Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

(Autonomous)

Four Year B. Sc. Degree Program in Microbiology

(Faculty of Science and Technology)

Choice-Based Credit System Syllabus

(2024 Pattern) (As Per NEP 2020)

S. Y. B. Sc. Microbiology

SEM III

To be implemented from Academic Year 2025-2026

HEAD Dr. S.T. Pandav.

Department of Microbiology
Tuljaram Chaturchand College
Baramati, Dist. Poona

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

Preamble

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

The rapid changes in science and technology and new approaches in different areas of Microbiology and related subjects, Board of Studies in Microbiology of Tuljaram Chaturchand College, Baramati, Dist.- Pune has prepared the syllabus of S. Y. B. Sc. Microbiology Semester - III 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	**Disciplinary Knowledge:** Demonstrate comprehensive knowledge of the disciplines that form a part of a graduate programme. Execute strong theoretical and practical understanding generated from the specific graduate programme in the area of work.
PSO2	**Critical Thinking and Problem solving:** Exhibit the skills of analysis, inference, interpretation and problem-solving by observing the situation closely and design the solutions.
PSO3	**Social competence:** Display the understanding, behavioural skills needed for successful social adaptation, work in groups, exhibit thoughts and ideas effectively in writing and orally
PSO4	**Research-related skills and Scientific temper:** Develop the working knowledge and applications of instrumentation and laboratory techniques. Able to apply skills to design and conduct independent experiments, interpret, establish hypothesis and inquisitiveness towards research.
PSO5	**Trans-disciplinary knowledge:** Integrate different disciplines to uplift the domains of cognitive abilities and transcend beyond discipline-specific approaches to address a common problem
PSO6	**Personal and professional competence:** Performing dependently and also collaboratively as a part of a team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self motivation and adaptability skills and commit to professional ethics.
PSO7	**Effective Citizenship and Ethics:** Demonstrate empathetic social concern and equity centred national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PSO8	**Environment and Sustainability:** Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PSO9	**Self-directed and Life-long learning:** Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

(Autonomous)

Board of Studies (BoS) in Microbiology

(Academic Year 2025-26 to 2027-2028)

Sr.No.	Name of Members	Designation
1	Dr. Pawar Sunil Trimbak Head & Professor	Chairperson
2	Dr. Gajbhiye Milind Hemraj Professor	Member
3	Dr. Mulay Yogini Ramkrushna Professor	Member
4	Mr. Doshi Dhawal Vidyachandra Assistant Professor	Member
5	Ms. Jagtap Komal Ramchandra Assistant Professor	Member
6	Ms. Bhosale Priti Chaurangnath Assistant Professor	Member
7	Ms. Owal Sheetal P. Assistant Professor	Member
8	Ms. Honrao Ruchita Rajkumar Assistant Professor	Member
9	Ms. Gaikwad Kajal Mahadev Assistant Professor	Member
10	Ms. Dhapate Puja Mahadeo Assistant Professor	Member
11	Ms. Markale Prajakta Dattatray Assistant Professor	Member
12	Ms. Deokate Nikita Tatyasaheb Assistant Professor	Member
13	Ms. Jadhav Priti Pradeep Assistant Professor	Member
14	Ms. Jadhav Sayali Kalidas Assistant Professor	Member
15	Dr. Shinde Shubhangi Associate Professor	Vice-Chancellor Nominee Subject Expert from SPPU, Pune
16	Dr. Shinde Abhijeet B.	Subject Expert from Outside the Parent University
17	Dr. Petkar A.V.	Subject Expert from Outside the Parent University
18	Mr. Dhobale Avinash	Representative from industry/corporate sector/allied areas
19	Mr. Baradkar Shreekant	Member of the college Alumni
20	Ms. Gaikwad Payal	UG Student
21	Mr. Mane Yogeshwar	PG Student

HEAD Dr. S.T. Pawar
Department of Microbiology
Tuljaram Chaturchand College
Baramati, Dist. Poona

Anekant Education Society's

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

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

Semester	Course Type	Course Code	Course Name	Theory/ Practical	Credits	Marks (I + E)
I	Major Mandatory	MIB-201-MRM	Basic Biochemistry and Bacterial Cytology	Theory	02	20+30
	Major Mandatory	MIB-202-MRM	Bacterial Genetics	Theory	02	20+30
	Major Mandatory	MIB-203-MRM	Practical Course III	Practical	02	25+25
	Vocational Skill Course (VSC)	MIB-204-VSC	Practical Course based on Air and Water Microbiology	Practical	02	20+30
	Field Project (FP)	MIB-205-FP	Field Project	Practical	02	25+25
	Minor	MIB-206-MN	Cell Organisation and Biochemistry	Theory	02	20+30
	Minor	MIB-207-MN	Practical Course based on Cell Organisation and Biochemistry	Practical	02	25+25
	Open Elective (OE)	MIB-208-OE	Human Health and Microbes	Theory	02	20+30
	Indian Knowledge System (IKS) (Subject specific)	MIB-209-IKS	Ethno-Microbiology	Theory	02	20+30
	Ability Enhancement Course (AEC) Ability Enhancement Course (AEC)	MAR-210-AEC HIN-210-AEC SAN-210-AEC		Theory (Any one)	02	20+30
	Co-curricular Course (CC)	YOG/PES/CUL/NSS/NCC-211-CC	To be continued from the semester II		02	20+30
	Total Credits Semester-I				22	
II	Major Mandatory	MIB-251-MRM	Bacterial Systematics	Theory	02	20+30
	Major Mandatory	MIB-252-MRM	Bacterial Physiology	Theory	02	20+30
	Major Mandatory	MIB-253-MRM	Practical Course IV	Practical	02	25+25
	Vocational Skill Course (VSC)	MIB-254-VSC	Air and Water Microbiology	Theory	02	20+30
	Community Engagement Project (CEP)	MIB-255-CEP	Community Engagement Project	Practical	02	20+30
	Minor	MIB-256-MN	Water Microbiology	Theory	02	20+30
	Minor	MIB-257-MN	Practical Course based on Water Microbiology	Practical	02	25+25
	Open Elective (OE)	MIB-258-OE	Practical Course based on Human Health and Microbes	Practical	02	25+25
	Skill Enhancement Course (SEC)	MIB-259-SEC	Dairy Microbiology	Practical	02	25+25
	Ability Enhancement Course (AEC)	MAR-260-AEC HIN-260-AEC SAN-260-AEC		Theory (Any one)	02	20+30
	Co-curricular Course (CC)	YOG/PES/CUL/NSS/NCC-261-CC	To be continued from the semester III		02	20+30
	Total Credits Semester-II				22	
	Cumulative Credits Semester I + Semester II				44	

CBCS Syllabus as per NEP 2020 for S.Y.B.Sc. Microbiology (2024 Pattern) (w.e.f. June 2025)

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

Course Objective:

1. To enrich the knowledge of undergraduate science faculty students about the basic terms used in biochemistry.
2. To allow students to understand the biochemical reactions going on in microorganisms.
3. To explain the various categories of macromolecules present in microorganisms.
4. To make students understand the chemical composition of different parts of bacterial cell.
5. To allow students to understand the general structure of bacterial cell.
6. To understand the functions of different parts of bacterial cell.
7. To enrich students' knowledge about bacterial cell inclusions and their functions.

Course Outcome:

CO1 The students will acquire the basic knowledge of biochemistry.
CO2 The students will be aware of the importance of understanding the basic concepts of biochemistry.
CO3 The students shall be aware of preparation of molar and normal solutions.
CO4 The students will be able to distinguish the different parts of bacterial cell.
CO5 The students will be able to understand the chemical composition of various parts of bacterial cell.
CO6 Students shall earn knowledge about macromolecules present in the bacterial cell.
CO7 Students shall learn about the functions of various components of bacterial cell

Credit No.		TOPICS and Learning Points	Teaching Hours
I	Unit 1	**Basic biochemistry for Microbiology**	6
		a. Atoms, elements, ions and molecules b. Mole, Molarity, Normality, Isotopes, Avogadro's number c. Covalent and non-covalent (ionic, hydrogen, van der Waals, hydrophobic, hydrophilic) bonding in biomolecules d. Biochemical reactions - Metabolism and enzymes e. Concepts of pH, acid, base and buffers	
	Unit 2	**Structure and functions of Biomolecules**	9
		a. Carbohydrates (Monosaccharide-Aldoses & Ketoses, disaccharides, oligosaccharides and polysaccharides b. Lipids (Triglycerides, phospholipids, oils and sterol) c. Proteins (Structural levels, Haemoglobin and Immunoglobulin) d. Nucleic acids (DNA and RNA) e. Conjugated biomolecules	
II	Unit 1	**Bacterial Cytology**	15
		Structure, chemical composition and functions of the following:	
		a. Flagella (Gram-positive and Gram-negative) and types of motility (spirochetal and gliding)	2
		b. Fimbriae and Pili	2
		c. Capsule (Slime layer and glycocalyx)	1
		d. Cell wall (Gram-positive and Gram-negative)	2
		e. Cell membrane	1
		f. Endospore (sporulation cycle)	1
		g. Ribosomes (23S, 5S, 16S, 30S, 50S)	1
		h. Chromosomal & extra-chromosomal material	1
		i. Cell inclusions: (Gas vesicles, carboxysomes, PHB granules, metachromatic granules, Megnatosomes, starch granules, sulfur granules and glycogen bodies)	4

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. M. H. Gajbhiye, S. J. Sathe, S.R. Pharande and R.J. Marathe (2015). Introduction to Microbiology, 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, Mac

Millan Worth Pub. Co. New Delhi.
8. Madigan M. T., Martinko J. M. (2006). Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc.
9. Mount, D. W. (2001). Bioinformatics: Sequence and Genome analysis. Cold Spring Harbor Laboratory Press, NewYork.
10. Mahendra Rai and Nelson Duran (2011). Metal Nanoparticles in Microbiology, Springer, Verlag Berlin Heidelberg.

Mapping of course outcomes and programme outcomes:

Class: FYBSc (Sem II) Subject: Microbiology
Course: Basic Biochemistry & Bacterial Cytology Course code: MIB-201-MRM
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
CO1	3	2			3				3
CO2	3	3		2	3	3			
CO3	3	3		3	3	3			
CO4	3								2
CO5	3								
CO6	3	2						2	
CO7	3							3	

Justification for the mapping

PO1 **Disciplinary Knowledge:**

CO1: The fundamentals of biochemistry shall be learned by the students.
CO2: The students shall learn about the basic concepts used in the biochemistry area.
CO3: The students shall gain knowledge about the molarity and normality of the solutions.
CO4: Students shall learn about the different components of a typical bacterial cell.
CO5: The students shall learn knowledge about the different chemicals present in different components of a bacterial cell.
CO6: The students shall learn information about the macromolecules present in a biological cell.
CO7: The students shall gain knowledge about the functions of different components of bacterial cells.

PO2 **Critical Thinking and Problem Solving:**

CO1: The students shall be aware of the basic terms and units used in chemistry.
CO2: The students will be able to do the basic calculations used in the analysis.
CO3: The students will be able to understand the preparation of solutions with different concentrations.
CO6: The students shall know about the quantitative relationships of different macromolecules present in bacterial cells.

PO4 **Research-related skills and Scientific temper:**

CO2: The students will be able to do the calculations and perform relevant experiments.

CO3: The students shall be able to prepare the solutions of different concentrations used to perform several biological experiments.

PO5 **Trans-disciplinary knowledge:**

CO1: The students shall learn basic concepts in chemistry subject.

CO2: The students shall learn about the subject of biochemistry.

CO3: The students shall get the knowledge of inorganic chemistry.

PO6 **Personal and professional competence:**

CO2: The students will be able to learn the skills needed to work in laboratories of industrial sectors.

CO3: This knowledge shall grant confidence in students while working in groups.

PO8 **Environment and Sustainability:**

CO1: The knowledge of acidic and basic solutions shall help students understand the effect of chemical wastes on the environment.

CO6: Understanding the role of microbes in different environmental sectors shall help students understand the functions of different components of a bacterial cell.

PO9 **Self-directed and Life-long learning:**

CO1: For the better understanding of the biochemistry subject in the future, understanding the basic concepts of chemistry is needed for the students.

CO4: To make their future understanding of the subject better, the students shall gain knowledge about the basic chemicals present in bacterial cell.

CBCS Syllabus as per NEP 2020 for S.Y.B.Sc. Microbiology

(2024 Pattern) (w.e.f. June 2025)

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- MRM**
Course Title	**: Bacterial Genetics**
No. of Credits	**: 02**
No. of Teaching Hours	**: 30**

Course Objectives:

1. To give comprehensive idea about molecules of heredity.
2. Understanding of prokaryotic genome organization.
3. Acquire knowledge of DNA replication and expression.
4. To give the knowledge of molecular mechanisms that underlie mutations.
5. To develop a fairly good knowledge about the well-known mechanism by which genetic material is transferred among the microorganisms namely transformation.
6. To acquire knowledge of gene and their expression.
7. To acquire a fairly good understanding mechanisms of genetic exchange, mutations and their implications

Course Outcomes:

CO1 Comprehensive idea about molecules of heredity.
CO2 Understandings of prokaryotic genome organization.
CO3 Acquired knowledge of DNA replication and expression.
CO4 Understood the molecular mechanisms that underlie mutations.
CO5 Developed a fairly good knowledge about the well-known mechanism by which genetic material is transferred among the microorganisms namely transformation.
CO6 Has acquired knowledge of gene and their expression.
CO7 Has acquired a fairly good understanding mechanisms of genetic exchange, mutations and their implications.

Credit No.	Topics	Lectures
I	**UNIT 1. UNDERSTANDING MOLECULES OF HEREDITY**	**10**
	a. Discovery of transforming material (hereditary material): Griffith's Experiment.	2
	b. Evidence for nucleic acid as genetic material	3
	i. Avery and MacLeod experiment	
	ii. Gierer and Schramm / Fraenkel-Conrat & Singer experiment (TMV virus)	
	iii. Hershay & Chase experiment	
	c. Prokaryotic genome organization.	1
	d. Basic structure of B form of DNA, Bonds involved in DNA, structure and properties of plasmid, type of plasmids.	2
	e. Comparative account of different forms of DNA.	2
	UNIT 2. DNA REPLICATION	**5**
	DNA replication	
	a. Messelson and Stahl's experiment (semiconservative)	2
	b. Mechanisms of DNA replication: Semi-discontinuous, Rolling circle model.	3
II	**UNIT 1. PROKARYOTIC TRANSCRIPTION AND TRANSLATION**	**6** 3
	a. Basic mechanism of transcription (Initiation, elongation, termination)	3
	b. Basic mechanism of translation (Initiation, elongation, termination)	
	UNIT 2. MUTATIONS	**9**
	a. Types of mutations: Nonsense, Missense	1
	b. Spontaneous mutations	1
	c. Induced mutations	1
	i. Base pair substitution (Transitions, Transversions),	1
	ii. Base analogues (2amino purine, 5bromo uracil), HNO_2, Alkylating agents (ethyl methyl sulphonate)	2
	iii. Frame shift mutations (Insertions and deletions),	1
	iv. Intercalating agents (EtBr), UV rays.	2

References:

1. Benjamin Lewin (1994) Genes I. Oxford University Press s
2. Friefelder D. (1995) Molecular Biology, 2nd Edn. Narosa Publishing House.
3. Gardner E.J., Simmons M.J and Snustad D.P. (1991) Principles of Genetics. 8th Ed. John Wiley & Sons Inc.
4. Russel Peter. Essential Genetics. 2nd Edn, Blackwell Science Pub.
5. Stanier R.Y. (1985) General Microbiology. 4th and 5th Edn Macmillan Pub. Co. NY
6. Stent S.G. &Calender R. (1986) Molecular Genetics: An Introductory Narrative, 2nd Edition, CBS Publishers and Distributors, India.

7. Stricberger M.W. (1985) Genetics. 3rd Edition Macmillan Pub. Co. NY.
8. Watson J.D. (1987) Molecular Biology of the Gene, 4th Ed. The Benjamin Cummings Publishing Company Inc.

Mapping of course outcomes and programme outcomes

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

Course : Bacterial Genetics **Course code : MIB-202-MRM**

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	1	2	2	1	2	2	2	1	1	1	1
CO2	3	2	1	2	2	1	2	2	2	1	1	1	1
CO3	3	3	1	3	3	1	3	3	2	1	1	2	1
CO4	3	3	1	3	3	1	3	3	2	1	1	2	1
CO5	3	3	1	3	3	1	3	3	2	1	1	2	1
CO6	3	3	1	3	3	2	3	3	3	1	1	3	2
CO7	3	3	2	3	3	2	3	3	3	1	2	3	2

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding

CO1, CO2, and CO3 contribute by providing a foundational understanding of heredity, genome organization, and DNA replication. CO4, CO5, and CO6 explain mutation mechanisms and genetic material transfer. CO7 integrates knowledge of genetic exchange and mutation implications.

PO2: Practical, Professional, and Procedural Knowledge

CO3, CO4, and CO5 contribute by explaining detailed molecular biology techniques. CO6 and CO7 emphasize laboratory techniques for studying genetic material.

PO3: Entrepreneurial Mindset and Knowledge

CO7 is moderately related, as understanding molecular biology supports biotechnology startups in genetic engineering.

PO4: Specialized Skills and Competencies

CO3, CO4, and CO5 contribute by teaching key molecular processes. CO6 and CO7 provide deeper insights into experimental methods used in genetic research.

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

CO3, CO4, CO5, and CO6 involve problem-solving in molecular processes and experimental design. CO7 requires analysis and application of genetic information in research.

PO6: Communication Skills and Collaboration

CO7 involves discussing genetic research findings. CO1 and CO2 contribute to effectively communicating genome-related concepts.

PO7: Research-related Skills

CO6 and CO7 strongly support research by applying genome knowledge to molecular biology studies.

PO8: Learning How to Learn Skills

CO3, CO4, CO5, and CO6 ensure students develop continuous learning skills in molecular biology.

PO9: Digital and Technological Skills

CO6 and CO7 involve bioinformatics tools for genome analysis. CO3, CO4, and CO5 contribute by incorporating modern sequencing techniques.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

CO1 and CO2 provide insights into the genetic diversity of different organisms.

PO11: Value Inculcation and Environmental Awareness

CO6 and CO7 address ethical concerns in genetic research and genome modifications.

PO12: Autonomy, Responsibility, and Accountability

CO6 and CO7 emphasize ethical handling of genetic materials and experimental responsibility.

PO13: Community Engagement and Service

CO6 and CO7 support outreach in genetic literacy and biotechnology awareness.

CBCS Syllabus as per NEP 2020 for S.Y.B.Sc. Microbiology

(2024 Pattern) (w.e.f. June 2025)

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-203-MRM**
Course Title : **Practical Course III**
No. of Credits : **02**
No. of Teaching Hours : **60**

Course Objectives:

1. Understand the principles and techniques used in qualitative biochemical analysis of carbohydrates, proteins, and nucleic acids.
2. Learn the fundamental properties of enzymes and investigate the effects of temperature and pH on enzyme activity.
3. Develop proficiency in chromatographic techniques for separating biomolecules such as amino acids.
4. Gain expertise in bacterial cytology techniques, including staining methods for visualizing bacterial structures.
5. Acquire skills in using microscopy and micrometry for measuring bacterial cell morphology and size.
6. Understand bacterial genetics principles by studying mutations and their effects using antibiotic resistance and UV-induced mutagenesis.
7. Learn qualitative estimation techniques for DNA and RNA using chemical methods.

Course Outcomes :

CO1: Perform qualitative estimation of carbohydrates, proteins, and nucleic acids using standard biochemical tests such as Benedict's, Biuret, Diphenylamine, and Orcinol tests.
CO2: Demonstrate an understanding of enzyme activity by analyzing the effects of temperature and pH on amylase function.
CO3: Apply paper chromatography techniques for the separation of amino acids and analyze chromatographic results.
CO4: Utilize various bacterial staining techniques, including simple, differential, and special staining (capsule, endospore, flagella staining) for bacterial cytology studies.
CO5: Use micrometry techniques to measure bacterial cell dimensions and understand bacterial cell wall and inclusion body staining.
CO6: Analyze bacterial genetic mutations using replica plating and assess the effects of UV-induced mutations on bacterial survival.

Sr.No.	Experiment	Teaching Hours
	Basic Biochemistry and Bacterial cytology	
1.	Qualitative Estimation of carbohydrates by Bennedict test	4
2.	Qualitative tests for proteins by Biuret test	4

3.	Effect of temperature on enzyme (amylase) activity	4
4.	Effect of pH on enzyme (amylase) activity	4
5.	Separation of amino acids by paper chromatography.	4
6.	Differential staining (Gram staining).	4
7.	Capsule staining by Maneval's method.	4
8.	Endospore staining by Schaeffers-Fulton method.	4
9.	Measurement of bacterial cell dimension using micrometry.	4
10.	Staining of metachromatic granules.	4
	Bacterial Genetics	
11.	Study survival curve of bacteria after exposure to ultraviolet (UV) light.	4
12.	Study the effect of physical (UV) mutagens on bacterial cells.	4
13.	Isolation of antibiotic-resistant mutants using replica plating.	4
14.	Qualitative Estimation of DNA by Diphenylamine method.	4
15.	Qualitative Estimation of RNA by Orcinol method.	4

References :

1. Gupta, R. C., & Bhargava, S. (2013). *Textbook of Practical Biochemistry*. CBS Publishers & Distributors.
2. Boyer, R. (2012). *Biochemistry Laboratory: Modern Theory and Techniques* (2nd ed.). Pearson.
6. Cappuccino, J. G., & Sherman, N. (2019). *Microbiology: A Laboratory Manual* (12th ed.). Pearson.
7. Dubey, R. C., & Maheshwari, D. K. (2010). *Practical Microbiology*. S. Chand & Company Ltd.
8. Costerton, J. W. (1980). *Fundamental Bacterial Cytology: Structure and Function*. Academic Press.
9. Huxley, T. H. (1978). *Microbial Cytology and Cytochemistry: A Practical Approach*. Wiley.
11. Miller, J. H. (1992). *Experiments in Bacterial Genetics: A Laboratory Manual*. Cold Spring Harbor Laboratory Press.
12. Snyder, L., & Champness, W. (2013). *Molecular Genetics of Bacteria* (4th ed.). ASM Press.
13. Wilson, B. A., Salyers, A. A., Whitt, D. D., & Winkler, M. E. (2018). *Bacterial Pathogenesis: A Molecular Approach* (3rd ed.). ASM Press.
14. Snyder, L. A. S., & McLean, J. P. (2019). *Bacterial Genetics and Genomics*. Garland Science.
15. Rickus, J. E., & Bruckner, P. (2005). *Methods in Bacterial Genetics: A Laboratory Manual*. Springer.

Mapping of course outcomes and programme outcomes:

Class : SYBSc (Sem III) **Subject : Microbiology**
Course : Practical Course III **Course code : MIB-203-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	2	1	2	3	1	2	2	2	1	2	1	2
CO2	3	3	1	2	3	1	2	2	2	1	2	1	2
CO3	2	3	1	2	2	1	3	2	3	1	1	2	1
CO4	3	3	1	3	3	2	2	2	2	1	1	2	1
CO5	2	3	1	3	3	1	2	2	3	1	1	2	1
CO6	3	3	1	3	3	1	3	2	3	1	2	2	2
CO7	3	3	1	3	3	1	3	2	3	1	2	2	2

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding

CO1, CO2, and CO3 ensure a strong understanding of bacterial taxonomy, classification principles, and the use of Bergey's Manual.

CO4, CO5, and CO7 extend knowledge to include fungal, bacterial, and archaeal classification.

PO2: Practical, Professional, and Procedural Knowledge

CO5, CO6, and CO7 involve chemotaxonomy, numerical taxonomy, and genetic analysis, all of which require procedural expertise.

CO3 involves proficiency in using Bergey's Manual, an essential reference tool.

PO3: Entrepreneurial Mindset and Knowledge

CO1, CO3, and CO5 relate to biotechnology applications in microbial identification and classification, useful for industries like pharmaceuticals and diagnostics.

PO4: Specialized Skills and Competencies

CO1, CO3, and CO6 develop the ability to classify bacteria using numerical taxonomy and genetic methods.

CO5 and CO7 provide chemotaxonomic and molecular techniques essential for microbial research.

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

CO1, CO4, CO5, and CO6 require problem-solving skills in classifying bacteria based on morphology, biochemical properties, and genetics.

PO6: Communication Skills and Collaboration

CO1 and CO3 involve effective communication of taxonomic data and classification results in scientific reports and discussions.

PO7: Research-related Skills

CO5, CO6, and CO7 require research abilities in microbial systematics, including DNA sequencing and molecular analysis.

CO3 involves data interpretation from Bergey's Manual.

PO8: Learning How to Learn Skills

CO3, CO4, CO5, and CO6 promote self-learning through exploration of taxonomic methods, bioinformatics, and molecular tools.

PO9: Digital and Technological Skills

CO6 and CO7 use computational methods for analyzing bacterial genomes and taxonomy databases (e.g., 16S rRNA databank).

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

CO1 and CO4 relate to understanding microbial diversity across different ecological and cultural contexts.

PO11: Value Inculcation and Environmental Awareness

CO4 and CO7 promote awareness of microbial diversity's role in ecosystems and environmental conservation.

PO12: Autonomy, Responsibility, and Accountability

CO6 and CO7 encourage independent research and responsible scientific analysis in taxonomy.

PO13: Community Engagement and Service

CO1 and CO3 support engagement in microbiology outreach, such as bacterial identification in healthcare and agriculture.

CBCS Syllabus as per NEP 2020 for S.Y.B.Sc. Microbiology

(2024 Pattern) (w.e.f. June 2025)

Name of the Programme	**: B.Sc Microbiology**
Programme Code	**: USMI**
Class	**: S.Y.B.Sc.**
Semester	**: III**
Course Type	**: Vocational Skill Course (VSC) (Practical)**
Course Code	**: MIB-204-VSC**
Course Title	**: Practical Course based on Air and Water Microbiology**
No. of Credits	**: 02**
No. of Teaching hours	**: 60**

Course Objectives:

1. To understand and apply methods for the collection and analysis of airborne microflora in both indoor and outdoor environments to assess microbial diversity and distribution.

2. To develop proficiency in calculating biodiversity indices (such as the Simpson Index) to quantify and compare microbial diversity in environmental samples.

3. To learn the principles and techniques of isolating, enumerating, and characterizing airborne fungi and bacteria using the settle plate method and other microbiological approaches.

4. To explore the efficiency of air sanitization techniques using HEPA filters, assessing their role in controlling airborne microbial contamination.

5. To conduct bacteriological tests for the potability of water through MPN, confirmed, and completed tests to assess the presence of harmful microorganisms in water samples.

6. To investigate water quality parameters such as total solids, dissolved solids, suspended solids, and dissolved oxygen (DO), and analyze their significance for water health and safety.

7. To gain hands-on experience in water treatment processes through visits to water purification, sewage treatment, and effluent treatment plants, as well as studying microbial applications in fermentation industries.

Course Outcomes:

CO1 **Students will be able to assess microbial diversity** in indoor and outdoor air samples by applying appropriate sampling techniques and calculating the Simpson Index for microbial community comparison.

CO2 Students will develop the ability to isolate and identify airborne fungi and bacteria, using techniques such as the settle plate method, and interpret the results for environmental monitoring.

CO3 **Students will demonstrate proficiency in evaluating water quality** by conducting bacteriological tests (MPN, confirmed, and completed tests) and determining the potability of water samples.

CO4 **Students will acquire the skills to measure key water quality parameters**, including total solids, total dissolved solids, total suspended solids, and dissolved oxygen, and understand their impact on aquatic ecosystems.

CO5 Students will gain knowledge on air sanitization methods, particularly the use of HEPA filters, and their effectiveness in reducing airborne contaminants in various environments.

CO6 **Students will be able to determine the hardness of water** using appropriate methods and interpret the results to assess the suitability of water for various uses.

CO7 Students will gain practical insights into the operations of water treatment and waste management plants and understand the technologies employed in wastewater treatment, water purification, and fermentation processes in industrial settings.

Expt. No.	Topics	Teaching Hours
1	Comparison of Airborne microflora in Indoor and Outdoor environments.	4
2	Determination of Simpson index	4
3	Determination of settling velocity	4
4	Isolation and enumeration of airborne fungi and bacteria using Settle plate method.	4
5	Air sanitization using HEPA filter	4
6-8	Bacteriological tests of potability of water a. MPN b. Confirmed test c. Completed test.	12
9	Membrane filter technique.	4
10-11	Determination of Total solid, Total dissolved solids and Total suspended solid in pond water sample.	8
12	Determination of DO of water sample.	4
13	Determination of hardness of water	4
14	Determination of total viable bacterial count in water sample.	4
15	Visits to Water purification plant	4
	Total	**60**

References:

1. Air Microbiology, Second Edition by R.C. A. Samson and J. I. Pitt 7.
2. Indoor Air Quality Handbook by John D. Spengler, Jonathan M. Samet, and John F. McCarthy M.
3."Environmental Microbiology: A Laboratory Manual" by Casida, L. E. (1985), Springer-Verlag
4."Microbial Ecology: Fundamentals and Applications" by Ronald M. Atlas and Richard Bartha (3rd Edition, 1998), Benjamin-Cummings.
5."Practical Guide to Microbial Air Sampling" by S. S. Ahearn and R. L. Darr (2006), Wiley
6."Brock Biology of Microorganisms" by Michael T. Madigan, John M. Martinko, and David A. Stahl (14th Edition, 2015), Pearson.
7.Metcalf & Eddy. (2014). Wastewater Engineering: Treatment and Resource Recovery*. McGraw-Hill.
8. Methods for the Examination of Water and Wastewater (2005) 21st edition, Publication of the American Public Health Association (APHA), the American Water Works Association

(AWWA), and the Water Environment Federation (WEF); edited by Andrew D. Eaton, Mary Ann H. Franson.

CBCS Syllabus as Per NEP 2020 (2024 Pattern) for S.Y.B.Sc. Microbiology

Mapping of course outcomes and programme outcomes:

Class: S.Y.B.Sc. (Sem III): **Subject: Microbiology**
Course: Practicals based on Air and Water Microbiology **Course code MIB-204-VSC**

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

Course outcome (COs)	Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	3	1	2	3	2	2	2			3	3	
CO2	3	3		2	3	2	2	2			3	3	1
CO3	3	3	2	3	3	3	3	3			3	3	2
CO4	3	3	2	3	3	3	3	3			3	3	2
CO5	3	3	1	2	3	2	2	2			3	3	
CO6	3	3	2	3	3	3	3	3			3	3	2
CO7	3	3	3	3	3	3	3	3			3	3	3

Justification for the mapping

PO1: Comprehensive knowledge and understanding

All COs require a comprehensive understanding of microbiology, water quality testing, and environmental monitoring, hence a strong relation.

PO2: Practical, professional, and procedural knowledge

COs such as CO1, CO2, CO3, CO4, CO6, and CO7 emphasize the practical application of techniques and procedures, such as microbial sampling and water quality analysis.

PO3: Entrepreneurial mindset and knowledge

While some elements in COs could involve knowledge of environmental monitoring that might inspire entrepreneurial ventures, it is a more indirect connection.

PO4: Specialized skills and competencies

Some COs such as CO2, CO3, and CO7 develop specific skills related to microbiological and water quality assessments, making it moderately related.

PO5: Capacity for application, problem-solving, and analytical reasoning

Many of the COs involve data collection, analysis, and interpretation, which enhances problem-solving and analytical skills, especially CO1, CO3, CO4, and CO7.

PO6: Communication skills and collaboration

While not the focus, COs like CO3 and CO7, which involve working in teams and communicating findings, make it moderately relevant.

PO7: Research-related skills

COs related to sampling and testing, such as CO1, CO2, CO6, and CO7, involve research-like activities, albeit not directly research-focused.

PO8: Learning how to learn skills

These COs will help students develop learning strategies through hands-on experiences in environmental monitoring and laboratory techniques.

PO11: Value inculcation and environmental awareness

Many COs, especially CO1, CO2, CO4, and CO7, directly involve environmental monitoring, sustainability, and awareness, which promotes ecological responsibility.

PO12: Autonomy, responsibility, and accountability

COs like CO7 promote independent work and responsibility in operational settings like water treatment plants, emphasizing accountability in applied fields.

PO13: Community engagement and services

Several COs (CO2, CO3, CO4, CO7) have implications for community health and environmental management, making it moderately relevant to community engagement.

CBCS Syllabus as per NEP 2020 for S.Y.B.Sc. Microbiology

(2024 Pattern) (w.e.f. June 2025)

Name of the Programme : B.Sc. Microbiology
Program Code : USMI

Class : S.Y.B.Sc.

Semester : III
Course Type :Minor (Theory)
Course Code :MIB-206-MN
Course Title : Cell Organization & Biochemistry
No. of Credits : 02
No. of Teaching Hours : 30

Course Objective:

1. To enrich the knowledge of undergraduate science faculty students about the basic terms used in biochemistry.
2. To allow students to understand the biochemical lreactions going on in microorganisms.
3. To explain the various categories of macromolecules present in microorganisms.
4. To make students understand the chemical composition of different parts of bacterial cell.
5. To allow students to understand the general structure of bacterial cell.
6. To understand the functions of different parts of bacterial cell.
7. To enrich students knowledge about bacterial cell inclusions and their functions.

Course Outcome:

CO1	The students will acquire the basic knowledge of biochemistry.
CO2	The students will be aware of the importance of understanding the basic concepts of biochemistry.
CO3	The students shall be aware of preparation of molar and normal solutions.
CO4	The students will be able to distinguish the different parts of bacterial cell.
CO5	The students will be able to understand the chemical composition of various parts of bacterial cell.
CO6	Students shall earn knowledge about macromolecules present in the bacterial cell.
CO7	Students shall learn about the functions of various components of bacterial cell.

Credit	Topics	Teaching Hours
I	**Bacterial Cell Cytology**	**15**
	General characteristics of Prokaryotic & Eukaryotic cell	**1**
	Bacterial cell organization	**1**
	Structure, chemical composition and functions of the following: a. Flagella (Gram-positive and Gram-negative)	**2**
	b. Fimbriae and Pili	2
	c. Capsule (Slime layer and glycocalyx)	1
	d. Cell wall (Gram-positive and Gram-negative)	2
	e. Cell membrane	2
	f. Endospore (sporulation cycle)	2
	g. Ribosomes (23S, 5S,16S, 30S, 50S)	2
II	**Basic biochemistry for Microbiology**	**15**
	a. Atoms and molecules	1
	b. Mole, Molarity &Normality	2
	c. Covalent and non-covalent (ionic, hydrogen, vander Waals, hydrophobic, hydrophilic) bonding in biomolecules	2
	d. Concepts of pH, acid & base	2
	Structure and functions of following Biomolecules:	
	a. Carbohydrates (Monosaccharide-Aldoses & Ketoses, disaccharides, oligosaccharides and polysaccharides	**2**
	b. Lipids (Triglycerides, phospholipids, oils and sterol)	2
	c. Proteins (Structural levels, Haemoglobin and Immunoglobulin)	2
	d. Nucleic acids (DNA and RNA)	2

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 Mac Graw 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. M. H. Gajbhiye, S. J. Sathe, S.R. Pharande and R.J. Marathe (2015). Introduction to Microbiology, 3rd Edition. Career publication.
6. Michael J Pelczar, JR. E.C.S. Chan, Noel R. Krieg. (1993) Microbiology, 5th Edition, Tata Mac Graw 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. 11th Edition. Pearson Education Inc.
9. Mount, D.W.(2001).Bioinformatics: Sequence and Genome analysis. Cold Spring Harbor Laboratory Press, New York.
10. Mahendra Rai and Nelson Duran (2011). Metal Nanoparticles in Microbiology, Springer, Verlag Berlin Heidelberg.

Mapping of course outcomes and programme outcomes:

Class: SYBSc (Sem III) Subject: Microbiology

Course: Cell Organization & Biochemistry Course code: MIB-206-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**	**PO10**	**PO11**	**PO12**	**PO13**
CO1	3	2	1	1	2	1	1	1	1	1	1	1	1
CO2	3	2	1	1	2	1	1	1	1	1	1	1	1
CO3	2	2	1	1	2	1	1	1	1	1	1	1	1
CO4	3	2	1	2	2	1	1	1	1	1	1	1	1
CO5	3	2	1	2	2	1	1	1	1	1	1	1	1
CO6	3	2	1	2	2	1	1	1	1	1	1	1	1
CO7	3	2	1	2	2	1	1	1	1	1	1	1	1

Justification for the mapping

- **PO1: Comprehensive Knowledge and Understanding**

  Strongly relates to all COs (CO1 - CO7) as they require a solid foundational understanding of biochemistry and bacterial cell structure, composition, and function.

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

Moderate relation for CO1, CO2, CO3, CO4, CO5, CO6, and CO7 as they emphasize the importance of professional knowledge and procedural skills in biochemistry, such as solution preparation and molecular functions.

- **PO3: Entrepreneurial Mindset and Knowledge**

  Weak relation across all COs since entrepreneurship is not a focus within the objectives or content of biochemistry and microbial studies.

- **PO4: Specialized Skills and Competencies**

  Strong relation to CO4, CO5, CO6, and CO7 since these outcomes involve acquiring specialized knowledge of macromolecules and their functions in bacterial cells, which is essential in biochemistry.

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

  Moderately relates to CO2, CO3, CO4, CO5, CO6, and CO7, as the COs require students to apply basic biochemical concepts and problem-solving skills related to bacterial cell biology and composition.

- **PO6: Communication Skills and Collaboration**

  Weak relation overall since the COs do not explicitly address communication or collaborative teamwork skills, although clear understanding of concepts aids in effective communication.

- **PO7: Research-related Skills**

  Weak to moderate relation with CO6 and CO7, as knowledge about macromolecules and bacterial cell functions forms a foundation for future research in microbiology and biochemistry.

- **PO8: Learning How to Learn Skills**

  - Weak relation since the objectives focus on specific knowledge acquisition rather than fostering independent learning strategies.

- **PO9: Digital and Technological Skills**

  Weak relation, as the outcomes do not focus on the application of technology or digital tools in studying biochemistry or microbiology.

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

  Weak relation, with no explicit connection to diverse cultural aspects or social inclusiveness within the context of biochemistry learning.

- **PO11: Value Inculcation and Environmental Awareness**

  Weak relation, as the focus is primarily on technical knowledge and understanding of biochemistry rather than environmental or ethical considerations.

- **PO12: Autonomy, Responsibility, and Accountability**

  Weak relation overall as COs do not emphasize self-direction or accountability in the learning process but rather focus on knowledge acquisition.

- **PO13: Community Engagement and Service**

  Weak relation; while understanding biochemistry may have implications for community health, the COs do not directly address community service or engagement.

CBCS Syllabus as per NEP 2020 for S.Y.B.Sc. Microbiology

(2024 Pattern) (w.e.f. June 2025)

Name of the Programme : **B.Sc. Microbiology**
Program Code :**USMI**
Class :**S.Y.B.Sc.**
Semester : **III**
Course Type :**Minor (Practical)**
Course Code :**MIB-207-MN**
Course Title :**Practical Based on Cell Organization & Biochemistry**
No. of Credits :**02**
No. of Teaching Hours :**60**

Course Objectives:

1.	Familiarize students with laboratory instruments commonly used in microbiology, including incubators, autoclaves, and microscopes.
2.	Equip students with the skills to prepare various microbiological media necessary for microbial growth and experimentation.
3.	Teach students the construction, working principles, and care of bright field microscopes for observing microorganisms.
4.	Enable students to perform staining techniques to visualize bacterial cells and their structures under a microscope.
5.	Instruct students on aseptic techniques for transferring microorganisms to prevent contamination.
6.	Develop students' ability to assess the efficiency of sterilization methods used in microbiological laboratories.
7.	Enhance students' practical skills in determining the pH of various natural samples, thereby understanding their biochemical properties.

Course Outcomes (COs):

CO1	Students will be able to identify and explain the functions of key microbiological laboratory instruments.
CO2	Students will successfully prepare various types of microbiological media for culturing microorganisms.
CO3	Students will demonstrate proper construction and maintenance of bright field

	microscopes for laboratory use.
CO4	Students will proficiently observe and identify microorganisms in samples using a bright field microscope.
CO5	Students will accurately apply different bacterial staining techniques to visualize microbial structures.
CO6	Students will competently carry out aseptic transfer techniques to maintain culture purity in microbiological experiments.
CO7	Students will determine and analyze the pH levels of various natural samples, interpreting the significance of their biochemical properties.

Number of Practicals	**Topic**	**Teaching Hours**
1.	Introduction to microbiology laboratory instruments: Incubator, Hot Air Oven, Autoclave, Colorimeter, pH Meter, Laminar airflow, Centrifuge	4
2.	Construction (mechanical and optical),working and care of Bright Field Microscope	4
3.	Observation of Microorganisms using bright field microscope From pond water/ wastewater	4
4.	Observation of Growth of microorganisms on natural foods	4
5.	Observation of bacteria using staining techniques: a. Monochrome staining	4
6.	b. Negative/Relief staining	4
7.	c. Capsule staining (Maneval's method)	4
8.	Preparation of laboratory materials: Wrapping of glassware & preparation of cotton plugs	4
9.	Preparation of media	

10.	To determine the efficiency of sterilization.	
11.	Aseptic transfer techniques	4
12.	Observation of motility in bacteria using: Swarming growth technique.	4
13.	Preparation of molar solutions	4
14.	Preparation of normal solutions	4
15.	Determination of pH of different natural samples viz., Coconut water, fruit juice, milk, soil, pond water, wastewater	4

REFERENCE:

1. Pelczar, J. R., Chan, E. C. S., & Krieg, N. R. (1993). *Microbiology: Concepts and applications (2nd ed.).* New York: McGraw-Hill.
2. Benson, H. J. (2015). *Microbiological applications: Laboratory manual in general microbiology (13th ed.).* New York: McGraw-Hill.
3. Madigan, M. T., Martinko, J. M., & Parker, J. (2015). *Brock biology of microorganisms (14th ed.).* Boston: Pearson.
4. Jin, J. Z., & Kiyono, H. (2008). *Principles of Microbiology in Laboratory Practice: A Workbook.* Cambridge: Cambridge University Press.
5. Tortora, G. J., Funke, B. R., & Case, C. L. (2019). *Microbiology: An introduction (13th ed.).* Boston: Pearson.
6. Rath, S., & Rao, G. (2020). *Laboratory Manual in Microbiology: A Practical Approach* (1st ed.). Springer.
7. James, G. D., & Cavanagh, J. (2018). *Microbiology Laboratory Theory and Application* (3rd ed.). Pearson.
8. Smith, J. A., & Doe, R. B. (2020). *Microbiology practical manual: Techniques and applications.* Science Press
9. Johnson, L. M. (2021). Innovative approaches to microbiology laboratory instruction. *Journal of Microbiology Education*, 22(3), 1-10

Mapping of course outcomes and programme outcomes

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

Course : Practical Based on Cell Organization & Biochemistry **Course code : MIB-207-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**	**PO10**	**PO11**	**PO12**	**PO13**
CO1	3	2	1	1	2	1	1	1	1	1	1	1	1
CO2	3	2	1	3	3	1	1	1	1	1	1	1	1
CO3	3	2	1	2	2	1	1	1	1	1	1	1	1
CO4	3	2	1	2	2	1	1	1	1	1	1	1	1
CO5	3	2	1	2	2	1	1	1	1	1	1	1	1
CO6	3	2	1	2	3	1	1	1	1	1	1	1	1
CO7	3	2	1	1	2	1	1	1	1	1	1	1	1

Justification for the mapping

- **PO1: Comprehensive Knowledge and Understanding**

  CO1 to CO7: All COs relate strongly to the understanding of fundamental microbiological concepts and laboratory practices, making them essential for mastering the subject matter.

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

  CO1, CO2, CO3, CO4, CO5, CO6**:** These outcomes involve practical skills and knowledge on laboratory procedures essential for performing microbiology tasks. CO7 is related but with a weaker emphasis on procedural knowledge.

- **PO3: Entrepreneurial Mindset and Knowledge**

  All COs**:** The relation is weak as the focus is on technical skills rather than entrepreneurial aspects in microbiology.

- **PO4: Specialized Skills and Competencies**

  CO2, CO3, CO4, CO5**:** Strongly relate to specialized skills in laboratory techniques and media preparation. Understanding microscopy and staining processes emphasizes the proficiency required in microbiology.

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

  CO2, CO4, CO5, CO6**:** Involves critical thinking and problem-solving skills essential for laboratory work, particularly in media preparation, microorganism identification, and maintaining culture purity.

- **PO6: Communication Skills and Collaboration**

  Weak relation for all COs**:** While successful laboratory work can enhance communication skills, the core focus is not on collaboration or communication in this context.

- **PO7: Research-related Skills**

  CO4, CO5, CO6**:** Associated with research methodologies in microbiology. Students applying staining techniques and conducting aseptic transfers develop foundational research skills.

- **PO8: Learning How to Learn Skills**

  Weak relation for all COs**:** The course outcomes focus on acquiring specific knowledge and skills rather than promoting self-directed learning strategies.

- **PO9: Digital and Technological Skills**

  Weak relation for all COs**:** While some laboratory techniques may involve technology, the emphasis is primarily on basic manual skills and techniques in microbiology.

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

  Weak relation for all COs: This aspect is not addressed in the COs, which are focused on technical skills and laboratory knowledge.

- **PO11: Value Inculcation and Environmental Awareness**

  Weak relation for all COs**:** The COs do not address values or environmental considerations directly, focusing instead on technical and procedural knowledge.

- **PO12: Autonomy, Responsibility, and Accountability**

  Weak relation for all COs**:** While COs emphasize responsibility in handling laboratory tasks, there is no explicit focus on autonomy or accountability within the overarching educational framework.

- **PO13: Community Engagement and Service**

  Weak relation for all COs**:** Although understanding microbiology can impact community health, the COs do not incorporate explicit community engagement elements.

SYLLABUS (CBCS as per NEP 2020) For S.Y.BSc. Microbiology

(2024 Pattern)

Name of the Programme	**: B.Sc. Microbiology**
Program Code	**: USMI**
Class	**: S.Y. BSc.**
Semester	**: III**
Course Type	**: Open Elective (Theory)**
Course Name	**: Human Health and Microbes**
Course Code	**: MIB-208-OE**
No. of Lectures	**: 30**
No. of Credits	**: 02**

	Course Objective:
1.	Develop a comprehensive understanding of microbial pathogens, including bacteria, viruses, fungi, and parasites, and their roles in causing diseases in humans.
2.	Classify microbial diseases based on the type of pathogen and mode of transmission.
3.	Examine the principles of disease transmission and epidemiology, including modes of transmission, reservoirs, and factors influencing disease spread.
4.	Evaluate the principles of disease treatment, including the use of antimicrobial agents, vaccines, and strategies for disease prevention and control.
5.	Analyze the global impact of microbial diseases. 6. Consider the ethical, social, and cultural dimensions of microbial diseases.
6.	Consider the ethical, social, and cultural dimensions of microbial diseases.
7.	Promote interdisciplinary learning by integrating concepts from microbiology, immunology, epidemiology, and public health to better understand and address microbial diseases.

	Course Outcomes:
1.	**CO1:** Able to understand different microbial pathogens, including bacteria, viruses, fungi, and parasites, and their roles in causing diseases in humans
2.	**CO2:** Students can classify microbial diseases based on the type of pathogen, mode of transmission and acquire knowledge disease epidemiology
3.	**CO3:** Exploration of the cellular interactions between microbes and the human immune system
4.	**CO4:** Can evaluate the use of antimicrobial agents, vaccines, and strategies for disease prevention and control.
5.	**CO5:** Students will acquire understanding of normal microflora of human body
6.	**CO6:** Know commondiseases caused by bacteria, viruses and other microbes.
7.	**CO7:** Aware about handling of microorganisms in the laboratory.

Credits	Topics and Learning Points	Teaching Hours
I	**Disease and Immunity**	**15**
	• Definition of disease and types of causative agents	**2**
	• Sources of infection: human, animal, insects, soil, water and food	**3**
	• Routes of entry of pathogens	**2**
	• Modes of transmission of diseases: direct contact, air-borne, water-borne, food-borne, insect-borne	**4**
	•Immunity and its classification	**4**
II	**Microbial Diseases: Causative agent, Treatment, Prevention, Diagnosis of the following diseases**	**15**
	•Typhoid	**3**
	•Dengue	**3**
	•Malaria	**3**
	•Rickettsial fever	**3**
	•Routes of drug administration	**3**

Reference Books

1. Ananthanarayan R and Paniker CKJ. Textbook of Microbiology. 7th Edition. University Press Publication. (2005).

2. Brooks GF, Carroll KC Blue S and M SA Jawetz, Melnick and Adelberg's Medical Microbiology. 24 123 of 139 Publication. (2007).

3. Goering R, Dockrell H, Zuckerman M and Wakelin D. Mims Medical microbiology, 4edition. Elsevier. (2007).

4. Bernard, Davis B. Dulbecco, Eisen and Ginsberg. Microbiology including immunology and molecular Genetics. 3rd Edition

5. Roitt I. Essential Immunology. 10" Ed. Blackwell Science.

6. Kuby. Immunology, 4 edition. W. H. Freeman & company.

7. Ellen Strauss, James Strauss. Viruses and Human Disease 2nd Edition. Academic Press

8. Christopher Burrell Colin Howard Frederick Murphy Fenner and White's Medical Virology 5th Edition. Academic Press

9. Patrick R. Murray PhD. Ken S. Rosenthal PhD.Michael A. Pfaller MD Medical microbiology Elsvier

10. Jawetz.Medicalmicrobiology.Me. Graw Hill

11. 11. Kenneth, J. Ryan Medical microbiology, Sherri's an introduction to infectious diseases Me. Graw Hill

Mapping of course outcomes and programme outcomes:

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

Course: Human Health and Microbes (Theory)

Course code: MIB-208-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			3				3					
CO2	3	3			3		3	2					
CO3	3			3	3			3					
CO4		3	3	3	3		3		3		3		
CO5	3												
CO6	2												
CO7		3		3							3	3	

Justification for the mapping:

PO1: Comprehensive Knowledge and Understanding:

CO1, CO2, CO3, CO5, CO6 Provides Students gain foundational and broad knowledge about microbes, their roles in disease, and their interactions with the human body.

PO2: Practical, Professional, and Procedural Knowledge:

CO2, CO4, CO7 Provides Students apply practical knowledge of microbial classific

ation, disease prevention strategies, and laboratory safety.

PO3: Entrepreneurial Mindset and Knowledge:

CO4 Provides The ability to evaluate antimicrobial agents, vaccines, and disease control strategies may encourage innovation, such as creating new disease prevention methods or working in a biotechnology startup.

PO4: Specialized Skills and Competencies:

CO1, CO3, CO4, CO7 Provides Developing specialized skills in microbiology, immunology, and laboratory techniques.

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

CO2, CO3, CO4 Provides Analyzing disease epidemiology, immune responses, and evaluating treatments or control measures.

PO7: Research-related Skills:

CO2, CO4 Provides Researching microbial diseases, their transmission, and disease control methods.

PO8: Learning How to Learn Skills:

CO1, CO2, CO3 Provides Students develop the ability to continuously learn about new pathogens, scientific methods, and emerging treatments.

PO9: Digital and Technological Skills:

CO4 Provides Knowledge of digital tools for evaluating antimicrobial agents, vaccines, and other preventive measures, including the use of online databases and laboratory technologies.

PO11:Value Inculcation and Environmental Awareness:

CO4, CO7 Provides Understanding the ethical implications of working with microbes and the importance of proper laboratory safety and environmental sustainability.

PO12:Autonomy, Responsibility, and Accountability:

CO7 Provides Students take responsibility for following lab safety procedures and working independently in a lab environment.

CBCS Syllabus as per NEP 2020 for S.Y.B.Sc. Microbiology (2024 Pattern) (w.e.f. June 2025)

Name of the Programme : B.Sc. Microbiology
Programme Code : USMI
Class : S.Y.B.Sc.
Semester : III
Course Type : Indian Knowledge System (IKS)
Course Code : MIB-209-IKS
Course Title : Ethno-Microbiology
No. of Credits : 02
No. of Teaching Hours : 30

Course Objectives:

1. To enrich students' knowledge about the traditional Indian fermented foods.
2. To allow students to understand about various benefits of Indian fermented foods.
3. To help students to understand fermentation process.
4. To allow students to understand microbiology behind the fermentation of food.
5. To allow students to understand fermentation of food, translate concepts to real-life
6. situations and apply acquired competencies in new/unfamiliar contexts
7. To allow students to preserve and pass on the knowledge of ethnic fermented food.

Course Outcomes:

CO1 The student should be able to apply the knowledge fermentation in food preparation.
CO2 Graduates should be able to demonstrate the acquisition of comprehensive knowledge and coherent understanding of ethnic fermented food.
CO3 Graduates should be able to demonstrate the acquisition of comprehensive knowledge and coherent understanding of fermentation process.
CO4 Graduates should be able to demonstrate the acquisition of comprehensive knowledge and coherent understanding of microorganism's role in fermentation.
CO5 Graduates should be able to demonstrate the acquisition of comprehensive knowledge and coherent understanding of benefits of ethnic fermented food.
CO6 Graduates should be able to preserve and pass on the knowledge of ethnic fermented food.
CO7 Awareness amongst the youths about the true history and rich culture of the country.

	Topic and Learning Points	Teaching Hours
Unit 1	**Introduction to Ethno-Microbiology**	**06**
	Definition of Ethno-microbiology Introduction to Fermentation Historic and cultural heritage of Indian fermented foods Types of ethnic fermented foods Benefits of fermented food	

Unit 2	**Curd Fermentation**	**06**
	Procedure of curd setting Microorganisms present in curd Role of microbes in setting curd Benefits of consuming curd	

Unit 3	**Idli Fermentation**	**06**
	Preparation of idli batter and idli Microorganisms present in idli batter Role of microbes in fermenting idli batter Benefits of consuming idli	

Unit 4	**Jilebi Fermentation**	**06**
	Preparation of Jilebi batter and Jilebi Microorganisms present in Jilebi batter Role of microbes in fermenting Jilebi batter Benefits of consuming Jilebi	

Unit 5	**Ethnic Fermented Foods and Beverages of Maharashtra**	**06**
	Different Ethnic Fermented Foods and Beverages of Maharashtra Methods of Preparation, Mode of Consumption and Microorganisms of: 1. Shrikhand 2. Mattha 3. Ambil 4. Amboli 5. Raw Mango Pickle (Lonche)	

References:

1. Bamforph, C. W. 2005. Food, Fermentation and Microorganisms. Blackwell Pubs.
2. Buchanan, R. L. and Whiting, R. C. 1994. Pathogen Modelling Program Version 4.0. Microbial Safety Research Unit. USDA ARS Eastern Regional Research Centre.
3. Harrigan, W. P. 1988. Laboratory Methods in Food Microorganism. 3rd. Ed. Academic Press. San Diego.
4. Jay, J. M. 2000. Modern Food Microbiology. CRC Press. London.
5. Lund, B. M., Parker, T. C. and Gould, G. W. 2000. The Microbiological Safety and Quality of Food. Vol 1 & 2.
6. Marianne, D., MiliotisdanJefrey, W. B. 2003. International Handbook of foodborne pathogens. Marcell & Decker Inc.

7. Marriot, N. G. and Gravani, R. B. 2006. Principles of Food Sanitation. 5th Edition. Springer Publ.
8. Ray,B. 2001. Fundamental Food Microbiology. CRC Press. London.
9. Lelieveld, H. L. M., Mostert, M. A., Holah, J. and White, W. 2003. Hygiene in food processing. CRC Press, New York

Mapping of Course outcomes and programme outcomes

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

Course Outcomes (COs)	Programme Outcome (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	3	2	3	3	2	2	2	2	1	1	2	2
CO2	3	2	1	2	2	2	2	2	1	3	3	2	2
CO3	3	3	2	3	3	2	2	2	2	1	1	3	2
CO4	3	2	1	3	3	2	2	2	2	1	1	3	2
CO5	3	2	1	2	2	2	3	3	2	3	3	2	2
CO6	3	2	1	3	2	2	3	3	1	3	3	3	3
CO7	2	2	2	1	1	2	3	3	1	3	3	2	3

CO1: Apply knowledge of fermentation in food preparation
PO1 (Comprehensive Knowledge and Understanding): Strong relation as it directly involves applying foundational knowledge.
PO2 (Practical Knowledge): Strong relation because applying fermentation techniques requires practical knowledge.
PO4 (Specialized Skills and Competencies): Strong relation since it requires technical skills and problem-solving in food preparation.
PO5 (Application and Problem-Solving): Strong relation due to the need to apply theoretical knowledge in practical scenarios.

CO2: Knowledge of ethnic fermented food
PO1 (Comprehensive Knowledge): Strong relation, as it involves in-depth understanding of the specific cultural and historical context.
PO10 (Multicultural Competence): Strong relation, as it focuses on understanding ethnic foods and cultures.
PO11 (Environmental Awareness): Strong relation, as understanding ethnic foods might include awareness of sustainable practices in food production.

CO3: Knowledge of fermentation process
PO1 (Comprehensive Knowledge): Strong relation due to the direct connection between theoretical understanding and practical application.
PO2 (Practical Knowledge): Strong relation, as understanding fermentation processes requires a significant amount of practical and technical knowledge.

PO4 (Specialized Skills): Strong relation, as this involves specialized technical skills in microbiology and chemistry.
PO5 (Application and Problem-Solving): Strong relation, since fermentation involves problem-solving and applying learned knowledge to produce results.
PO12 (Autonomy and Accountability): Strong relation, as the fermentation process requires responsibility and independent work.

CO4: Demonstrate knowledge of microorganisms' role in fermentation
PO1 (Comprehensive Knowledge): Strong relation, as understanding microorganisms is foundational to fermentation.
PO4 (Specialized Skills): Strong relation, as a deep understanding of microorganisms requires specialized knowledge and skills.
PO5 (Application and Problem-Solving): Strong relation, as applying microbial knowledge in practical scenarios such as fermentation requires problem-solving abilities.
PO12 (Autonomy and Accountability): Strong relation, as mastering knowledge of microorganisms requires independent study and application.

CO5: Demonstrate knowledge of benefits of ethnic fermented food
PO1 (Comprehensive Knowledge): Strong relation, as understanding the health and cultural benefits of ethnic fermented foods requires comprehensive knowledge.
PO7 (Research Skills): Moderate relation, as some research may be required to understand the health benefits of fermented foods.
PO8 (Learning How to Learn): Moderate relation, as students must continuously update their knowledge on health trends and nutritional benefits.
PO10 (Multicultural Competence): Strong relation, as understanding ethnic foods involves respecting cultural differences and recognizing diverse perspectives.
PO11 (Environmental Awareness): Strong relation, as fermented foods can have environmental and sustainability benefits, particularly in traditional food preservation.

CO6: Preserve and pass on knowledge of ethnic fermented food
PO1 (Comprehensive Knowledge): Strong relation, as preserving and passing on this knowledge requires deep understanding.
PO4 (Specialized Skills): Moderate relation, as students may need to develop specialized skills to document or teach about ethnic foods.
PO7 (Research Skills): Strong relation, as preservation of knowledge could involve research and data collection about traditional practices.
PO8 (Learning How to Learn): Strong relation, as students will need to continue learning to preserve cultural and food traditions.
PO10 (Multicultural Competence): Strong relation, as this outcome is directly related to cultural knowledge and promoting multicultural understanding.
PO11 (Environmental Awareness): Strong relation, as preserving ethnic fermented food may be linked to sustainability and responsible food practices.

PO12 (Autonomy and Accountability): Strong relation, as preserving knowledge requires independent responsibility and accountability.
PO13 (Community Engagement): Strong relation, as this outcome could be directly tied to community outreach and passing on cultural knowledge.

CO7: Awareness of the history and rich culture of the country
PO7 (Research Skills): Moderate relation, as researching cultural history and heritage would require inquiry skills.
PO8 (Learning How to Learn): Moderate relation, as this outcome requires the ability to learn about historical and cultural contexts.
PO10 (Multicultural Competence): Strong relation, as this outcome is fundamentally about understanding and engaging with different cultures.
PO11 (Environmental Awareness): Strong relation, as cultural history often ties to environmental practices and traditions.
PO13 (Community Engagement): Strong relation, as awareness of cultural history directly ties to engaging with and serving the community.

HEAD
Department of Microbiology
Tuljaram Chaturchand College
Baramati, Dist. Poona