Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science andCommerce, Baramati

(Autonomous)

Four Year B. Sc. Degree Program in Microbiology

(Faculty of Science and Technology)

Choice-Based Credit System Syllabus

(2023 Pattern) (As Per NEP 2020)

S. Y. B. Sc. Microbiology

Semester III

To be implemented from Academic Year 2023-2024

Title of the Programme: S.Y.B.Sc. (Microbiology)

Preamble

Anekant Education Society's Tuljaram Chaturchand College has decided to change 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, Dist.- Pune has prepared the syllabus of F. Y. B. Sc. Microbiology Semester - I as per 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.

Microbiology is a branch of science that studies "Life" taking an example of microorganisms such as bacteria, protozoa, algae, fungi, viruses, etc. These studies integrate cytology, physiology, ecology, genetics and molecular biology, evolution, taxonomy and systematics with a focus on microorganisms; in particular bacteria. The relevance and applications of these microorganisms to the surrounding environment including human life and Mother Nature becomes part of this branch. Since inception of this branch of science, Microbiology has remained a field of actively research and ever expanding in all possible directions; broadly categorized as pure and applied science. Different branches of Pure Microbiology based on taxonomy are Bacteriology, Mycology, Protozoology and Parasitology, Phycology and Virology; with considerable overlap between these specific branches over each other and also with other disciplines of life sciences, like Biochemistry, Botany, Zoology, Cell Biology, Biotechnology, Nanotechnology, Bioinformatics, etc. Areas in the applied Microbial Sciences can be identified as: Medical, Pharmaceutical, Industrial

(Fermentation, Pollution Control), Air, Water, Food and Dairy, Agriculture (Plant Pathology and Soil Microbiology), Veterinary, Environmental (Ecology, Geomicrobiology); and the technological aspects of these areas. Knowledge of different aspects of Microbiology has become crucial and indispensable to everyone in the society. Study of microbes has become an integral part of education and human progress. Building a foundation and a sound knowledge- base of Microbiological principles among the future citizens of the country will lead to an educated, intellectual and scientifically advanced society. Microbiological tools have been extensively used to study different life processes and are cutting edge technologies. There is a continual demand for microbiologists in the work force – education, industry and research. Career opportunities for the graduate students are available in manufacturing industry and research institutes at technical level.

Programme Specific Outcomes (PSOs)

PSO1 **Comprehensive Knowledge and Understanding**: Graduates will possess a profound understanding of their field of study, including foundational theories, principles, methodologies, and key concepts, within a broader multidisciplinary context.

PSO2 **Practical, Professional, and Procedural Knowledge**: Graduates will acquire practical skills and expertise essential for professional tasks within their field. This includes knowledge of industry standards, best practices, regulations, and ethical considerations, with the ability to apply this knowledge effectively in real-world scenarios.

PSO3 **Entrepreneurial Mindset and Knowledge**: Graduates will cultivate an entrepreneurial mindset, identifying opportunities, fostering innovation, and understanding business principles, market dynamics, and risk management strategies.

PSO4 **Specialized Skills and Competencies**: Graduates will demonstrate proficiency in technical skills, analytical abilities, problem-solving, effective communication, and leadership, relevant to their field of study. They will also adapt and innovate in response to changing circumstances.

PSO5 **Capacity for Application, Problem-Solving, and Analytical Reasoning**: Graduates will possess the capacity to apply learned concepts in practical settings, solve complex problems, and analyze data effectively. This requires critical thinking, creativity, adaptability, and a readiness to learn and take calculated risks.

PSO6 **Communication Skills and Collaboration**: Graduates will effectively communicate complex information, both orally and in writing, using appropriate media and language. They will also collaborate effectively in diverse teams, demonstrating leadership qualities and facilitating cooperative efforts toward common goals.

PSO7 **Research-related Skills**: Graduates will demonstrate observational and inquiry skills, formulate research questions, and utilize appropriate methodologies for data collection and analysis. They will also adhere to research ethics and effectively report research findings.

PSO8 **Learning How to Learn Skills**: Graduates will acquire new knowledge and skills through self-directed learning, adapt to changing demands, and set and achieve goals independently.

PSO9 **Digital and Technological Skills**: Graduates will demonstrate proficiency in using ICT, accessing information sources, and analyzing data using appropriate software.

PSO10 **Multicultural Competence, Inclusive Spirit, and Empathy**: Graduates will engage effectively in multicultural settings, respecting diverse perspectives, leading diverse teams, and demonstrating empathy and understanding of others' perspectives and emotions.

PSO11 **Value Inculcation and Environmental Awareness**: Graduates will embrace ethical and moral values, practice responsible citizenship, recognize and address ethical issues, and take appropriate actions to promote sustainability and environmental conservation.

PSO12 **Autonomy, Responsibility, and Accountability**: Graduates will apply knowledge and skills independently, manage projects effectively, and demonstrate responsibility and accountability in work and learning contexts.

PSO13 **Community Engagement and Service**: Graduates will actively participate in community-engaged services and activities, promoting societal well-being.

Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science andCommerce, Baramati
(Autonomous)

Board of Studies (BoS) in Microbiology

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	Ms P. C. Bhosale	Member
7	Prof. Dr. Snehal Kulkarni	Expert from SPPU, Pune
8.	Prof. Dr. T. A. Kadam	Expert from other University
9.	Prof. Dr. A. V. Pethkar	Expert from other University
10.	Mr. Pradip Lonkar	Industry Expert
11	Ms Chaitrali Pathak	Meritorious Alumni
12.	Ms Sonali Sawant	Student Representative

Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati (Autonomous)

Course Structure for S.Y.B.Sc. 2023-2024 (Microbiology) (2023 Pattern)

Sem	Course Type	Course Code	Course Name	Theory/ Practical	Credits	Marks (I + E)
III	Major Mandatory	MIB-201-MJM	Bacterial Systematics	Theory	02	20+30
	Major Mandatory	MIB-202-MJM	Soil Microbiology	Theory	02	20+30
	Major Mandatory	MIB-203-MJM	Air Microbiology	Theory	02	20+30
	Major Mandatory	MIB-204- MJM	Practicals on Bacterial Systematics, Soil Microbiology, Air Microbiology	Practical	02	25+25
	Minor	MIB-241- MN	Basic Microbiology	Theory	02	20+30
	Minor	MIB-242- MN	Basic Microbiological Techniques	Practical	02	25+25
	Open Elective (OE)	MIB-216-OE	Scope & History of Microbiology	Theory	02	20+30
	Vocational Skill Course (VSC)	MIB-221-VSC	Dairy Microbiology	Theory	02	20+30
	Ability Enhancement Course (AEC)	MAR-231-AEC HIN-231-AEC SAN-231-AEC	भाषिक उपयोजन व लेखन कौशल्य हिंदी भाषा कौशल प्राथमिक संभाषण कौशल्यम्	Theory	02	20+30
	Field Project (FP)	MIB-235-FP	Field Project	Practical	02	25+25
	Co-curricular Course (CC)	YOG/PES/CUL/NSS/NCC-239-CC	NSS/NCC/Yoga/Cultural activities/Sports	Theory	02	20+30
	Generic IKS Course	GEN-245-IKS	Indian Knowledge System (Generic)	Theory	02	20+30
	Total Credits Semester-III				24	
IV	Major Mandatory	MIB-251-MJM	Bacterial Physiology	Theory	02	20+30
	Major Mandatory	MIB-252-MJM	Industrial Microbiology	Theory	02	20+30
	Major Mandatory	MIB-253-MJM	Water Microbiology	Theory	02	20+30
	Major Mandatory	MIB-254-MJM	Practical Based on Bacterial Physiology, Industrial Microbiology, Water Microbiology	Practical	02	25+25
	Minor	MIB-261-MN	Essentials of Microbiology	Theory	02	20+30
	Minor	MIB-262-MN	Microbiology laboratory essentials	Practical	02	25+25
	Open Elective (OE)	MIB-266-OE	Practicals on Scope & History of Microbiology	Practical	02	25+25
	Skill Enhancement Course (SEC)	MIB-276-SEC	Practicals on Dairy Microbiology	Practical	02	25+25
	Ability Enhancement Course (AEC)	MAR-281-AEC HIN-281-AEC SAN-281-AEC	लेखन निर्मिती व परिक्षण कौशल्ये हिंदी भाषा □संप्रेषण कौशल प्रगत संभाषण कौशल्यम्	Theory	02	20+30
	Community Engagement Project (CEP)	MIB-285-CEP	Community Engagement Project	Practical	02	25+25
	Co-curricular Course (CC)	YOG/ PES/ CUL/NSS/ NCC-289-CC	NSS/NCC/Yoga/Cultural activities/Sports	Theory	02	20+30
	Total Credits Semester-IV				22	

	Cumulative Credits Semester III + Semester IV	**46**	

Name of the Programme : **B.Sc Microbiology**
Programme Code : **USMI**
Class : **S.Y.B.Sc.**
Semester : **III**
Course Type : **Major Mandatory (Theory)**
Course Code : **MIB-201- MJM**
Course Title : **Bacterial Systematics**
No. of Credits : **02**
No. of Teaching Hours : **30**

Course Objectives:

1. To understand the fundamental principles underlying bacterial taxonomy and classification.
2. To comprehend the concept of species, taxa, and strain within bacterial classification systems.
3. To familiarize students with the structure and organization of Bergey's Manual of Systematic Bacteriology as a primary reference for bacterial classification.
4. To explore the general characteristics and classification of various bacterial groups including Fungi, Eubacteria, Archaebacteria, Mycoplasma, and Rickettsia.
5. To introduce students to chemotaxonomy as a method for classifying bacteria based on chemical composition.
6. To provide an overview of numerical taxonomy techniques used in bacterial systematics for quantitative analysis and classification.
7. To examine the genetic basis of bacterial taxonomy, focusing on G + C content, DNA hybridization, and base sequence similarity using the 16s rRNA databank.

Course Outcomes:

CO1 Students will be able to apply principles of bacterial taxonomy and classification to classify various bacterial species accurately.
CO2 Students will demonstrate a clear understanding of the distinctions between species, taxa, and strains within bacterial classification systems.
CO3 Students will be proficient in navigating Bergey's Manual of Systematic Bacteriology for reference and classification purposes.
CO4 Students will be able to identify and differentiate between different groups of bacteria, including Fungi, Eubacteria, Archaebacteria, Mycoplasma, and Rickettsia.
CO5 Students will develop the skills to utilize chemotaxonomy methods effectively in bacterial classification based on chemical composition.
CO6 Students will be able to apply numerical taxonomy techniques to quantitatively analyze and classify bacterial populations.
CO7 Students will gain competence in analyzing the genetic basis of bacterial taxonomy, including G + C content, DNA hybridization, and base sequence similarity using the 16s rRNA databank.

Credit		Learning & Teaching Points	Teaching Hours
I	**Unit 1**	**Principles of Bacterial Systematics**	**15**
		1. Introduction to bacterial taxonomy	1
		2. Classification and Linnaean System	2
		3. Natural System of Classification,	1
		4. Haeckel's three kingdom of classification	2
		5. Whittaker's five kingdom classification	3
		6. Three domain concept of Carl Woese.	2
		7. Outlines of bacterial classification as per Bergey's manual of systematic bacteriology	2
		8. Concept of species, taxa, strain	2
II	**Unit 1**	**Chemotaxonomy & Numerical taxonomy**	**6**
		1. Chemotaxonomy : Cell wall composition, Lipid composition, Fatty acid composition, Cytochrome, Isoprenoid quinones, Protein profile, Amino acid sequences.	4
		2. Numerical taxonomy	2
	Unit 2	**Genetic basis of taxonomy**	**9**
		1. G + C content	3
		2. DNA hybridization	3
		3. Gene sequence similarity 16 S rRNA sequencing	3
Total			**30**

References :

1. Bergey D. H. & Holt J. G. (1994) Bergey's Manual of Determinative Bacteriology. 9th Edition. Lippincott Williams & Wilkins. (Unit I)
2. Garrity G. M. (2005) Bergey's Manual of Systematic Bacteriology. 2nd Edition. (Vols. 1 – 4). Williams & Wilkins. (Unit I)
3. Madigan M. T., Martinko J. M. (2006) Brock's Biology of Microorganisms. 11thEdition. Pearson Education Inc. (Unit I, II& III)
4. Prescott L. M., Harley J. P. and Klein D. A. (2005) Microbiology, 6th Edition. MacGraw Hill Companies Inc.(Unit II)
5. Priest F. G. & Brian Austin. (1993) Modern Bacterial Taxonomy. Edn 2, Springer. (Unit I)

Mapping of course outcomes and programme outcomes:

Class : SYBSc (Sem III) **Subject : Microbiology**
Course : Bacterial Systematics **Course code : MIB-201-MJM**

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

Course outcomes (COs)	Programme Outcomes (POs)												
	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	1	3											
CO3	3							3				3	
CO4	3										3		
CO5	2			2	3								
CO6	1			3	3	3							
CO7	3			3	2		3		3				
CO8	1												

Justification for the mapping

PO1 Comprehensive Knowledge and Understanding
All COs aims to equip students with a deep understanding of bacterial taxonomy and classification principles.

PO2 Practical, Professional, and Procedural Knowledge
CO2 is focuses on distinguishing between species, taxa, and strains within bacterial classification systems, which is essential practical knowledge in microbiology.

PO4 Specialized Skills and Competencies
CO5, CO6, and CO7 contribute to developing skills in chemotaxonomy, numerical taxonomy, and genetic analysis, which are highly specialized competencies in microbiology.

PO5 Capacity for Application, Problem-Solving, and Analytical Reasoning
CO5, CO6, and CO7 emphasizing the application of taxonomy techniques, problem-solving in bacterial classification, and analytical reasoning based on genetic data.

PO6 Communication Skills and Collaboration
CO6 likely involves collaboration as numerical taxonomy often requires teamwork and communication skills to analyze data effectively.

PO7 Research-related Skills
CO7 it focuses on analyzing the genetic basis of bacterial taxonomy, which is a fundamental aspect of research in microbiology.

PO8 Learning How to Learn Skills
CO3 encourages students to navigate Bergey's Manual effectively, which enhances their ability to learn independently.

PO9 Digital and Technological Skills
CO7 involves utilizing databases and bioinformatics tools for genetic analysis,

contributing to the development of digital and technological skills in students.

PO11 Value Inculcation and Environmental Awareness

Understanding microbial diversity (CO1) and the ecological roles of different bacterial groups (CO4) could contribute to environmental awareness and the importance of microbial ecosystems,

PO12 Autonomy, Responsibility, and Accountability

CO3, in particular, requires students to take responsibility for navigating complex reference materials like Bergey's Manual, thereby fostering autonomy and accountability in their learning process.

Name of the Programme	**: B.Sc Microbiology**
Programme Code	**: USMI**
Class	**: S.Y.B.Sc.**
Semester	**: III**
Course Type	**: Major Mandatory (Theory)**
Course Code	**: MIB-202- MJM**
Course Title	**: Soil Microbiology**
No. of Credits	**: 02**
No. of Teaching Hours	**: 30**

Course Objectives:

1. Understand the composition and diversity of soil microbial communities.
2. Analyze the ecological roles and functions of soil microorganisms in nutrient cycling and organic matter decomposition.
3. Investigate the interactions between soil microbes and plants.
4. Students accomplished in there knowledge about environmental factors on soil microbial activity and community structure
5. Students will be able to explain the importance of microbial biomass and activity in soil ecosystems and their implications for soil health and fertility.
6. Apply critical thinking skills in analyzing and interpreting soil microbiology data.
7. Demonstrate ethical conduct and professional responsibility in soil microbiology research.

Course Outcomes:

CO1 Students will acquire a comprehensive understanding of the fundamentals of soil microbiology and its relevance in environmental systems

CO2 Students will comprehend the ecological functions of soil microorganisms and their interactions with the surrounding environment.

CO3 Students will analyze the diverse roles of microorganisms in soil ecosystems, including their contributions to nutrient cycling and organic matter decomposition.

CO4 Students will demonstrate proficiency in identifying and classifying different types of microbial interactions in soil environments.

CO5 Students will evaluate the influence of environmental factors on soil microbial communities and their impact on ecosystem dynamics.

CO6 Students will understand the significance of mycorrhizal associations in plant nutrition and ecosystem sustainability.

CO7 Students will assess the role of microorganisms in composting, humus formation, and organic matter decomposition processes in soil.

Credit		Topic & Learning Points	Teaching Hours
I	**Unit 1**	**Introduction to Soil Microbiology**	**15**
		1. Soil microorganisms, composition and types of soil.	3
		2. Rhizosphere microflora and its role in the rhizosphere.	3
		3. Role of microorganisms in composting and humus formation.	2
		4. Role of microorganisms in degradation of cellulose, hemicelluloses, lignin and pectin.	4
		5. Microbial biomass and activity in soil ecosystems.	3
II	**Unit 1**	**Ecological Functions of Soil Microorganisms**	**8**
		1. Influence of environmental factors on soil microbial communities.	3
		2. Mycorrhizal associations and their significance in plant nutrition.	2
		3. Types of microorganisms in soil and its role.	3
	Unit 2	**Microbial Interactions.**	**7**
		1. Different Types of Microbial interactions- Symbiosis,Neutralism,Commensalism,Competition,Ammensalism,Synergism, Parasitism, and Predation	4
		2. Role of microorganisms in following elemental cycles in nature i. Carbon ii. Nitrogen iii. Sulphur.	3
Total			**30**

References:

1. Sylvia, D. M., Fuhrmann, J. J., Hartel, P. G., & Zuberer, D. A. (2015). Principles and Applications of Soil Microbiology (Third Edition). Pearson.
2. Paul, E. A. (2014). Soil Microbiology, Ecology and Biochemistry (Fourth Edition). Academic Press.
3. Lynch, J. M., & Bragg, E. (2015). Microorganisms in Soils: Roles in Genesis and Functions (3rd Edition). CRC Press.
4. van Elsas, J. D., Trevors, J. T., & Wellington, E. M. H. (2012). Modern Soil Microbiology (2nd Edition). CRC Press.
5. Ingraham J. L. And Ingraham C.A. (2004) Introduction to Microbiology. 3nd Edition. Thomson Brooks / Cole.
6. Martin A. Introduction to Soil Microbiology (1961) John Wiley& Sons, New York and London publication
7. SubbaRao N. S. (1977) Soil Microbiology, 4th Ed., Oxford & IBH Publishing

Co. Pvt. Ltd.
8. Dubey R.C., and Maheswari, D.K. Textbook of Microbiology, S. Chand & Co.
9. Mexander M. (1977) Introduction to soil microbiology, John Wilery NY.
10. Rangaswami G. (1979) Recent advances in biological nitrogen fixation. Oxford and IBH. New Delhi

Mapping of Program Outcomes with Course Outcomes

Class : S.Y.B.Sc (Sem III) **Subject: Microbiology**
Course : Soil microbiology **Course Code : MIB-202-MJM**
Weightage:1=weak or low relation,2=moderate or partial relation,3=strong or direct relation

	Programme Outcomes (POs)												
Course outcomes (COs)	**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			2	1		2	3			2	2	
CO2	2			3	2		3	2			2	3	
CO3	3			2	3		3	2			3	2	
CO4	3	3		2	2	2	2	2			3	3	
CO5	2			3	3	3	3	3			2	2	
CO6	3			2	2		2	3			2	3	
CO7	3			3	2		2	3			2	3	

Justification for the mapping

PO1 Comprehensive knowledge and Understanding:
All CO1 to CO7are directly related to acquiring comprehensive knowledge and understanding of soil microbiology and its environmental relevance.

PO2 Practical, Professional, and Procedural Knowledge:
CO4 directly involves demonstrating proficiency,

PO4 Specialized Skills and Competencies:
CO4 directly addresses specialized skills in identifying and classifying microbial interactions, while other CO1,CO2,CO3 ,CO5,CO6andCO7contribute to specialized knowledge in soil microbiology.

PO5 Capacity for Application, Problem-Solving, and Analytical Reasoning:
All COs emphasize analyzing, evaluating, and understanding the roles and impacts of soil microorganisms

PO6 Communication Skills and Collaboration:
CO7 directly involves assessment and potentially collaborative work.

PO7 Research-related Skills:
All COs involve analyzing, evaluating, and understanding soil microbiology concepts, which are fundamental to research-related skills.

PO8 Learning How to Learn Skills:
All COs provide a foundation for continuous learning and adaptation in the field of soil microbiology..

PO11 Value Inculcation and Environmental Awareness:
All COs directly involve understanding the environmental relevance of soil microbiology.

PO12 PO12: Autonomy, Responsibility, and Accountability:
All COs involve analyzing, evaluating, and understanding soil microbiology concepts, which promote autonomy, responsibility, and accountability in learning and research.

Name of the Programme : B.Sc Microbiology
Program Code : USMI
Class : S.Y.B.Sc
Semester : III
Course Type : Major Mandotary (Theory)
Course Title : Air Microbiology
Course Code : MIB-203-MJM
No. of Credits : 02
No. of Teaching Hours : 30

Course objective:

1. To introduce students transient nature of air flora, distinguishing between bacteria, fungi, viruses, and other microorganisms present in the air.
2. To teach students significance of studying microorganisms in the air, emphasizing their roles in human health, environmental processes.
3. To enhance students understanding of natural and anthropogenic sources of airborne microorganisms and to study the factors influencing their emission and dispersion in the atmosphere.
4. To enrich students knowledge in Identifying common chemical pollutants in the air, their sources, and the effects on human health, emphasizing the relationship between air quality and microbial presence.
5. To develop students skills in different air sampling methods , learn to identify and classify the airborne pathogens.
6. To make students to understands different physical and chemical methods for air sanitation, focusing on their application in controlling and preventing the spread of airborne microorganisms
7. To make students knowledgeable about latest developments in the field of air microbiology, including technological advancements, research trends, and innovative approaches

Course Outcomes :-

CO1. Students will be able to identify and categorize different types of airborne microorganisms, understanding their unique characteristics and ecological roles.
CO 2. Students will comprehend the importance of airborne microorganisms in influencing human health, ecological balance, and various environmental processes.
CO 3. Students will be capable of identifying natural and human-induced sources of airborne microorganisms and analyzing the environmental factors affecting their dispersion.
CO 4. Students will demonstrate the ability to recognize and assess common chemical pollutants in the air, understanding their impact on both air quality and microbial communities.
CO 5. Students will acquire proficiency in various air sampling techniques, demonstrating the capability to identify and classify airborne pathogens using appropriate methods..
CO 6. Students will be able to evaluate and apply physical and chemical methods for air sanitation, demonstrating knowledge of their effectiveness in controlling airborne microorganisms.
CO 7. Students will stay informed about the latest developments in air microbiology, showcasing an understanding of technological advancements, current research trends, and innovative approaches in the field.

Credit		Topic & Learning Points	Teaching Hours
I	**Unit 1**	**Introduction to Air Microbiology**	**15**
		1. Defination and scope of air microbiology	2
		2. Air flora : Transient nature of air flora	1
		3. Sources and emission of airbone microorganisms present in air	2
		4. Droplet, droplet nuclei, and aerosols	1
		5. Factors affecting microbial survival in air	1
		6. Air pollution: Chemical pollutants, their sources in air and effects on human health.	4
		7. Air sanitation: Physical and chemical methods	4
II	**Unit 1**	**Methods of Air sampling and types of air samplers**	**8**
		1. Impaction on solids	2
		2. Impingement in liquid	2
		3. Sedimentation	1
		4. Centrifugation	1
		5. Electrostatic Precipitation.	2
	Unit 2	**Health implication of Airborne Microorganisms**	**7**
		1. Types of airborne pathogens	1
		2. Airborne infections	2
		3. Control and prevention measures for airborne infections	2
		4. Emerging trends in Air Microbiology	2
Total			**30**

References:

1. Salle, A. J. (1948). Fundamental Principles of Bacteriology.
2. Madigan, M. T., Martinko, J. M., Bender, K. S., Buckley, D. H., & Stahl, D. A. (2014). Brock Biology of Microorganisms (14th ed.). Pearson.
3. Prescott, L. M., Harley, J. P., & Klein, D. A. (2008). Microbiology (7th ed.). McGraw-Hill Education.
4. Tortora, G. J., Funke, B. R., & Case, C. L. (2013). Microbiology: An Introduction (11th ed.). Pearson.
5. Atlas, R. M. (2010). Handbook of Microbiological Media (4th ed.). CRC Press.
6. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2010). Microbiology: Concepts and Applications (8th ed.). McGraw-Hill Education.
7. Singleton, P., Sainsbury, D., & Greenwood, D. (2002). Dictionary of Microbiology and Molecular Biology (3rd ed.). Wiley-Blackwell.
8. Murray, P. R., Rosenthal, K. S., & Pfaller, M. A. (2015). Medical Microbiology (8th ed.). Elsevier.
9. Ryan, K. J., Ray, C. G., Sherris, J. C., & Pfaller, M. A. (2015). Sherris Medical Microbiology (6th ed.). McGraw-Hill Education.

10. Jawetz, E., Melnick, J. L., & Adelberg, E. A. (2013). Medical Microbiology (26th ed.). McGraw-Hill Education.
11. Murray, P. R., Rosenthal, K. S., & Pfaller, M. A. (2015). Medical Microbiology (8th ed.). Elsevier.
12. Rao, C. S., & Trivedi, P. C. (2017). A Textbook of Microbiology (2nd ed.). McGraw-Hill Education.
13. Tortora, G. J., Funke, B. R., & Case, C. L. (2013). Microbiology: An Introduction (11th ed.). Pearson.

Mapping of Program Outcomes with Course Outcomes

Class : S.Y.B.Sc (Sem III) **Subject: Microbiology**
Course : Air Microbiology **Course Code : MIB-203-MJM**

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

Course Outcomes	Programme Outcomes (POs)												
	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			3									
CO 2	3				2			3					
CO 3	3	3			3					3	3		3
CO 4	3									3	3		
CO 5	3		3	3	3							3	
CO 6	3	2										3	
CO 7	3	3				3	2	3	3				3

Justification for the mapping

PO1 Comprehensive knowledge and understanding

CO1: Students can identify and categorize various types of airborne microorganisms, thereby enhancing their understanding of microbial diversity and taxonomy.
CO2: students develop a comprehensive understanding of the role of microorganisms in ecosystems and their impact on broader systems.
CO3: Understanding natural and human-induced sources of airborne microorganisms and the environmental factors affecting their dispersion provides students with a comprehensive understanding of the complex interactions between microorganisms and their environment.
CO4 Assessing common chemical pollutants in the air not only enhances students' understanding of air quality but also contributes to a comprehensive understanding of the interactions between chemical pollutants and microbial communities in the air.
CO5: Acquiring proficiency in various air sampling techniques allows students to gather comprehensive data on airborne microorganisms.
CO6: Understanding and applying physical and chemical methods for air sanitation provide students with comprehensive knowledge of strategies to control airborne microorganisms
CO7: Staying updated with the latest developments in air microbiology ensures students have a comprehensive understanding of current research trends and technological

advancements

PO2 Practical, Professional and Procedural Knowledge :

CO6: Students learn how to perform air sampling using different techniques and evaluate the effectiveness of various air sanitation methods

CO3:Identifying sources of airborne microorganisms and analyzing environmental factors involve critical thinking and problem-solving skills

CO7: Emphasizes the importance of staying updated with the latest developments in air microbiology. .

PO3 Enterpreneurial Mindset and knowledge:

CO5: Enables students to collect data on airborne pathogens, which can be valuable for market research purposes.

PO4 Specialized skills and competencies:

CO1 and CO5: These skills are essential for conducting precise and accurate assessments of airborne microorganisms, demonstrating proficiency in specialized techniques relevant to the field.

PO5 Capacity for Application ,Problem-Solving ,and Analytical Reasoning :

CO2: This require students to analyze and interpret scientific literature, research findings, and technological advancements in the field.

CO3 and CO4: This cultivates problem-solving skills, enabling students to address challenges related to environmental contamination and public health risks.

PO6 Communication Skills and Collaboration:

CO7: Staying informed about the latest developments in air microbiology showcases personal and professional competence, reflecting an understanding of current research trends and innovative approaches..

PO7 Research –Related skills :

CO7: This encourages students to engage in independent research, critically evaluate scientific literature, and contribute to ongoing research efforts in the field..

PO8 Learning How to Learn Skills:

CO2 and CO7: Students learn to be proactive in seeking out new information, adapting to changes in the field, and continuously expanding their knowledge and expertise..

PO9 Digital and Technological Skills :

CO7: Digital and technological skills by encouraging students to stay updated with advancements in technology relevant to air microbiology

PO10 Multicultural Competence ,Inclusive Spirit , and Empathy:

CO3: Enhances multicultural competence by exploring the diversity of sources for airborne microorganisms, which can vary across different regions and cultures.

CO4: By addressing the impact of chemical pollutants on air quality and microbial communities, emphasizes the importance of inclusivity in environmental considerations.

PO11 Value Inculcation and Environmental Awareness:

CO3: Enhances environmental awareness by exploring the sources of airborne microorganisms and their dispersion, which fosters an understanding of environmental processes.

CO4 Deepens environmental awareness by addressing the impact of chemical pollutants on air quality and microbial communities, instilling a sense of

responsibility towards environmental stewardship.

PO12 Autonomy , Responsibility and Accountability :

CO5 and CO6: Promote autonomy by providing students with the skills and knowledge to identify and address airborne pathogens and pollutants independently.

PO13 Community Engagement and Services:

CO3: Encourages community engagement by exploring both natural and human-induced sources of airborne microorganisms, fostering an understanding of local environmental issues and opportunities for community involvement.

CO7: Promotes community engagement by encouraging students to stay informed about the latest developments in air microbiology, providing opportunities for students to contribute their knowledge and skills to community initiatives and service projects.

Name of the Programme	**: B.Sc Microbiology**
Programme Code	**: USMI**
Class	**: S.Y.B.Sc.**
Semester	**: III**
Course Type	**: Major Mandatory (Practical)**
Course Code	**: MIB-204- MJM**
Course Title	**: Practicals on Bacterial systematics, Air Microbiology & Soil Microbiology**
No. of Credits	**: 02**
No. of Practicals	**: 15**

Course Objectives:

1. To understand the principles and techniques involved in biochemical tests for the identification of bacteria, including sugar utilization, fermentation, and enzyme detection.
2. To apply the IMVIC test to differentiate between bacterial species based on their metabolic characteristics.
3. To develop proficiency in identifying key enzymes such as amylase, gelatinase, catalase, and oxidase, and their significance in bacterial identification.
4. To comprehend the oxidative-fermentative test and its utility in distinguishing between oxidative and fermentative pathways in bacterial metabolism.
5. To utilize Bergy's Manual of Systematic Bacteriology for the identification of bacterial isolates up to the genus level based on given characteristics.
6. To perform physical analysis of agricultural soil, including pH, moisture content, texture, and color, and understand their impact on soil microbiology.
7. To isolate and enumerate soil bacteria from various locations, focusing on techniques for proper isolation and identification.

Pr. No	Topic & Learning Points	Teaching Hours
	Bacterial systematics	
	Biochemical Tests for Identification of bacteria:	
1	Sugar utilization test	4
2	Sugar fermentation test	4
3	IMVIC	4
	Enzyme detection	
4	Amylase	4
5	Gelatinase	4
6	Catalase, Oxidase	4
7	Oxidative-fermentative test	4
8	Identification of Any one bacterial isolates at least up to genus level from the given characters using Bergey's manual of systematic bacteriology.	4
	Soil Microbiology	
9	Isolation and Enumeration of bacteria from different soil types.	4
10	Isolation of cellulolytic bacteria from soil	4
11	Isolation of nitrogen fixing bacteria from soil.	4
	Air Microbiology	
12	Air sampling using an air sampler & determination of microbial diversity.	4
13	Determination of Simpson index	4
14	Determination of Settling velocity	4
15	Isolation of Airborne Fungi using Settle plate method	4
Total		**60**

References :

1. Bergey's Manual of Systematic Bacteriology by John G. Holt et al.
2. Practical Handbook of Microbiology, Third Edition by Emanuel Goldman and Lorrence H. Green
3. Microbial Physiology, Fourth Edition by Moat, John, Foster, and Michael P.

4. Soil Microbiology, Ecology, and Biochemistry, Fourth Edition by Eldor A. Paul
5. Methods in Soil Biology by Frank B. Dazzo, Joseph A. Klein, and Paul S. J. Verburg
6. Air Microbiology, Second Edition by R.C. A. Samson and J. I. Pitt
7. Indoor Air Quality Handbook by John D. Spengler, Jonathan M. Samet, and John F. McCarthy

Mapping of course outcomes and programme outcomes:

Class : SYBSc (Sem III) **Subject : Microbiology**

Course : Practicals on MIB-201-MJM, MIB-202-MJM, MIB-203-MJM

Course code : MIB-204-MJM

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**	**PO11**	**PO12**	**PO13**
CO1	3	2		2	2					3		2	
CO2	3	3		3	1							3	
CO3	3	3		3								3	
CO4	3	3		3	3							3	
CO5	3	2		3	2			2	2	3		2	
CO6	3	3	3		3	3	2		2	2	3	3	3
CO7	3		2	2	2		3			3	3	3	3

Justification for the mapping

PO1 Comprehensive Knowledge and Understanding
All COs providing students with comprehensive knowledge and understanding of bacterial physiology, taxonomy, and identification techniques.

PO2 Practical, Professional, and Procedural Knowledge
CO1, CO2, CO3, CO4, CO5, and CO6 directly focus on practical laboratory techniques, professional analysis of data, and procedural knowledge required for bacterial identification and soil analysis.

PO3 Entrepreneurial Mindset and Knowledge
CO6 and CO7could potentially foster an entrepreneurial mindset by recognizing opportunities for innovation in agriculture or environmental biotechnology.

PO4 Specialized Skills and Competencies
CO1, CO2, CO3, CO4, CO5, and CO7 contribute to developing specialized skills in biochemical testing, metabolic pathway analysis, enzyme characterization, bacterial classification, and soil microbiology techniques.

PO5 Capacity for Application, Problem-Solving, and Analytical Reasoning
CO1, CO2, CO4, CO5, CO6, and CO7 directly requiring students to apply their

knowledge in practical situations, solve problems related to bacterial identification and soil analysis, and employ analytical reasoning to interpret results.

PO6 Communication Skills and Collaboration
CO6 likely involves collaboration as soil analysis often requires teamwork and communication skills to interpret and communicate findings effectively.

PO7 Research-related Skills
CO6 and CO7 providing students with research-related skills such as designing experiments, collecting data, and analyzing results in the context of soil microbiology.

PO8 Learning How to Learn Skills
CO5 encourages students to utilize Bergey's Manual effectively, enhancing their ability to learn independently and navigate complex reference materials.

PO9 Digital and Technological Skills
CO5 and potentially CO6 may involve utilizing digital resources and technologies for bacterial identification and soil analysis, contributing to the development of digital and technological skills in students.

PO10 Multicultural Competence, Inclusive Spirit, and Empathy
understanding microbial diversity (CO1, CO5) and the importance of soil health (CO6, CO7) may indirectly foster multicultural competence, inclusive spirit, and empathy towards diverse ecosystems and communities.

PO11 Value Inculcation and Environmental Awareness
CO6 and CO7 directly fostering environmental awareness through the study of soil microbiology and its implications for ecosystem health and sustainability.

PO12 Autonomy, Responsibility, and Accountability
CO1, CO2, CO3, CO4, CO5, CO6, and CO7 require students to take responsibility for conducting experiments, analyzing data, and interpreting results, thereby fostering autonomy, responsibility, and accountability in their learning and research activities.

PO13 Community Engagement and Service
CO6 and CO7 have the potential to contribute to community engagement and service by providing insights into soil health and microbial communities, which are essential for sustainable agriculture and environmental conservation efforts.

Name of the Programme	**: B.Sc Microbiology**
Programme Code	**: USMI**
Class	**: S.Y.B.Sc.**
Semester	**: III**
Course Type	**: Minor Mandatory (Theory)**
Course Code	**: MIB-241- MN**
Course Title	**: Basic Microbiology**
No. of Credits	**: 02**
No. of Teaching Hours	**: 30**

Course Objectives:

1. To acquaint students with the fundamental principles and methodologies utilized in microbiology, emphasizing microscopy, staining, and sterilization approaches.
2. To introduce students to the diverse varieties of microscopes, their constituent parts, and their applications in microbiological investigations.
3. To equip students with an understanding of the principles and processes involved in staining methodologies for visualizing and distinguishing microbial entities.
4. To familiarize students with the principles and applications of various microscopy types, including bright-field, fluorescence, and electron microscopy.
5. To cultivate students' theoretical understanding of microscope upkeep, calibration, and problem-solving.
6. To empower students to grasp the importance of precise staining techniques in the identification and categorization of microorganisms.
7. To enrich students' comprehension of the significance of aseptic practices and sterilization in averting contamination and ensuring the accuracy of experimental outcomes.

Course Outcomes:

CO1 Students will comprehend the principles and operations of various microscope types, along with an understanding of their components.

CO2 Students will acquire knowledge regarding diverse staining techniques utilized in microbiology, encompassing simple staining and differential staining.

CO3 Students will exhibit an understanding of the applications and limitations inherent in different microscopy techniques employed in microbiology research and diagnostics

CO4 Students will elucidate the significance of sterilization techniques in upholding

aseptic conditions within the laboratory and thwarting contamination.

CO5 Students will amass knowledge pertaining to the execution of sterilization and disinfection methods.

CO6 Students will acknowledge the significance of aseptic techniques and the meticulous handling of sterile materials in microbiological experiments, ensuring the precision of results.

CO7 Students will apply the acquired techniques to scrutinize and interpret experimental data within the microbiological context.

Credit		Topic & Learning Points	Teaching Hours
I	**UNIT 1**	**Introduction to Microscopy**	**10**
		1. Introduction to Microscopy	1
		2. Fundamental concepts of Magnification, Numerical Aperture and Resolving Power	2
		3. Types and functions of :	
		a. Condensers	1
		b. Eye-pieces	1
		c. Objectives	**1**
		4. Principle & Applications of:	2
		a) Dark field Microscopy	
		b) Fluorescence Microscopy	
		c) Electron Microscopy	
		5. Construction, working , ray diagram and applications of Bright Field Microscopy	2
	UNIT 2	**Staining Techniques**	**5**
		1. Definitions and Types of stains (Basic and Acidic)	1
		2. Properties and role of Fixatives, Mordants, Decolorisers and Accentuators	1
		3. Principles of following staining techniques:	
		a) Monochrome staining	1
		b) Negative (Relief) staining	1

		c) Differential staining -(Gram staining and Acid-Fast staining)	**1**
II	**UNIT 1**	**Sterilization and Disinfection**	**6**
		1. Definition and concept of sterilization and disinfection	1
		2. Physical methods –	
		a. Heat	2
		b. Radiation	1
		c. Filtration	2
	UNIT 2	**Disinfection**	**9**
		1. Chemical agents and their mode of action –	
		a. Aldehydes	1
		b. Halogens	1
		c. Quaternary ammonium compounds	1
		d. Phenol and phenolic compounds	1
		e. Heavy metals	1
		f. Alcohol	1
		g. Detergents	1
		2. Characteristics of an ideal Disinfectant	1
		3. Concept of Phenol Coefficient	1
TOTAL			**30**

References:

1. Tortora G.J., Funke B.R., Case C.L. (2006). Microbiology:An Introduction. 8th Edition.Pearson Education Inc
2. Salle A.J. (1971) Fundamental Principles of Bacteriology. 7th Edition. Tata MacGraw HillPublishing Co.
3. Stanier R.Y., Adelberg E.A. and Ingraham J.L. (1987)General Microbiology, 5th Edition.Macmillan Press Ltd.
4. Prescott, Lancing. M., John, P. Harley and Donald, A. Klein (2006) Microbiology, 6thEdition, McGraw Hill Higher Education
5. Michael J Pelczar, JR. E.C.S. Chan, Noel R. Krieg. (1993) Microbiology, 5th Edition, TataMacGraw Hill Press.

6. McDonnell G. E. (2020). Antisepsis, Disinfection, and Sterilization: Types, Action, andResistance. United States: Wiley.

7. Murphy D. B. and Davidson M. W. (2012). Fundamentals of Light Microscopy andElectronic Imaging. Germany: Wiley.

Mapping of course outcomes and program outcomes:

Class: S.Y.BSc (Sem III) **Subject: Microbiology**
Course: Basic Microbiology **Course code: MIB-241- MN**
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**	**PO 10**	**PO 11**	**PO 12**	**PO 13**
CO1	3	3		3									
CO2	3	3		3		2				1			
CO3	3		1	3			3						
CO4	3	3		3				2					
CO5	3	3		3									
CO6	3	3		3								3	
CO7	3			3	3		3						

Justification for the mapping

PO 1 Comprehensive Knowledge and Understanding:
CO1, CO2, CO3, CO4, CO5, CO6, and CO7 all contribute to students' comprehensive knowledge and understanding of microbiology techniques, including microscopy, staining, sterilization, and aseptic techniques. Understanding these principles and operations contributes to comprehensive knowledge and understanding in the field of microbiology.

PO2 Practical, Professional, and Procedural Knowledge:
CO1, CO2, CO4, CO5, and CO6 involve practical knowledge of laboratory techniques and procedures used in microbiology. These course outcomes emphasize practical skills such as executing sterilization techniques, handling sterile materials, and maintaining aseptic conditions in laboratory settings.

PO3 Entrepreneurial Mindset and Knowledge:
PO3: The course outcomes do not directly relate to entrepreneurial mindset and knowledge.

PO4 Specialized Skills and Competencies:
CO1, CO2, CO3, CO4, CO5, CO6, and CO7 all contribute to developing specialized

skills and competencies in microbiology laboratory techniques.

PO5 Capacity for Application, Problem-Solving, and Analytical Reasoning:
CO7 involves applying acquired techniques to scrutinize and interpret experimental data, which demonstrates capacity for application, problem-solving, and analytical reasoning.

PO6 Communication Skills and Collaboration:
While the course outcomes may involve some communication and collaboration in a laboratory setting, it is not the primary focus of the outcomes.

PO7 Research-related Skills:
CO3 and CO7 specifically involve research-related skills such as understanding the applications and limitations of microscopy techniques and analyzing experimental data.

PO8 Learning How to Learn Skills:
While the course outcomes involve learning various microbiology techniques, they may not explicitly focus on teaching learning how to learn skills.

PO9 Digital and Technological Skills:
The course outcomes do not directly relate to digital and technological skills.

PO10 Multicultural Competence, Inclusive Spirit, and Empathy:
The course outcomes do not directly relate to multicultural competence, inclusive spirit, and empathy.

PO11 Value Inculcation and Environmental Awareness:
The course outcomes do not directly relate to value inculcation and environmental awareness.

PO12 Autonomy, Responsibility, and Accountability:
CO6 involves understanding the significance of aseptic techniques and meticulous handling of materials, which demonstrates autonomy, responsibility, and accountability in laboratory practices.

PO13 Community Engagement and Service:
The course outcomes do not directly relate to community engagement and service.

Name of the Programme	**: B.Sc Microbiology**
Programme Code	**: USMI**
Class	**: S.Y.B.Sc.**
Semester	**: III**
Course Type	**: Minor Mandatory**
Course Code	**: MIB-242-MN**
Course Title	: **Basic Microbiological techniques (Practical)**
No. of Credits	**: 02**
No. of Practicals	**: 15**

Course Objective:

1. Students will be able to understand the basics of microbiology, including the types of microorganisms, their characteristics and their roles in various environments.
2. Students will able to learn about the factors affecting microbial growth and the methods used to culture and maintain microorganisms in the laboratory.
3. Students will able to understand different methods of sterilization and disinfection used to eliminate or reduce microbial contamination.
4. Student will able to understand aseptic techniques to handle microorganisms without contaminating the samples or the environment.
5. Student will able to learn microscopic examination use a microscope to observe and identify different types of microorganisms.
6. To understand the methods used to isolate and identify specific microorganisms from a mixed culture.
7. Students will able to understand safety in laboratory.

Course Outcome:

CO1. Students will understand the basic principles of microbiology.
CO2. Students will acquire skills in aseptic techniques for handling microorganisms.
CO3. Students will be able to perform basic microbiological tests such as staining, culture, and identification of microorganisms.
CO4. Students able to learn about microbial growth, nutrition, and control.
CO5. Students will be able to develop skills in microscopy for the observation of microorganisms.
CO6. Students will understand the importance of microbiology in various industries and fields.
CO7. Students will gain practical experience in microbiological techniques through laboratory exercises and experiments.

Sr.No.	Name of Experiments	Teaching Hours
1	Safety in microbiological laboratory.	4
2	Sterilization & disinfection techniques	4
3	Preparation of cotton plugs & wrapping of glasswares	4
4	Aseptic transfer techniques	4
5	Preparation of media (Nutrient agar, broth)	4
6	Serial dilution and plate count by spread plate method	4
7	Isolation of bacteria by streak plate method	4
8	Isolation of bacteria from soil/water samples	4
9	Observation of natural sample (water) by using bright field microscopy.	4
10	Study of colony characteristics of following bacteria: *Bacillus/ E. coli/ Staphylococcus/ Pseudomonas*, etc.	4
11	Maintenance of stock cultures: slants/ stabs/ glycerol stock	4
12	Preparation of bacterial smear & monochrome staining	4
13	Gram's staining	4
14	Detection of oxidase	4
15	Detection of Catalase	4
	Total	**60**

References:

1. Tortora G.J., Funke B.R., Case C.L. (2006). Microbiology:An Introduction. 8th Edition. Pearson Education Inc
2. Salle A.J. (1971) Fundamental Principles of Bacteriology. 7th Edition. Tata MacGraw Hill Publishing Co.
3. Stanier R.Y., Adelberg E.A. and Ingraham J.L. (1987)General Microbiology, 5th Edition. Macmillan Press Ltd.
4. Prescott, Lancing. M., John, P. Harley and Donald, A. Klein (2006) Microbiology, 6th Edition, McGraw Hill Higher Education
5. Michael J Pelczar, JR. E.C.S. Chan, Noel R. Krieg. (1993) Microbiology, 5th Edition, Tata MacGraw Hill Press.
6. McDonnell G. E. (2020). Antisepsis, Disinfection, and Sterilization: Types, Action, and Resistance. United States: Wiley.
7. Murphy D. B. and Davidson M. W. (2012). Fundamentals of Light Microscopy and Electronic Imaging. Germany: Wiley.

Mapping of course outcomes and programme outcomes:

Class: S.Y.B.Sc. (Sem III) **Subject:** Microbiology
Course: Basic Microbiological Techniques (Practical) **Course code:** MIB-242- MN
Weightage: 1= weak or low relation, 2= Moderate or partial relation, 3= Strong or direct relation

Course outcomes (COs)	Programme Outcomes (POs)												
	PO 1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**	**PO1 3**
CO1	2												
CO2	2	2		2				2					
CO3	3						3						
CO4											2	2	
CO5								2				2	
CO6			2										
CO7		3			3		2		2				
CO8													

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding:

CO1: Basic microbiological techniques practical serve as the foundation for understanding fundamental principles and concepts in microbiology. Students learn essential techniques such as aseptic technique, microbial culturing, staining, and microscopy, which form the basis of more advanced microbiological studies.
CO2: Practical laboratory exercises provide students with hands-on experience and reinforce theoretical concepts learned in lectures or textbooks.
CO3: Comprehensive knowledge and understanding enable students to apply theoretical principles to real-world laboratory scenarios, enhancing comprehension and retention of material.

PO2: Practical, Professional, and Procedural Knowledge:

CO2: Basic microbiological techniques practical provide students with opportunities to develop practical skills essential for working in laboratory settings.
CO7: Through hands-on experience, students gain proficiency in techniques such as aseptic handling, microbial culturing, staining, and microscopy, enhancing their practical competency and confidence.

PO3: Entrepreneurial Mindset and Knowledge:

CO6: Basic microbiological techniques practical provide opportunities for students to apply innovative thinking and creativity in solving scientific problems and developing novel solutions.

PO4: Specialized Skills and Competencies:

CO2: Basic microbiological techniques practical require specialized skills such as aseptic technique, microbial culturing, staining, microscopy, and biochemical assays. Students develop hands-on proficiency in performing these techniques accurately, efficiently, and safely, laying the foundation for more advanced microbiological studies.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning:

CO7: Microbiological experiments often require careful planning and design to address specific research questions or hypotheses. Application problem-solving skills enable students to select appropriate methodologies, design experimental protocols, and identify variables that may impact experimental outcomes, fostering critical thinking and analytical reasoning in experimental planning.

PO7: Research-related Skills:

CO3: Basic microbiological techniques practical involve designing experiments to test hypotheses or address research questions.

CO4: Research-related skills enable students to develop experimental designs that are scientifically rigorous, feasible, and appropriate for the objectives of the study.

PO8: Learning How to Learn Skills:

CO2: Basic microbiological techniques practical provide an opportunity for students to learn how to adapt to new environments, procedures, and challenges.

CO5: Learning how to learn skills enable students to quickly acquire new knowledge, techniques, and protocols, allowing them to adapt and thrive in diverse laboratory settings.

PO9: Digital and Technological Skills:

CO7: Microbiological experiments generate large volumes of data that require organization, analysis, and storage. Digital skills enable students to use spreadsheet software, databases, and laboratory information management systems (LIMS) to manage experimental data efficiently, ensuring accuracy, accessibility, and reproducibility.

PO11:Value Inculcation and Environmental Awareness:

CO4: Microbiological research involves ethical considerations regarding the responsible use of microorganisms, adherence to biosafety protocols, and respect for research participants and the environment.

PO12:Autonomy, Responsibility, and Accountability:

CO4: Autonomy allows students to make independent decisions during experiments, such as selecting appropriate procedures and interpreting results.

CO5: Accountability in this setting means students are accountable for accurately documenting their procedures, results, and any deviations, as well as taking responsibility for the overall success and integrity of the experiment.

Name of the Programme	**: B.Sc Microbiology**
Programme Code	**: USMI**
Class	**: S.Y.B.Sc.**
Semester	**: III**
Course Type	**: Open Elective (Theory)**
Course Code	**: MIB-216-OE**
Course Title	**: Scope & History of Microbiology.**
No. of Credits	**: 02**
No. of Lecture	**: 30**

Course Objective:

1. To comprehend the diverse applications of microbiology in various fields including industrial processes, biotechnology, medical diagnostics, immunology, genetics, food production, and agriculture.
2. To explore the historical journey of microbiology, including the pivotal contributions of Antony Van Leeuwenhoek and the debate between abiogenesis and biogenesis, examining key experiments such as the Fly Experiment and Swan-Necked Flask Experiment.
3. To analyze the evolution of microbiology in the 19th century, from the germ theory of fermentation by Louis Pasteur to the germ theory of disease by Robert Koch and T.M. River, and the advancements in disease prevention including surgical antisepsis and vaccination.
4. To evaluate the advancements in microbiology during the 20th and 21st centuries, including the development of chemotherapy with concepts like the "magic bullet" by Paul Ehrlich and the discovery of antibiotics, as well as recognizing Nobel Prize recipients for their contributions to microbiology.
5. To demonstrate an understanding of industrial microbiology and biotechnology, recognizing their importance in various industries and their role in innovation and sustainable practices.
6. To assess the significance of medical microbiology and immunology in diagnosing and treating infectious diseases, including the development of vaccines and immunotherapies.
7. To investigate the application of microbial genetics in understanding genetic mechanisms, evolutionary processes, and its implications in biotechnology, medicine, and agriculture.

Course Outcomes:

CO1 Students will able to Demonstrate a comprehensive understanding of the scope and applications of microbiology, including its relevance in various fields such as industrial microbiology, biotechnology, medical microbiology, immunology, microbial genetics, food and dairy microbiology, and agricultural microbiology.

CO2 Students will able to analyze the historical contributions of key figures such as Antony Van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Edward Jenner, and others towards the development of microbiology, including the experiments and theories related to abiogenesis vs. biogenesis.

CO3 Students will able to evaluate the evolution of microbiology in the 19th century, including the discovery of microbial roles in fermentation, the germ theory of disease, and advancements in disease prevention techniques such as surgical antisepsis and vaccination.

CO4 Students will able to critically assess the advancements in microbiology in the 20th and 21st centuries, including the evolution of chemotherapy with concepts like the "magic bullet" and the discovery of antibiotics, as well as the contributions of Nobel Prize recipients in the field of microbiology.

CO5 Students will able to apply knowledge of microbiological principles to analyze and solve problems related to industrial processes, medical treatments, disease prevention strategies, and environmental issues.

CO6 Students will able to demonstrate proficiency in laboratory techniques commonly used in microbiology, including microbial culturing, staining, microscopy, and molecular biology methods.

CO7 Students will able to communicate effectively about microbiological concepts, research findings, and applications through written reports, oral presentations, and discussions, while demonstrating ethical and responsible conduct in scientific inquiry and communication

No. of Credits	No. of Unit	Topic & Learning Points	No. of Lectures
I	**Unit 1**	**Understanding the Scope and Applications of Microbiology**	**10**
		a) Industrial Microbiology & Biotechnology	
		b) Medical Microbiology	
		c) Immunology	
		d) Microbial Genetics	
		e) Food and Dairy Microbiology	
		f) Agricultural microbiology.	
	Unit 2	**Tracing the History of Microbiology**	**6**
		a. Contribution of Antony Van Leeuwenhoek toward discovery of animalcules.	**3**
		b. Abiogenesis v/s biogenesis	**3**
		i. Aristotle's notion about spontaneous generation.	
		ii.The Fly Experiment.	
		iii. Swan/S-necked flask experiment and Tyndall's Experiment.	
II	**Unit 1**	**Evolution of Microbiology in the 19th Century**	**8**
		a. Discovery of microbial role in transformation of organic matter.	**2**
		i. Germ theory of fermentation by Louis Pasteur.	
		b. Discovery of microbes as pathogens and disease prevention.	**2**
		i. Germ theory of disease by Robert Koch's & T.M. River	
		c. Development in disease prevention	**4**
		i. Surgical antisepsis by joseph Lister.	
		ii. Vaccination: Contributions of Edward Jenner For chicken cholera vaccine and Louis Pasteur in developing vaccines for and rabies	
		iii.	

	Unit 2	**Advancements in Microbiology in the 20th and 21st Centuries:**	**6**
		a. Evolution of Chemotherapy: i. "Magic bullet" concept by Paul Ehrlich ii. Discovery of "sulfa drugs" by Gerhard Domagk iii. "Miracle drug" by Alexander Fleming.	**3**
		b. Recipients of the Nobel Prize. i Elie Metchnikoff. ii. Burnett. iii. George Beadle. iv. Edward Tatum. v. Porter and Edelman. vi. Kohler and Milstein.	**3**

References:

1. Tortora G. J., Funke B. R., Case C. L. (2006). Microbiology: An Introduction.8th Edition. Pearson Education Inc.
2. Salle A. J. (1971). Fundamental Principles of Bacteriology. 7th Edition. TataMacGraw Hill Publishing Co.
3. Stanier R. Y., Adelberg E. A. and Ingraham J. L. (1987). General Microbiology, 5thEdition. Macmillan Press Ltd.
4. Prescott, Lancing, M., John, P. Harley and Donald, A. Klein (2006). Microbiology, 6thEdition, McGraw Hill Higher Education.
5. M. H. Gajbhiye, S. J. Sathe, S.R. Pharande and R.J. Marathe (2015). Introduction toMicrobiology, 3rd Edition. Career publication.
6. Michael J Pelczar, JR. E.C.S. Chan, Noel R. Krieg. (1993) Microbiology, 5th Edition,Tata MacGraw Hill Press.
7. Nelson D. L. and Cox M. M. (2002) Lehninger's Principles of Biochemistry, MacMillan Worth Pub. Co. New Delhi.
8. Madigan M. T., Martinko J. M. (2006). Brock's Biology of Microorganisms. 11thEdition. Pearson Education Inc.
9. Mount, D. W. (2001). Bioinformatics: Sequence and Genome analysis. Cold SpringHarbor Laboratory Press, NewYork.
10. Mahendra Rai and Nelson Duran (2011). Metal Nanoparticles in Microbiology,Springer, Verlag Berlin Heidelberg.

Mapping of course outcomes and program outcomes:

Class: S.Y.BSc (Sem III) **Subject: Microbiology**

Course: Scope &History of Microbiology **Course code: MIB-216-OE**

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**	**PO11**	**PO12**	**PO13**
CO1	3		2	3	3			2			2		
CO2	3	3			2		3			1			
CO3	3				3								
CO4	3	3			3		3	2					
CO5	3	3	2	3	3		2	2			2		
CO6	2	3		3	3				3				2
CO7	2				2	3	3					3	

Justification for the mapping

PO1 Comprehensive knowledge and Understanding:
CO1-CO7 all are directly related to this PO as they require a comprehensive understanding of microbiology and its various aspects.

PO2 Practical, Professional, and Procedural Knowledge:
CO2: Students will able to analyze the experiments and theories related to abiogenesis vs. biogenesis.
CO4: Students will able to critically concepts like the "magic bullet" and the discovery of antibiotics
CO5: Students will able to apply knowledge of microbiological principles to analyze and solve problems related to Disease prevention.
CO6: Students will able to demonstrate proficiency in laboratory techniques commonly used in microbiology.

PO3 Entrepreneurial Mindset and Knowledge:
CO1: Students will able to understand scope and applications of microbiology in various fields.
CO5: Students will able to apply knowledge of microbiological principles to analyze industrial processes, medical treatments, disease prevention strategies.

PO4 Specialized Skills and Competencies:
CO1: Students will able to understand scope and applications of microbiology in
CO5: Students will be capable of utilizing their understanding of microbiological principles to analyze industrial processes, medical treatments, and strategies for disease prevention.
CO6: Students will be able to exhibit skillfulness in laboratory techniques commonly utilized in the field of microbiology.

PO5 Capacity for Application, Problem-Solving, and Analytical Reasoning:
All CO relates to this PO as it involves applying knowledge to analyze and solve

problems related to microbiology.

PO6 Communication Skills and Collaboration:

CO7: Students will able to communicate effectively about microbiological concepts research findings, and applications through written reports, oral presentations, and discussions

PO7 Research-related Skills:

CO2: Students will able to analyze the historical contributions of Antony Van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Edward Jenner, and others towards the development of microbiology.

CO4: Students will able to critically assess through the evolution of chemotherapy with concepts like the "magic bullet" and the discovery of antibiotics, as well as the contributions of Nobel Prize recipients in the field of microbiology.

CO5: Students will possess the capability to apply their comprehension of microbiological principles in the analysis of industrial processes, medical treatments, and strategies aimed at preventing diseases.

CO7: Students will possess the ability to effectively convey microbiological concepts, research findings, and applications through written reports, oral presentations, and discussions.

PO8 Learning How to Learn Skills:

All CO's especially CO1, CO4, and CO5, entail ongoing learning and adjustment to emerging information and technologies within the realm of microbiology.

PO9 Digital and Technological skills:

CO6: Students will be able to demonstrate skillfulness in laboratory techniques commonly utilized in the field of microbiology.

PO10 Multicultural Competence, Inclusive Spirit, and Empathy:

CO2: Indirectly, multicultural competence and empathy may be embedded in understanding the diverse applications and implications of microbiology.

PO11 Value Inculcation and Environmental Awareness:

CO1: Students will able to comprehensive understanding of the scope and applications of microbiology in various fields such as industrial microbiology, biotechnology, medical microbiology, immunology, microbial genetics, food and dairy microbiology, and agricultural microbiology.

CO5: Students will able to apply knowledge of microbiological principles to disease prevention strategies, and environmental issues.

PO12 Autonomy, Responsibility, and Accountability:

CO7: Students will be capable of articulating microbiological concepts, research discoveries, and their practical applications adeptly through both written reports and oral presentations, fostering ethical and responsible conduct in scientific inquiry and communication.

PO13 Community Engagement and Service:

CO6: Students will able to demonstrate proficiency in laboratory techniques commonly used in microbiology, including microbial culturing, staining, microscopy, and molecular biology methods.

Name of the Programme : B.Sc Microbiology
Program Code : USMI
Class : S.Y.B.Sc
Semester : III
Course Type : Vocational Skill Course (Theory)
Course Title : Dairy Microbiology
Course Code : MIB-221-VSC
No. of Credits : 02
No. of Teaching Hours : 30

Course Objective :-

1. To enrich students' knowledge about the fundamental definition of milk and its significance in dairy microbiology.
2. To teach students the diverse range of microorganisms present in dairy products and their roles in product quality and safety.
3. To enrich students' knowledge to grasp the concept of clean milk and its importance in maintaining microbial quality and safety in dairy products.
4. To introduce students understanding about the physicochemical properties of milk and their impact on microbial growth, processing, and product development.
5. To enhance students understanding about the alkaline phosphatase tests to assess milk pasteurization efficiency and ensure compliance with regulatory standards.
6. To make students knowledgeable about adulteration tests, including water content, urea, and formalin detection, to prevent fraudulent practices and ensure consumer safety.
7. To develop skills in students to master the preparation techniques for yogurt (curd), cheese, and Paneer, including microbial inoculation, fermentation, curdling, and product maturation.

Course Outcomes:

CO1. Students will be able to understand the fundamental definition of milk and its role in dairy microbiology, allowing for informed discussions on the importance of milk in various dairy products.
CO2. Students will be able to apply knowledge gained to assess and promote the concept of clean milk, demonstrating a commitment to maintaining high microbial quality and safety standards in dairy production.
CO3. Students will be able to identify and analyze a diverse range of microorganisms present in dairy products, showcasing a comprehensive understanding of their roles in influencing product quality and ensuring safety.
CO4. Students will be able to analyze the physicochemical properties of milk and apply this knowledge to predict and control microbial growth, facilitating informed decision-making in dairy processing and product development.
CO5. Students will be able to demonstrate proficiency in conducting alkaline phosphatase tests, ensuring the ability to assess milk pasteurization efficiency and comply with regulatory standards for dairy product safety.
CO6. Students will be able to develop practical skills in adulteration tests to detect and prevent fraudulent practices, ensuring a commitment to consumer safety and product authenticity in the dairy industry .

CO7. Students will be able to understand the importance of preparation techniques for yogurt (curd), cheese, and Paneer, showcasing advanced skills in microbial inoculation, fermentation, curdling, and product maturation for diverse and high-quality dairy products.

Credit No		Topic & Learning Points	Teaching Hours
I	**Unit 1**	**Introduction to Dairy Microbiology**	**15**
		1. Defination of milk	1
		2. Composition of milk	2
		3. Types of milk	2
		4. Concept of clean milk	2
		5. Microbial diversity in milk	2
		6. Physicochemical properties of milk	4
		7. Spoilage of milk	2
II	**Unit 1**	**Quality control test in Dairy**	**9**
		1. Milk fat estimation test	1
		2. Alkaline Phosphatase test	2
		3. Mastitis test	1
		4. Dye reduction test	1
		5. Adulteration test : Water content testing ,Urea testing , Formalin detection	4
	Unit 2	**Preparation of Dairy Products**	**6**
		1. Yogurt (Curd)	2
		2. Cheese	2
		3. Paneer	2
Total			**30**

References :

1. Smith, S., & Sherman, N. (2019). Dairy Microbiology: A Practical Approach. John Wiley & Sons
2. Quigley, L., & O'Sullivan, O. (Eds.). (2017). Dairy Microbiology and Biochemistry: Recent Developments. Nova Science Publishers.
3. Jay, J. M., Loessner, M. J., & Golden, D. A. (2005). Modern Food Microbiology (7th ed.). Springer.
4. Tamime, A. Y. (Ed.). (2008). Probiotic Dairy Products (2nd ed.). John Wiley & Sons.
5. Sudha, M. L., & Reddy, S. Y. (2019). Food Safety and Quality in Dairy Industry. Springer.
6. Hui, Y. H. (Ed.). (2008). Handbook of Food Science, Technology, and Engineering: Dairy Science, Eggs, Meat, Poultry, and Seafood (Vol. 2). CRC Press.
7. Andrews, A. T. (Ed.). (2017). Food Safety Regulatory Compliance: Catalyst for a Lean and Sustainable Food Supply Chain. Academic Press.

Mapping of Program Outcomes with Course Outcomes

Class: S.Y.BSc (Sem III) **Subject: Microbiology**
Course: Dairy Microbiology **Course code: MIB-221-VSC**
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									3			
CO 2		3			2							3	3
CO 3	3									3			
CO 4	3				3						3	3	
CO 5		3		3					3				
CO 6		2	3	2	3				3		3		
CO 7	3	3	3	3		3	2	3					3

Justification for the mapping

PO1 **Comprehensive knowledge and understanding:**

CO1: Provides students with a fundamental understanding of milk and its role in dairy microbiology, forming the basis for comprehensive knowledge about dairy products.
CO3: Enhances comprehensive knowledge by focusing on identifying and analyzing microorganisms in dairy products, contributing to a deeper understanding of their impact on product quality and safety.
CO4: Contributes to comprehensive knowledge by exploring the physicochemical properties of milk and how they influence microbial growth, facilitating informed decision-making in dairy processing.
CO7: Broadens comprehensive knowledge by covering preparation techniques for various dairy products, showcasing advanced skills in microbial processes and product development.

PO2 **Practical, Professional and Procedural Knowledge :**

CO2: Emphasizes the application of knowledge to assess and promote clean milk, demonstrating a commitment to professional standards and safety in dairy production.
CO5 and CO6: Focus on practical skills such as conducting tests for pasteurization efficiency and adulteration detection, providing students with hands-on experience in ensuring product quality and safety.
CO7: Enhances practical knowledge by covering preparation techniques for dairy products, including microbial inoculation, fermentation, and product maturation, which are essential aspects of professional dairy processing.

PO3 **Entrepreneurial Mindset and knowledge:**

CO6: Addresses the entrepreneurial aspect by focusing on detecting and preventing fraudulent practices, emphasizing the importance of consumer safety and product authenticity in the dairy industry.
CO7: Contributes to entrepreneurial knowledge by covering preparation techniques for diverse and high-quality dairy products, preparing students to innovate and

develop unique products in the market.

PO4 **Specialized skills and competencies:**

CO5 and CO6: Involve proficiency in conducting specific tests related to pasteurization efficiency and adulteration detection, which are specialized competencies necessary for ensuring product safety and quality.

CO7: Emphasizes the development of practical skills in preparing various dairy products like yogurt, cheese, and Paneer, showcasing expertise in microbial processes and product development.

PO5 **Capacity for Application ,Problem-Solving ,and Analytical Reasoning :**

CO2: Requires students to apply their understanding of milk and dairy microbiology to assess and promote clean milk, demonstrating the application of theoretical knowledge to practical situations.

CO4: Involves analyzing physicochemical properties of milk to predict and control microbial growth, requiring analytical reasoning to make informed decisions in dairy processing.

CO6: Focuses on developing skills in adulteration tests to detect fraudulent practices, which involves problem-solving to address issues related to product authenticity and consumer safety.

PO6 **Communication Skills and Collaboration:**

CO7: involves the preparation techniques for various dairy products, which often require coordination and collaboration among team members in a dairy processing setting.

PO7 **Research –Related skills :**

CO7: Involves understanding the latest developments in dairy processing techniques, indicating a focus on research-related skills.

PO8 **Learning How to Learn Skills:**

CO7: Encourages students to stay informed about the latest developments in dairy science, fosters a continuous learning mindset?

PO9 **Digital and Technological Skills :**

CO5: Proficiency in conducting tests like alkaline phosphatase tests may involve using digital instruments or software for data analysis and interpretation. Students may learn to operate and interpret results from digital equipment used in quality control processes.

CO6: Adulteration tests may involve using digital tools or technologies such as spectroscopy or chromatography for identifying adulterants in dairy products. Students may learn to operate and interpret results from such digital equipment.

PO10 **Multicultural Competence ,Inclusive Spirit , and Empathy:**

CO1: Understanding the cultural significance of milk and dairy products in different societies can foster multicultural competence. Acknowledging and appreciating diverse cultural perspectives regarding the consumption and utilization of milk can promote an inclusive spirit among students..

CO3: Considering the diversity of microorganisms found in dairy products may involve understanding cultural variations in traditional fermentation practices and the role of specific microorganisms in different cuisines.

PO11 **Value Inculcation and Environmental Awareness:**

CO4: The physicochemical properties of milk and their influence on microbial growth can lead to more efficient and sustainable dairy processing practices. By optimizing processing conditions and reducing waste generation, students contribute to environmental conservation efforts.

CO6: Preventing fraudulent practices such as milk adulteration not only ensures consumer safety and product authenticity but also promotes ethical and environmentally responsible behavior.

PO12 **Autonomy , Responsibility and Accountability :**

CO2: Students will demonstrate autonomy by independently evaluating the need for and implementing measures to maintain high standards in dairy production.

CO4: Analyzing the physicochemical properties of milk empowers students to predict and control microbial growth, enabling them to make informed decisions in dairy processing.

PO13 **Community Engagement and Services:**

CO2: Engaging with local dairy farmers, processors, and communities to promote clean milk practices can be a form of community engagement..

CO7: Collaborating with local dairy producers or artisanal cheese makers to share knowledge and techniques for dairy product preparation can foster community engagement.