Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

(Autonomous)

Two Year Degree Program in Microbiology

Choice Based Credit System Syllabus (2023 Pattern)

(As Per NEP 2020)

M.Sc. Microbiology Part-II Semester -III

To be implemented from Academic Year 2024-2025

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	**Comprehensive Knowledge and Understanding:** Postgraduates will possess a profound understanding of their field, encompassing foundational theories, methodologies, and key concepts within a multidisciplinary context.
PSO2	**Practical, Professional, and Procedural Knowledge:** Postgraduates will acquire practical skills and expertise necessary for professional tasks, including industry standards, regulations, and ethical considerations, with effective application in real-world scenarios.
PSO3	**Entrepreneurial Mind-set, Innovation, and Business Understanding:** Postgraduates will cultivate an entrepreneurial mind-set, identify opportunities, foster innovation, and understand business principles, market dynamics, and risk management strategies.
PSO4	**Specialized Skills, Critical Thinking, and Problem-Solving:** Postgraduates will demonstrate proficiency in technical skills, analytical abilities, effective communication, and leadership, adapting and innovating in response to changing circumstances.
PSO5	**Research, Analytical Reasoning, and Ethical Conduct:** Postgraduates will exhibit observational and inquiry skills, formulate research questions, utilize appropriate methodologies for data analysis, and adhere to research ethics while effectively reporting findings
PSO6	**Communication, Collaboration, and Leadership:** Postgraduates will effectively communicate complex information, collaborate in diverse teams, demonstrate leadership qualities, and facilitate cooperative efforts toward common goals.
PSO7	**Digital Proficiency and Technological Skills:** Postgraduates will demonstrate proficiency in using ICT, accessing information sources, analyzing data using appropriate software, and adapting to technological advancements.
PSO8	**Multicultural Competence, Inclusive Spirit, and Empathy:** Postgraduates will engage effectively in multicultural settings, respect diverse perspectives, lead diverse teams, and demonstrate empathy and understanding of others perspectives and emotions.
PSO9	**Value Inculcation, Environmental Awareness, and Ethical Practices:** Postgraduates will embrace ethical and moral values, practice responsible citizenship, recognize and address ethical issues, and promote sustainability and environmental conservation.
PSO10	**Autonomy, Responsibility, and Accountability:** Postgraduates will apply knowledge and skills independently, manage projects effectively, and demonstrate responsibility and accountability in work and learning contexts, contributing to societal well-being.

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(Autonomous)

From 2022-23 to 2024-25

Sr. No.	Name	Designation
1.	Prof. Dr. S. T. Pawar	Chairman
2.	Prof. Dr. M. H. Gajbhiye	Member
3.	Prof. Dr. Y. R. Mulay	Member
4.	Mr. D. V. Doshi	Member
5.	Mrs. K. R. Jagtap	Member
6	Miss. P. C. Bhosale	Member
7	Prof. Dr. Snehal Kulkarni	Expert from SPPU, Pune
11	Miss. Markale Prajakta	Student Representative
12.	Miss. Pathak Chaitrali	Student Representative

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

Course Structure for M.Sc. Microbiology Part II (2023 Pattern as per NEP 2020)

Semester	Course Type	Course Code	Title of Course	Theory/ Practical	No. of Credits	Marks (I + E)
III	Major (Mandatory)	MIB-601-MJM	Immunology	Theory	4	40 + 60
	Major (Mandatory)	MIB-602-MJM	Molecular Biology	Theory	4	40 + 60
	Major (Mandatory)	MIB-603-MJM	Practical Course V	Practical	2	25 + 25
	Major (Mandatory)	MIB-604-MJM	Practical Course VI	Practical	2	25 + 25
	Major (Elective)	MIB-611-MJE(A)	Taxonomy and Bioinformatics	Theory	2	20 + 30
		MIB-611-MJE(B)	Diversity			
	Major (Elective)	MIB-612-MJE(A)	Practical Course VII(A)	Practical	2	25 + 25
		MIB-612-MJE(B)	Practical Course VII(B)			
	RP	MIB-621-RP	Research Project I	Project	4	50 + 50
	Total credits Semester III				20	
Semester	Course Type	Course Code	Title of Course	Theory/ Practical	No. of Credits	
IV	Major (Mandatory)	MIB-651-MJM	Recombinant DNA technology	Theory	4	40 + 60
	Major (Mandatory)	MIB-652-MJM	Microbial metabolism	Theory	4	40 + 60
	Major (Mandatory)	MIB-653-MJM	Practical Course VIII	Practical	2	25 + 25
	Major (Elective)	MIB-661-MJE(A)	Enzymology	Theory	2	20 + 30
		MIB-661-MJE(B)	Biostatistics			
	Major (Elective)	MIB-662-MJE(A)	Practical Course IX(A)	Practical	2	25 + 25
		MIB-662-MJE(B)	Practical Course IX(B)			
	RP	MIB-681-RP	Research Project II	Project	6	75 + 75
	Total credits Semester IV				20	

SYLLABUS (CBCS as per NEP 2020) FOR M.Sc. I. Microbiology
(w. e. from June, 2024)

Name of the Programme	**: M.Sc. Microbiology**
Program Code	**: PSMI**
Class	**: M.Sc. II**
Semester	**: III**
Course Type	**: Major Mandatory Theory**
Course Name	**: Immunology**
Course Code	**: MIB-601-MJM**
No. of Lectures	**: 60**
No. of Credits	**: 04**

Course Objectives:

1. Understand the structure and function of key immune receptors including G-protein coupled receptors, Toll-like receptors, cytokine receptors, T Cell receptor, B Cell Receptor, and TCR-CD3 complex
2. Examine the role of adhesion molecules in immune activation, including adhesion, Selectin, and Mucin.
3. Explore the signal transduction pathways involved in immune response, focusing on the IL-2 pathway, JAK/STAT, Ras/MAP Kinase Pathway
4. Understand the mechanisms of negative regulation in immunological tolerance, including tolerance induction and maintenance.
5. Investigate the regulation of immune responses by antigens, antigen-antibody complexes, and network theory principles.
6. Investigate the metastasis process and tumors of the lymphoid system.
7. Understand approaches in cancer immunotherapy, including immune adjuvant and tumor vaccine therapy.

Course Outcome:

1. Students will be able to describe the structure and function of various immune receptors and their significance in immune responses.
2. Students will analyze the role of adhesion molecules in immune activation and their impact on cell-cell interactions.
3. Students will be able to explain the signal transduction pathways involved in immune responses, with a specific focus on the IL-2 pathway, JAK/STAT, and Ras/MAP Kinase Pathways
4. Students will be able to explain the mechanisms underlying immunological tolerance and its significance in immune homeostasis.
5. Students will be able to analyse cellular transformations during neoplastic growth and classify different types of tumors.
6. Students will be able to describe the escape mechanisms of tumors from host
7. Students will understand the principles and approaches in cancer immunotherapy, including immune adjuvant and tumor vaccine therapy.

CONTENTS:

UNIT 1: Cell surface molecules and receptors (15L)

1. Structure and function of:
    a) G protein coupled receptors,
    b) Toll like receptors,
    c) Cytokine receptors,
    d) T Cell receptor,
    e) B Cell Receptor,
    f) TCRCD3 complex.
2. Adhesion molecules in immune activation (adhesion, Selectin, Mucin)
3. Signal transduction pathways: JAK/STAT, Ras /MAP Kinase Pathways, IP3 mediated pathway

UNIT 2: Regulation of Immune response (15L)

1. Negative regulation-Immunological tolerance, Mechanisms of tolerance induction (related experimentation using transgenic animals),
2. T cell mediated suppression of immune response
3. Regulation of immune responses by antigen, Antigen-antibody complexes, Network theory and its experimental evidence
4. Cytokine mediated cross regulation of TH subsets (TH1 & TH2)
5. Immunomodulation - Biological Response Modifiers for cancer therapy and autoimmune disorders

UNIT 3: Experimental Immunology (15L)

1. In vitro systems –Quantification of cytokines (ELISPOT assay),functional assays for phagocytes and cytokines (cytotoxicity and growth assays)
2. In vivo systems – Experimental animals in immunology research (Inbred animal strains, Knockout mice, transgenic animals), Animal models for autoimmunity and AIDS

UNIT 4: Tumor Immunology (15L)

1. Cellular transformations during neoplastic growth, Classification of tumors (sarcoma, Carcinoma, Lukemia, Benign And Malignanat tumor)
2. Metastasis Process
3. Tumors of lymphoid system (lymphoma, myeloma, Hodgkin’s disease,)
4. Escape mechanisms of tumor from host defense,
5. Host immune response to tumor – Effecter mechanisms - NK cells, Macrophage, ADCC, Immuno- surveillance theory
6. Diagnosis of tumors – biochemical and immunological tumor markers (alphafoetal proteins, carcino embryonic antigen, Cancer therapeutics).
7. Approaches in cancer immunotherapy: Immune adjuvant and tumour vaccine therapy

Text / Reference Books:

1. Akihiko Yoshimura, Tetsuji Naka and Masato Kubo, (2007), SOCS proteins, cytokine signaling and immune regulation, Nature Reviews, Immunology, 7:454-465.
2. Austyn J. M. and Wood K. J. (1993) Principles of Molecular and Cellular Immunology, Oxford University Press,
3. Barret James D. (1983) Text Book of Immunology 4th edition, C. V. Mosby & Co. London.
4. Boyd William C. (1966) Fundamentals of Immunology, Interscience Publishers, NY.
5. Christopher K. Garcia and Erin J. Adams, (2005), How the T Cell Receptor Sees Antigen A Structural View, Cell, Vol. 122: 333– 336, Elsevier Inc.
6. David A. Hafler, (2007), Cytokines and interventional immunology, Nature Reviews, Immunology, 7: 423
7. Gangal Sudha and Sontakke Shubhangi (2013), Textbook of Basic and Clinical Immunology Paperback, University Press, India
8. Kindt, Osborne, Goldsby, (2006), Kuby Immunology, 6th Ed., W. H. Freeman & Co.
9. Abbas A. K. and Litchman A. H. (2004), Basic Immunology, Functions and Disorders of Immune System, 2nd Ed., Elsevier Inc
10. Bhushan Patwardhan, Sham Diwanay and Manish Gautam. (2006). Botanical Immunomodulators and Chemoprotectants in Cancer Therapy.
11. In Drug discovery and development Volume I: Drug Discovery. Ed. Chorghade
12. Mukund S., (2006), WileyInterscience, John Wiley and Sons Inc. USA. 405-424.
13. Michael C Carroll, (2004), The complement system in regulation of adaptive immunity, Nature Immunology 10:981-986.
14. Roitt I. M. (1988) Essentials of Immunology, ELBS, London.
15. Roitt M. (1984) Essentials of Immunology, P. G. Publishers Pvt. Ltd., New Delhi.
16. House Robert V., (1998), Therapeutic Manipulation of Cytokines, Biotechnology and Safety Assessment, 2nd Ed., Taylor & Francis, 81-105.
17. Masters John R. W., (2000), Animal Cell Culture A Practical Approach, 3rd Ed., Oxford University Press.
18. Mather Jennie P. and Penelope E. Roberts, (1998), Introduction to Cell and Tissue Culture Theory and Technique, Plenum Press, New York.
19. Roitt Evan, Brostoff J. Male D. (1993) Immunology 6th Ed., Mosby & Co. London.
20. Talwar G. P. (1983) Handbook of Immunology, Vikas Publishing Pvt. Ltd. New Delhi.
21. William E., Md. Paul, (2003), Fundamental Immunology, 5th Ed, Lippincott Williams &Wilkins Publishers

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. (Sem-lll) **Subject: Microbiology**

Course: Immunology **Course Code: MIB-601-MJM**

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

	Programme Outcomes (POs)									
Course Outcome (CO)	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	2	1	3	2	1	2	1	1	2
CO2	2	3	1	3	2	2	2	1	1	2
CO3	3	2	1	3	2	2	3	1	1	2
CO4	3	2	1	3	3	2	2	1	1	2
CO5	2	3	1	3	2	3	2	1	1	2
CO6	2	2	1	3	2	3	2	1	1	2
CO7	2	2	1	3	2	3	2	1		

Justification for each Program Outcome with each Course Outcome:

PO1: Comprehensive Knowledge and Understanding

CO1, CO3, CO4: Understanding the structure, function, and signaling pathways of immune receptors and tolerance mechanisms require comprehensive knowledge and understanding.

CO2, CO5, CO6, CO7: These outcomes involve analyzing complex processes and mechanisms, also requiring a comprehensive understanding.

PO2: Practical, Professional, and Procedural Knowledge

CO2, CO5, CO6, CO7: Analyzing cellular transformations, tumor escape mechanisms, and cancer immunotherapy principles require practical knowledge and understanding of procedures.

PO3: Entrepreneurial Mind-set, Innovation, and Business Understanding

CO1, CO3, CO4: While these outcomes are more focused on foundational knowledge, they indirectly support an entrepreneurial mindset by providing the basis for potential innovations in cancer treatment.

PO4: Specialized Skills, Critical Thinking, and Problem-Solving

CO1, CO2, CO3, CO4, CO5, CO6, CO7: All course outcomes involve specialized knowledge and critical thinking related to understanding immune responses, tumor biology, and cancer immunotherapy.

PO5: Research, Analytical Reasoning, and Ethical Conduct

CO4, CO5, CO6: Understanding immunological tolerance, tumor classifications, and tumor escape mechanisms involves research and analytical reasoning, while discussing ethical conduct in cancer treatment.

PO6: Communication, Collaboration, and Leadership

CO1, CO2, CO3, CO5, CO6, CO7: These outcomes involve understanding and conveying complex concepts, collaborating with others in research or clinical settings, and potentially taking leadership roles in cancer research or treatment.

PO7: Digital Proficiency and Technological Skills

All COs: In modern medical education and research, proficiency in digital tools and technology is necessary across all aspects of understanding immune responses and cancer biology.

PO8: Multicultural Competence, Inclusive Spirit, and Empathy

CO5, CO6: Understanding tumor biology and escape mechanisms can involve considerations of diverse patient populations and promoting empathy in cancer care.

PO9: Value Inculcation, Environmental Awareness, and Ethical Practices

CO4, CO5, CO6: Discussions around immunological tolerance, cancer classifications, and tumor escape mechanisms touch upon ethical practices in research and clinical care.

PO10: Autonomy, Responsibility, and Accountability

All COs: Achieving these outcomes requires students to take responsibility for their learning, demonstrate autonomy in research or clinical tasks, and be accountable for their understanding and actions in cancer-related contexts.

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. II
Semester : III
Course Type : Major Mandatory theory
Course Name : Molecular Biology
Course Code : MIB-602-MJM
No. of Lectures : 60
No. of Credits : 04

Course objective:

1. Grasping the concepts behind operons and the mechanisms governing gene regulation within cells.
2. Exploring the function and importance of riboswitches in gene regulation and comprehending the role of sigma factors in response to phage infections across various bacterial hosts.
3. Developing a detailed understanding of the molecular processes involved in mRNA, rRNA, and tRNA processing within cells.
4. Gaining insight into the role and significance of non-coding RNAs, as well as comprehending the mechanisms of RNA interference in gene regulation.
5. Students will comprehend the roles of activators and repressors in regulating gene expression and their mechanisms of action in controlling transcription.
6. Students will gain an understanding of the processes involved in chromatin remodeling, how it impacts gene expression, and its significance in regulating transcription.
7. Students will explore the mechanisms and significance of DNA methylation and imprinting in epigenetic regulation and their roles in altering gene expression.

Course outcome:

CO1. Students will showcase an extensive grasp of operons and the diverse regulatory mechanisms controlling gene expression in both prokaryotic and eukaryotic systems.
CO2. Students will understand the functional importance of riboswitches in gene regulation, along with comprehending how sigma factors respond to phage infections across varied bacterial hosts.
CO3. Students will attain a thorough comprehension of the intricate molecular processes involved in the processing of mRNA, rRNA, and tRNA, encompassing splicing, modifications, and maturation.
CO4. Students will grasp the functions and mechanisms of non-coding RNAs, including their active involvement in RNA interference pathways and their impact on gene silencing.
CO5. Students will be able to explain the distinct roles of activators and repressors in controlling gene expression.
CO6. They will analyze and describe the processes involved in altering chromatin structure and accessibility, leading to changes in gene expression.
CO7. Students will explain the mechanisms of DNA methylation and genomic imprinting.

UNIT 1: RNA processing (15L)

1. mRNA processing: splicing, capping, polyadenylation
2. Coordination of mRNA processing
3. rRNA processing
4. tRNA processing
5. Non coding RNAs and their production

UNIT 2: Fine Control of Prokaryotic transcription (15L)

1. Lactose operon: - repressor-operator interactions, mechanism of repression, Positive control of lac operon-Mechanism of CAP action, catabolite repression
2. The Arabinose operon: - Ara operon repression loop, evidence for repression loop, autoregulation of araC
3. The Tryptophan operon: - control of trp operon by attenuation, defeating attenuation
4. Riboswitches
5. Sigma factor Switching: - Phage infection- T4, T7 infection in *E. coli*, SPO1 infection in *B. subtilis*

UNIT 3: Fine Control of Eukaryotic transcription (15L)

1. Activators and Repressors
2. Chromatin remodeling
3. Histone Acetylation, methylation, phosphorylation
4. RNA interference
5. Role of SiRNA, micro-RNA in gene silencing

UNIT 4: Epigenetic effects (15L)

1. Epigenetic effect sustained by a proteinaceous structure that assembles on DNA: - Heterochromatin, Polycomb group proteins, Condensins
2. Epigenetic effect sustained by a covalent modification of DNA: - DNA methylation and imprinting
3. Epigenetic effect sustained by a protein aggregate: - Yeast prions, Mammal prions

Text / Reference Books:

1. James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Loswick (2004) *Molecular Biology of the Gene*, 5th Edition, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc.
2. Lewin's Genes XI, (2014) Jones and Bartelett Publishers Inc.
3. Molecular Biology of the Cell, Bruce Albert et. al. , 6th Edn., Garland Sciences.
4. Molecular Biology, Loddishet. al., 7th Edn., W. H. Freeman, 2012
5. Weaver R., (2007) *Molecular Biology*, 4th Edition, McGrew Hill Science.
6. S.B Primrose and R M Twyman 2006 7th edition. Blackwell publishing
7. R. Glick, J.J. Pasterneck, Principles and applications of recombinant DNA, 3rd Ed., ASM press.
8. Walker J.M., Rapley R. (eds.) Molecular Biology and Biotechnology, 4th Ed., 2009, Royal Society Press, U.K.

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. (Sem-lll) **Subject: Microbiology**

Course: Molecular Biology **Course Code: MIB-602-MJM**

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

	Programme Outcomes (POs)									
Course Outcome (CO)	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3									
CO2		3								
CO3					3					
CO4				3						
CO5	3									
CO6		3								
CO7					3					

Justification for each Program Outcome with each Course Outcome:

PO1: Comprehensive Knowledge and Understanding

CO1: Operons and gene expression regulation are fundamental concepts in molecular biology, directly related to comprehensive knowledge and understanding.

CO5: Understanding the roles of activators and repressors is fundamental to comprehending gene expression regulation.

PO2: Practical, Professional, and Procedural Knowledge

CO2: Understanding riboswitches and sigma factors requires practical knowledge of gene regulation mechanisms, aligning with the practical aspect of this PO.

CO6: Analyzing chromatin structure changes requires practical knowledge and procedural skills related to chromatin modification.

PO5: Research, Analytical Reasoning, and Ethical Conduct

CO3: Research and analytical reasoning are essential to understanding complex molecular processes like RNA processing.

CO7: Understanding DNA methylation and genomic imprinting involves research, analytical reasoning, and ethical considerations related to genetic regulation.

PO4: Specialized Skills, Critical Thinking, and Problem-Solving

CO4: Understanding non-coding RNAs requires specialized skills and critical thinking, directly related to this PO.

SYLLABUS (CBCS as per NEP 2020) FOR M.Sc. I. Microbiology
(w. e. from June, 2024)

Name of the Programme : M.Sc. Microbiology
Program Code : PSMI
Class : M.Sc. II
Semester : III
Course Type : Major Mandatory practical
Course Name : Practical Course V
Course Code : MIB-603-MJM
No. of Lectures : 60
No. of Credits : 02

Course Objectives:

1. To demonstrate the principles of double immunodiffusion for the qualitative detection of antigens and antibodies.
2. To learn techniques for the separation of T and B lymphocytes using specific markers.
3. To understand the principles and procedures involved in immuno electrophoresis for the identification of proteins.
4. To understand the principles and techniques of single radial immunodiffusion for quantitative analysis of antigens.
5. To learn the technique of rocket immuno electrophoresis for the quantitative analysis of specific antigens.
6. To understand the principles of agglutination reactions and their application in blood group typing.
7. To learn the principles and techniques for the qualitative detection of IgM and IgG antibodies to dengue virus in human serum/plasma

Course Outcome:

1. Students will be able to perform single radial immune diffusion and double immuno-diffusion assays and interpret the results for the presence of specific antigens and antibodies.
2. Students will be able to isolate T and B lymphocytes from human peripheral blood using appropriate separation methods.
3. Students will be able to perform immuno electrophoresis to separate and identify proteins based on their antigenic properties.
4. Students will be able to perform rocket immuno electrophoresis assays to quantify specific antigens in biological samples.
5. Students will be able to determine the titre of isoantibodies to human blood group antigens using agglutination techniques.
6. Students will be able to determine packed cell volume (PCV) in a blood sample.
7. Students will demonstrate the ability to determine erythrocyte sedimentation rate (ESR)

Unit 1: Antigen-Antibody Interactions (12L)

1. To quantify the amount of antigen, present in test sample by single radial immune diffusion.
2. To quantify the amount of antigen present in test sample by double diffusion.
3. Titre determination of iso antibodies to human blood group antigens

Unit 2: Cells of immune system (24L)

4. To identify different WBC cells, present in the blood smear
5. Separation of T And B Lymphocytes From Human Peripheral Blood(T-Cell Resetting method)
6. PCV determination.
7. Determination of ESR.
8. Total Platelet Count by Neubauer's Haemocytometer.
9. RBC Count by Neubauer's Haemocytometer

Unit 3: Techniques in immunology (24L)

10. To perform quantification of antigen using ELISA
11. To perform quantification of Cytokine producing cell using ELISPOT
12. Immuno electrophoresis,
13. Rocket immuno electrophoresis
14. Western blot
15. To determine whether the complement has been fixed using sheep rbcs and antibodies against sheep RBCs Indirect coomb's test

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. (Sem lll) **Subject: Microbiology**

Course: Practical III **Course Code: MIB-603-MJM**

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

	Programme Outcomes (POs)									
Course outcome CO's	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	1	3	2	2	2	1	2	2
CO2	2	3	1	3	2	3	2	2	1	2
CO 3	3	3	1	3	3	2	2	1	2	2
CO 4	3	3	1	3	3	2	2	1	2	2
CO5	3	3	1	3	3	2	2	1	2	2
CO6	2	3	1	2	2	2	2	2	1	2
CO7	2	3	1	2	2	2	2	2	1	2

Justification for each Program Outcome with each Course Outcome:

PO1: Comprehensive Knowledge and Understanding:
CO1, CO2, CO3, CO4, CO5: These outcomes require a comprehensive understanding of immunology techniques and principles, protein separation methods, and blood analysis, aligning well with the aim of fostering comprehensive knowledge and understanding.

PO2: Practical, Professional, and Procedural Knowledge:
CO1, CO2, CO3, CO4, CO5, CO6, CO7: All course outcomes involve practical skills and procedural knowledge in laboratory techniques, blood sample analysis, and professional conduct, making this relation strong.

PO3: Entrepreneurial Mind-set, Innovation, and Business Understanding:
CO1, CO2, CO3, CO4, CO5: While the techniques taught in the course have applications in medical diagnostics and research, there's less emphasis on entrepreneurial or business aspects, hence the weak relation.

PO4: Specialized Skills, Critical Thinking, and Problem-Solving:
CO1, CO2, CO3, CO4, CO5: The course outcomes require specialized skills in immunology, critical thinking to interpret results, and problem-solving to troubleshoot experimental procedures, thus a strong relation exists.

PO5: Research, Analytical Reasoning, and Ethical Conduct:
CO1, CO3, CO4, CO5: These outcomes involve research-like activities, analytical reasoning to interpret results, and adherence to ethical standards in handling samples and conducting experiments, indicating a strong relation.

PO6: Communication, Collaboration, and Leadership:
CO1, CO2, CO3, CO4, CO5: While the course involves some collaboration in laboratory settings and may require communication of results, there's less emphasis on leadership, resulting in a moderate relation.

PO7: Digital Proficiency and Technological Skills:

CO1, CO3, CO4: The course involves the use of digital tools for data analysis and may require familiarity with technological equipment in laboratory settings, hence a moderate relation exists.

PO8: Multicultural Competence, Inclusive Spirit, and Empathy:

CO1, CO2, CO3, CO4, CO5, CO6, CO7: There's limited direct relation between the course outcomes and multicultural competence or empathy, hence the relation is weak.

PO9: Value Inculcation, Environmental Awareness, and Ethical Practices:

CO1, CO2, CO3, CO4, CO5, CO6, CO7: While ethical practices are emphasized in laboratory work, there's less direct relation to environmental awareness or broader value inculcation, indicating a weak relation.

PO10: Autonomy, Responsibility, and Accountability:

CO1, CO2, CO3, CO4, CO5, CO6, CO7: The course outcomes require students to take responsibility for their work, exhibit autonomy in experimental design and execution, and be accountable for the accuracy of their results, thus a strong relation exists

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

Name of the Programme	**: M.Sc. Microbiology**
Program Code	**: PSMI**
Class	**: M.Sc. II**
Semester	**: III**
Course Type	**: Major Mandatory practical**
Course Name	**: Practical Course VI**
Course Code	**: MIB-604-MJM**
No. of Lectures	**: 60**
No. of Credits	**: 02**

Course objective:

1. To understand the principles and methods of bacterial genomic DNA purification.
2. To learn the techniques for the estimation of DNA concentration and purity.
3. To perform agarose gel electrophoresis of bacterial genomic DNA and analyze the results.
4. To gain proficiency in yeast genomic DNA purification techniques.
5. To master the purification of RNA from yeast and bacteria.
6. To accurately estimate RNA concentration and assess its quality.
7. To acquire skills in plasmid DNA extraction and determination of its molecular weight.

Course Outcomes:

CO1. Students will be able to explain the importance of bacterial genomic DNA purification in various molecular biology applications.
CO2. Students will demonstrate the ability to accurately estimate DNA concentration and assess its purity.
CO3. Students will be proficient in performing agarose gel electrophoresis of bacterial genomic DNA and interpreting the results.
CO4. Students will have the skills to perform yeast genomic DNA purification effectively.
CO5. Students will be able to purify RNA from yeast and bacteria with high efficiency.
CO6. Students will accurately estimate RNA concentration and assess its quality using appropriate methods.
CO7. Students will demonstrate proficiency in plasmid DNA extraction and determining its molecular weight using suitable techniques.

UNIT 1: Genomic DNA extraction, estimation and characterisation. (24L)

1. Bacterial genomic DNA Purification.
2. Estimation of DNA.
3. Agarose gel electrophoresis of bacterial genomic DNA
4. Yeast genomic DNA Purification.
5. Determination of DNA melting temperature and G+C content percentage.
6. Gene annotation.

UNIT 2: Cellular RNA purification and its Estimation. (12L)

7. Purification of RNA from Yeast.
8. Purification of RNA from Bacteria.
9. Estimation of RNA.

UNIT 3: Purification, characterisation and curing of Plasmid DNA. (16L)

10. Plasmid DNA extraction.
11. Determination of molecular weight of plasmid DNA.
12. To cure plasmid using EtBr.
13. Isolation of plasmid cured cells.

UNIT 4: Transformation of *E. coli* cells. (8L)

14. Preparation of competent *E. coli* cells.
15. Transformation of *E. coli* cells with exogenous plasmid DNA.

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. (Sem-lll) **Subject: Microbiology**

Course: Practical course VI **Course Code: MIB-604-MJM**

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

	Programme Outcomes (POs)									
Course Outcome (CO)	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3									
CO2		3		3	2					
CO3		3		3	2					
CO4		3		3	2					
CO5		3		3	2					
CO6		3		3	2					
CO7		3		3	2					

Justification for each Program Outcome with each Course Outcome:

1. PO1: Comprehensive Knowledge and Understanding

CO1: The CO directly relates to understanding the significance of bacterial genomic DNA purification, aligning well with the PO.

2. PO2: Practical, Professional, and Procedural Knowledge
CO2, CO3, CO4, CO5, CO6, CO7: These COs directly relate to the practical, professional, and procedural knowledge required for molecular biology techniques.

4. PO4: Specialized Skills, Critical Thinking, and Problem-Solving
CO2, CO3, CO4, CO5, CO6, CO7: The COs emphasize developing specialized skills and applying critical thinking and problem-solving in molecular biology techniques.

5. PO5: Research, Analytical Reasoning, and Ethical Conduct
CO2, CO3, CO4, CO5, CO6, CO7: While the COs focus on research skills and analytical reasoning, the direct mention of ethical conduct is lacking.

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

Name of the Programme : M.Sc. Microbiology
Program Code : PSMI
Class : M.Sc. II
Semester : III
Course Type : Major Elective Theory
Course Name : Taxonomy and Bioinformatics
Course Code : MIB-611-MJE (A)
No. of Lectures : 30
No. of Credits : 02

Course Objective:

1. Understand the principles and significance of bacterial taxonomy
2. Explore the fundamental concepts and differences between the 5-kingdom classification system and the 3-domain classification system.
3. Familiarize with Bergey's Manuals and their role in the classification and identification of prokaryotes.
4. Learn about determinative and systematic bacteriology and the phylogenetic approach to bacterial classification
5. Gain an understanding of bioinformatics and learn how to search and download literature from databases relevant to bioinformatics research.
6. Develop skills in nucleic acid and protein sequence analysis, including pairwise sequence alignment and multiple sequence alignment techniques.
7. Acquire knowledge of database search tools such as BLAST and FASTA and structure databases such as PDB and NDB

Course Outcome:

CO1. Students will be able to explain the principles and importance of bacterial taxonomy and classification systems.
CO2. Students will understand the differences between the 5-kingdom and 3-domain classification systems and their relevance in modern taxonomy.
CO3. Students will be proficient in using Bergey's Manuals for the classification and identification of prokaryotes.
CO4. Students will be able to apply the phenetic approach to classify bacteria based on observable characteristics and the phylogenetic approach to bacterial classification using molecular techniques and polyphasic approach to bacterial taxonomy, integrating traditional and molecular methods for classification.
CO5. Students will grasp the significance of bioinformatics in biological research and its applications in data analysis.
CO6. Students will develop proficiency in nucleic acid and protein sequence analysis techniques, including alignment methods.
CO7. Students will be capable of using database search tools like BLAST and FASTA and also will gain proficiency in accessing and utilizing structure databases like PDB and NDB for studying biological molecule structures.

UNIT 1: Taxonomy. (15L)

Introduction to Bacterial Taxonomy

1. Science of classification
2. The 5-Kingdom classification system
3. The 3-Domain classification system
4. Bergey's Manuals and the classification of prokaryotes.
5. Determinative Bacteriology (Phenetic Approach)
6. Systematic Bacteriology (Phylogenetic Approach
7. Polyphasic Approach

UNIT 2: Bioinformatics (15L)

1. Introduction to Bioinformatics
2. Literature Databases (Searching and Downloading)
3. Nucleic acid and protein sequence analysis
    - Pairwise sequence alignment
    - Multiple sequence alignment
4. Database Searches
    - Introduction to BLAST and FASTA
5. Structure database
    - PDB,NDB

References:

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Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. (Sem-lll) **Subject: Microbiology**

Course: Taxonomy and Bioinformatics **Course Code: MIB-611-MJE (A)**

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

	Programme Outcomes (POs)									
Course outcomes (COs)	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	2								
CO2	2	2								
CO3	3	3								
CO4	3	3		3						
CO5	2		3	2	3	1	3			
CO6	2			2	2	1				
CO7	3				3	2	2			

Justification for each Program Outcome with each Course Outcome:

PO1: Comprehensive Knowledge and Understanding:
All Cos directly contribute to this outcome by providing a deep understanding of bacterial taxonomy, classification systems, and identification techniques.

PO2: Practical, Professional, and Procedural Knowledge:
CO1 to CO4 involve practical knowledge of using classification manuals and applying classification methods, aligning well with this outcome.

PO3: Entrepreneurial Mind-set, Innovation, and Business Understanding:
CO5 introduces students to bioinformatics, which is relevant for innovation and modern biological research, albeit with a weaker relation.

PO4: Specialized Skills, Critical Thinking, and Problem-Solving:
CO4, CO5, and CO6 specifically focus on developing specialized skills in bacterial classification, bioinformatics, and sequence analysis, enhancing critical thinking and problem-solving abilities.

PO5: Research, Analytical Reasoning, and Ethical Conduct:
CO5, CO6, and CO7 directly involve research skills, analytical reasoning, and ethical conduct through the use of bioinformatics tools and databases.

PO6: Communication, Collaboration, and Leadership:
While there's some indirect contribution from CO5 to CO7 in terms of communication and collaboration (through data sharing and analysis), it's not the primary focus of the outcomes.

PO7: Digital Proficiency and Technological Skills:
CO5 and CO7 specifically address digital proficiency and technological skills through the use of bioinformatics tools and databases.

SYLLABUS (CBCS as per NEP 2020) FOR F.Y.B.Sc. Microbiology
(w. e. from June, 2023)

Name of the Programme : M.Sc. Microbiology
Program Code : PSMI
Class : M.Sc. II
Semester : III
Course Type : Major Elective Theory
Course Name : Microbial Diversity
Course Code : MIB-611- MJE (B)
No. of Lectures : 30
No. of Credits : 02

Course Objective:

1. To enrich students' knowledge and train them in the pure microbialsciences
2. To introduce the concepts of application and research in Microbiology
3. To inculcate sense of scientific responsibilities and social and environment awareness
4. To help student's build-up a progressive and successful career
5. Students should be able to define diversity and explain its importance in various contexts, including social, cultural, and organizational.
6. Students should be familiar with key theories and frameworks related to diversity, such as social identity theory, intersectionality, and multiculturalism, and be able to critically evaluate their relevance and applicability.
7. Students should understand the impact of diversity on individuals, groups, and societies, including issues related to discrimination, privilege, and social justice.

Course Outcome:

CO1. Enrich students' knowledge and train them in the pure microbialsciences
CO2. Introduce the concepts of application and research in Microbiology
CO3. Students should be able to explain and critically evaluate key theories and concepts related to diversity, such as social identity theory, intersectionality, and critical race theory.
CO4. Students should be able to analyze the complexities of diversity, including how various factors such as race, gender, sexuality, class, and ability intersect and impact individuals and societies.
CO5. Students should be able to evaluate diversity issues in various contexts, such as education, healthcare, politics, and the workplace, and understand how these issues are shaped by historical, social, and cultural factors.
CO6. Students should be able to apply diversity theories to analyze and address real-world diversity challenges, such as discrimination, inequality, and social exclusion.
CO7. Students should be able to collaborate effectively with individuals from diverse backgrounds, demonstrating cultural competence and the ability to work collaboratively in diverse teams.

UNIT 1: Microbial diversity (15L)

1. The expanse of microbial diversity
2. Estimates of total number of species
3. Species Divergence and the measurement of microbial diversity.
4. Measures and indices of diversity.

UNIT 2: Exploration of Un-culturable bacteria (15L)

1. Concept of 'unculturable' bacterial diversity.
2. Strategies for culture of 'unculturable' bacteria.
3. Culture independent molecular methods for identifying unculturable bacteria.
4. Methods of extracting total bacterial DNA from a habitat and metagenome analysis.

References:

1. Breed and Buchanan. Bergey's Manual of Determinative Bacteriology. 8th Edition, 1974.
2. Breed and Buchanan. Bergey's Manual of Determinative Bacteriology. 9th Edition, 1982.
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Mapping of course outcomes and programme outcomes:

Class: M.Sc. II (Sem III) **Subject: Microbiology**

Course: Microbial Diversity (Theory) **Course code: MIB-611-MJE (B)**

Weightage: 1= weak or low relation, 2= Moderate or partial relation, 3= Strong or direct relation

	Programme Outcomes (POs)									
Course outcomes (COs)	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2			3						
CO2	2									
CO3	3	3		2	3					
CO4					2					
CO5								2		
CO6									3	
CO7			3			3				
CO8										

Justification for each Program Outcome with each Course Outcome:

PO1: Comprehensive Knowledge and Understanding

CO1: Students develop critical thinking skills as they analyze and interpret complex information about microbial diversity, including its ecological, evolutionary, and biotechnological implications. They learn to evaluate evidence, formulate hypotheses, and draw informed conclusions.

CO2: Understanding microbial diversity equips students with problem-solving abilities, enabling them to address real-world challenges related to health, agriculture, environment, and biotechnology. They learn to apply scientific knowledge creatively to develop innovative solutions.

CO3: They learn to apply scientific knowledge creatively to develop innovative solutions.

PO2: Practical, Professional, and Procedural Knowledge:

CO3: Students gain proficiency in a wide range of laboratory techniques, including microbial isolation, cultivation, identification, and characterization. This leads to the program outcome of developing strong laboratory skills necessary for conducting research and practical applications in microbiology and biotechnology.

PO3: Entrepreneurial Mindset, Innovation, and Business Understanding

CO7: The syllabus cultivates an entrepreneurial mindset among students by encouraging them to identify opportunities for innovation and commercialization in microbiology and biotechnology.

PO4: Specialized Skills, Critical Thinking, and Problem-Solving

CO1: The syllabus focuses on developing specialized skills relevant to microbial diversity research and applications. This includes proficiency in laboratory techniques, bioinformatics tools, data analysis methods, experimental design, and microbial identification.

CO3: These specialized skills are essential for conducting high-quality research and contributing to advancements in microbiology and biotechnology.

PO5: Research, Analytical Reasoning, and Ethical Conduct

CO3: The syllabus focuses on developing research competence among students by introducing them to research methodologies, experimental design, data collection techniques, and data analysis tools specific to microbial diversity research.

CO4: This program outcome equips students with the skills needed to plan, conduct, and analyze research effectively in microbiology and related fields.

PO6: Communication, Collaboration, and Leadership

CO7: In a microbial diversity course, students must communicate complex concepts related to microbiology, ecology, and genetics. This includes effectively explaining microbial diversity theories, research findings, and their implications. Communication skills are essential for presenting research findings, participating in group discussions, and conveying information through reports or presentations.

PO8: Multicultural Competence, Inclusive Spirit, and Empathy

CO5: Microbial diversity theories often emerge from research conducted in various cultural contexts and ecosystems worldwide. Understanding and analyzing these theories from diverse cultural perspectives enriches students' comprehension and appreciation of the complexity and interconnectedness of microbial ecosystems.

PO9: Value Inculcation, Environmental Awareness, and Ethical Practices

CO6: Microbial diversity theory is inherently linked to fundamental values in scientific inquiry. By emphasizing the value of curiosity, students are encouraged to ask critical questions and explore the complexities of microbial ecosystems. Integrity is promoted through honest and transparent engagement with data and theories, fostering a culture of scientific rigor.

SYLLABUS (CBCS as per NEP 2020) FOR M.Sc. II. Microbiology
(w. e. from June, 2024)

Name of the Programme : M.Sc. Microbiology
Program Code : PSMI
Class : M.Sc. II
Semester : III
Course Type : Major Elective Practical
Course Name : Practical Course VII(A)
Course Code : MIB-612-MJE (A)
No. of Lectures : 60
No. of Credits : 02

Course Objectives:

1. To Gain practical experience in handling natural samples and isolating specific types of bacteria and interpret the characteristics of Actinomycetes bacteria.
2. To Explore methods for the isolation and identification of mold and yeast from natural samples, the morphological and biochemical characteristics of mold and yeast and document the findings from the isolation and identification process.
3. To understand the ecological importance of Cyanobacteria & the morphological and physiological characteristics of Cyanobacteria.
4. To explore the diversity of extremophiles bacteria through the isolation of Thermophiles, Halophiles, Acidophiles, and Alkaliphiles types & the unique adaptations of extremophiles bacteria to extreme environmental conditions.
5. To Gain theoretical knowledge about genome and protein sequence analysis using the BLAST algorithm, the principles of multiple sequence alignment using PSI-BLAST & gain hands-on experience in performing multiple sequence alignments.
6. To learn the principles and methods of phylogenetic analysis using the FASTA algorithm & the results and interpret the evolutionary relationships depicted in the trees.
7. Explore the techniques for determining protein structure using RASMOL and CN-3D software, gain hands-on experience in visualizing and analyzing protein structures & the importance of protein structure in the context of molecular biology and bioinformatics

Course Outcomes:

CO1. Students will be able to isolate actinomycetes bacteria from natural samples, demonstrating proficiency in bacterial isolation techniques and understanding their characteristics.
CO2. Students will acquire skills in the isolation and identification of mold and Yeast from natural samples, showcasing competence in fungal identification techniques and knowledge of their characteristics.
CO3. Students will demonstrate the ability to isolate and identify Cyanobacteria from natural samples, highlighting expertise in working with photosynthetic microorganisms.
CO4. Students will master the isolation techniques for extremophiles bacteria, including Thermophiles, Halophiles, Acidophiles, and Alkaliphiles types, illustrating proficiency in handling microorganisms thriving in extreme conditions
CO5. Students will gain hands-on experience in genome and protein sequence analysis using the BLAST algorithm, demonstrating the ability to interpret results and draw conclusions.

CO6. Students will understand and apply concepts related to multiple sequence alignment, phylogenetic trees, and associated terminology, showcasing proficiency in bioinformatics analysis
CO7. Students will learn and apply methods for determining protein structure using RASMOL and CN-3D software, demonstrating competence in visualizing and analysing protein structures.
CO8. Students will integrate the results obtained from different experiments, applying interdisciplinary knowledge to draw comprehensive conclusions about microbial diversity and evolutionary relationships & develop research skills, including experimental design, data interpretation, and critical analysis, fostering a scientific inquiry mind-set essential for future microbiological research endeavours.

CONTENTS:

Unit 1: Isolation of Actinomycetes, fungi and cyanobacteria (20L)

1-2. Isolation & characterisation of Actinomycetes from natural sample.
3-4. Isolation and characterisation of the following types of fungi from natural sample.
   a. Mold.
   b. Yeast.
5. Isolation of Cyanobacteria from natural sample.

Unit 2: Isolation of extremophiles (16L)

6-9 Isolation and characterisation of the following types of extremophiles from natural sample.
   a. Thermophiles
   b. Halophiles
   c. Acidophiles
   d. Alkaliphiles

Unit 3: Bio-informatics. (24L)

10-11. Sequence analysis by using BLAST algorithm.
   a. Genome sequence analysis by using BLAST algorithm.
   b. Protein sequence analysis by using BLAST algorithm.
12. Multiple Sequence Alignment by using PSI- BLAST.
13. DNA translation from nucleotides to amino acids and identifying potential protein products encoded by a nucleotide using blastx.
14. Phylogenetic analysis and tree building methods by using FASTA.
15. Determination of protein structure (PDB) by using iCn3D structure viewer.

Mapping of course outcomes and program outcomes:

Class: MSc-II (Sem III) **Subject: Microbiology**

Course: Practical Course VII(A) **Course code: MIB-612-MJE(A)**

Weightage: 1= weak or low relation, 2= Moderate or partial relation, 3= Strong or direct relation

	Programme Outcomes (POs)									
Course outcomes (COs)	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	1			3				2
CO2	2	3	1			3				2
CO3	2	3	1			3				2
CO4	2	3	1	3		3				2
CO5	2		1	2	3	2	3			2
CO6	2		1	3	3	3				2
CO7	2		1			3	3			2
CO8	3	3	2		3	3		3	3	3

Justification for each Program Outcome with each Course Outcome:

PO1: Comprehensive Knowledge and understanding:

All COs contribute significantly to this PO, as they involve acquiring comprehensive knowledge about different types of microorganisms, their characteristics, and analytical techniques related to them.

PO2: Practical, Professional, and Procedural knowledge:

CO1: Students will demonstrate proficiency in bacterial isolation techniques and understanding the characteristics of actinomycetes bacteria through isolating them from natural samples.

CO2: Students will focus on practical skills such as isolation and identification techniques.

CO3: Students will demonstrate the ability to isolate and identify Cyanobacteria & highlighting expertise in working with photosynthetic microorganisms

CO4: Students will master the isolation techniques for extremophiles bacteria.

CO8: Students will integrate the results obtained from different experiments, applying interdisciplinary knowledge to draw comprehensive conclusions about microbial diversity and Bioinformatics.

PO3: Entrepreneurial Mind-set, Innovation, and Business understanding:

All CO are weakly related this program outcome. While microbiological research may lead to innovations.

PO4: Specialized skills, Critical thinking, and Problem-solving:

CO4: Students will master the isolation techniques for extremophiles bacteria, including Thermophiles, Halophiles, Acidophiles, and Alkaliphiles

CO5: Students will acquire practical skills through hands-on experience in conducting genome and protein sequence analysis utilizing the BLAST algorithm.

CO6**:** Students will understand and apply concepts related to multiple sequence alignment, phylogenetic trees, and associated terminology.

PO5: Research, Analytical reasoning, and Ethical Conduct:

CO5: Students will gain hands-on experience in genome and protein sequence analysis using the BLAST algorithm, demonstrating the ability to interpret results and draw conclusions

CO6: Students will comprehend and utilize principles concerning multiple sequence alignment, phylogenetic trees, and relevant terminology.

CO8: Students will utilize interdisciplinary knowledge to consolidate findings from various experiments, thereby drawing comprehensive conclusions regarding microbial diversity and bioinformatics.

PO6: Communication, Collaboration, and Leadership:

All CO strongly relates to this PO as students will particularly emphasizes communication, collaboration, and leadership skills required for integrating results and drawing comprehensive conclusions.

PO7: Digital Proficiency and Technological Skills:

CO5: Students will demonstrate the ability to interpret results and draw conclusions in genome and protein sequence analysis using the BLAST algorithm.

CO7: Students will learn and apply methods for determining protein structure using RASMOL and CN-3D software

PO8: Multicultural Competence, Inclusive Spirit, and Empathy:

CO8: Students will integrate the results & develop research skills, including experimental design, data interpretation, and critical analysis, fostering a scientific inquiry mind-set essential for future microbiological research endeavours.

PO9: Value Inculcation, Environmental Awareness, and ethical Practice:

CO8: Students will apply interdisciplinary knowledge to integrate results from various experiments, thereby drawing comprehensive conclusions regarding microbial diversity and bioinformatics & research skills, including experimental design, data interpretation, and critical analysis

PO10: Autonomy, Responsibility, and Accountability:

All CO are moderately related to this PO as students will emphasizes autonomy, responsibility, and accountability through research skills, experimental design, data interpretation, and critical analysis.

SYLLABUS (CBCS as per NEP 2020) FOR M.Sc. II. Microbiology
(w. e. from June, 2024)

Name of the Programme : M.Sc. Microbiology
Program Code : PSMI
Class : M.Sc. II
Semester : III
Course Type : Major Elective Practical
Course Name : Practical Course VII(B)
Course Code : MIB-612-MJE (B)
No. of Lectures : 60
No. of Credits : 02

Course Objectives:

1. To introduce students to methods for measuring microbial diversity
2. To analyze microbial diversity using diversity indices
3. To impart practical skills in bacterial DNA extraction and purification
4. To explore microbial diversity based on physiological factors
5. To assess microbial diversity based on nutritional requirements
6. To cultivate and maintain pure cultures
7. To consider the environmental implications of microbial diversity and its measurement, fostering awareness of sustainability issues related to microbial ecosystems

Course Outcomes:

CO1. Students will understand and apply various methods for measuring microbial diversity, including culture-dependent and culture-independent techniques
CO2. Students will gain knowledge about analysing and interpret diversity indices to assess microbial community complexity & evaluate the impact of environmental factors on microbial diversity, fostering critical thinking
CO3. Students will gain practical skills in bacterial DNA extraction, purification, and detection, enhancing research-related skills.
CO4. Students will connect microbiological principles with broader environmental factors, considering the trans-disciplinary nature of microbial diversity.
CO5. Students will develop practical laboratory skills in microbial diversity analysis, contributing to personal and professional competence.
CO6. Students will foster a mind-set of self-directed learning through hands-on experiences in microbial diversity techniques.
CO7. Students will understand the ecological implications of microbial diversity and its sensitivity to environmental factors, aligning with principles of sustainability.
CO8. Students will encourage continuous learning by emphasizing the importance of maintaining and cultivating pure microbial cultures throughout one's career.

CONTENTS:

Unit:1 Microbial Diversity. (20L)

1-5 Determination of Diversity indices By using

a. Simpson's Diversity Index (D).
b. Shannon-Wiener Diversity Index (H').
c. Species richness (S).
d. Simpson’s evenness
e. Shannon’s evenness

f. Margalef diversity index (d)
g. Berger-Parker index - Dominance indices
h. Sorensen similarity index

Unit 2 **Extraction of DNA from environmental samples** **(12L)**

6-8
a. Purification of DNA from soil.
b. Purification of DNA from water
c. Detection of Isolated DNA by using spectrophotometric method.

Unit:3 & Unit:4 **Effect of physiological factors on Diversity.** **(28L)**

9-13 Diversity based on physiological factors:
a. Nacl
b. pH
c. Temperature
d. Oxygen
e. Radiation
f. Antibiotic

14 To determine the effect of carbon source on diversity of bacteria.

15 Cryopreservation of bacterial pure culture.

Mapping of course outcomes and program outcomes:

Class: MSc-II (Sem III) **Subject: Microbiology**

Course: Practical Course VII(B) **Course code: MIB-612-MJE (B)**

Weightage: 1= weak or low relation, 2= Moderate or partial relation, 3= Strong or direct relation

	Program Outcome (PO'S)									
Course outcomes (COs)	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3		1	3	3			2		
CO2	3		1	3	3	3		2		
CO3		3	1	3	3		3	2		
CO4			1	3	2	1		1		
CO5		2	1	3	3	2		2		
CO6		2	1	3	2			2		3
CO7			1	3	3	2		2	3	
CO8			1	3	3			2		

Justification for each Program Outcome with each Course Outcome:

PO1: Comprehensive Knowledge and understanding:

CO1: Students will focus on understanding various methods for measuring microbial diversity and interpreting diversity indices.

CO2: Students will acquire the skills to analyse and interpret diversity indices for assessing the complexity of microbial communities.

PO2: Practical, Professional, and Procedural knowledge:

CO3: Students will acquire hands-on proficiency in bacterial DNA extraction, purification, and detection, thereby bolstering their research-oriented abilities.

CO5: Students will acquire practical laboratory skills in analysing microbial diversity, enhancing their personal and professional capabilities.

CO6: Students will cultivate a mind-set of self-directed learning by engaging in practical experiences with microbial diversity techniques.

PO3: Entrepreneurial Mind-set, Innovation, and Business understanding:

All the CO's are weakly related to this PO.

PO4: Specialized skills, Critical thinking, and Problem-solving:

All CO's are strongly pertaining to this PO as they involve critical thinking, problem-solving, and specialized skills in microbiology.

PO5: Research, Analytical reasoning, and Ethical Conduct:

CO2: Students will gain knowledge about analysing and interpret diversity indices to assess microbial community complexity.

CO4: Students will connect microbiological principles with broader environmental factors.

CO5: Students will develop practical laboratory skills for analysing microbial diversity, thereby enhancing both their personal and professional capabilities.

CO7: Students will grasp the ecological significance of microbial diversity and its responsiveness to environmental factors, in line with sustainability principles.

PO6: Communication, Collaboration, and Leadership:

CO2: Students will involve in involve fostering self-directed learning

CO5: Students will comprehend laboratory skills, and research-related skills.

CO6: Students will understand often requiring communication and collaboration.

PO7: Digital Proficiency and Technological Skills:

CO3: It involves bacterial DNA extraction and detection, which may involve technological skills.

PO8: Multicultural Competence, Inclusive Spirit, and Empathy:

Most of the CO's are slightly related to this PO as they primarily focus on microbiological and research skills rather than cultural competence.

PO9: Value Inculcation, Environmental Awareness, and ethical Practice:

CO7: Students will focus on understanding the ecological implications of microbial diversity and its sensitivity to environmental factors.

PO10: Autonomy, Responsibility, and Accountability:

CO6: Students will it involves fostering self-directed learning.

SYLLABUS (CBCS as per NEP 2020) FOR M.Sc. II. Microbiology
(w. e. from June, 2024)

Name of the Programme	**: M.Sc. Microbiology**
Program Code	**: PSMI**
Class	**: M.Sc. II**
Semester	**: III**
Course Type	**: Research Project**
Course Name	**: Research Project I**
Course Code	**: MIB-621-RP**
No. of Lectures	**: 60**
No. of Credits	**: 04**

Course Objectives:

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 in still the importance of lifelong learning in the field of research.

Course Outcome:

CO1. Understand the research process, including the formulation of research questions, hypotheses, and objectives.
CO2. Identify appropriate research designs and methods based on the research questions and objectives.
CO3. Critically evaluate and select relevant literature for conducting a comprehensive literature review.
CO4. Develop research proposals that outline the research design, methodology, and ethical considerations.
CO5. Apply various 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. Effectively communicate research findings through written reports and oral presentations.
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. Develop a research mindset and understand the importance of continuous learning in the field of research.

CO10. Students will able to Understand philosophy and ethics of research
CO11. Students should be able to write research proposal.

CONTENTS:

1. A dissertation can be carried out by a single student or by group of students where the group should not contain more than four students. The dissertation report will be prepared as per the thesis format. Submission of the dissertation report will be at least three days before the date of examination. One copy of the report will be preserved in the department. If there is more than one student carrying out a single dissertation, a single report can be submitted and these students will be assessed based on single oral presentation. In such case, presentation should be carried out by all the students carrying out the same work; dividing the presentation equally among them.
2. At the time of presentation, the external and internal examiners appointed by the university will be present; the dissertation guide may or may not be present.
3. Presentation should be carried out to an audience comprising of examiners appointed by the university, departmental teaching staff and the postgraduate students of the department. Oral presentation can be carried out using posters, blackboard, transparencies, model or LCD projector. The allotted time for each oral presentation (one project) should be 10 to 12 minutes, followed by question-answer session of 5 to 8 minutes. The audience can participate in this session.
4. The assessment of the Research project I is for total of 100 marks, out of which the end-semester - will be for 50 marks and the in-semester assessment will be for 50 marks.
5. The assessment of in-semester examination will be carried out by the guide who has supervised the work of the candidate(s) throughout the semester. The assessment will be carried out on the basis of the points, as per the accompanied format. Head of the department should communicate this point wise assessment system to the dissertation supervisor (Guide), well in advance. Guide will give appropriate marks, point-wise and submit it in a sealed envelope to the Head of the respective department, three days prior to examination and project presentation. On the day of examination, Head of the department will hand over these unopened envelopes to the examiners.

Points for Evaluation	**Max. Marks**	**Evaluation**
Intellectual potential – Understanding of the research problem by the student	5	
Research aptitude – 1. Depth of literature survey for the proposed work. 2. Inputs of student in development of plans and protocols for the experimentation 3. Ability to analyze data and formulate a solution 4. Analytical and reasoning abilities of the student for interpretation of data, inputs in discussion	 5 10 5 7.5	
Motivation – punctuality, meeting dead-lines and seriousness	2.5	

Ability to work with others	2.5	
Maturity of scientific thoughts	2.5	
Communication skill – oral and written	10	
Total	**50**	

6. Assessment of end-semester examination will be carried out (i.e., oral presentation) for individual student at the time of examination jointly by internal and external examiners. The assessment will be carried out on the basis of the points as per the accompanied format.

Points for Evaluation	**Max. Marks**	**Evaluation**
Proficiency of presentation skills – use of audio-visual aids, preparation of graphs, charts, models, etc., use of scientific language	20	
Quality of the work, results and interpretation, outcome of the study and possible future plans, publication potential of the work	10	
Submission of progress reports, the dissertation report preparation (scientific writing) and its contents	15	
Abilities of satisfactory responses to the queries from the audience	5	
Total	**50**	

7. Students should be made aware of the assessment parameters, on which they will be assessed at the end of the fourth semester.

8. The external and internal examiners by mutual agreement will appropriately settle the marks given by the guide (reconsider, if necessary) and marks of oral presentation.

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. (Sem-lll) **Subject: Microbiology**

Course: Research Project I **Course Code: MIB-621-RP**

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

	Programme Outcomes (POs)									
Course Outcome (CO)	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3			3	3					
CO2	3			3	3					
CO3	3			3	3					
CO4	3			3	3					
CO5		3		3						
CO6	3	3		3	3					
CO7		3				3				
CO8	3			3	3				2	2
CO9	3				3					2
CO10										
CO11										

Justification for each Program Outcome with each Course Outcome:

PO1: Comprehensive Knowledge and Understanding
CO1, CO2, CO3, CO4, CO6, CO8, and CO9: are strongly related to PO1, because they all involve understanding, formulating, and executing research processes and methodologies.

PO2: Practical, Professional, and Procedural Knowledge
CO5, CO6, and CO7: Deal with applying practical and professional knowledge in data collection, analysis, and communication of findings.

PO4: Specialized Skills, Critical Thinking, and Problem-Solving
CO1, CO2, CO3, CO4, CO5, CO6, and CO8: All involve critical thinking, problem-solving, and specialized skills in research.

PO5: Research, Analytical Reasoning, and Ethical Conduct
CO1, CO2, CO3, CO4, CO6, CO8, and CO9: These are strongly related to PO5, as they all deal with research, analytical reasoning, and ethical conduct.

PO6: Communication, Collaboration, and Leadership
CO7: Involves communication of research findings.

PO9: Value Inculcation, Environmental Awareness, and Ethical Practices
CO8: Ethical practices are part of environmental awareness and value inculcation.

PO10: Autonomy, Responsibility, and Accountability
PO10 is moderately related to CO8 and CO9, as they both involve responsibility, accountability, and continuous learning in research.