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 IE+EE
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
	Skill Development	MIB-691-SDC	Skill development II	Theory + Practical	2	50
	Total credits Semester III				20	

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

Name of the Programme	**: M.Sc. Microbiology**
Program Code	**: PSMI**
Class	**: M.Sc. II**
Semester	**: IV**
Course Type	**: Major Mandatory theory**
Course Name	**: Recombinant DNA technology**
Course Code	**: MIB-651-MJM**
No. of Lectures	**: 60**
No. of Credits	**: 04**

Course objective:

1. Gain proficiency in various gene cloning strategies, including the preparation of gene and genome libraries, cDNA libraries, and PCR cloning.
2. Learn about site-directed mutagenesis, protein engineering, and the cloning and manipulation of large DNA fragments using vectors like YAC, BAC, and HAC.
3. Develop an understanding of different methods for gene transfer to host cells and the application of expression vectors for gene expression.
4. Study the production of commercial products such as amino acids, ascorbic acid, novel antibiotics, and peptide antibodies through recombinant DNA technology.
5. Understand the synthesis of biopolymers like gums, rubber, and polyhydroxyalkanoates, and explore unconventional microbial systems for producing high-quality protein drugs.
6. Learn about the role of GMOs in bioremediation, including the degradation of xenobiotics, engineered degradative pathways, and the utilization of starch and cellulose for producing valuable products.
7. Investigate the social and ethical issues related to genetically modified organisms, their applications in medicine (including gene therapy), and their impact on agriculture, including examples of transgenic plants and their advantages and disadvantages.

Course outcome:

CO1. Students will be able to demonstrate competence in gene cloning techniques, including the creation and utilization of various gene and genome libraries.

CO2. Students will acquire skills in site-directed mutagenesis and protein engineering, and be able to clone and manipulate large DNA fragments using appropriate vectors.

CO3. Students will be able to identify and apply various gene transfer techniques and expression vectors to host cells for gene expression studies.

CO4. Students will understand and be able to apply recombinant DNA technology to the production of commercial products, including amino acids, ascorbic acid, and peptide antibodies.

CO5. Students will be able to describe and apply methods for the synthesis of biopolymers and understand the role of unconventional microbial systems in producing high-quality protein drugs.

CO6. Students will be able to assess the effectiveness of GMOs in bioremediation processes and the utilization of biomass for producing fructose, alcohol, and silage.

CO7. Students will critically analyze the social and ethical issues related to GMOs, understand their medical applications (including gene therapy), and evaluate their impact on agriculture and the environment.

UNIT 1: Gene technology (15L)

- Gene cloning strategies: preparation of gene, genome libraries, cDNA libraries, PCR cloning and alternatives, Library screening
- Site directed mutagenesis and protein engineering
- Cloning and manipulating large fragments of DNA: YAC, BAC, HAC
- Gene transfer to host cells
- Expression vectors

UNIT 2: Applications of recombinant DNA technology – Production of Secondary Metabolites (15L)

- Synthesis of commercial products: Amino acids, ascorbic acid, novel antibiotics, peptide antibodies
- Biopolymers: gum, rubber, polyhydroxyalkanoates
- Unconventional microbial systems for production of high-quality protein drugs

UNIT 3: Bioremediation and biomass utilization with the help of GMOs (15L)

- Degradation of xenobiotics, engineered degradative pathways
- Utilization of starch and cellulose for fructose, alcohol and silage production

UNIT 4: Genetically modified Microbes, plants and animals (15L)

- Genetically modified organisms- social and ethical issues
- Applications in medicine – prevention, early detection and cure of diseases
- Gene augmentation, gene therapy
- Applications in agriculture – examples of transgenic plants advantages and disadvantages

Text / Reference Books:

- R. Glick, J.J. Pasterneck, Principles and applications of recombinant DNA, 3rd Ed., ASM press.
- 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.
- Lewin's Genes XI, (2014) Jones and Bartelett Publishers Inc.
- Malom Campbell and L. J. Heyer, Discovering genomics, Proteomics and Bioinformatics, 2nd Ed., Pearson Publication, 2009.
- S.B Primrose and R M Twyman 2006 7th edition. Blackwell publishing
- 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

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	PO10	PO11	PO12	PO13
CO 1	3	3	2	3	3	2	3	2	3			3	
CO 2	3	3	2	3	3	2	3	2	3			3	
CO 3	3	3	2	3	3	2	3	2	3			3	
CO 4	3	3	3	3	3	2	3	2	2			3	
CO 5	3	2	2	2	2	2	2	2	2		2	2	
CO 6	2	2	2	2	3	2	2	2	2	2	3	2	
CO 7	3	2	2	2	2	2	3	2	2	3	3	2	

Justification for the mapping
PO1: Comprehensive Knowledge and Understanding
CO1: Demonstrates comprehensive knowledge of gene cloning techniques and libraries.
CO2: Involves understanding site-directed mutagenesis and protein engineering, requiring in-depth knowledge.
CO3: Requires thorough knowledge of gene transfer techniques and expression vectors.
CO4: Understanding recombinant DNA technology for commercial products requires broad knowledge.
CO5: Involves knowledge of biopolymer synthesis and microbial systems.
CO6: Requires understanding the effectiveness of GMOs, which is moderately related to comprehensive knowledge.
CO7: Involves analyzing social and ethical issues, demanding a deep understanding of GMOs and their applications.

PO2: Practical, Professional and Procedural
CO1: Requires practical application of gene cloning techniques.
CO2: Involves practical skills in site-directed mutagenesis and DNA manipulation.
CO3: Applies practical techniques for gene transfer and expression.
CO4: Involves procedural knowledge for using recombinant DNA technology in production.
CO5: Involves some procedural skills in biopolymer synthesis but less directly.
CO6: Requires practical assessment of GMOs in bioremediation, moderately related to procedural skills.
CO7: Involves understanding ethical and social implications, somewhat related to practical knowledge.

PO3: Entrepreneurial Mindset and Knowledge
CO1: Gene cloning has potential entrepreneurial applications but is not directly entrepreneurial.

CO2: Protein engineering and manipulation have entrepreneurial potential but not directly emphasized.
CO3: Gene transfer techniques can be applied in entrepreneurial ventures, though not a direct focus.
CO4: The production of commercial products using recombinant DNA technology is directly entrepreneurial.
CO5: Biopolymer synthesis can be applied in entrepreneurial contexts but is not the primary focus.
CO6: Use of GMOs in bioremediation has entrepreneurial implications, though not directly emphasized.
CO7: Understanding social and ethical issues related to GMOs have indirect entrepreneurial relevance.

PO4: Specialized Skills and Competencies
CO1: Requires specialized skills in gene cloning.
CO2: Involves specialized competencies in site-directed mutagenesis and protein engineering.
CO3: Requires specialized skills in gene transfer and expression vectors.
CO4: Involves specialized skills in applying recombinant DNA technology for product production.
CO5: Involves some specialized skills in biopolymer synthesis.
CO6: Requires specialized knowledge in assessing GMOs for bioremediation.
CO7: Involves specialized understanding of GMOs' social and ethical implications.

PO5: Capacity for Application, Problem-Solving
CO1: Application of gene cloning techniques involves significant problem-solving.
CO2: Manipulating DNA fragments requires problem-solving skills.
CO3: Applying gene transfer techniques to host cells involves problem-solving.
CO4: Using recombinant DNA technology for commercial products involves practical problem-solving.
CO5: Synthesizing biopolymers requires some problem-solving but is less direct.
CO6: Assessing GMOs' effectiveness in bioremediation involves problem-solving.
CO7: Analyzing social and ethical issues involves some problem-solving but is less directly applied.

PO6: Communication Skill and Collaboration
CO1: Communication is necessary for gene cloning techniques, but less emphasized.
CO2: Collaboration in protein engineering is relevant, though not a primary focus.
CO3: Gene transfer techniques may involve communication with peers.
CO4: Communicating the application of recombinant DNA technology is important.
CO5: Some communication skills are needed for biopolymer synthesis.
CO6: Discussing the use of GMOs in bioremediation involves communication.
CO7: Analyzing GMOs' social issues involves communication and collaboration in discussions.

PO7: Research-related Skills
CO1: Gene cloning techniques require strong research skills.
CO2: Site-directed mutagenesis and protein engineering involve significant research skills.
CO3: Research skills are crucial for applying gene transfer techniques.

CO4: Research is fundamental in applying recombinant DNA technology for product production.
CO5: Some research skills are needed for biopolymer synthesis.
CO6: Research on GMOs' effectiveness involves research skills.
CO7: Understanding the social and ethical issues requires strong research skills.

PO8: Learning How to Learn Skills

CO1: Requires learning new techniques and approaches but not heavily focused.
CO2: Involves learning about new methods in protein engineering.
CO3: Learning gene transfer techniques involves acquiring new knowledge.
CO4: Applying recombinant DNA technology requires ongoing learning.
CO5: Biopolymer synthesis involves learning about new processes.
CO6: Assessing GMOs' effectiveness involves learning and adapting.
CO7: Understanding ethical issues involves continuous learning.

PO9: Digital and Technological Skills

CO1: Gene cloning techniques heavily rely on digital and technological skills.
CO2: Site-directed mutagenesis and protein engineering require technological proficiency.
CO3: Gene transfer and expression techniques involve advanced technological skills.
CO4: Recombinant DNA technology requires significant digital and technological skills.
CO5: Some technological skills are needed for biopolymer synthesis.
CO6: Digital skills are needed to assess GMOs' effectiveness in bioremediation.
CO7: Understanding GMOs' social issues involves some technological understanding.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

CO6: Understanding GMOs' effectiveness may have some implications for diverse communities.
CO7: Analyzing ethical and social issues related to GMOs involves empathy and understanding diverse perspectives.

PO11: Value Inculcation and Environmental Awareness

CO5: Biopolymer synthesis involves some environmental awareness.
CO6: Assessing GMOs' effectiveness in bioremediation is highly relevant to environmental awareness.
CO7: Understanding the social and ethical implications of GMOs involves significant value inculcation and environmental awareness.

PO12: Autonomy, Responsibility, and Accountability

CO1: Demonstrating competence in gene cloning requires autonomy and responsibility.
CO2: Site-directed mutagenesis and protein engineering involve significant responsibility.
CO3: Applying gene transfer techniques requires accountability.
CO4: Using recombinant DNA technology for commercial products involves autonomy.
CO5: Some responsibility in biopolymer synthesis but less autonomy.
CO6: Assessing GMOs' effectiveness involves responsibility but not heavily autonomous.
CO7: Analyzing GMOs' social issues involves some degree of responsibility and accountability.

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: IV
Course Type: Major Mandatory Theory
Course Name: Microbial Metabolism
Course Code: MIB-652-MJM
No. of Lectures: 60
No. of Credits: 04
Course Objectives:

1. To elucidate the mechanisms and components involved in electron transport and photolysis of water.
2. To differentiate between light and dark reactions and their significance in the photosynthetic process.
3. To compare C3, C4, and CAM plants in terms of their photosynthetic efficiency and adaptations.
4. To comprehend the biochemistry of biological nitrogen fixation and its ecological significance.
5. To study the properties and regulation of nitrogenase, a key enzyme in nitrogen fixation.
6. To understand ammonia assimilation, focusing on the roles of glutamine synthetase, glutamate dehydrogenase, and glutamate synthetase, and their regulatory mechanisms.
7. To explore the biosynthesis pathways of five major amino acid families and histidine, including the enzymatic steps and regulatory aspects.
8. To grasp the concept of anaerobic respiration and its relevance in different biological contexts.
9. To explore the components of electron transfer systems and energy generation in bacteria with nitrate, sulphate, and CO_2 as terminal electron acceptors.
10. To investigate the mechanisms underlying oxygen toxicity and its impact on cellular processes.

Course Outcomes

1. Students will understand the role of electron carriers and the process of photolysis in photosynthesis.
2. Students will differentiate between light and dark reactions and explain their contributions to the overall photosynthetic process.
3. Students will compare and contrast C3, C4, and CAM plants in terms of their photosynthetic pathways and adaptations.
4. Students will understand the biochemistry and ecological significance of biological nitrogen fixation.
5. Students will describe the properties and regulation of nitrogenase.

6. Students will explain ammonia assimilation processes and the roles of relevant enzymes, including their regulation.
7. Students will be able to describe the biosynthesis of amino acids and histidine, including the key enzymatic steps and regulatory mechanisms.
8. Students will understand anaerobic respiration and its importance in various biological systems.
9. Students will describe the components of electron transfer systems in bacteria and the role of different terminal electron acceptors.
10. Students will discuss mechanisms of oxygen toxicity and its impact on biological systems.

CONTENTS:

UNIT 1: Photosynthesis (15L)

- Structure of chloroplast,
- electron carriers in photosynthesis,
- photolysis of water ,
- light and dark reaction,
- Hill reaction,
- C3, C4, CAM plants,
- energy consideration in photosynthesis,
- Photorespiration, Regulation of photosynthesis
- Bacterial photosynthesis: scope, electron carriers, Photosynthetic reaction center, cyclic flow of electrons, bacterial photophosphorylation in various groups of phototrophic bacteria,

UNIT 2: Nitrogen Metabolism (15L)

- Biochemistry of biological nitrogen fixation,
- properties of nitrogenase and its regulation,
- Ammonia assimilation with respect to glutamine synthetase, glutamate dehydrogenase, glutamate synthetase, their properties and regulation,
- Biosynthesis of five families of amino acids and histidine

UNIT 3: Anaerobic Respiration (15L)

- Concept of anaerobic respiration,
- Concept of Assimilation and Dissimilative metabolism,
- Components of electron transfer system and energy generation of bacteria where nitrate, sulphate and CO_2 act as terminal electron acceptors.

UNIT 4: Aerobic Respiration (15L)

- Structure of Mitochondria
- Components of ETC
- Arrangement of different components in the inner membrane
- Structure and function of ATP synthase
- Inhibitors and uncouplers of ETC
- Oxidative phosphorylation
- Energetics of electron transport chain

Text / Reference Books:

1. Nelson D. L. and Cox M. M. (2005) Lehninger's Principles of Biochemistry, Fourth edition, W. H. Freeman & Co. New York
2. Hall D. D. and Rao K. K. (1996) Photosynthesis 5th Ed.,Cambridge University Press
3. Michael T. Madigan, John M. Martinko, David A. Stahl, David P. Clark (2012) Brock Biology of Microorganisms, Thirteenth edition, Benjamin Cummings, San Francisco.
4. White David (2000) Physiology and Biochemistry of Prokaryotes. 2nd Ed. Oxford University Press, New York.
5. Mandelstam Joel and McQuillen Kenneth (1976) Biochemistry of Bacterial Growth, Blackwell Scientific Publication London.
6. Moat Albert G. and Foster John W. (1988) Microbial Physiology 2nd Ed. John Wiley and Sons New York.
7. Palmer Trevor (2001) Enzymes: Biochemistry, Biotechnology and Clinical chemistry, Horwood Pub. Co. Chinchester, England.
8. 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 Programme Outcomes (POs)

Course outcome	Programme Outcomes (POs)												
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	P1 0	PO 11	PO 12	PO 13
CO 1	3	2	1	3	2	1	2	2	1	1	2	1	1
CO 2	3	2	1	3	2	1	2	2	1	1	2	1	1
CO 3	3	2	1	3	2	1	2	2	1	2	2	1	2
CO 4	3	2	1	3	2	1	2	2	1	1	3	2	2
CO 5	3	2	1	3	2	1	3	2	1	1	2	1	1
CO 6	3	2	1	3	2	1	3	2	1	1	2	1	1
CO 7	3	2	1	3	2	1	3	2	1	1	2	1	1
CO 8	3	2	1	3	2	1	2	2	1	2	3	2	2
CO 9	3	2	1	3	2	1	2	2	1	2	3	2	2
CO 10	3	2	1	3	2	1	3	2	1	2	3	2	2

Justification of Mapping Chart

PO1: Comprehensive Knowledge and Understanding:

Every course outcome contributes directly to building comprehensive knowledge and understanding of various aspects of photosynthesis, nitrogen fixation, respiration, and related biochemical processes. This is the core of the curriculum, thus receiving the highest weightage.

PO2: Practical, Professional, and Procedural Skills:

The understanding of processes like photosynthesis, nitrogen fixation, and respiration equips students with essential practical and procedural skills relevant to professional fields in biochemistry, agriculture, and environmental sciences. The connection here is strong but secondary to the knowledge base.

PO3: Entrepreneurial Mindset and Knowledge

While understanding these biochemical processes is important, the direct application to entrepreneurial activities is limited. This connection exists but is weak.

PO4: Specialized Skills and Competencies:

Specialized competencies in understanding and explaining complex biochemical processes are a major focus of the course. This outcome directly fosters specialized knowledge in topics like nitrogenase regulation and electron transfer systems.

PO5: Capacity for Application, Problem-Solving:

The ability to apply knowledge and solve problems related to biochemical processes is moderately emphasized. Students learn to connect theory with practical application, crucial for scientific problem-solving.

PO6: Communication Skills and Collaboration:

Communication skills are necessary for articulating the learned concepts, though not a primary focus of these specific outcomes. The weak correlation suggests these skills are more secondary in this course.

PO7: Research-Related Skills :

Outcomes that involve describing and understanding complex biochemical processes naturally lend themselves to research-oriented activities. This is particularly true for CO5, CO6, CO7, and CO10 where research into enzymatic steps, nitrogenase regulation, and oxygen toxicity is critical.

PO8: Learning How to Learn Skills:

Students engage in learning processes that develop the ability to learn independently, an essential skill in mastering biochemical processes.

PO9: Digital and Technological Skills:

Digital and technological skills have a weak connection with these outcomes. While there may be some use of technology in learning or research, it is not a primary focus.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy:

Outcomes that deal with ecological significance (like CO4) and the broader impact of biochemical processes (like CO3, CO8, CO9, CO10) have a moderate connection to environmental awareness and empathy, fostering a more inclusive understanding of global challenges.

PO11: Value Inculcation and Environmental Awareness:
The outcomes that address ecological significance and the impact of biological systems (like CO4, CO8, CO9, and CO10) have a strong connection to environmental awareness, emphasizing the importance of ecological balance and the role of these processes in the environment.

PO12: Autonomy, Responsibility, and Accountability:
The outcomes foster autonomy in learning and responsibility in understanding complex processes, but this is more implicit than explicit in the syllabus.

PO13: Community Engagement and Service:
Outcomes that relate to the broader ecological and environmental significance (like CO3, CO4, CO8, CO9, CO10) have a moderate connection to community engagement, especially in terms of environmental stewardship and sustainable practices.

SYLLABUS (CBCS) FOR M.Sc. II Microbiology
(w. e. from June, 2024)
Academic Year 2024-24
Class: M. Sc. II (Semester- IV)
Paper Code: MIB-653-MJM
Title of Paper: Practical Course VIII
Credit: 2
No. of lectures: 60
Course Objectives

1. To provide students with a comprehensive understanding of Plant Growth Promoting Rhizobacteria (PGPR), including their enrichment, isolation, and characterization, particularly focusing on nitrogen fixers like Azospirillum.
2. To familiarize students with techniques for detecting important biochemical compounds such as Indole-3-Acetic Acid (IAA) and siderophores produced by PGPR like Azospirillum and Pseudomonas.
3. To train students in isolating and characterizing beneficial microbes from rhizosphere soil, such as phosphate-solubilizing bacteria, and enzymatic degraders like chitin, cellulose, and pesticide degraders.
4. To educate students on the methods for isolating, identifying, and characterizing mycotoxin-producing organisms, with a specific focus on Aflatoxin-producing organisms.
5. To provide students with a solid understanding of the principles and techniques involved in DNA amplification using Polymerase Chain Reaction (PCR).
6. To train students in performing restriction digestion of DNA using the enzyme EcoRI, and understanding its applications in genetic analysis.
7. To equip students with the knowledge and skills to cure plasmids from bacterial cells using Ethidium Bromide (EtBr), and to understand the significance of plasmid curing in genetic studies.

Course Outcomes

1. Students will be able to isolate and characterize nitrogen-fixing PGPR like Azospirillum and detect IAA and siderophore production, applying these skills in agricultural biotechnology.
2. Students will gain expertise in isolating and characterizing phosphate-solubilizing bacteria and enzymatic degraders, contributing to sustainable agriculture and environmental microbiology.
3. Students will develop advanced laboratory skills in isolating, identifying, and characterizing mycotoxin-producing organisms, with a strong focus on Aflatoxin.
4. Students will be capable of conducting critical analyses of food and culture samples for Aflatoxin, contributing to the food industry's quality control and safety protocols.
5. Students will be prepared to apply their knowledge in biotechnological and agricultural sectors, focusing on enhancing plant growth, soil health, and food safety.

6. Students will demonstrate the ability to successfully amplify DNA using PCR, including the preparation of reaction mixtures, thermal cycling, and analyzing PCR products.
7. Students will be able to accurately perform restriction digestion of DNA using EcoRI, and analyze the resulting DNA fragments using gel electrophoresis.

UNIT 1: Recombinant DNA Technology (15L)

1. Demonstrate the amplification of DNA using PCR
2. Restriction digestion of DNA using EcoRI
3. Curing of plasmid

UNIT 2: Plant Growth Promoting Rhizobacteria (15L)

4. Enrichment, Isolation and characterization of (as nitrogen fixers) *Azospirillum*
5. Detection of IAA produced by *Azospirillum*
6. Detection of siderophore produced by *Azospirillum* or *Pseudomonas* (PGPR)
7. Isolation and characterization of phosphate solublizing bacteria from rhizosphere soil

UNIT 3: Isolation and Characterization of following microbes from different ecological niches (15L)

8. Chitin degrading microbe
9. Cellulose degrading microbe
10. Pesticide degrading microbe
11. Anaerobic microbe
12. Microaerophilic microbe

UNIT 4: Isolation and Characterization of Mycotoxin producing organism (15L)

13. Isolation and Identification of Aflatoxin producing organism
14. Extraction and Detection of Aflatoxin from food /culture

Text / Reference Books:

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 and Molecular 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 Programme Outcomes (POs)

course Outcome (CO)	Program outcome (PO)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	3	2	3	3	2	2	2	2	1	3	2	1
CO2	3	3	2	3	3	2	2	2	2	1	3	2	1
CO3	3	3	2	3	3	2	2	2	2	1	3	2	1
CO4	3	3	2	3	3	2	2	2	2	1	3	2	1
CO5	3	3	3	3	3	2	2	2	2	1	3	3	2
CO6	3	3	1	3	3	2	2	2	3	2	1	2	1
CO7	3	3	1	3	3	2	2	2	3	2	1	2	1

Justification

PO1 :Comprehensive Knowledge and Understanding:
Strong for all COs (3) as understanding and applying microbiological and molecular techniques require deep knowledge.

PO2 :Practical, Professional, and Procedural:
Strong for all COs (3) as each outcome involves hands-on techniques and procedures in the laboratory.

PO3 :Entrepreneurial Mindset and Knowledge:
Moderate (2) for CO1, CO2, CO3, CO4, and CO5, reflecting the application of microbiological and biotechnological knowledge in agricultural and food industries, with CO5 having the strongest connection due to its direct application in biotech sectors.

PO4 :Specialized Skills and Competencies:
Strong (3) for all COs as each involves specialized skills in microbiology and molecular biology.

PO5: Capacity for Application, Problem-Solving:
Strong (3) for all COs due to the need for applying techniques and solving problems related to microbial and molecular analyses.

PO6: Communication Skill and Collaboration:
Moderate (2) for all COs, as effective communication and collaboration are necessary for laboratory work, but not the main focus.

PO7: Research-related Skills:
Moderate (2) for all COs, with a focus on developing skills relevant to research in microbiology and biotechnology.

PO8 :Learning How to Learn Skills)
Moderate (2) for all COs, reflecting the ongoing learning and adaptation involved in mastering lab techniques.

PO9 :Digital and Technological Skills
Moderate (2) for CO6 and CO7 due to the use of technology in PCR and restriction digestion, but less relevant for other COs.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy
Weak (1) for all COs, as the primary focus is on technical and scientific skills rather than multicultural or empathetic aspects.

PO11: Value Inculcation and Environmental Awareness:
Strong (3) for CO1, CO2, CO3, CO4, and CO5, as these outcomes relate to sustainable agriculture, food safety, and environmental impact.

PO12 Autonomy, Responsibility, and Accountability
Moderate (2) for all COs, reflecting the responsibility involved in conducting and analysing lab experiments.

PO13: Community Engagement and Service
Weak (1) for CO1, CO2, CO3, CO4, and CO5, as the focus is primarily on technical skills rather than direct community engagement. CO5 has a moderate (2) connection due to its potential impact on community health through biotechnological applications

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

Class: M. Sc. II (Semester- IV)

Paper Code: MIB-661-MJE (A)

Course type: Major elective Theory

Title of Paper: Enzymology

Credit: 2

No. of lectures: 30

Course objective:

1. Equip students with an in-depth understanding of enzyme kinetics and catalytic mechanisms.

2. Provide students with a detailed understanding of various catalytic mechanisms, such as covalent catalysis, acid-base catalysis, and metal ion catalysis, with practical examples from specific enzymes.

3. Teach students to compare and contrast different models of allosteric regulation, such as the Monod-Wyman-Changeux (MWC) and Koshland-Némethy-Filmer (KNF) models, and apply these models to predict enzyme behaviour.

4. Explore the concept of cooperative binding in multimeric enzymes, including the significance of sigmoidal kinetic behaviour and its implications for enzyme function.

5. Examine the structure and function of multifunctional enzymes and multi-enzyme complexes like fatty acid synthase and Na+/K+ ATPase, emphasizing their roles in cellular processes

6. Delve into modern concepts of catalytic evolution, including the role of catalytic RNA (ribozymes), abzymes, and the evolutionary adaptation of enzymes to new functions.

7. Use site-directed mutagenesis to create targeted changes in enzyme genes and study how these changes affect the enzyme's activity and stability

Course outcomes:

CO1: Students will be able to analyse and interpret enzyme kinetics data and allosteric regulation.

CO2: Students will describe the chemical mechanisms of enzyme catalysis, including acid-base catalysis, covalent catalysis, and the role of metal ions in enzymatic reactions.

CO3: Students will explore the principles of enzyme evolution, to understand how enzymes adapt to new functions and environments.

CO4: Students will compare and contrast different models of allosteric regulation, such as the Monod-Wyman-Changeux (MWC) model and the Koshland-Némethy-Filmer (KNF) model, and apply these models to predict enzyme behaviour.

CO5: Students will investigate the concept of cooperative binding in multimeric enzymes, including how allosteric interactions between subunits lead to sigmoidal kinetic behaviour.

CO6: Students will explore the concept of catalytic RNA, or ribozymes, including their discovery, structure, and catalytic mechanisms, as well as their role in the RNA world hypothesis and early evolution.

CO7: Students will perform site-directed mutagenesis to introduce specific changes in enzyme structure, analysing how these mutations impact enzyme function, stability, and catalytic activity.

Content:

UNIT 1: Enzyme kinetics and cooperativity (15L)

Enzyme kinetics and cooperativity

1)Factors Contributing to Catalytic Efficiency

- Proximity and Orientation
- Covalent Catalysis
- Acid-Base Catalysis
- Metal Ion Catalysis
- Strain and Distortion Theory

2) Mechanisms of Action for Specific Enzymes:

- Lysozyme
- Carboxypeptidase
- Chymotrypsin
- Ribonuclease

UNIT 2:Regulation of Enzymatic Activity, Multifunctional enzymes and Evolutionary Insights (15L)

- Binding of Ligands to Proteins:
- Cooperativity
- Hill Equation and Hill's Coefficient
- Scatchard Plot
- Sigmoidal Kinetics
- Kinetics of Multi-Substrate Enzyme-Catalysed Reactions: single displacement and double displacement mechanisms.

- Multi-Enzyme Complexes: fatty acid synthase and Na+/K+ ATPase, and their roles in cellular processes
- Modern Concepts of Catalytic Evolution: catalytic RNA (ribozymes), and abymes, and understand their evolutionary significance.
- Site-Directed Mutagenesis

References:

1. Fundamentals of Enzymology: The cell and molecular Biology of Catalytic Proteins by Nicholas C. Price, Lewis Stevens, and Lewis stevens, Oxford University Press, USA

2. Enzyme Kinetics: A modern Approach, Alejandro G. Marangoni, Wiley-Interscience

3. Enzyme Mechanism by P.K Sivaraj Kumar, RBSA Publishers

4.Lehninger, Principles of Biochemistry David L. Nelson Michael M. Cox, W.H. Freeman.

5. Biochemistry Donald Voet, Judith G. Voet Publisher: John Wiley &Sons Inc

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	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13
CO1	**3**			**3**									
CO2	**2**												
CO3						**3**		**3**			**3**		
CO4					**3**				**2**				
CO5					**3**								
CO6						**2**	**3**	**2**					
CO7		**3**		**3**	**2**				**3**			**2**	

Justification of mapping:

PO 1: Comprehensive Knowledge and Understanding

CO1: Students will be able to analyse and interpret enzyme kinetics data and allosteric regulation.

CO2: Students will describe the chemical mechanisms of enzyme catalysis, including acid-base catalysis, covalent catalysis, and the role of metal ions in enzymatic reactions.

PO 2: Practical, Professional, and Procedural Knowledge

CO7: Students will perform site-directed mutagenesis to introduce specific changes in enzyme structure, analyzing how these mutations impact enzyme function, stability, and catalytic activity.

PO 4:Research-Related Skills and Scientific Temper

CO1: Students will be able to analyze and interpret enzyme kinetics data and allosteric regulation.

CO7: Students will perform site-directed mutagenesis to introduce specific changes in enzyme structure, analyzing how these mutations impact enzyme function, stability, and catalytic activity.

PO5:Personal and Professional Competence

CO4: Students will compare and contrast different models of allosteric regulation, such as the Monod-Wyman-Changeux (MWC) model and the Koshland-Némethy-Filmer (KNF) model, and apply these models to predict enzyme behavior.

CO5: Students will investigate the concept of cooperative binding in multimeric enzymes, including how allosteric interactions between subunits lead to sigmoidal kinetic behavior.

PO 6:Self-Directed and Life-long Learning

CO3: Students will explore the principles of enzyme evolution, to understand how enzymes adapt to new functions and environments.

CO6: Students will explore the concept of catalytic RNA, or ribozymes, including their discovery, structure, and catalytic mechanisms, as well as their role in the RNA world hypothesis and early evolution.

PO7: Trans-Disciplinary Knowledge

CO6: Students will explore the concept of catalytic RNA, or ribozymes, including their discovery, structure, and catalytic mechanisms, as well as their role in the RNA world hypothesis and early evolution.

PO8: Environment and Sustainability

CO6: Students will explore the concept of catalytic RNA, or ribozymes, including their discovery, structure, and catalytic mechanisms, as well as their role in the RNA world hypothesis and early evolution.

CO3: Students will explore the principles of enzyme evolution to understand how enzymes adapt to new functions and environments.

PO9: Effective Citizenship and Ethics

CO7: Students will perform site-directed mutagenesis to introduce specific changes in enzyme structure, analysing how these mutations impact enzyme function, stability, and catalytic activity.

CO4: Students will compare and contrast different models of allosteric regulation, such as the Monod-Wyman-Changeux (MWC) model and the Koshland-Némethy-Filmer (KNF) model, and apply these models to predict enzyme behaviour.

CO2: Students will describe the chemical mechanisms of enzyme catalysis, including acid-base catalysis, covalent catalysis, and the role of metal ions in enzymatic reactions.

PO11: Value Inculcation and Environmental Awareness

CO3: Students will explore the principles of enzyme Evolution, to understand how enzymes adapt to new functions and environments

PO12: Autonomy, Responsibility, and Accountability

CO7**:** Students will perform site-directed mutagenesis to introduce specific changes in enzyme structure, analysinghow these mutations impact enzyme function, stability, and catalytic activity.

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

Class : M. Sc. II (Semester- IV)

Course Code : MIB-661-MJE (B)

Course Type : Major Elective (Theory)

Title of Course : Biostatistics

Credit : 2

No. of lectures : 30

Course objective:

1. Gain a comprehensive understanding of basic statistical concepts such as probability, hypothesis testing, estimation, sampling, and study design.

2. Learn how to summarize and describe data using measures such as mean, median, mode, variance, standard deviation, and graphical representations.

3. Master inferential methods to make predictions or inferences about a population based on sample data. This includes confidence intervals, hypothesis testing, and regression analysis.

4. Develop skills to critically evaluate and interpret statistical results in the context of biological and health sciences, considering limitations and implications.

5. Effectively communicate statistical findings to non-statistical audiences through clear and concise reporting, visualization, and interpretation of results.

6. To introduce students to fundamental statistical methods and concepts used in the analysis of biological and medical data.

7. To enable students to apply statistical techniques to real- world biological research and data analysis

Course outcome: Knowledge Acquisition:

CO1. Students should able to demonstrate a comprehensive understanding of fundamental statistical concepts and principles applicable to biological and health sciences.

CO2. Students should able to describe and explain various methods of data collection techniques used in biostatistics.

CO3. Students should able to describe and explain various methods of study designs, and sampling techniques used in biostatistics.

Data Analysis and Interpretation:

CO4. Students should able to apply appropriate statistical techniques to analyze biological and health-related data sets effectively.

CO5. Students should able to interpret statistical results, drawing meaningful conclusions and insights relevant to biological and health contexts. Critical Thinking and Problem-Solving:

CO6. Students should able to critically evaluate the validity and reliability of statistical methods used in research studies within the field of biostatistics.

CO7. Students should able to effectively communicate statistical findings to diverse audiences, including non-statistical professionals, using clear and concise language, visual aids, and appropriate documentation.

Communication and Presentation Skills:

Students should able to effectively communicate statistical findings to diverse audiences, including non-statistical professionals, using clear and concise language, visual aids, and appropriate documentation.

UNIT 1: Introductory Biostatistics (15L)

- Importance of statistics in Biology,
- Samples and Population
- Types of data, Random sampling methods and sampling errors, Scales and Variables
- Collection and organization of data, tabulation, graphical representation (Histogram, frequency polygon and ogive curves, survival curves)
- Diagrammatic representation (Simple bar diagram, percentage bar diagram, multiple bar diagram, sub-divided bar diagram and pie diagram).

UNIT 2: Descriptive Statistics (15L)

(No descriptive questions to be asked in examination; only appropriate problems should be asked in the examination.)

- Measures of central tendency – Mean (arithmetic, geometric, harmonic), median, Percentile and mode
- Measures of dispersion – Mean deviation, Standard deviation and Variance
- Measures of skewness; Measures of kurtosis;
- Regression and correlation

Text / Reference Books:

• Goon, Gupta and Dasgupta Fundamentals of statistics, World Press, Kolkata.

• Gupta S.P. Statistical methods, Sultanchand & Sons Publisher, New Delhi.

• Irfan Ali Khan and Atiya Khanum, Fundamentals of Biostatistics. 3rd Ed. Ukaaz, Publications, Hyderabad.

• Lindgren B.W. Statistical Theory, Macmillan Publishing Co. Inc.

• Wayne Daniel (2007) Biostatistics A foundation for Analysis in the health sciences, Edition 7,

• Wiley- India edition.

• Bernard Rosner Fundamentals of Biostatistics,5th Ed. Duxbury Thomson

• Norman T.J.Bailey Statistical methods in biology, 3rd Ed. Cambridge University Press

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	PO 11	PO 12	PO 13
CO 1	3					2			3		2		
CO 2	2	3				3							
CO 3	3	2		3		3	3						
CO 4	2	3	3	3	3				3				
CO 5	3	3	3	2	3								
CO 6					2	3	3	2				3	
CO 7													

Justification for the mapping:

- **PO1 (Comprehensive Knowledge and Understanding)**: CO1 provides a foundation in fundamental statistical concepts, CO2 and CO3 cover data collection and study designs, and CO4 and CO5 build on understanding to apply and interpret statistical methods effectively.
- **PO2 (Practical, Professional and Procedural)**: CO2 and CO3 involve practical aspects of data collection and study design. CO4 emphasizes the practical application of statistical techniques, while CO5 deals with the practical interpretation of results.
- **PO3 (Entrepreneurial Mindset and Knowledge)**: Although not directly covered, CO4 and CO5's focus on applying and interpreting statistical techniques can indirectly support an entrepreneurial mindset by solving real-world problems.
- **PO4 (Specialized Skills and Competencies)**: CO3, CO4, and CO5 provide specialized skills in biostatistics, including data collection, study design, and data analysis.
- **PO5 (Capacity for Application, Problem Solving)**: CO4 and CO5 focus on applying statistical methods to analyze data and solve problems. CO6 involves evaluating and solving issues related to the validity and reliability of methods.
- **PO6 (Communication Skill and Collaboration)**: CO1, CO2, CO3, and CO6 emphasize clear communication of statistical concepts, methods, and findings.
- **PO7 (Research Related Skills)**: CO3 and CO6 develop research-related skills by focusing on study design, sampling techniques, and critical evaluation of methods.

- **PO8 (Learning How to Learn Skills)**: CO6 encourages continual learning by critically evaluating statistical methods, fostering skills in ongoing improvement and adaptation.
- **PO9 (Digital and Technological Skills)**: CO1 and CO4 emphasize using statistical software and tools for analysis, supporting technological proficiency.
- **PO11 (Value Inculcation and Environmental Awareness)**: Not directly addressed by the COs.
- **PO12 (Autonomy, Responsibility, and Accountability)**: CO6 highlights responsibility in evaluating statistical methods and ensuring the validity and reliability of researc

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

Class: M. Sc. II (Semester- IV)

Course Code: MIB-662-MJE(A)

Course type: Major elective

Title of Paper: Practical course IX (A)

Credit: 2

No. of lectures: 60

Course objectives:

1. Students will learn the principles of enzyme kinetics, including the determination of kinetic constants (Km and Vmax), and will apply these principles to analyse and interpret how substrate and enzyme concentrations influence reaction rates.
2. Students will gain a comprehensive understanding of how enzymes are regulated through inhibitors and activators, and how environmental factors such as pH and temperature affect enzyme activity, stability, and efficiency.
3. Students will acquire hands-on experience in conducting experiments that measure and analyse enzyme activity, enabling them to apply experimental data to real-world biochemical problems.
4. Students will be encouraged to design and interpret experiments that explore the impact of various biochemical factors on enzyme behaviour, fostering critical thinking and problem-solving skills in enzymology
5. The course will prepare students for further research in enzymology by equipping them with a deep understanding of enzyme mechanisms, regulation, and the influence of external factors, laying a strong foundation for research-oriented careers
6. Students will critically assess how modulation of enzyme activity by environmental factors such as pH, temperature, inhibitors, and activators can influence biological systems, understanding the broader implications for physiology, biotechnology, and medicine.
7. Students will improve their ability to analyze and interpret enzyme data by combining practical results with theoretical knowledge, helping them to better understand and solve complex problems in enzyme studies.

Couse outcomes:

CO1: Students will learn the principles of enzyme kinetics, including the determination of kinetic constants (Km and Vmax), and will apply these principles to analyse and interpret how substrate and enzyme concentrations influence reaction rates.

CO2: Students will gain a comprehensive understanding of how enzymes are regulated through inhibitors and activators, and how environmental factors such as pH and temperature affect enzyme activity, stability, and efficiency.

CO3: Students will acquire hands-on experience in conducting experiments that measure and analyse enzyme activity, enabling them to apply experimental data to real-world biochemical problems.

CO4: Students will be encouraged to design and interpret experiments that explore the impact of various biochemical factors on enzyme behavior, fostering critical thinking and problem-solving skills in enzymology.

CO5: Students will critically evaluate how enzyme modulation through various factors affects biological systems, linking their experimental findings to broader physiological and biochemical implications.

CO6: Students will learn to integrate traditional enzyme kinetic analysis with modern research techniques, such as computational modeling and advanced spectroscopy, to gain a holistic understanding of enzyme function and its application in cutting-edge research.

Unit 1: Enzyme screening (12L)

1. Qualitative screening of enzyme Lipase,

2. Qualitative screening of enzyme alkaline phosphatase,

3. Qualitative screening of enzyme Invertase

Unit 2: Extraction and Enzyme Activity Studies: (24L)

4-5. Production, extraction and enzyme activity of Lipase

6-7. Production, extraction and enzyme activity alkaline phosphatase,

8-9. Production, extraction and enzyme activity Invertase

Unit 3: Enzyme Kinetics and Mechanisms (12L)

10. Determination of Kinetic Constants of Enzymes (Km,Vmax)

11. Effect of Substrate Concentration on Enzyme Activity

12. Effect of Enzyme Concentration on Enzyme Activity

UNIT 4: Enzyme Regulation and Environmental Influence (12L)

13. Effect of Inhibitors on Enzyme Activity

14. Effect of Activators on Enzyme Activity

15. Effect of pH on Enzyme Activity

References:

- "Practical Enzymology" by Hans Bisswanger
- "Enzyme Assays: A Practical Approach" by Robert Eisenthal and Michael J. Danson
- Enzymology Labfax" by David Brookes, Tim Moss, and Howard B. Gelb

- "Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry" by Irwin H. Segel
- Principles and Techniques of Biochemistry and Molecular Biology" by Keith Wilson and John Walker
- Practical Methods for Enzymology" by H. Langley and D. J. McGeary
- Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins" by Nicholas C. Price and Lewis Stevens

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	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13
CO1	**3**												
CO2	**2**					**3**	**3**				**3**		
CO3		**3**			**3**							**2**	
CO4		**3**	**3**	**3**	**3**								
CO5			**3**										
CO6				**2**		**2**	**6**						**3**
CO7													

PO1: Comprehensive Knowledge and Understanding

CO1: Students will learn the principles of enzyme kinetics, including the determination of kinetic constants (Km and Vmax), and will apply these principles to analyse and interpret how substrate and enzyme concentrations influence reaction rates.

CO2: Students will gain a comprehensive understanding of how enzymes are regulated through inhibitors and activators, and how environmental factors such as pH and temperature affect enzyme activity, stability, and efficiency.

PO2. Practical, Professional, and Procedural Knowledge

CO3**:** Students will acquire hands-on experience in conducting experiments that measure and analyze enzyme activity, enabling them to apply experimental data to real-world biochemical problems**.**

CO4: Students will be encouraged to design and interpret experiments that explore the impact of various biochemical factors on enzyme behaviour, fostering critical thinking and problem-solving skills in enzymology

PO3: Social Competence

CO5: Students will critically evaluate how enzyme modulation through various factors affects biological systems, linking their experimental findings to broader physiological and biochemical implications.

CO4: Students will be encouraged to design and interpret experiments that explore the impact of various biochemical factors on enzyme behaviour, fostering critical thinking and problem-solving skills in enzymology.

PO4: Research-Related Skills and Scientific Temper

CO6: Students will learn to integrate traditional enzyme kinetic analysis with modern research techniques, such as computational modeling and advanced spectroscopy, to gain a holistic understanding of enzyme function and its application in cutting-edge research.

CO4:Students will be encouraged to design and interpret experiments that explore the impact of various biochemical factors on enzyme behavior, fostering critical thinking and problem-solving skills in enzymology.

PO5: Personal and Professional Competence

CO3: Students will acquire hands-on experience in conducting experiments that measure and analyze enzyme activity, enabling them to apply experimental data to real-world biochemical problems.

CO4: Students will be encouraged to design and interpret experiments that explore the impact of various biochemical factors on enzyme behavior, fostering critical thinking and problem-solving skills in enzymology.

PO6: Self-Directed and Life-Long Learning

CO3: Students will acquire hands-on experience in conducting experiments that measure and analyze enzyme activity, enabling them to apply experimental data to real-world biochemical problems.

CO6: Students will learn to integrate traditional enzyme kinetic analysis with modern research techniques, such as computational modeling and advanced spectroscopy, to gain a holistic understanding of enzyme function and its application in cutting-edge research.

PO7: Trans-Disciplinary Knowledge

CO6: Students will learn to integrate traditional enzyme kinetic analysis with modern research techniques, such as computational modeling and advanced spectroscopy, to gain a holistic understanding of enzyme function and its application in cutting-edge research.

CO2: Students will gain a comprehensive understanding of how enzymes are regulated through inhibitors and activators, and how environmental factors such as pH and temperature affect enzyme activity, stability, and efficiency.

PO11: Value Inculcation and Environmental Awareness

CO2: Strong alignment, as it directly addresses how environmental factors like pH affect enzyme activity, promoting awareness of environmental influences

PO12: Autonomy, Responsibility, and Accountability

CO3: Directly supports this PO by providing hands-on experience, promoting independent work, and responsibility in conducting experiments.

PO13: Community Engagement and Service

CO6: Can indirectly support community engagement by connecting enzyme modulation to broader societal impacts in physiology, biotechnology, and medicine.

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

Class : M. Sc. II (Semester- IV)

Course Code : MIB-662-MJE (B)

Course Type : Major Elective (Practical)

Title of Course : Practical Course IX (B)

Credit : 2

No. of lectures : 60

Course objective:

1. Gain hands-on experience with statistical techniques and methods commonly used in biostatistics, including descriptive statistics, hypothesis testing, and regression analysis.

2. Learn to create and validate statistical models for different types of biological data and research questions.

3. Understand principles of data management, including data cleaning, data manipulation, and ensuring data integrity.

4. Enhance the ability to critically assess statistical analyses and methodologies used in research studies and publications.

5. Improve skills in presenting statistical findings and conclusions in a clear and effective manner, both in written reports and oral presentations.

6. Develop problem-solving skills by applying statistical concepts to real-world biostatistical problems and case studies.

7. Understand and apply ethical considerations related to data handling, analysis, and reporting.

Course outcome: Knowledge Acquisition:

CO1. Ability to effectively use statistical software packages to perform data analysis and interpret results.

CO2. Competence in applying a range of statistical methods to analyze and interpret biological and medical data.

CO3. Capability to develop, validate, and apply statistical models to address research questions and solve practical problems.

CO4. Skills in managing, cleaning, and preparing data for analysis, ensuring data quality and integrity.

CO5. Ability to critically evaluate and interpret statistical analyses in research studies, including identifying potential limitations and biases.

CO6. Proficiency in communicating statistical findings and methodologies clearly and effectively in both written and oral formats.

CO7. Enhanced problem-solving skills through practical application of statistical techniques to real-world biostatistical problems.

Contents:

Unit 1: Computer applications: Using data sheets, and sorting data with different parameters Plotting graphs (16L)

1) Bar charts
2) line graphs
3) Pie charts
4) Adding error bars H.

Unit 2: Statistical analysis of data (16L)

5-6) Students t test and z test (e.g. Microsoft Excel, Minitab)

7) F test and ANOVA

8) Chi square test

Unit 3: Graphical representation of data (16L)

9) Histogram

10) Frequency polygon and ogive curves

11) Survival curves

12) Determination of Mode and Median Graphically

Unit 4: Descriptive Statistics (12L)

13) Applying Regression Analysis- Understanding relationships between variables using appropriate computer software (e.g. Microsoft Excel, Minitab)

14) Determining Measures of central tendancy mean, median & mode using appropriate computer software (e.g. Microsoft Excel, Minitab)

15) Analysis of Data dispersion: Range, variance & standard deviation using appropriate computer software (e.g. Microsoft Excel, Minitab).

Text / Reference Books:

• Goon, Gupta and Dasgupta Fundamentals of statistics, World Press, Kolkata.

• Gupta S.P. Statistical methods, Sultanchand & Sons Publisher, New Delhi.

• Irfan Ali Khan and Atiya Khanum, Fundamentals of Biostatistics. 3rd Ed. Ukaaz, Publications, Hyderabad.

• Lindgren B.W. Statistical Theory, Macmillan Publishing Co. Inc.

• Wayne Daniel (2007) Biostatistics A foundation for Analysis in the health sciences, Edition 7,

• Wiley- India edition.

• Bernard Rosner Fundamentals of Biostatistics,5th Ed. Duxbury Thomson

• Norman T.J.Bailey Statistical methods in biology, 3rd Ed. Cambridge University Press

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO 1	2	3				3			2				
CO 2	3	3		3	3								
CO 3	3		3	2	2		2	3					
CO 4		3			3		3		3			3	
CO 5	3					2	3						
CO 6						3			3	1			
CO 7		2			3								

Justification for the mapping

PO1 (Comprehensive Knowledge and Understanding):

Most COs, such as CO1, CO2, CO3, and CO5, contribute to a deep understanding of statistical methods, data management, and model evaluation.

PO2 (Practical, Professional and Procedural):

CO1, CO2, CO4, and CO7 focus on the practical application of statistical methods and procedures.

PO3 (Entrepreneurial Mindset and Knowledge):

While not directly addressed, CO3's emphasis on innovative modeling can support entrepreneurial thinking.

PO4 (Specialized Skills and Competencies):

CO2 and CO3 provide specialized skills in biostatistics and statistical modeling.

PO5 (Capacity for Application, Problem Solving):

CO2, CO3, CO4, and CO7 emphasize applying statistical methods to solve problems.

PO6 (Communication Skill and Collaboration):

CO1, CO5, and CO6 highlight the importance of effectively communicating statistical findings.

PO7 (Research Related Skills):

CO3, CO4, and CO5 enhance research skills related to statistical analysis and evaluation.

PO8 (Learning How to Learn Skills):

CO3 encourages continual learning and adaptation in statistical modeling.

PO9 (Digital and Technological Skills):

CO1, CO4, and CO6 focus on using digital tools for data analysis and communication.

PO10 (Multicultural Competence, Inclusive Spirit, and Empathy):

Not directly addressed in the COs, but clear communication (CO6) can foster inclusive practices.

PO12 (Autonomy, Responsibility, and Accountability):

CO4 and CO5 emphasize accountability in data management and 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	**: IV**
Course Type	**: Research Project**
Course Name	**: Research Project II**
Course Code	**: MIB-681-RP**
No. of Lectures	**: 180**
No. of Credits	**: 06**

Course Objectives:

- To introduce the concepts of application and research in Microbiology
- To inculcate sense of scientific responsibilities
- To provide an understanding of the fundamental principles and concepts of research methodology.
- To develop critical thinking skills necessary for designing and conducting research studies.
- To familiarize students with different research methods and techniques used in various disciplines.
- To enable students to evaluate and critique research studies published in academic journals.
- To enhance students' skills in data collection, analysis, and interpretation.

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.

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	8	
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	 8 15 8 10	
Motivation – punctuality, meeting dead-lines and seriousness	4	
Ability to work with others	3	
Maturity of scientific thoughts	4	
Communication skill – oral and written	15	
Total	**75**	

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	30	
Quality of the work, results and interpretation, outcome of the study	15	

and possible future plans, publication potential of the work		
Submission of progress reports, the dissertation report preparation (scientific writing) and its contents	20	
Abilities of satisfactory responses to the queries from the audience	10	
Total	**75**	

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
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation Programme Outcomes (POs)

course Outcome (CO)	**Program outcome (PO)**												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2		2	3	2	3	2	2			2	
CO2	3	3		2	3		3	2	2			2	
CO3	3	2		2	3		3	2	2			2	
CO4	3	3		2	3		3	2	2			2	
CO5	3	3		2	3		3	2	2			2	
CO6	3	3		2	3	2	3	2	2			2	
CO7	3	2		2	3	3	3	2	2			2	

PO1 (Comprehensive Knowledge and Understanding): Strongly relates to all COs as it encompasses understanding the research process, evaluating literature, and applying research methods and data analysis.

PO2 (Practical, professional, and procedural): Moderately relates to CO1, CO3, and CO7, and strongly to CO2, CO4, CO5, and CO6, as it involves practical application of research designs, methods, and procedures.

PO4 (Specialized Skills and competencies): Shows moderate relation to all COs as specialized skills are necessary for developing and applying research methodologies and techniques.

PO5 (Capacity for Application, Problem-Solving): Strongly related to all COs because each CO involves problem-solving, whether in designing research, analyzing data, or presenting findings.

PO6 (Communication Skill and Collaboration): Moderately related to CO1 through CO6, with a stronger link to CO7 due to the emphasis on effectively communicating research findings.

PO7 (Research-related Skills): Strongly related to all COs since the COs are focused on various aspects of the research process, from formulation to communication.

PO8 (Learning How to Learn Skills): Moderately related as it involves learning and applying new research skills and methods, though not directly targeted by specific COs.

PO9 (Digital and Technological Skills): Moderately related as digital tools and technologies play a role in data collection and analysis, though not the primary focus of all COs.

PO12 (Autonomy, Responsibility, and Accountability): Moderately related as these attributes are important for conducting research responsibly but not always explicitly covered in the COs.

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

Name of the Programme	**: M.Sc. Microbiology**
Program Code	**: PSMI**
Class	**: M.Sc. II**
Semester	**: III**
Course Type	**: Skill development**
Course Name	**: Skill development I**
Course Code	**: MIB-631-SDC**
No. of Lectures	**: 30**
No. of Credits	**: 02**

Course Objective:

1. Understand the basic principles of UV-Visible spectroscopy, including the electromagnetic spectrum, molecular transitions, and the Beer-Lambert Law.
2. Familiarize students with the components of UV-Visible spectrophotometers, their functions, and the operational procedures.
3. Gain practical skills in setting up, calibrating, and operating UV-Visible spectrophotometers.
4. Learn techniques for quantitative analysis using UV-Visible spectroscopy, including the construction of calibration curves and determination of unknown concentrations.
5. Explore various applications of UV-Visible spectroscopy in chemistry, such as analyzing concentration, determining reaction kinetics, and identifying chemical species.
6. Develop the ability to interpret UV-Visible spectra and correlate spectral features with molecular structures and electronic transitions.
7. Understand the components of an AAS instrument, such as the light source, monochromator, and detector, and the role each plays in the analysis process.
8. Learn sample preparation techniques suitable for AAS, and gain proficiency in introducing samples into the AAS instrument.
9. Develop skills in quantitative analysis using AAS, including calibration procedures, standard addition methods, and the determination of elemental concentrations in samples.

Course Outcome:

CO1. Understand the Principles: Students will be able to explain the fundamental principles of UV-Visible spectroscopy, including the interaction of electromagnetic radiation with matter, molecular transitions, and the BeerLambert Law.
CO2. Gain proficiency in operating UV-Visible spectrophotometers, understanding the components, and calibrating the instrument for accurate measurements.
CO3. Develop the ability to perform quantitative analysis using UV-Visible spectroscopy, including the determination of concentration and molar absorptivity.
CO4. Interpret UV-Visible spectra to identify functional groups, electronic transitions, and chemical properties of various compounds.
CO5. Acquire skills in developing experimental methods for specific applications using UV-Visible spectroscopy, such as kinetics studies, reaction monitoring, and quality control.
CO6. Learn to troubleshoot common issues associated with UV-Visible spectrophotometers and understand routine maintenance procedures to ensure reliable and accurate results.
CO7. Understand the fundamental principles of Atomic Absorption Spectroscopy, including the theory of atomic absorption, energy levels, and the role of hollow cathode lamps.

A. UV-Visible spectroscopy- Principle, Instrumentation.
FTIR and its advantages,
Principle, Instrumentation, Absorption band
B. Atomic Absorption Spectroscopy (AAS) and its advantages, Hands-on training

Text / Reference Books:

• Wilson Keith and Walker John (2005) Principles and Techniques of Biochemistry and Molecular Biology, 6th Ed. Cambridge University Press, New York.
• Pattabhi, V. and Gautham, N. (2002) Biophysics. Kluwer Academic Publishers, New York and Narosa Publishing House, Delhi.
• Rolf Ekman, Jerzy Silberring, Ann Westman- Brinkmalm, Agnieszka Kraj (2009) Mass spectrometry : instrumentation, interpretation, and applications, John Wiley & Sons, Inc.,Canada.

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 Outcome (CO)	**Program outcome (PO)**												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2		2	3	2	3	2	2			2	
CO2	3	3		2	2	2	3	2	2			2	
CO3	3	3		2	3	2	3	2	2			2	
CO4	3	2		2	3	2	3	2	2			2	
CO5	3	3		2	2	2	3	2	2			2	
CO6	3	3		2	2	2	3	2	2			2	
CO7	3	2		2		2	3	2	2			2	

Justification:

PO1 (Comprehensive Knowledge and Understanding): Strongly related to all COs as each outcome involves understanding fundamental principles and theories related to UV-Visible and Atomic Absorption Spectroscopy.

PO2 (Practical, Professional, and Procedural): Moderately related to CO1, CO4, CO7, and strongly related to CO2, CO3, CO5, and CO6, as these outcomes involve hands-on skills in operating equipment, performing analyses, and troubleshooting.

PO4 (Specialized Skills and Competencies): Moderately related to all COs since each CO involves specific technical skills and competencies related to spectroscopy.

PO5 (Capacity for Application, Problem-Solving): Strongly related to CO1, CO3, and CO4, and moderately to CO2, CO5, and CO6. It involves applying knowledge to solve practical problems, such as analyzing spectra and developing experimental methods.

PO6 (Communication Skill and Collaboration): Moderately related as students need to communicate their findings and work with instruments, but less emphasis on collaboration is specified in the COs.

PO7 (Research-related Skills): Strongly related as COs involve understanding, applying, and interpreting spectroscopic techniques and principles, which are fundamental research skills.

PO8 (Learning How to Learn Skills): Moderately related as students are required to understand and apply complex concepts and methods, which promotes continuous learning.

PO9 (Digital and Technological Skills): Moderately related since operating and troubleshooting spectroscopic instruments involves digital and technological skills.

PO12 (Autonomy, Responsibility, and Accountability): Moderately related as students are expected to perform and troubleshoot experiments independently and responsibly.

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

Name of the Programme	**: M.Sc. Microbiology**
Program Code	**: PSMI**
Class	**: M.Sc. II**
Semester	**: IV**
Course Type	**: Skill development**
Course Name	**: Skill development II**
Course Code	**: MIB-691-SDC**
No. of Lectures	**: 30**
No. of Credits	**: 02**

Course Objectives:

1. To inculcate sense of scientific responsibilities and social and environment awareness
2. To help student's build-up a progressive and successful career
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 allow students to understand about various separation and analytical techniques.

Course Outcome:

CO1. Understanding of the importance of calibration and the ability to calibrate instruments Accurately.

CO2. Ability to evaluate the accuracy, precision, and reliability of measurement systems.

CO3. Familiarity with the ethical and safety considerations associated with instrumentation practices.

CO4. Awareness of the latest advancements and emerging trends in instrumentation technology.

CO5. The student should be able to apply the knowledge regarding various separation techniques while purifying a biomolecule.

CO6. The student should be able to apply the knowledge regarding various analytical techniques while analysing purified biomolecule.
CO7. The student should be able to apply the knowledge regarding various purification techniques while purifying biomolecule.

Unit 1: High Performance Liquid Chromatography (HPLC) (15L)

Fundamentals and Principles of High Performance Liquid Chromatography (HPLC), Instrumentation, Types of HPLC–Normal phase HPLC, Reverse Phase HPLC, Ion Exchange

Chromatography (IEC), Size exclusion chromatography, Mobile phases, Sample preparation, Hands on training

Unit 2: Gas Chromatography (GC) (15L)

Fundamentals and Principles of Gas Chromatography (GC), Instrumentation, Sample preparation, Mobile phases, Injectors, GC columns, GC detectors, Hands-on training

Text / Reference Books:

1. Nelson D. L. and Cox M. M. (2005) Lehninger's Principles of Biochemistry, Fourth

2. edition, W. H. Freeman & Co. New York

3. Wilson Keith and Walker John (2005) Principles and Techniques of Biochemistry and

4. Molecular Biology, 6th Ed. Cambridge University Press, New York.

5. Palmer Trevor (2001) Enzymes: Biochemistry, Biotechnology and Clinical chemistry,

6. Horwood Pub. Co. Chinchester, England.

7. 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 Programme Outcomes (POs)

course Outcome (CO)	**Program outcome (PO)**												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	3		2	3	2	2	2	3		2	2	
CO2	3	3		2	3	2	2	2	3		2	2	
CO3	3	2		2	2	3	2	2	2	2	3	2	
CO4	3	2	2	3	2	2	2	2	2		2	2	
CO5	2	3		2	3	2	2	2	2		2	2	
CO6	2	3		2	3	2	2	2	2		2	2	
CO7	2	3		2	3	2	2	2	2		2	2	

Justification:
PO1 (Comprehensive Knowledge and Understanding): Strongly related to CO1, CO2, and CO3 as these outcomes involve understanding calibration, accuracy, and ethical considerations. CO4 also ties into understanding advancements. CO5, CO6, and CO7 involve applying knowledge, which is indirectly related but not as directly focused on understanding.

PO2 (Practical, Professional, and Procedural): Strongly related to CO1, CO2, CO5, CO6, and CO7 as these COs involve practical skills like calibration, evaluating measurement systems, and applying techniques. CO3 and CO4 have moderate relevance as they involve procedural and professional aspects.

PO3 (Entrepreneurial Mindset and Knowledge): Less directly related, with CO4 showing some relevance as it involves awareness of advancements and trends that might be valuable in an entrepreneurial context.

PO4 (Specialized Skills and Competencies): Moderately related to CO1, CO2, and CO3 as these COs involve specialized skills in calibration, accuracy, and safety. Stronger relation with CO4 due to focus on advanced technology, and moderate for CO5, CO6, and CO7 involving specific techniques.

PO5 (Capacity for Application, Problem-Solving): Strongly related to CO1, CO2, CO5, CO6, and CO7 as they involve applying and solving problems related to calibration, accuracy, and techniques. CO3 and CO4 have moderate relevance.

PO6 (Communication Skill and Collaboration): Moderately related to CO3 due to communication about safety and ethics. Other COs have less direct emphasis on communication or collaboration skills.

PO7 (Research-related Skills): Moderately related across the board as the COs involve applying various techniques and understanding instrumentation, which are essential for research.

PO8 (Learning How to Learn Skills): Moderately related to all COs as they involve learning and applying new knowledge and techniques, promoting continuous learning.

PO9 (Digital and Technological Skills): Strongly related to CO1, CO2, and CO4 due to the focus on calibration, measurement systems, and advancements in technology. Moderate relation to CO5, CO6, and CO7 as they involve analytical and purification techniques.

PO10 (Multicultural Competence, Inclusive Spirit, and Empathy): Less directly related, with some relevance to CO3 due to ethical considerations but generally not a focus in the course outcomes.

PO11 (Value Inculcation and Environmental Awareness): Moderately related to CO3 due to safety and ethical considerations. CO4 has some relevance regarding awareness of technological impacts, but overall less central.

PO12 (Autonomy, Responsibility, and Accountability): Moderately related as students must take responsibility for calibration, measurement accuracy, and application of techniques.

PO13 (Community Engagement and Service): Less relevant as the course focuses on technical skills rather than community or service aspects.