrumentation in various fields such as engineering, physics, chemistry, and biology.
2. To explore the different types of instruments used for measurement, control, and analysis in scientific application.
3. To gain knowledge about the design, construction, and operation of instrumentation systems.
4. To understand the importance of calibration, accuracy, and reliability in instrumentation.
5. To explore the emerging trends and advancements in instrumentation technology.
6. To enrich students' knowledge and train them in the instrumentation
7. To allow students to understand about various separation and analytical techniques.

Course Outcome:

CO1. Ability to explain the fundamental principles and concepts of instrumentation and their applications in different fields.
CO2. Knowledge of different types of instruments, their functions, and their appropriate use in specific measurement and control tasks.
CO3. Understanding of the importance of calibration and the ability to calibrate instruments accurately.
CO4. Ability to evaluate the accuracy, precision, and reliability of measurement systems.
CO5. Familiarity with the ethical and safety considerations associated with instrumentation practices.
CO6. Awareness of the latest advancements and emerging trends in instrumentation technology.
CO7. The student should be able to apply the knowledge regarding various separation techniques while purifying a biomolecule.
CO8. The student should be able to apply the knowledge regarding various analytical techniques while analysing purified biomolecule.

CONTENTS:

UNIT 1: Chromatography (15L)

Partition Coefficient, Selectivity, Resolution, Column Efficiency, Van Deemter equation, Interpretation of chromatograms

Principle, components of instrument, operation and application of:

- Gel filtration chromatography
- Ion-exchange Chromatography
- Affinity chromatography

- Gas chromatography
- High Performance Liquid Chromatography

UNIT 2 Spectroscopy (15L)

Electromagnetic spectrum, atomic orbitals, Molecular orbitals, Electronic, Rotational and Vibrational transitions in spectroscopy, Interpretation of spectra.

Principle, working, construction and application of:

- UV/Visible spectroscopy
- Fluorescence spectroscopy
- Infrared spectroscopy
- Atomic spectroscopy

UNIT 3: Electrophoresis and Centrifugation (15L)

- Electrophoresis – AGE, NATIVE PAGE, SDS-PAGE, Isoelectric focusing.
- Ultra-centrifugation, Differential centrifugation, Isopycnic and Rate zonal centrifugation

UNIT 4: Industrial Biosafety and Environment Regulation (15L)

- Laminar air flow: Aseptic area, Design, Types, operating principle
- Biosafety cabinet: Types, working and principle
- HVAC system: Heating
  Cooling
  Ventilation and Air conditioning

References:

1. Clive Dennison (2002) *A guide to protein isolation*, Kluwer Academic Publishers
2. Pattabhi, V. and Gautham, N. (2002) *Biophysics.* Kluwer Academic Publishers, NewYork and Narosa Publishing House, Delhi.
3. David J Holme, Hazel Peck (1998) *Analytical Biochemistry*, 3rd ed., Prentice HallPearson Education Limited, Harlow England.
4. Rodney F. Boyer (2000*) Modern Experimental Biochemistry* 3d edition., Benjamin Cummings.
5. Nölting, B. (2006) *Methods in modern biophysics.* Second Edition. Springer, Germany.
6. Wilson Keith and Walker John (2005) *Principles and Techniques of Biochemistry andMolecular Biology*, 6th Ed. Cambridge University Press, New York.
7. Rolf Ekman, Jerzy Silberring, Ann Westman- Brinkmalm, Agnieszka Kraj (2009) *Massspectrometry: instrumentation, interpretation, and applications*, John Wiley & Sons,Inc.,Canada.
8. Irwin H. Segel (1976) *Biochemical Calculations: How to Solve Mathematical Problems inGeneral Biochemistry*, 2nd Edition. John Wiley & Sons.
9. Harvey Lodish, Arnold Berk, S. Lawrence Zipursky, Paul Matsudaira, David Baltimore, And James Darnell (2000) Molecular Cell Biology, 4th edition, W. H. Freeman & c

Mapping of Program Outcomes with Course Outcomes

Weightage: 1=weakorlowrelation,2=moderateorpartialrelation,3=strongordirectrelation

	Programme Outcomes(POs)								
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2							
CO2	3	3	3						
CO3	1	2	2	2	2				
CO4		2	2	2	2				
CO5				2	3	3			
CO6				3		2			
CO7						2	3		
CO8						2			

Justification for the mapping

PO1:DisciplinaryKnowledge

CO1: Students will understand the basic principles and concepts of instrumentation and their practical applications across diverse fields.

CO2: Students will develop a deep understanding ofvarious instrument types, their functionalities, and their appropriate application in specific measurement and control contexts.

CO3: Students will master and developing the ability to recognizing the significance of calibration and the skill to precisely calibrate instruments.

PO2: Critical Thinking and Problem Solving

CO1: Students will apply their knowledge of articulating the fundamental principles and concepts of instrumentation and their practical applications across diverse fields.

CO2: Students will use their understanding ofdifferent instrument types, their functionalities, and their appropriate application in specific measurement and control contexts.

CO3: Students will apply their knowledge of interpreting ability to calibrate instruments.

CO4: Students will use their knowledge to assess the accuracy, precision, and reliability of measurement systems.

PO3: Social competence

CO2: Students will learn about various instrument types, their functionalities, and their appropriate application in specific measurement and control contexts.

CO3: Students will gain knowledge to Competence in recognizing the significance of calibration and the skill to precisely calibrate instruments.

CO4: Students will develop competence in assessing the accuracy, precision, and reliability of measurement systems

PO4: Research-related skills and Scientific temper

CO3: Students will apply their knowledge to recognizing the significance of calibration.

CO4: Students will apply their knowledge of accuracy, precision, and reliability of measurement systems.

CO5: Students will able to applythe role of ethical and safety considerations associated with practices in instrumentation.

CO6: Students will be able to comprehendknowledge oflatest advancements and emerging trends in the realm of instrumentation technology.

PO5: Trans-disciplinary Knowledge

CO3: Students will understand the ability to interpret calibration and the skill to precisely calibrate instruments

CO4: Students will apply their knowledge of accuracy, precision, and reliability of measurement systems.

CO5: Students will able to applythe role of safety considerations associated with practices in instrumentation.

PO6: Personal and Professional Competence

CO6: Students will showcase their proficiency in latest advancements and emerging trends in the realm of instrumentation technology.

CO7:Students will demonstrate their competency invarious separation techniques in the purification of biomolecules.

CO8: students will explore to the knowledge of various analytical techniques in the analysis of purified biomolecules.

PO7: Self-directed and Life-long Learning

CO7: Students will acquire the skill of separation techniques in the purification of biomolecules.

SYLLABUS (CBCS as per NEP 2020) FOR M.Sc. I. Microbiology
(w. e. from June, 2023)

Name of the Programme : M.Sc. Microbiology
Program Code : PSMI
Class : M.Sc. I
Semester : I
Course Type : Major Mandatory
Course Name : Microbial Technology
Course Code : MI-502-MJM
No. of Lectures : 60
No. of Credits : 04

Course Objective:

1. To understand the different designs of bioreactors and process variables.
2. To provide students with a comprehensive understanding of microbial technology, its principles, and applications.
3. To introduce students to the diversity of microorganisms and their roles in various industrial processes.
4. To explore the techniques and methodologies used in microbial technology, including microbial isolation, cultivation, and manipulation.
5. To develop students' skills in the use of microbial tools and techniques for biotechnological applications.
6. To promote ethical considerations and responsible practices in research.
7. To enhance students understanding of the economic, social, and environmental implications of microbial technology.

Course Outcome:

CO1. A comprehensive understanding of varied bioreactor designs and the variables within the process.
CO2. Understand the fundamental principles of microbial technology, including microbial physiology, genetics, and metabolism.
CO3. Identify and classify different types of microorganisms, understanding their roles in various industrial processes.
CO4. Demonstrate proficiency in employing techniques for the isolation, cultivation, and maintenance of microorganisms in laboratory settings.
CO5. Apply knowledge of microbial technology to tackle practical challenges and devise solutions in the field of biotechnology.
CO6. Analyze and interpret data obtained from microbial experiments to draw valid conclusions.
CO7. Evaluate the ethical considerations and societal impacts of microbial technology in various sectors, including healthcare, agriculture, and environmental remediation.

CONTENTS:

UNIT 1: Bioreactor Design (15L)

A. Designing of bioreactors - Design aspects CSTRs: The dimensional ratios of the outer shell, and the operational aspects such as working volume and impellers.
B. The configuration (placement) of impellers in a vessel and the different types of impellers (types of turbines and propellers, and their combinations)
C. Immobilized cell reactors and air-lift reactors – Design and operation.
D. Batch, Fed-batch and Continuous operation: Applications, advantages and limitations of

each type.

UNIT 2: Process Variables and Monitoring (15L)

A. **Process Variables**:

I. Aeration - Theory of oxygen transfer in bubble aeration, Oxygen transfer kinetics (Oxygen Uptake Rate –OUR; Oxygen Transfer Rate OTR; Ccrit), determination of KLa.

II. Agitation - Functions of agitation. Flow patterns with different types of impellers.

III. Fermentation broth rheology and power requirements for agitation – Concept of Newtonian and non-Newtonian fluids, effect of broth rheology on heat, nutrient and oxygen transfer, Reynold's number, Power number, Aeration number

B. **Monitoring of process variables**:

Use of various types of sensors and biosensors for monitoring environmental parameters (pressure, pH, temperature, DO and DCO_2), Basic principles of operation, types of biosensors

UNIT 3: Microbial Processes (15L)

Upstream, Fermentation and Downstream Processing for the following:

I. Antibiotics (Rifamycin)
II. Microbial enzymes (Chitinase)
III. Exopolysaccharides (Pullulan)

Use of immobilized cells / enzymes to produce protease

UNIT 4: Principles of Validation Process / Method Validation and IPR (15L)

a. The concept of ISO Certification.

b. Preparation of SOPs

c. Validation protocols for methods in:

i. Quality Control

ii. Process validation

The above should be discussed within WHO Norms. Exercises on preparation of SOPs, operationand validation for analytical methods

Intellectual Property Rights (IPR):

i. Basic concepts of IPR

ii. Introduction to forms of IPR – Patents and Designs

References:

1. Bioreactor Design and Product Yield (1992), BIOTOL series, Butterworths Heinemann.
2. Doran Pauline (1995) Bioprocess Engineering Principles, Academic Press.
3. Lydersen B., N. a. D' Elia and K. M. Nelson (Eds.) (1993) Bioprocess Engineering: Systems, Equipment and Facilities, John Wiley and Sons Inc.
4. Ratledge C and Kristiansen B eds. (2001) Basic Biotechnology 2nd Ed. Cambridge Univ.Press. Cambridge
5. Operational Modes of Bioreactors, (1992) BIOTOL series, Butterworths Heinemann.
6. Shuichi and Aiba. Biochemical Engineering. Academic Press. 1982
7. Stanbury and Whittaker. Fermentation technology
8. Klegerman, M.E and Groves M.J. (1992) Pharmaceutical Biotechnology: Fundamentalsand Essentials. Interpharm Press Ltd. Buffalo Grove IL
9. Peppler H. J. and D. Perlman (1970) Microbial Technology Volume 1 and 2, AcademicPress New York.

10. Ponkhshe S. (1988) Management of Intellectual Property, Bhate and PonkhshePrakasham, Pune
11. Reed G. Ed. Prescott and Dunn's Industrial Microbiology. 4th Ed., CBS Pub. New Delhi.
12. Van Damme E. J. (1984) Biotechnology of Industrial Antibiotics, Marcel Dekker Inc.New York.
13. Wiseman A.(1985) Topics in Enzyme and Fermentation Biotechnology, Vol. 1 and 2,John Wiley and Sons, New York
14. Supplementary Training Modules on Good Manufacturing Practice. Validation WHOTechnical Report Series, No.937, 2006, Annex 4.
15. The FDA's draft process validation Guidance A perspective from industry. By NaulaCalnan, Alice Redmond and Stan O' Neill. Process Validation Guidance

Mapping of Program Outcomes with Course Outcomes

Weightage:1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3								
CO 2	3	2			2				
CO 3	2								2
CO 4				2		3			
CO 5		5							3
CO 6				2		2			
CO 7					2				

Justification for the mapping

PO1: Disciplinary Knowledge

CO1: The disciplinary knowledge of fermentation techniques is justified due to its central role in various scientific and industrial applications.
CO2: Understanding the principles and intricacies of fermentation is essential for optimizing processes in fields such as biotechnology, food and beverage production, pharmaceuticals, and bioenergy.
CO3: Disciplinary knowledge in fermentation enables professionals to design and control fermentation processes, ensuring the production of desired products efficiently and economically. It forms the foundation for making informed decisions related to strain selection, substrate utilization, and process conditions This expertise is vital for achieving consistent and high-quality outcomes in diverse fermentation applications, thereby justifying the significance of disciplinary knowledge in this domain
CO4: Students will evaluate the kinetics and mechanisms of microbial growth based on experimental studies of all dynamic manifestations of microbial life (Growth, survival, death, product formation, mutation, cell cycles, and environmental effect) and analysis of underlying mechanisms using mathematical model.

PO2: Critical Thinking and Problem Solving

CO2: Critical thinking and problem-solving in fermentation technology are justified due to their pivotal roles in optimizing processes, troubleshooting issues, and innovating in the field. These skills enable practitioners to analyze complex data, identify potential challenges, and devise effective solutions to enhance fermentation efficiency. In the dynamic realm of bioprocessing, critical thinking fosters adaptability, allowing professionals to navigate evolving conditions and implement improvements.

CO5: Overall, the application of critical thinking and problem-solving in fermentation technology is essential for advancing the effectiveness and sustainability of biotechnological processes.

PO4:Research related skills and scientific temper.

CO6: Research-related skills and a scientific temper are crucial in the context of fermentation techniques as they contribute to the advancement of knowledge and innovation in bioprocessing. Possessing strong research skills enables scientists to design robust experiments, collect accurate data, and derive meaningful conclusions about fermentation processes. A scientific temper, characterized by curiosity, objectivity, and a commitment to evidence-based inquiry, ensures the pursuit of knowledge in a systematic and ethical manner.

CO6:These skills collectively empower researchers to address complex challenges, optimize fermentation conditions, and explore novel applications. In the ever-evolving field of biotechnology, research-related skills and a scientific temper are key drivers for pushing the boundaries of understanding and developing sustainable and efficient fermentation technologies.

PO5: Trans-disciplinary Knowledge

CO7: The transdisciplinary knowledge of fermentation is justified as it integrates insights from diverse fields, combining biology, chemistry, engineering, and more. Fermentation processes are not confined to a single discipline; they involve intricate interactions between microorganisms, substrates, and environmental conditions.

CO2: Transdisciplinary knowledge allows for a holistic understanding of these processes, fostering innovation and the development of sustainable solutions. It encourages collaboration among experts from various domains, leading to a more comprehensive approach in optimizing fermentation techniques. This interconnected knowledge is particularly relevant in addressing complex challenges and exploring applications beyond traditional boundaries, contributing to advancements in fields such as medicine, bioenergy, and environmental remediation. In essence, the transdisciplinary approach in fermentation is justified for its potential to yield holistic and transformative insights.

PO6: Personal and Professional Competence

CO6: The personal and professional competence in fermentation techniques is justified due to its practical implications and impact across various industries. On a personal level, developing competence in fermentation involves acquiring skills related to experimental design, data analysis, and troubleshooting. This personal competence fosters a deep understanding of biological processes and enhances problem-solving abilities.

CO4: Professionally, competence in fermentation techniques is highly sought after in industries such as biotechnology, food and beverage, and pharmaceuticals. Individuals with expertise in this area are well-equipped to contribute to the optimization of production processes, ensuring efficiency and quality. The application of fermentation techniques in these industries is vital for the development of products like biofuels, pharmaceuticals, and specialty chemicals.

PO9: Self-directed and Life-long Learning

CO5: Self-directed and lifelong learning in fermentation techniques is justified given the dynamic nature of scientific and technological advancements. Continuous learning is essential in the field of fermentation as it evolves with new discoveries, methodologies, and technologies.

CO3: Individuals engaged in self-directed and lifelong learning stay current with emerging trends, enabling them to adapt to evolving challenges in bioprocessing. This proactive approach ensures that professionals in the fermentation domain can incorporate the latest innovations, contribute to ongoing research, and implement best practices. Moreover, a commitment to lifelong learning fosters a mindset of curiosity and adaptability, crucial attributes for staying relevant and making meaningful contributions to the field over the course of one's career.

SYLLABUS (CBCS as per NEP 2020) FOR M.Sc. I. Microbiology
(w. e. from June, 2023)

Name of the Programme	**: M.Sc. Microbiology**
Program Code	**: PSMI**
Class	**: M.Sc. I**
Semester	**: I**
Course Type	**: Major Mandatory**
Course Name	**: Practical Course I**
Course Code	**: MI-503-MJM**
No. of Lectures	**: 60**
No. of Credits	**: 02**

Course Objectives:

1. To provide students with practical hands-on experience in operating and troubleshooting various instruments commonly used in scientific research and industrial settings.
2. To familiarize students with the principles, working mechanisms, and applications of different types of instruments
3. To develop students skills in instrument calibration, data acquisition, and data analysis techniques.
4. To promote an understanding of assurance in instrument operation and data interpretation.
5. To enhance students' ability to effectively use instrumentation in scientific experiments, measurements, and analysis.
6. To foster problem-solving abilities and critical thinking skills in the context of instrument operation and troubleshooting.
7. To promote safe and ethical practices in the use of instruments, including proper handling, maintenance, and disposal procedures.

Course Outcomes:

CO1. Demonstrate proficiency in the operation of various instruments, such as spectrophotometers, chromatographs.
CO2. Understand the principles and mechanisms behind the operation of different types of instruments
CO3. Perform instrument calibration procedures accurately and effectively, ensuring reliable and accurate measurements.
CO4. Collect and analyze data using appropriate techniques and software for data acquisition and analysis.
CO5. Troubleshoot common issues and problems that may arise during instrument operation and propose appropriate solutions.
CO6. Interpret and critically evaluate instrument-generated data and results.Apply quality control and assurance measures to ensure the accuracy and precision of instrument readings and measurements.
CO7. Demonstrate safe laboratory practices and adhere to ethical guidelines in instrument handling, maintenance, and disposal.

CONTENTS:

UNIT 1: Spectroscopy (12L)

- Determination of molar extinction coefficient of biological molecule.
- Biological synthesis of nanoparticles by using actinomycetes /fungi /yeast.
- Characterization of biologically synthesized nanoparticles by UV-Visible spectroscopy.

UNIT 2: Separation of Biomolecules by Electrophoresis (24L)

- Sample preparation and casting polyacrylamide gel slab for Native PAGE.
- Separation of protein mixture by Native PAGE.
- Staining the gel and recording protein banding pattern after electrophoresis.
- Sample preparation and casting polyacrylamide gel slab for SDS PAGE.
- Separation of protein mixture by SDS PAGE.
- Staining the gel and recording banding pattern after electrophoresis (SDS PAGE).
- Sample preparation and casting agarose gel slab forAGE.
- Separation of DNA fragments by Agarose Gel Electrophoresis.
- Staining the gel and recording DNA banding pattern after electrophoresis.

UNIT 3: Separation of Biomolecules by Chromatography (24L)

- Separation of amino acids using paperchromatography.
- Separation of sugars using thin layerchromatography.
- Preparation of gel matrix and column filling for ion exchange chromatography.
- Separation of proteins using ion exchangechromatography.
- Preparation of matrix and column filling for gel filtration chromatography.
- Gel filtration chromatography.

References:

1. Nelson D. L. and Cox M. M. (2005) *Lehninger's Principles of Biochemistry*, Fourth edition, W. H. Freeman & Co. New York
2. Wilson Keith and Walker John (2005) *Principles and Techniques of Biochemistry andMolecular Biology*, 6th Ed. Cambridge University Press, New York.
3. Palmer Trevor (2001) *Enzymes: Biochemistry, Biotechnology and Clinical chemistry*, Horwood Pub. Co. Chinchester, England.
4. Segel Irvin H. (1997) *Biochemical Calculations* 2nd Ed., John Wiley and Sons, New York

Mapping of Program Outcomes with Course Outcomes

Weightage:1=weak or low relation,2=moderate or partial relation,3=strong or direct relation

Course Outcomes	**Programme Outcomes(POs)**								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3			2					
CO2	3			2					
CO3	3			2	2	2			1

CO4	3	2		3	2	2			2
CO5	3	2	2	2	2	3	2		2
CO6	3	2	2	2		2			2
CO7	3	3	2	2		2	2	2	2

Justification for the mapping

PO1: Disciplinary Knowledge

Almost all the course outcomes CO1to CO7 imparts disciplinary knowledge by delving into the study of terms and concepts related to Spectroscopy, electrophoresis and chromatographic techniques

PO2: Critical Thinking and Problem Solving

CO4. Collect and analyze data using appropriate techniques and software for data acquisition and analysis.

CO5.Troubleshoot common issues and problems that may arise during instrument operation and propose appropriate solutions.

CO6.Interpret and critically evaluate instrument-generated data and results.

CO7.Apply quality control and assurance measures to ensure the accuracy and precision of instrument readings and measurements.

PO3: Social competence

CO7. Demonstrate safe laboratory practices and adhere to ethical guidelines in instrument handling, maintenance, and disposal.

PO4: Research related skills and scientific temper

Almost all the course outcomes CO1to CO7 imparts research related skills by delving into the study of terms and concepts related to Spectroscopy, electrophoresis and chromatographic techniques

PO5: Trans-disciplinary knowledge

CO3, CO4, CO5 promotes trans-disciplinary knowledge by integrating principles from microbiology, chemistry, and engineering to address complex environmental challenges. This cross-cutting approach equips students with a versatile skill set applicable across diverse scientific and engineering fields.

PO6: Personal and professional competence

The CO3, CO4, CO5, CO6, CO7enhances personal and professional competence by providing students with the knowledge and practical skills needed to in research.

PO7: Effective citizenship and ethics

CO5.Troubleshoot common issues and problems that may arise during instrument operation and propose appropriate solutions.

CO7. Demonstrate safe laboratory practices and adhere to ethical guidelines in instrument handling, maintenance, and disposal.

PO8: Environment and sustainability

CO7. Demonstrate safe laboratory practices and adhere to ethical guidelines in instrument handling, maintenance, and disposal.

PO9: Self –directed and life –long learning

CO3, CO4,CO5, CO6, CO7 fosters self-directed and lifelong learning by encouraging students to explore cutting-edge research, and stay current with advancements in microbiological techniques and technology.

SYLLABUS (CBCS as per NEP 2020) FOR M.Sc. I. Microbiology
(w. e. from June, 2023)

Name of the Programme : M.Sc. Microbiology
Program Code : PSMI
Class : M.Sc. I
Semester : I
Course Type : Major Mandatory
Course Name : Practical Course II
Course Code : MI-504-MJM
No. of Lectures : 60
No. of Credits : 02

Course Objective:

1. Understand the principles and applications of microbial immobilization techniques.
2. Gain practical skills in immobilizing microorganisms for various biotechnological applications.
3. Explore the factors influencing immobilization efficiency and the stability of immobilized microbialsystems.
4. Learn the methods for the production and characterization of exopolysaccharides by microorganisms.
5. Acquire knowledge of the downstream processing techniques for the recovery and purification oforganic acids produced by microbial fermentation.
6. Develop laboratory skills in analyzing and quantifying exopolysaccharides and organic acids.

Course Outcomes:

CO1. Explain the principles and significance of microbial immobilization in biotechnology.
CO2. Understand the different methods and materials used for microbial immobilization.
CO3. Describe the factors affecting immobilization efficiency and stability.
CO4. Explain the mechanisms and applications of exopolysaccharide production by microorganisms.
CO5. Understand the downstream processing techniques for the recovery and purification of organic acids.
CO6. Demonstrate proficiency in immobilizing microorganisms using different immobilization techniques.
CO7. Analyze and quantify exopolysaccharides using appropriate laboratory techniques.

CONTENTS:

UNIT 1: Microbial processes (16L)

- Determination of oxygen transfer rate in bioprocess.
- Preparation of immobilized cell
- Comparative study of free cell and immobilized cell
- Bioconversions using immobilized systems (cells) Parameter testing
    - Effect of gel concentration
    - Effect of cell concentration

UNIT 2: Laboratory scale production (24L)

- Media optimization using placket-burman design for exopolysaccharide production.
- Laboratory scale production

- Extraction of exopolysaccharide
- Estimation of exopolysaccharide
- Purification of exopolysaccharide

UNIT 3: Microbial downstream processing (20L)

- Laboratory scale production of organic acid
- Separation of biomass by using Filtration /Centrifugation
- Concentration of product by evaporation
- Purification by gel filtration chromatography
- Formulation by drying process

References:

1. Reed G. Ed. Prescott and Dunn's Industrial Microbiology. 4th Ed., CBS Pub. New Delhi.
2. Van Damme E. J. (1984) Biotechnology of Industrial Antibiotics, Marcel Dekker Inc.New York.
3. Wiseman A.(1985) Topics in Enzyme and Fermentation Biotechnology, Vol. 1 and 2,John Wiley and Sons, New York

Mapping of Program Outcomes with Course Outcomes

Weightage:1=weak or low relation,2=moderate or partial relation,3=strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	2								
CO 2		2			2				
CO 3	2								
CO 4			3			4			
CO 5				2					2
CO 6						6			
CO 7				2					

Justification for the mapping

PO1: Disciplinary Knowledge

CO1: Disciplinary Knowledge in immobilization practical is crucial for stabilizing and optimizing the performance and biocatalysts, such as enzymes or microorganisms.
CO3: Immobilization practical knowledge is applicable in the biomedical field for the various therapeutic applications.

PO2: Critical Thinking and Problem Solving

CO2: Critical thinking allows oractitioners to assess and o[ptimize the microbial immobilization method. This includes evaluating the choice of matrices, immobilization technique, and environmental conditions to enhance the overall performance and efficiency of microbial systems.

PO3: Social competence

CO4: EPS production involves collaboration between microbiologits, biochemists, engineers,and possibly experts from other disciplin. Social competence ensures effective communication and collaboration, leading to a more comprehensive and successful EPS practical.

PO4:Research related skills and scientific temper.

CO7:Proficiency in experimental design ensures the systematic and controlled execution of EPS experiments. Researchers with strong skills in this area can design experiments that generate reliable and meaningful data.

CO5: A strong background in literature review is essential for understanding existing downstream processing techniques for organic acid recovery. The ability to synthesize information from various sources contributes to informed decision-making in selecting appropriate methods.

PO5: Trans-disciplinary Knowledge

CO2: Immobilization matrices require careful selection based on mechanical, chemical, and biological considerations.

PO6: Personal and Professional Competence

CO4: Developing personal and professional competence in EPS signifies specialized expertise in the isolation, characterization, and application of these biopolymers. This expertise is crucial for advancing scientific understanding and cntributing to advancements in relevent industries.

CO6: Personal and professional competence fosters collaboration across disciplines. Competance in immobilization practical allows individuals to contribute innovatively to research. This can involve developing novel immobilization methods, optimizing existing processes, or applying immobilization techniques to new areas, leading to advancement in biotechnology and related fields.

PO9: Self-directed and Life-long Learning

CO6:Lifelong learning enables individuals to explore and implement new strategies for optimizing downstream processes. This includes understanding the latest chromatographic techniques, filtration methods, and other purification technologies that can enhance overall process efficiency.

SYLLABUS (CBCS as per NEP 2020) FOR M.Sc. I. Microbiology
(w. e. from June, 2023)

Name of the Programme : M.Sc. Microbiology
Program Code : PSMI
Class : M.Sc. I
Semester : I
Course Type : Major Elective
Course Name : Biochemistry
Course Code : MI-511-MJE(A)
No. of Lectures : 60
No. of Credits : 04

Course Objective:

1. To apply basic principles of chemistry to biological systems and molecular biology
2. Know about the composition of living matter and importance of water and buffer in life
3. To provide students with a solid foundation in the fundamental principles of biochemistry, including the structure, function, and metabolism of biological molecules.
4. To introduce students to the techniques and methodologies used in biochemical research and analysis.
5. To explore the relationship between structure and function of biomolecules and their role in cellular processes.
6. To foster critical thinking and problem-solving skills in the context of biochemical processes and pathways.
7. To promote an awareness of the applications of biochemistry in various fields, such as medicine, biotechnology, and agriculture.

Course Outcome:

CO1. Demonstrate a comprehensive understanding of the structure, function, and properties of biomolecules, including proteins, carbohydrates, lipids, and nucleic acids.
CO2. Apply knowledge of biochemical principles to analyze and interpret experimental data related to biological molecules and processes.
CO3. Evaluate the applications of biochemistry in various fields, such as drug discovery, biotechnology, and genetic engineering.
CO4. Students will be able to demonstrate an understanding of fundamental biochemical principles.
CO5. Students will be able to develop in- depth understanding of the area of biochemistry to choose for the research purpose.
CO6. inculcate a healthy attitude to be a lifelong learner,

CONTENTS:

UNIT 1: Bioorganic Chemistry (15L)

- Covalent bonds – Glycosidic bond, Peptide bond, Phosphodiester bond
- Bonding other than covalent – H-bonds, Van der Waal's interaction, ionic bonding.
- Reactions of organic molecules: Substitution, Addition, Elimination, Rearrangement, Oxidation, Reduction, etc.
- Bioorganic mechanism of enzyme catalysed reactions: Acid – base, covalent catalysis and metal ion catalysis with examples of respective enzymes.

- Stereochemistry: Three-dimensional shape of molecules, conformation and configuration, structure and biological activity.
- Structure of water and ionization, Concept of pH of weak acids and weak bases, Henderson-Haselbech equation, concept of buffer, strength of buffer, buffer value, important biological buffers.

UNIT 2: Nucleic acid chemistry (15L)

- Structure of bases, nucleosides, nucleotides, phosphodiester linkages
- 5' phosphate, 3'hydroxyl polarity of nucleic acids
- Tautomeric forms of bases and their implication in pairing of bases
- Structure of DNA (A, B and Z forms)
- Tm value Cot curves
- Structure of tRNA, rRNA, and mRNA and other RNAs

UNIT 3: Protein Chemistry (15L)

- Physical and chemical properties of amino acids
- Classification of amino acids
- Amino acids as buffers
- Non-covalent interactions
- Conformational properties of proteins
- Polypeptide chain geometry
- Resonance forms of the peptide group
- *cis/trans* isomers of peptide group
- Ramachandran plot
- Secondary, Super-secondary, Motif & Domain
- Tertiary and Quaternarystructures of proteins, (Myoglobin &Hemoglobin)

UNIT 4: Carbohydrate, lipid &vitamin biochemistry (15L)

a. Carbohydrate Chemistry:

- Structure and function of Mono, di, oligosaccharides and polysaccharides with examples
- asymmetric centre in sugars
- Dseries, L- series, dextro, leavo-rotatory
- reducing and non- reducing sugars
- sugar anomers
- sugar epimers
- sugar derivatives such as sugar alcohols, amino sugars, sugar acids, deoxy sugars
- Any two methods of estimation of carbohydrates

b. Lipid Chemistry:

- Classification of lipids according to chemical structure, fatty acids, saturated, unsaturated,branched,
- nomenclature system,
- structure and function of triglycerides, phospholipids, sphingolipids, terpenes, prostaglandins, waxes, and steroids,
- any two methods of estimation and characterization of lipids

c. Vitamin Chemistry:Fat soluble Vitamin – Type (A, D, E, K),

- Source,
- forms,

- function,
- deficiency,
- RDI (Recommended Daily Intake),
- Overdose

References:

1. Clayden, Greeves, Warren and Wothers, *Organic Chemistry*, Oxford Press
2. Jerry March, *Advanced Organic Chemistry*, John Wiley
3. Voet Donald and Voet Judith G. (1995) *Biochemistry*, 2nd Ed.. John Wiley and sons, NewYork.
4. Conn Eric, Stumpf Paul K., Bruuening George, Doi Roy H., (1987) *Outlines of Biochemistry* 5th Ed, John Wiley and Sons, New Delhi.
5. Nelson D. L. and Cox M. M. (2002) *Lehninger's Principles of Biochemistry*, Mac Millan Worth Pub. Co. New Delhi
6. Segel Irvin H. (1997). *Biochemical Calculations*. 2nd Ed. John Wiley and Sons, New York.
7. Campbell M. K.(1999)Biochemistry. 3rd edition Harcourt Brace College Publishers
8. Garrett, R. H. and Grisham, C. M. (2004) *Biochemistry.* 3rd Ed. Brooks/Cole, Publishing Company, California.
9. David J Holme, Hazel Peck (1998) *Analytical Biochemistry,* 3rd Ed., Prentice Hall, PearsonEducation Limited, Harlow England.
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11. Garrett, R. H. and Grisham, C. M. (2004) *Biochemistry.* 3rd Ed. Brooks/ Cole, PublishingCompany, Californ

Mapping of Program Outcomes with Course Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)									
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2									
CO 2		2								
CO 3			3		2		2			
CO 4				2						
CO 5				2						
CO 6						2				2

Justification for the mapping

PO1.Disciplinary Knowledge:

CO1 demonstrates a comprehensive understanding of biomolecules, showcasing disciplinary knowledge in biochemistry.

PO2.Critical Thinking and Problem Solving:

CO2 involves applying knowledge of biochemical principles to analyze and interpret experimental data, reflecting critical thinking and problem-solving skills.

PO3.Social Competence:

While not explicitly mentioned in the provided sentences, the applications of biochemistry in drug discovery, biotechnology, and genetic engineering (CO3) can have social implications and may involve collaboration and communication skills.

PO4.Research-related Skill:

CO4 and CO5 involve demonstrating an understanding of fundamental biochemical principles and developing an in-depth understanding of biochemistry for research purposes, emphasizing research-related skills.

PO5.Transdisciplinary Knowledge:

CO3, which involves evaluating the applications of biochemistry in various fields, touches upon transdisciplinary knowledge as it connects biochemistry with other disciplines like drug discovery, biotechnology, and genetic engineering.

PO6.Personal and Professional Competence:

CO6 aims to instill a healthy attitude as a lifelong learner, reflecting personal and professional competence.

PO7.Effective Citizenship and Ethics:

Ethics is implicit in CO3 when evaluating the applications of biochemistry, especially in drug discovery and genetic engineering, and is aligned with effective citizenship and ethical considerations.

PO8.Environment and Sustainability:

The provided sentences do not explicitly address environmental aspects or sustainability.

PO9.Self-directed and Lifelong Learning:

CO6 explicitly mentions the goal of inculcating a healthy attitude to be a lifelong learner, emphasizing self-directed learning.

SYLLABUS (CBCS as per NEP 2020) FOR M.Sc. I. Microbiology
(w. e. from June, 2023)

Name of the Programme : M.Sc. Microbiology
Program Code : PSMI
Class : M.Sc. I
Semester : I
Course Type : Major Elective
Course Name : Ecology
Course Code : MI-511-MJE(B)
No. of Lectures : 60
No. of Credits : 04

Course Objective:

1. To introduce the fundamental principles and concepts of ecology.
2. To develop an understanding of the interrelationships between organisms and their environment.
3. To explore the diversity of ecosystems and the factors influencing their structure and function.
4. To examine the impacts of human activities on ecosystems and the importance of conservation and sustainable practices.
5. To provide students with a comprehensive understanding of the principles and concepts of ecology, including the interactions between organisms and their environment.
6. To introduce students to the different levels of ecological organization, from individual organisms to ecosystems, and the processes that shape them.
7. To explore the diversity of ecosystems and habitats, including terrestrial, aquatic, and marine environments, and their ecological dynamics.
8. To foster critical thinking and problem-solving abilities in the context of ecological issues, including conservation, biodiversity, and ecosystem management.
9. To promote an understanding of the interactions between humans and the environment, including the impacts of human activities on ecological systems.

Course Outcome:

CO1. Students will be able to define and explain key ecological terms and concepts.
CO2. Students will understand the principles of population dynamics and how populations interact within communities.
CO3. Students will recognize the importance of biodiversity and understand the threats to biodiversity conservation.
CO4. Students will be able to evaluate the impact of human activities on ecosystems, such as pollution, habitat destruction, and climate change.
CO5. Understand the fundamental principles and concepts of ecology, including population dynamics, community interactions, and ecosystem processes.
CO6. Describe the different levels of ecological organization, from individuals to populations, communities, and ecosystems, and understand the interrelationships between these levels.
CO7. Apply ecological principles and concepts to analyze and evaluate real-world ecological issues, such as habitat fragmentation, climate change, and species conservation.

CONTENTS:

UNIT 1: Introduction to ecology (15L)

- Environment: Physical environment, biotic environment, biotic and abiotic interactions.
- Concept of habitat and niche
- Niche width and overlap
- Fundamental and realized niche
- Niche differentiation and resource partitioning

UNIT 2: Population ecology & Species interactions (15L)

- Characteristics of a population
- population growth curves
- population regulation
- life history strategies (r and K selection)
- Species Interactions: Types of interactions, interspecific competition, herbivory, Carnivory, pollination, symbiosis.

UNIT 3: Community Ecology (15L)

- Community structure and attributes,
- Levels of species diversity and its measurement, edges and ecotones.
- Ecological Succession: Pattern ,Types, mechanisms, Models of Succession
- Ecosystem Ecology: Ecosystem structure, ecosystem function, energy flow, primary production and decomposition; structure and function of some Indian ecosystems

UNIT 4: Applied Ecology (15L)

- Environmental pollution and global environmental change
- Biodiversity status, major drivers of biodiversity change, biodiversity management approaches.
- Conservation Biology: Principles of conservation, major approaches to management, Indian case studies on conservation strategy.

References:

1. Smith, TM and Smith RL 2015. Elements of Ecology, Pearson Education, India.
2. Cain, ML, Bowman, WD and Hacker SD 2011. Ecology, 2nd Edition, Sinauer Associates Inc.
3. Odum, E. P. (2004). Fundamentals of Ecology, Oxford and IBH Publishing Co. Pvt. Ltd.
4. Singh, J.S., S.P & Gupta, S.R. 2006. Ecology, Environment and Resource conservation. Anamaya Publ., New Delhi, 688 pp.
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11. Pandit, M.K., White, S.M.&Pocock, M.J.O. 2014. The contrasting effects of genome size, chromosome number and ploidy level on plant invasiveness: a global analysis. New Phytologist 203: 697-703.
12. Pimentel, D. (Ed.). 2011. Biological invasions: Economic and environmental costs of alien plant, animal, and microbe species. CRC Press.
13. Wilson, E. O. 1985. The Biological Diversity Crisis. BioScience 35: 700-706.

Mapping of Program Outcomes with Course Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	2	2				2			
CO 2	3	2							
CO 3		2			3				
CO 4	3					2			
CO 5					2	2	3		
CO 6									2

Justification for the mapping

PO1: Disciplinary Knowledge.

CO1: Ecology provides the foundational understanding needed to analyze and solve environmental issues. Whetther it's habitat destruction, pollution, or climate change, ecological knowledge is essential for developing effective solutions.
CO2: Ecological principles guide sustainable resource use by assessing the impacts of human activities on ecosystems.
CO4: Understanding ecological processes is key to addressing climate change. Ecologists contribute by researching how ecosystems respond to climate variations and by developing strategies for mitigation and adaptaion.

PO2: Critical Thinking and Problem Solving
CO1: Critical thinking allows to analyze intricate relationships within ecosystem. Theis skill is crucial for understanding the causes and consequences of environmental changes, enabling effective problem identification and resolution.
CO2: To identify and interpret various ecological relationships, such as competition, predation, mutualism and commensalism. This skills is essential for recognizing the intricate web of interactions shaping community dynamics.
CO3: Helping to design strategies for mitigating negative impacts on biodiversity and ecosystem services. , development of conservation strategies by assessing the interplay of polulations within communities.

PO5: Trans-disciplinary Knowledge

CO3: Sustainable development by considering the interconnectedness of ecological, social, and economics systems.

CO2: By combiniing ecological knowledge with insights from social sciences and communication experts, educational programs can effectively convey the importance of ecological conservation and sustainable practices.

PO6: Personal and Professional Competence

CO1: Students will demonstrate the ability to understand the concepts and techniques in ecology and evolutionary biology that covers various ranges of ages and scales, which can also help them to comprehend human impact on the global ecosystem and find measures to achieve more sutainable development.

CO4: Accurate ecological assessments are essential for making informed decisions and implementing effective conservation strategies.

CO5: Competence in communication is crucial for conveying complex ecological concepts to diverse communication enhances the impact of ecological research and encourages informed decision- making.

PO9: Self-directed and Life-long Learning

CO6: This field of ecology is continually evolving with new research findings, methodologies and technologies. Self- directed and lifelong learning enable to stay abreast of the latest developments, ensuring that their knowledge remains current and relevent.

SYLLABUS (CBCS as per NEP 2020) FOR M.Sc. I. Microbiology
(w. e. from June, 2023)

Name of the Programme	**: M.Sc. Microbiology**
Program Code	**: PSMI**
Class	**: M.Sc. I**
Semester	**: I**
Course Type	**: Major Elective**
Course Name	**: Medical Microbiology**
Course Code	**: MI-511-MJE(C)**
No. of Lectures	**: 60**
No. of Credits	**: 04**

Course Objective:

1. To provide students with a comprehensive understanding of the fundamental principles of medical microbiology, including the identification, pathogenesis, and epidemiology of microorganisms causing human diseases.
2. To introduce students to the techniques and methodologies used in the laboratory diagnosis and management of infectious diseases.
3. To explore the interactions between microorganisms and the human immune system, including host defense mechanisms and immune responses to microbial pathogens.
4. To develop students knowledge of antimicrobial agents, their mechanisms of action, and the principles of antimicrobial susceptibility testing.
5. To foster critical thinking and problem-solving abilities in the context of medical microbiology, including the interpretation of clinical microbiology laboratory results and the selection of appropriate antimicrobial therapy.
6. To promote an understanding of the public health aspects of infectious diseases, including outbreak investigation, disease surveillance, and infection control measures.
7. To enhance students awareness of emerging and re-emerging infectious diseases, global health challenges, and the impact of microbial resistance on public health.

Course Outcome:

CO1. Identify microorganisms associated with human diseases, understand their epidemiology and modes of transmission.
CO2. Understand the principles and techniques used in the laboratory diagnosis of infectious diseases, including specimen collection, culture, identification, and antimicrobial susceptibility testing.
CO3. Analyze and interpret clinical microbiology laboratory results, including microbial growth patterns, biochemical tests, and molecular diagnostic methods.
CO4. Understand the principles of microbial pathogenesis, including mechanisms of virulence and host-pathogen interactions.
CO5. Explain the mechanisms of action and resistance of antimicrobial agents, and apply knowledge to guide appropriate antimicrobial therapy.
CO6. Students will able to learn multidrug resistance in bacterial pathogens.

CONTENTS:

UNIT 1 & 2: Determinants of Microbial Pathogenicity (30L)

- Adhesion and Colonization
- Invasion
- Evasion

- Toxigenesis (mode of action and *in vitro* and *in vivo* assay systems for diphtheria, cholera,tetanus toxins and endotoxins of Gram negative bacteria)
- Bacterial resistance to host defenses: phagocytosis, nonspecific and specific humoral
- factors
- Molecular basis of bacterial pathogenicity – cytoskeletal modulation of host cell, virulencegenes and pathogenicity islands

UNIT 3: Clinical Microbiology (15L)

Epidemiological and investigational approaches for emerging infectious diseases:
Viral diseases:

- SARS (severe acute respiratory syndrome),
- Avian and Swine influenza,
- COVID-19

Diseases by multi-drug resistant bacterial pathogens: Mechanisms of development of drug resistance

- Vancomycin resistant Enterococci (VRE),
- Methicillin resistant *Staphylococcus aureus (*MRSA),
- Vancomycin resistant *Staphylococcus aureus (*VRSA),
- Extended Spectrum Beta Lactamase (ESBL) producers

UNIT 4: Discovery of anti-infectives (15L)

- Drug targets in bacteria with examples of established drugs: Cell wall biosynthesis, Cell
- membrane function, Proteins synthesis and Nucleic acid synthesis and metabolism
- Methods to quantify growth / inhibition and metabolic changes in microbial population on exposure to anti-infectives, for evaluation of antiinfective activity and developing insightin its' mode of action:

1. Direct counts (Counting chambers, calibrated smears, proportionate counts),
2. Tubidometry and nephalometry,
3. Electrical Resistance, Electrical impendance,
4. Microcalorimetry,
5. Flow cytometry and
6. Radiometric methods
7. Radiolabelling techniques

References:

1. Babych E. M., Ryzhkova T. A., Kalinichenko S. V. and Sklyar N. I., (2008), *General Characteristic of the methods for detection of diphtheria toxin,* Annals of MechnikovInstitute, 19 21 (www.imiamn.org/journal.htm).
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15. Vyas S. P and Dixit V. R. (2002), *Pharmaceutical Biotechnology*, CBS Publishers and Distributors, New Delhi.

Mapping of Program Outcomes with Course Outcomes

Weightage: 1=weakorlowrelation,2=moderateorpartialrelation,3=strongordirectrelation

	Programme Outcomes(POs)								
Course Outcomes	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	1								
CO2	2	3			3	2			
CO3	1	2			3	2			
CO4	3		3	2					
CO5	1		2	3					
CO6				2					
CO7							2		
CO8							3		

Justification for the mapping

PO1: Disciplinary Knowledge

CO1: Students will understand the basic principles of medical microbiology, including the identification, pathogenesis, and epidemiology of microorganisms causing human diseases.

CO2: Students will develop a deep understanding of various techniques used in the laboratory diagnosis of infectious diseases.

CO3: Students will master and developing the ability to analyze and interpret clinical microbiology laboratory results

CO4: Students will grasp the concept of microbial pathogenesis, including mechanisms of virulence and host-pathogen interactions.

CO5: Students will comprehend mechanisms of action and resistance of antimicrobial agents, and apply knowledge to guide appropriate antimicrobial therapy

PO2: Critical Thinking and Problem Solving

CO2: Students will use their understanding of principles and techniques used in the laboratory diagnosis of infectious diseases, including specimen collection, culture, identification, and antimicrobial susceptibility testing.

CO3: Students will apply their knowledge of interpreting ability clinical microbiology laboratory results, including microbial growth patterns, biochemical tests, and molecular diagnostic methods.

PO3: Social competence

CO4: Students will develop competence in principles of microbial pathogenesis, including mechanisms of virulence and host-pathogen interactions.

CO5: Students will acquire proficiency in explaining the mechanisms of action and resistance of antimicrobial agents

PO4: Research-related skills and Scientific temper

CO4: Students will apply their knowledge of mechanisms of virulence and host-pathogen interactions.

CO5: Students will able to apply the role of action and resistance of antimicrobial agents, and apply knowledge to guide appropriate antimicrobial therapy.

CO6: Students will be able to comprehend knowledge of learning multidrug resistance in bacterial pathogens.

PO5: Trans-disciplinary Knowledge

CO2: Students will gain the knowledge of principles and techniques used in the laboratory diagnosis of infectious diseases, including specimen collection, culture, identification, and antimicrobial susceptibility testing.

CO3: Students will understand the ability Analyze and interpret clinical microbiology laboratory results, including microbial growth patterns, biochemical tests, and molecular diagnostic methods.

PO6: Personal and Professional Competence

CO2: Students will showcase their proficiency in techniques used in the laboratory diagnosis of infectious diseases, including specimen collection, culture, identification, and antimicrobial susceptibility testing.

CO3: Students will demonstrate their competency in clinical microbiology laboratory results, including microbial growth patterns, biochemical tests, and molecular diagnostic methods.

PO7:Self-directed and Life-long Learning

CO5: Students will acquire the skill of antimicrobial activity and antimicrobial therapy

CO6: Students will gain skills in learning multidrug resistance in bacterial pathogens.

SYLLABUS (CBCS as per NEP 2020) FOR M.Sc. I. Microbiology
(w. e. from June, 2023)

Name of the Programme	**: M.Sc. Microbiology**
Program Code	**: PSMI**
Class	**: M.Sc. I**
Semester	**: I**
Course Type	**: RM**
Course Name	**: Research Methodology**
Course Code	**: MI-521-RM**
No. of Lectures	**: 60**
No. of Credits	**: 04**

Course Objective:

1. To introduce the concepts of application and research in Microbiology
2. To inculcate sense of scientific responsibilities
3. To provide an understanding of the fundamental principles and concepts of research methodology.
4. To develop critical thinking skills necessary for designing and conducting research studies.
5. To familiarize students with different research methods and techniques used in various disciplines.
6. To enable students to evaluate and critique research studies published in academic journals.
7. To enhance students' skills in data collection, analysis, and interpretation.
8. To promote ethical conduct in research and emphasize the importance of research integrity.
9. To encourage students to communicate research findings effectively through written and oral presentations.
10. To cultivate a research mindset and instill the importance of lifelong learning in the field of research.

Course Outcomes:

1. Understand the research process, including the formulation of research questions, hypotheses, and objectives.
2. Identify appropriate research designs and methods based on the research questions and objectives.
3. Critically evaluate and select relevant literature for conducting a comprehensive literature review.
4. Develop research proposals that outline the research design, methodology, and ethical Considerations.
5. Apply various data collection techniques, such as surveys, interviews, experiments, and observations.
6. Analyze and interpret quantitative and qualitative data using appropriate statistical and analytical methods.
7. Effectively communicate research findings through written reports and oral presentations.

8. Demonstrate ethical conduct in research by adhering to guidelines for responsible research practices.Critique and evaluate research studies published in academic journals, identifying strengths and limitations.
9. Develop a research mindset and understand the importance of continuous learning in the field of research.
10. Students will able to Understand philosophy and ethics of research

CONTENTS:

UNIT 1: Introduction to Research **(8L)**

- Philosophical foundation of research
- Understanding research publications
- Online Referencing Tools
- Plagiarism

UNIT 2: Scientific Writing **(30L)**

Writing Dissertation

- Construction of title
- Preparation of abstract
- Writing literature review
- Writing materials and methods
- Writing results
- Writing discussion
- Writing conclusion
- Drawing graphs (using Microsoft Excel)
- Reference citation

Writing Research Proposal

- Construction of title
- Writing background and Rationale
- Writing review of literature
- Writing objectives
- Writing methodology
- Plan of work and time schedule
- Budget allocation

UNIT 3: Writing Research Paper **(12L)**

- Construction of title
- Preparation of abstract
- Writing materials and methods
- Writingresults
- Writingdiscussion
- Writing conclusion
- Drawing graphs (using Microsoft Excel)
- Reference citation

UNIT4: Presenting research **(10L)**

- **Poster presentation**
  Types of posters (E-poster, Printed poster, etc)
  Structure of poster
- **Oral presentation**
  Use of Microsoft Power point presentation for preparation of slides
  Structure of presentation

Mapping of Program Outcomes with Course Outcomes

Weightage:1=weak or low relation,2=moderate or partial relation,3=strong or direct relation

	Programme Outcomes(POs)								
Course Outcoms	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	3		3		2			2
CO2	3					3		2	3
CO3	2	3							3
CO4	3	2		2		2		3	3
CO5	3	3		3		3			3
CO6	2	2		3		2		3	3
CO7	3			2		2			2
CO8		2		3	3	3			
CO9	3	3			3				3
CO10	3								2

Justification for the mapping

PO1: Disciplinary Knowledge

CO1: Attain fundamental knowledge of research.

CO2: Acquire knowledge regarding research design and methods aligned with research questions and objectives.

CO3:Understand the concept of literature review.

CO4 and CO5:Gain knowledge of research proposals outlining research design, methodology, and ethical considerations, including data collection techniques such as surveys, interviews, experiments, and observations.

CO6: Analyze and interpret quantitative and qualitative data using appropriate statistical and analytical methods.

CO7: Develop basic knowledge of oral presentation.

CO10: Understand the philosophy and ethics of research.

PO2: Critical Thinking and Problem Solving

CO1:Apply learned knowledge to the research process, including the formulation of research questions, hypotheses, and objectives.

CO3:Develop basic knowledge of research designs and methods based on research questions and objectives.

CO4, CO5, and CO6:Attain an overall understanding of research design, methodology, and ethical considerations, including data collection techniques and the analysis and interpretation of quantitative and qualitative data.

CO8:Demonstrate ethical conduct in research by adhering to guidelines for responsible research practices. Critique and evaluate research studies published in academic journals, identifying strengths and limitations.

CO9:Understand the importance of continuous learning in the field of research.

PO4: Research-related Skill and Scientific Temper

CO1:Understand basic knowledge of research methodology.

CO4 and CO5: Acquire knowledge of research proposals outlining research design, methodology, and ethical considerations, including data collection techniques such as surveys, interviews, experiments, and observations.

CO6: Analyze and interpret quantitative and qualitative data using appropriate statistical and analytical methods.

CO7: Comprehend and appreciate ethical conduct in research by adhering to guidelines for responsible research practices. Critique and evaluate research studies published in academic journals, identifying strengths and limitations.

CO8:Develop a research mindset and understand the importance of continuous learning in the field of research.

PO5: Trans-disciplinary Knowledge

CO8:Demonstrate ethical conduct in research by adhering to guidelines for responsible research practices. Critique and evaluate research studies published in academic journals, identifying strengths and limitations.

CO9: Explore and apply knowledge in the field of research.

PO6: Personal and Professional Competence

CO1 and CO2:Understand the research process, research design, and its methods.

CO4, CO5, and CO6:Utilize data collection techniques, such as surveys, interviews, experiments, and observations. Analyze and interpret quantitative and qualitative data using appropriate statistical and analytical methods.

CO7:Effectively communicate research findings through written reports and oral presentations.

CO8Develop a research mindset and understand the importance of continuous learning in the field of research.

PO9: Self-directed and Life-long Learning

CO1:Attain fundamental knowledge of research.

CO2:Acquire knowledge regarding research design and methods.

CO3:Understand the concept of literature review.

CO4 and CO5:Gain knowledge of research proposals outlining research design, methodology, and ethical considerations, including data collection techniques such as surveys, interviews, experiments, and observations.

CO6: Analyze and interpret quantitative and qualitative data using appropriate statistical and analytical methods.

CO7:Develop basic knowledge of oral presentation.

CO8:Develop a research mindset and understand the importance of continuous learning in the field of research.

CO9:Understand philosophy and ethics of research.