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

(2023 Pattern) (As Per NEP 2020)

F. Y. B. Sc. Microbiology

Semester I

To be implemented from Academic Year 2023-2024

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 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.

Eligibility:

First Year B.Sc.:

A. Higher Secondary School Certificate (10+2) or its equivalent Examination with English and Biology; and two of the science subjects such as Physics, Chemistry, Mathematics, Geography, Geology, etc.

OR

B. Diploma in Pharmacy Course of Board of Technical Education conducted by Government of Maharashtra or its equivalent.

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

From 2022-23 to 2024-25

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

Credit Distribution Structure for F.Y.B.Sc. 2023-2024 (Microbiology) (2023 Pattern)

Level	Semester	Major		Minor	OE	VSC, SEC, (VSEC)	AEC, VEC, IKS	OJT, FP, CEP, CC, RP	Cum. Cr/ Sem	Degree/ Cum.Cr.
		Mandatory	Electives							
4.5	I	MIB-101-MJM Introduction to Microbiology(2 credits) (Theory)	-	–	MIB-116-OE Microorganisms for HumanWelfare (2 credits) (Theory)	MIB-121-VSC Agricultural Microbiology (2 credits) (Theory)	ENG-131-AEC Functional English-I (2 credits) (Theory)	CC (2 credits) (YOG/ PES/ CUL/NSS/ NCC)	22	UG Certificate 44 credits
		MIB-102-MJM Basic Techniques inMicrobiology (2 credits) (Theory)					MIB-135-VEC Environmental Science-I (2 credits) (Theory)			
		MIB-103-MJM Laboratory Procedures in Microbiology(2 Credits) (Practical)			MIB-117-OE Food, Agricultural and Pharmaceutical Microbiology (2 credits) (Practical)	MIB-126-SEC Microbiology Laboratory Techniques (2 credits) (Practical)	MIB-137-IKS Ethno-Microbiology (2 credits) (Theory)			
	II	MIB-151-MJM Basic Biochemistry & Bacterial cytology (2credits) (Theory)		MIB-161-MN Basic Medical Microbiology (2 credits) (Theory)	MIB-166-OE Food Microbiology (2 credits) (Theory)	MIB-171-VSC Agriculture Microbiology (2 credits) (Practical)	ENG-181-AEC Functional English-II (2 credits) (Theory)	YOG/ PES/ CUL/NSS/ NCC-189-CC (2 credits)	22	
		MIB-152-MJM Fundamental Microbiology(2 credits) (Theory)			MIB-167-OE Biofertilizer Production (2 credits)(Practical)	MIB-176-SEC Clinical pathology(2 credits) (Practical)	COS-185-VEC Digital and Technological Solutions (2 credits) (Theory)			
		MIB-153-MJM Techniques in Microbiology (2 credits) (Practical)								
	Cum Cr.	12		2	8	8	10	4	44	

Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati
(Autonomous)
Course Structure for F.Y. B. Sc. Microbiology (2023 Pattern)

Semester	Course Type	Course Code	Course Name	Theory/ Practical	Credits	Marks (I + E)
I	Major Mandatory	MIB-101-MJM	Introduction to Microbiology	Theory	02	20+30
	Major Mandatory	MIB-102-MJM	Basic Techniques in Microbiology	Theory	02	20+30
	Major Mandatory	MIB-103-MJM	Laboratory Procedures in Microbiology	Practical	02	25+25
	Open Elective (OE)	MIB-116-OE	Microorganisms for Human Welfare	Theory	02	20+30
	Open Elective (OE)	MIB-117-OE	Food, Agricultural and Pharmaceutical Microbiology	Practical	02	25+25
	Vocational Skill Course (VSC)	MIB-121-VSC	Agricultural Microbiology	Theory	02	20+30
	Skill Enhancement Course (SEC)	MIB-126-SEC	Microbiology Laboratory Techniques	Practical	02	25+25
	Ability Enhancement Course (AEC)	ENG-131-AEC	Functional English-I	Theory	02	20+30
	Value Education Course (VEC)	MIB-135-VEC	Environmental Science-I	Theory	02	20+30
	Indian Knowledge System (IKS)	MIB-137-IKS	Ethno-Microbiology	Theory	02	20+30
	Co-curricular Course (CC)		NSS/NCC/Yoga/Cultural activities/Sports	Theory	02	20+30
	Total Credits Semester-I				22	
II	Major Mandatory	MIB-151-MJM	Basic Biochemistry & Bacterial cytology	Theory	02	20+30
	Major Mandatory	MIB-152-MJM	Fundamental Microbiology	Theory	02	20+30
	Major Mandatory	MIB-153-MJM	Techniques in Microbiology	Practical	02	25+25
	Minor	MIB-161-MN	Basic Medical Microbiology	Theory	02	20+30
	Open Elective (OE)	MIB-166-OE	Food Microbiology	Theory	02	20+30
	Open Elective (OE)	MIB-167-OE	Biofertilizer Production	Practical	02	20+30
	Vocational Skill Course (VSC)	MIB-171-VSC	Agriculture Microbiology	Practical	02	25+25
	Skill Enhancement Course (SEC)	MIB-176-SEC	Clinical pathology	Practical	02	25+25
	Ability Enhancement Course (AEC)	ENG-181-AEC	Functional English-II	Theory	02	20+30
	Value Education Course (VEC)	COS-185-VEC	Digital and Technological Solutions	Theory	02	20+30
	Co-curricular Course (CC)	YOG/ PES/ CUL/NSS/ NCC-189-CC	NSS/NCC/Yoga/Cultural activities/Sports	Theory	02	20+30
	Total Credits Semester-II				22	
	Cumulative Credits Semester I + Semester II				44	

CBCS Syllabus as per NEP 2020 for F.Y.B.Sc. Microbiology (2023 Pattern)

Name of the Programme : **B.Sc. Microbiology**

Program Code : **USMIB**

Class : **F.Y.B.Sc.**

Semester **I**

Course Type : **Major Mandatory (Theory)**

Course Code : **MIB-101-MJM**

Course Title : **Introduction to Microbiology**

No. of Credits **02**

No. of Teaching Hours **30**

Course Objectives:

1. To enrich the knowledge of undergraduate science faculty students about the different areas of microbiology.
2. To allow students to understand the mysterious world of microorganisms.
3. To explain the various categories of microorganisms and their general characteristics.
4. To make students understand the role of beneficial microorganisms present in different habitats.
5. To allow students to understand the general classification scheme of living things.
6. To understand the historical developments in the field of microbiology.
7. To enrich students' knowledge about recent inventions and discoveries in microbiology.

Course Outcomes:

CO1 The students will acquire the basic knowledge of microbiology fields by thefreshers in microbiology.

CO2 The students will be aware of the importance of microorganisms concerning beneficial and harmful impacts on society.

CO3 The students shall be aware of modern microbial technology for future developments.

CO4 The students will be able to distinguish the different categories of microorganisms.

CO5 The students will be able to identify the various processes happening in the surrounding domestic environment in which microbes are involved.

CO6 Understanding the historical developments in microbiology, students shall earn knowledge about setting up basic experiments.

CO7 Students shall learn about the theory of the origin of life and the experimental setups leading to different conclusions.

CO8 Students shall learn about how different experimental setups led to different conclusions.

CO9 Understanding the significant developments in recent times shall direct the students in the selection of microbiology fields for the future.

	Topic & Learning Points	Teaching Hours
Unit 1	**Scope and Application of Microbiology** a. Industrial Microbiology and Biotechnology b. Medical Microbiology c. Immunology d. Microbial Genetics e. Geomicrobiology f. Food and Dairy Microbiology g. Nano-Biotechnology	**4**
Unit 2	**Applications of Microbiology with special reference to:** a. Significance of normal flora and probiotics in human health b. Microbes as Biofertilizers (e.g. Nitrogen fixers, Phosphate solubilizers) and Biocontrol Agents (*Bacillus thuriengensis*) c. Use of bacteriophages as biocontrol agents in agriculture	**4**
Unit 3	**Morphological and differentiating characters ofmicroorganisms:** a. Whittaker five Kingdom classification system b. Structures of prokaryotic and eukaryotic cell c. Bacteria: (Eubacteria, Archaebacteria, Rickettsia, Chlamydia,Actinomycetes, Mycoplasma and bacterivorous bacteria); Introduction to Bergey's Manual of Determinative and Systemic Bacteriology d. Protozoa e. Algae f. Fungi (Molds and Yeasts) g. Viruses (Animal & plant viruses, Bacteriophages) h. Viroids and prions	**8**
Unit 4	**History of Microbiology** a. Invention of microscope (Micrographia of Antony van Leeuwenhoek and Robert Hooke) b. Abiogenesis v/s biogenesis i. Aristotle's notion about spontaneous generation; Needham's experiment ii. Redi's experiment iii. Louis Pasteur's & Tyndall's experiments	**4**
Unit 5	**Development of Microbiology in 19th century** a. Observations and role of microorganisms in transformation of organic matter. i. Germ theory of fermentation ii. Discovery of anaerobic life & physiological significance offermentation b. Discovery of microbes as pathogens and disease prevention	**7**

i. Surgical antisepsis (Joseph Lister-Father of modern surgery)
ii. Germ theory of disease – Robert Koch's experiment, Koch's & River's postulates
iii. Vaccination: Edward Jenner and Louis Pasteur – chicken choleraand Rabies

Unit 6 Developments in 20th and 21st Centuries with respect to: 3

a. Chemotherapy : Paul Ehrlich, Domagk, Walkman and Alexander Fleming
b. Contributions of Nobel Laureates (Elie Metchnikoff, Burnett, George Beadle, Edward Tatum, Porter and Edelman, Kohler andMilstein)
c. Molecular Biology & Biotechnology: Watson and Crick and Hargobind Khurana

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:

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

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

PO1 **Disciplinary Knowledge:**

CO1:The basics of different fields of microbiology shall belearnedby thestudents.

CO2: The students shall learn about the importance of microbes in life.

CO3: The students shall be able to differentiate among the categories of microbes.

CO4: Students shall learn about the different categories of microorganisms.

CO7:The students shall gain knowledge about the recent developments in microbiology.

PO2 **Critical Thinking and Problem Solving:**

CO5: The students shall be aware of the basic knowledge required for setting up experiments.

CO7:The students shall know about the important experiments performed by different researchers.

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

CO6:The students will be able to learn basic experimental techniques.

CO7: Understanding modern microbiological developments shall help students to develop scientific temper.

PO6 **Personal and professional competence**

CO1: The students will be able to learn different areas and linkages of microbiology subject.

CO4: Students shall understand different categories of microbes and its relatedness with other sciences.

CO5: Students shall inculcate the ideas about the experimental setups.

PO8 **Environment and sustainability**

CO1: Students shall understand the environmental microbiology area of microbiology.

CO2: Students will acquire knowledge about the role of microbes in environment.

CO7: Understanding modern developments shall help students to know advanced microbiological technology for sustainable development.

PO9 **Self directed and life long learning**

CO1: Students shall gain knowledge about the areas of microbiology that shall benefit students for a long period in learning process.

CO2: The students will understand the roles of microbes in real life workings.

CO3: This knowledge shall benefit students till completion of undergraduate and post graduate studies.

CO4: Understanding microbial diversity shall help students to distinguish microbes.
CO5: Students shall learn the techniques for setting up of experiments.

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

(2023 Pattern)

Name of the Programme	**: B.Sc. Microbiology**
Program Code	**: USMIB**
Class	**: F.Y.B.Sc.**
Semester	**I**
Course Type	**: Major Mandatory (Theory)**
Course Code	**: MIB-102-MJM**
Course Title	**: Basic Techniques in Microbiology**
No. of Credits	**02**
No. of Teaching Hours	**30**

Course Objectives:

1. To introduce students to the fundamental principles and techniques used in microbiology, focusing on microscopy, staining, and sterilization methods.
2. To familiarize students with the different types of microscopes, their components, and their applications in microbiological research.
3. To provide students with an understanding of the principles and procedures involved in staining techniques for microbial visualization and differentiation.
4. To introduce students to the principles and applications of different types of microscopy, such as bright-field, fluorescence and electron microscopy
5. To develop students' theoretical knowledge of microscope maintenance, calibration, and troubleshooting.
6. To enable students to comprehend the significance of proper staining techniques in microbial identification and classification.
7. To enhance students' understanding of the importance of aseptic techniques and sterilization in preventing contamination and ensuring accurate experimental results.

Course Outcomes:

CO1. Students will be able to understand the principle and functioning of different types of microscopes and their components.

CO2. Students will acquire knowledge of the different staining techniques used in microbiology, including simple staining, differential staining

CO3. Students will demonstrate an understanding of the applications and limitations of different microscopy techniques in microbiology research and diagnostics

CO4. Students will be able to explain the importance of sterilization techniques in maintaining aseptic conditions in the laboratory and preventing contamination.

CO5. Students will gain knowledge about performing sterilization and disinfection methods

CO6. Students will recognize the importance of aseptic techniques and sterile handling in microbiological experiments, ensuring accurate results.

CO7. Students will applying the learned techniques to analyze and interpret experimental data in the context of microbiology.

Topic & Learning Points	Teaching Hours

UNIT1: Microscopy **10**

• Structure, working and ray diagram of Bright Field Microscopy

• Concepts of Magnification, Numerical Aperture and Resolving Power

• Types and functions of :

a) Condensers

b) Eye-pieces

c) Objectives

• Aberrations in lenses :(Spherical, Chromatic, Comma and Astigmatism)

• Principle and Applications of:

a) Fluorescence Microscopy

b) Electron Microscopy

UNIT2: Staining Techniques **10**

• Definitions of Stain; Types of stains (Basic and Acidic)

• Properties and role of Fixatives, Mordants, Decolorisers and Accentuators

• Principles of staining techniques of the following:

a) Monochrome staining

b) Negative (Relief) staining

c) Differential staining -(Gram staining and Acid-Fast staining)

UNIT3: Sterilization and Disinfection **10**

- Definition and concept of sterilization and disinfection

- Physical methods –
    a) Heat
    b) Radiation
    c) Filtration
- Chemical agents and their mode of action –
    a) Aldehydes
    b) Halogens
    c) Quaternary ammonium compounds
    d) Phenol and phenolic compounds
    e) Heavy metals
    f) Alcohol
    g) Detergents
- Characteristics of an ideal Disinfectant
- Concept of Phenol Coefficient

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.

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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:

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		2		
CO2		3		2			2	2	
CO3		3					3	2	
CO4				3				3	
CO5								2	
CO6					3		2	3	
CO7			3			3			2
CO8									

Justification for the mapping

PO1: Disciplinary Knowledge:

CO1 aligns with PO1 as it introduces students to the microbiology laboratory and familiarizes them with common microbiology laboratory instruments. This lays the foundation for disciplinary knowledge in microbiology.

PO2: Critical Thinking and Problem Solving:

CO2 and CO3 contribute to critical thinking as students attain proficiency in preparing and interpreting stained microbial slides, analyze and interpret microscopic images, and detail morphological features. These activities require analytical skills and problem-solving abilities.

PO3: Social Competence:

While the provided information doesn't explicitly mention social competence, the development of expertise in applied fields (CO7) implies the potential for interaction and collaboration in social and professional settings.

PO4: Research-related Skills and Scientific Temper:

CO4 emphasizes the understanding of the importance of proper microscope maintenance, calibration, and troubleshooting, which is crucial for scientific temper and aligns with research-related skills in a laboratory setting.

PO5: Trans-disciplinary Knowledge:

CO6, which involves enumerating and quantifying microorganisms through various methods, may require knowledge from multiple disciplines such as statistics and mathematics, contributing to trans-disciplinary knowledge.

PO6: Personal and Professional Competence:

CO7 directly aligns with PO6, as it aims to develop expertise enabling students to engage in applied fields such as industry or institutions without additional training, showcasing personal and professional competence.

PO7: Self-directed and Life-long Learning:

CO1, CO2, CO3, and CO6 collectively contribute to self-directed learning by providing students with the foundational skills and knowledge needed for further exploration and application in microbiology beyond the course.

PO8: Environment and Sustainability:

While the provided information does not explicitly address environmental aspects, the skills developed in microscopy and microorganism analysis (CO2, CO3, CO4, CO5, CO6) indirectly contribute to environmental and sustainability concerns, especially in areas such as food and water safety.

PO9: Self-directed and Life-long Learning:

CO7 further reinforces the idea that students are equipped to directly engage in applied fields without additional training, emphasizing the continuous learning aspect throughout their professional life.

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

(2023 Pattern)

Name of the Programme	**: B.Sc. Microbiology**
Program Code	**: USMIB**
Class	**: F.Y.B.Sc.**
Semester	**I**
Course Type	**: Major Mandatory Practicals**
Course Code	**: MIB-103-MJM**
Course Title	**: Laboratory Procedures in Microbiology**
No. of Credits	**02**
No. of Teaching Hours	**60**

Course Objectives:

1. To enrich students' knowledge and train them in core Microbiology
2. To teach students the various methods of sterilization and their significance in maintaining aseptic conditions in the laboratory.
3. To provide students with hands-on experience in microbial staining techniques for microscopic examination.
4. Students will get acquainted with skills of aseptic culture technique
5. To introduce students to the techniques of microbial enumeration and quantification
6. To make students proficient at laboratory skills and safety procedures.
7. Students will develop critical thinking and problem-solving

Course Outcomes:

CO1. Students will be Introduced to microbiology laboratory and common microbiology laboratory instruments.

CO2. Students will gain proficiency in preparing and interpreting stained microbial slides under the microscope.

CO3. Students will be able to analyze and interpret microscopic images of microorganisms and describe their morphological features.

CO4. Students will understand the significance of proper microscope maintenance, calibration, and troubleshooting for optimal microscopy results.

CO5. Students will be able to perform staining techniques to visualize and differentiate microorganisms under the microscope.

CO6. Students will gain knowledge Students will be able to enumerate and quantify microorganisms using different methods

CO7. Students will get expertise to work directly in applied fields (industry or institutions), without any additional training.

No of Experiments	Topic	Teaching Hours
1	Introduction to microbiology laboratory instruments: Incubator, Hot Air Oven, Autoclave	4
2	Introduction to microbiology laboratory instruments: Colorimeter, pH Meter, Laminar air flow hood, Centrifuge	4
3	Construction (mechanical and optical), working and care of Bright Field Microscope	4
4	Observation of Microorganisms (Bacteria, Protozoa, Molds and Yeasts, Algae) using bright field microscope from pond water	4
5	Observation of Microorganisms (Bacteria, Protozoa, Molds and Yeasts, Algae) using bright field microscope wastewater	4
6	Preparation of Winogradsky column and observation of different types of microorganisms using bright field microscope	4
7-10	Observation of bacteria using staining techniques: a. Monochrome staining b. Negative /Relief staining c. Capsule staining (Maneval's method) d. Gram staining	4 4 4 4
11	Observation of motility in bacteria using: Hanging Drop Method	4
12	Enumeration of cells using Neubauer chamber	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 juices, milk, soil, pond water, wastewater	4

References:

1. James G. Cappuccino and Natalie Sherman (2014) Microbiology: A Laboratory Manual, 10th Edition Pearson.

2. David T. Plummer (2010) An introduction to practical biochemistry: By McGraw-Hill

3. Dr. R.C. Dubey and Dr. D.K. Maheshwari (2010) - Practical Microbiology

4. Burton E.Pierce and Michael J.Leboffe(2012) Microbiology laboratory theory and application 3rd edition

5. Harley J. P. and Prescott L. (2020). Laboratory Exercises in Microbiology. Independently Published.

6. Karwa A.S., Rai M.K. and Singh H.B. (2012). Handbook of Techniques in Microbiology: A Laboratory Guide to Microbes. Scientific Publishers, Jodhpur, Rajasthan, India

7.Kumar V. (2012). Laboratory Manual of Microbiology. Scientific Publishers, Jodhpur, Rajasthan, India

8. Sastry A. S. and Bhat S. K. (2017). Essentials of Practical Microbiology. Jaypee Brothers, Medical Publishers Private Limited, Pune, Maharashtra, India

Mapping of course outcomes and programme outcomes:

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		1				2		3
CO2		3	2				2	2	2
CO3		3	2				2	1	2
CO4			2	3				2	1
CO5			1					1	3
CO6			1		2		2	2	2
CO7						3			
CO8									2

Justification for the mapping

PO1: Disciplinary Knowledge:

CO1 corresponds to PO1 by introducing students to the microbiology laboratory environment and acquainting them with commonly used instruments, establishing the groundwork for disciplinary knowledge in microbiology

PO2: Critical Thinking and Problem Solving:

CO2 and CO3 contribute to the cultivation of critical thinking as students acquire proficiency in preparing and interpreting stained microbial slides, along with analyzing microscopic images, demanding analytical skills and problem-solving capabilities.

PO3: Social Competence:

The hands-on nature of microbiology labs (as suggested in CO1, CO2, CO3, CO4, CO5, CO6) may entail collaborative work, indirectly fostering social competence within a laboratory environment.

PO4: Research-related Skills and Scientific Temper:

CO4 underscores the significance of proper microscope maintenance, calibration, and troubleshooting, aligning with research-related skills and nurturing a scientific temper within the laboratory setting**.**

PO5: Trans-disciplinary Knowledge:

CO6 introduces students to the enumeration and quantification of microorganisms using various methods, necessitating knowledge from diverse disciplines and contributing to trans-disciplinary knowledge.

PO6: Personal and Professional Competence:

CO7 directly corresponds to PO6, aiming to cultivate expertise that empowers students to seamlessly participate in applied fields without the need for additional training, showcasing both personal and professional competence

PO7: Self-directed and Life-long Learning:

CO1, CO2, CO3, and CO6 collectively contribute to fostering self-directed learning by imparting foundational skills and knowledge, establishing the foundation for ongoing learning in microbiology beyond the course

PO8: Environment and Sustainability:

The skills developed in microscopy and microorganism analysis (CO2, CO3, CO4, CO5, CO6) may indirectly contribute to environmental and sustainability considerations, particularly in areas like food and water safety.

PO9: Self-directed and Life-long Learning:

Upon completing the course, students are equipped to directly engage in applied fields without additional training, reinforcing the concept of life-long learning throughout their professional journey.

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

(2023 Pattern)

Name of the Programme	**: B.Sc. Microbiology**
Program Code	**: USMIB**
Class	**: F.Y.B.Sc.**
Semester	**I**
Course Type	**: Open Elective (Theory)**
Course Code	**: MIB-116-OE**
Course Title	**: Microorganisms for Human Welfare**
No. of Credits	**02**
No. of Teaching Hours	**30**

Course Objective:

1. To enrich the knowledge of undergraduate science faculty students about the different areas of microbiology.
2. To allow students to understand the role of microorganisms in food fermentation.
3. To explain the various categories of microorganisms involved in agriculture.
4. To make students understand the role of beneficial microorganisms present in rhizosphere.
5. To allow students to understand the general characters of drugs produced in pharmaceutical industry.
6. To understand the use of different antibiotics in chemotherapy.
7. To enrich students' knowledge about developments in vaccine technology.

Course Outcome:

CO1. The students will acquire the basic knowledge of microbiology fields by the freshers in microbiology.

CO2. The students will be aware of the importance of microorganisms concerning beneficial role in foods.

CO3. The students shall be aware of modern microbial technology for agricultural developments.

CO4. The students will be able to distinguish the role of microorganisms in different fields of microbiology.

CO5. The students will be able to identify the various processes happening in the surrounding domestic environment in which microbes are involved.

CO6. Students shall earn knowledge about setting up basic experiments.

CO7. Students shall learn about the differences among drugs, antibiotics and vaccines.

CO8. Students shall learn about how different experimental setups led to different conclusions.

CO9. Understanding the significant developments in recent times in the development of vaccines.

	Topic & Learning Points	Teaching Hours
Unit 1	**Fermented food & it's products**	**10**
	Fermented Foods – Types, nutritional values and health benefits. Probiotics, prebiotics, synbiotics and nutraceuticals. Fermented Products – Alcoholic and non-alcoholic beverages, dairy products.	
Unit 2	**Agricultural Microbiology**	**10**
	Introduction to agricultural microbiology.	
	Bio-fertilizers and bio-pesticides - types and applications, beneficial microorganisms in agriculture, arbuscular mycorrhiza fungi, mushroom cultivation, biogas production	
Unit 3	**Pharmaceutical Microbiology**	**10**
	Introduction to pharmaceutical microbiology.	
	Drugs – types, development and applications. Antibiotics – types, functions and antibiotic therapy. Vaccines – types, properties, functions and schedules.	

References:

Ananthnarayanan, R and Jeyaram Panicker, C. K. 2010.Textbooks of Microbiology, Orient Longman.

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10. Willey, J.M., Sherwood L.M and Woolverton C.J., Prescott, Harley and Klein's. 2013. Microbiology. McGraw Hill Higher education. 9th Edition.

Mapping of Program Outcomes with Course Outcomes

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

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

Justification for the mapping

PO1: Disciplinary Knowledge:
The course outcomes encompass the basic knowledge of microbiology (CO1), understanding the impacts of microorganisms on society (CO2), awareness of modern microbial technology (CO3), and the ability to distinguish different categories of microorganisms (CO4), demonstrating alignment with disciplinary knowledge.

PO2: Critical Thinking and Problem Solving:
The ability to distinguish microorganisms and understand experimental setups for microbiological studies requires critical thinking. Identifying processes in the domestic environment involving microbes (CO5), understanding historical developments (CO6), and interpreting experimental setups leading to different conclusions (CO7, CO8) showcase critical thinking and problem-solving skills.

PO3: Social Competence:
The awareness of the beneficial and harmful impacts of microorganisms on society (CO2) reflects social competence as students understand the broader implications of microbiology on communities.

PO4: Research-related skills and Scientific temper:
Learning historical developments, setting up basic experiments, and understanding the theory of the origin of life (CO6, CO7) contribute to research-related skills. The exploration of different experimental setups and selecting microbiology fields for the future (CO8, CO9) reflects the development of a scientific temper.

PO5: Trans-disciplinary knowledge:
Awareness of the impacts of microorganisms on society (CO2), understanding modern microbial technology (CO3), and the ability to choose microbiology fields for the future (CO9) demonstrate trans-disciplinary knowledge as students relate microbiology to broader contexts.

PO6: Personal and professional competence:
All course outcomes contribute to the development of personal and professional competence by providing a comprehensive understanding of microbiology, its applications, and the skills needed for future developments.

PO8: Environment and Sustainability:
The awareness of the impacts of microorganisms on society (CO2) extends to environmental considerations, aligning with the focus on environment and sustainability.

PO9: Self-directed and Life-long learning:
Learning historical developments, experimental setups, and selecting microbiology fields for the future (CO6, CO8, CO9) fosters a mindset of self-directed and life-long learning.

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

(2023 Pattern)

Name of the Programme	**: B.Sc. Microbiology**
Program Code	**: USMIB**
Class	**: F.Y.B.Sc.**
Semester	**I**
Course Type	**: Open Elective (Practical)**
Course Code	**: MIB-117-OE**
Course Title	**: Food, Agricultural and Pharmaceutical Microbiology**
No. of Credits	**02**
No. of Teaching Hours	**60**

Course Objectives:

1. To enrich students' knowledge and train them in basic fermentation technology
2. To teach students the various methods of production of alcoholic beverages under laboratory conditions.
3. To provide students with hands-on experience in microbial production techniques.
4. Students will get acquainted with skills of aseptic culture techniques
5. To introduce students to the techniques of microbial production and quantification
6. To make students proficient at laboratory skills.
7. Students will develop critical knowledge about the domestic microbial processes.

Course Outcomes:

CO1. Students will be able to perform the production of alcoholic beverage in laboratory.

CO2. Students will understand the different types of raw materials that can be used in the production of alcoholic beverages.

CO3. Students will be able to analyze and interpret the results of use of different raw materials used.

CO4. Students will understand the significance of selection of microorganisms in different production processes.

CO5. Students will be able to learn about the troubleshooting of the problems associated with the production processes.

CO6. Students will gain knowledge about different start ups in microbiology.

CO7. Students will get the expertise to work directly in industrial sectors, without any additional training.

No of Experiments	Topic	Teaching Hours
1-4	Production of ethanol: a. using grape juice as raw material b. using jaggery medium as raw material c. assembly, decontamination, inoculation, incubation d. harvesting of broth	16
5	Production of curd	4
6-8	Production of mushrooms: a. Pretreatment of paddy straw b. Inoculation c. Production & harvesting	12
9-12	Production of biofertilizer: a. Isolation of *Azotobacter* sp. b. Biomass production c. Preparation of biofertilizer d. Application	16
13	Isolation of antibiotic producing microorganisms by crowded plate technique	4
14	Antibacterial activity assay	4
15	Antifungal activity assay	4

References:

1. James G. Cappuccino and Natalie Sherman (2014) Microbiology: A Laboratory Manual, 10th Edition Pearson.

2. David T. Plummer (2010) An introduction to practical biochemistry: By McGraw-Hill

3. Dr. R.C. Dubey and Dr. D.K. Maheshwari (2010) - Practical Microbiology

4. Burton E.Pierce and Michael J.Leboffe(2012) Microbiology laboratory theory and application 3rd edition

5. Harley J. P. and Prescott L. (2020). Laboratory Exercises in Microbiology. Independently Published.

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Mapping of Program Outcomes with Course Outcomes

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

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

Justification for the mapping

PO1: Disciplinary Knowledge:

The course outcomes cover the introduction to microbiology laboratory and instruments (CO1), proficiency in preparing stained microbial slides (CO2), analysis of microscopic images and description of morphological features (CO3), understanding microscope maintenance and troubleshooting (CO4), performing staining techniques (CO5), and enumerating microorganisms using different methods (CO6), all contributing to disciplinary knowledge in microbiology.

PO2: Critical Thinking and Problem Solving:

Analyzing and interpreting microscopic images (CO3), understanding the significance of microscope maintenance (CO4), performing staining techniques (CO5), enumerating microorganisms (CO6), and gaining expertise to work directly in applied fields (CO7) require critical thinking and problem-solving skills.

PO4: Research-related skills and Scientific temper:

Proficiency in preparing stained microbial slides (CO2), analyzing microscopic images (CO3), understanding microscope maintenance (CO4), performing staining techniques (CO5), and enumerating microorganisms (CO6) all contribute to the development of research-related skills and a scientific temper.

PO6: Personal and professional competence:

The course outcomes collectively contribute to the development of personal and professional competence by providing a range of laboratory skills and preparing students for direct entry into applied fields without additional training (CO7).

PO9: Self-directed and Life-long learning:

The course outcomes, especially the introduction to laboratory instruments (CO1), proficiency in preparing stained slides (CO2), understanding microscope maintenance (CO4), performing staining techniques (CO5), enumerating microorganisms (CO6), and gaining expertise to work directly in applied fields (CO7), contribute to fostering self-directed and life-long learning skills.

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

(2023 Pattern)

Name of the Programme	**: B.Sc. Microbiology**
Program Code	**: USMIB**
Class	**: F.Y.B.Sc.**
Semester	**I**
Course Type	**: Vocational Skill Course (Theory)**
Course Code	**: MIB-121-VSC**
Course Title	**: Agricultural Microbiology**
No. of Credits	**02**
No. of Teaching Hours	**30**

Course Objective :

1. To enrich the students knowledge about agricultural microbiology for building a pathway for sustainable agriculture.
2. To gain knowledge on several beneficial and harmful micro-organisms.
3. To know the complex interaction between agriculture system and micro-organism.
4. To make the students knowledgeable with respect to biofertilizer and biocontrol agents as a sense of social and environmental awareness.
5. To expose the students to various emerging areas of agricultural microbiology.
6. To develop their ability to apply the knowledge of agricultural microbiology in day to day life
7. To help students to buildup successful career.

Course Outcomes:

CO1 Students should be able to identify and classify different types of soil based on their physical and chemical characteristics

CO2 Students should gain a comprehensive understanding of the microbial community in soil, including the diversity of microorganisms and their interactions.

CO3 Students should be able to assess the microbial populations in the rhizosphere and phyllosphere and understand their roles in plant health.

CO4 Students should be able to explain how microorganisms contribute to soil fertility through processes such as nutrient cycling, organic matter decomposition, and plant-microbe interactions.

CO5 Understand the different mechanisms of biological nitrogen fixation (symbiotic, asymbiotic, and associative) and their importance in providing nitrogen to plants.

CO6 Integrate the principles of agricultural microbiology to recognize the scope and importance of microorganisms in soil and plant ecosystems, both for beneficial and harmful purposes.

CO7 Students should be able to define microbial biofertilizers, categorize types, and understand their application in sustainable agriculture.

Topic & Learning Points	Teaching Hours

Unit 1: Soil microbiology **10**

- Types of soil
- Microbial community in soil
- Microflora in Rhizosphere and Phyllosphere
- Role of microbes in soil fertility and crop production
- Biological nitrogen fixation (symbiotic, asymbiotic and associative).

Unit 2: Agricultural microbiology **10**

- Introduction to agricultural microbiology.
- Scope and importance of agricultural microbiology.
- Role of microorganisms in soil and plant ecosystems.
- Beneficial and harmful microorganisms in agriculture.

Unit 3: Microbiology for sustainable agriculture **10**

- Microbial biofertilizers: definition, types of biofertilizers.
- Biocontrol agents for plant diseases.
- Recent emerging trends in agricultural microbiology.

References:

1. Bagyaraj, D. J., & Rangaswami, G. (2007). *Agricultural microbiology*. PHI Learning Pvt. Ltd..
2. Brill, W. J. (1981). Agricultural microbiology. *Scientific American*, *245*(3), 198-215.
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Mapping of Program Outcomes with Course Outcomes

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

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

Justification for the mapping

PO1 **Disciplinary Knowledge:**

CO1: This outcome involves understanding soil science, which is a fundamental aspect of disciplinary knowledge.

CO2: Understanding the microbial community in soil is a key component of disciplinary knowledge in microbiology and environmental science.

CO3: The assessment of microbial populations and their roles directly contributes to disciplinary knowledge in microbiology and plant science.

CO4: Explaining microbial contributions to soil fertility involves understanding microbiological processes within the discipline.

CO5: Understanding nitrogen fixation mechanisms is a core aspect of disciplinary knowledge in soil science and microbiology.

CO6: Integration of principles in agricultural microbiology directly contributes to disciplinary knowledge in microbiology and agriculture.

CO7: Defining and categorizing microbial biofertilizers requires a solid understanding

of microbiology and its application in agriculture.

PO2 **Critical Thinking and Problem Solving:**

CO2: Understanding the microbial community requires critical thinking to analyze the complexity of interactions and diverse microorganisms involved..

CO6: Integrating principles across disciplines involves critical thinking to recognize the scope and importance of microorganisms, requiring problem-solving skills.

PO3 **Social Competence**

CO4: Explaining complex concepts may involve effective communication to convey information, contributing to social competence.s.

CO5: Understanding and discussing nitrogen fixation mechanisms may involve collaboration and communication with peers..

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

CO1: Involves observational and analytical skills related to soil characteristics, contributing to the development of research-related skills.

CO5: Understanding different mechanisms of nitrogen fixation involves research-related skills to explore and comprehend scientific literature.

CO6:Principles involves synthesizing information from various sources, demonstrating research-related skills, and fostering a scientific temper in understanding the broader scope and significance of microorganisms.

PO5 **Trans-disciplinary knowledge:**

CO1: The primary focus is on soil science, the identification and classification may involve considerations from related disciplines

CO7: Biofertilizers application involves knowledge from microbiology and sustainable agriculture, contributing to a moderate level of trans-disciplinary knowledge

PO6 **Personal and professional competence:**

CO2: Understanding microbial communities may contribute to personal and professional competence, especially if it involves interpreting complex interactions.

CO7: Defining and categorizing biofertilizers contributes to professional competence.

PO8 **Environment and Sustainability:**

CO3: Understanding microbial roles in plant health is crucial for environmental sustainability.

CO5: Knowledge of nitrogen fixation is important for sustainable agricultural practices.

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

CO1: This outcome may foster a degree of self-directed learning, especially if students are encouraged to explore additional resources on soil classification.

CO2: Developing a comprehensive understanding may encourage self-directed learning, especially as the field evolves.

CO7: Keeping up with advancements in biofertilizers may contribute to lifelong learning.

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

(2023 Pattern)

Name of the Programme	**: B.Sc. Microbiology**
Program Code	**: USMIB**
Class	**: F.Y.B.Sc.**
Semester	**I**
Course Type	**: Skill Enhancement Course (Practical)**
Course Code	**: MIB-126-SEC**
Course Title	**: Microbiology Laboratory Techniques**
No. of Credits	**02**
No. of Teaching Hours	**60**

Course Objectives:

1. To introduce students to the fundamental concepts and principles of microbiology and its practical applications.
2. To familiarize students with the basic laboratory techniques used in microbiology research and diagnostics.
3. To develop students' skills in aseptic technique and safe handling of microorganisms.
4. To enable students to understand and perform various methods of microbial cultivation
5. To teach students the principles and procedures involved in handling of instruments
6. To make student knowledgeable about microbiological techniques and the impact of microbes on our daily lives
7. To enhance students' understanding of laboratory safety practices and waste disposal methods in microbiology.

Course Outcomes:

CO1 To cater the needs of students for building up their careers in industry & research

CO2. To enrich student's knowledge and train them in core Microbiology.

CO3. To inculcate sense of scientific responsibilities, social and environment awareness

CO4. Students will be able to get hand on traning to operate and handle the Laboratory instruments

CO5. Students will be able to demonstrate proficiency in aseptic technique and proper handling of microorganisms.

CO6. Students will acquire the skills to cultivate different types of microorganisms using various media and techniques.

CO7: To help students build-up a progressive and successful career.

No of Experiments	Topic	Teaching Hours
1-8	Handling of the following instruments with respect to SOP:	
	a. Laminar air flow	4
	b. Incubator	4
	c. Water bath	4
	d. Colorimeter	4
	e. Micropipette	4
	f. pH meter	4
	g. Distillation	4
	h. Refrigerator	4
9	Cleaning of glassware	4
10	Wrapping of glassware	4
11	Preparation of media and slants	4
12	Sterilization of media and glassware	4
13	Preparation of stains and reagents	4
14	Fumigation techniques	4
15	Disposal of laboratory waste	4

References:

1. Aneja K. R. (2007). Experiments in Microbiology, Plant Pathology and Biotechnology. New Age International, New Delhi, India

2. Baunthiyal M., Saxena J. and Ravi I. (2015). Laboratory Manual of Microbiology,Biochemistry and Molecular Biology. Scientific Publishers, Jodhpur, Rajasthan, India.

3. Bisen P. S. (2014). Laboratory Protocols in Applied Life Sciences. United Kingdom:CRC Press.

4. Cappuccino J. and Welsh C. (2019). Microbiology: A Laboratory Manual, Loose Leaf Edition. United Kingdom: Pearson Education.

5. Gunasekaran P. (2007). Laboratory Manual in Microbiology. New Age International Private Limited, New Delhi, India.

6. Harley J. P. and Prescott L. (2020). Laboratory Exercises in Microbiology.Independently Published.

Mapping of Program Outcomes with Course Outcomes

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

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

Justification for the mapping

PO1 **Disciplinary Knowledge:**

CO2: This outcome directly contributes to building students' knowledge in core Microbiology, aligning with the goal of disciplinary knowledge.

CO3: It contribute to a broader understanding of scientific responsibilities and awareness.

CO4: While career success is not explicitly related to disciplinary knowledge, the overall program outcome includes knowledge acquisition, contributing to disciplinary knowledge.

CO5: Proficiency in aseptic techniques directly relates to core microbiology knowledge and skills.

CO6: Acquiring skills in cultivating microorganisms directly contributes to core microbiology knowledge..

PO2 **Critical Thinking and Problem Solving:**

CO4: Operating laboratory instruments may involve problem-solving, contributing to critical thinking.

CO6: Acquiring skills in cultivating microorganisms involves critical thinking and problem-solving.

PO3 **Social Competence**

CO1: Career building involves social interactions, contributing to social competence.

CO5: Proficiency in aseptic techniques may involve communication and teamwork, contributing to social competence.

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

CO2: Enriching knowledge contributes to research-related skills.

CO3: Inculcating a sense of scientific responsibilities aligns with developing a scientific temper

CO6: Acquiring skills in cultivating microorganisms involves research-related skills and contributes to a scientific temper.

PO5 **Trans-disciplinary knowledge:**

CO2: Enriching knowledge in core Microbiology may involve aspects from related

disciplines, contributing to a moderate level of trans-disciplinary knowledge.

CO6: Acquiring skills in cultivating microorganisms may involve aspects from microbiology and related disciplines, contributing to a moderate level of trans-disciplinary knowledge.

PO6 **Personal and professional competence:**

CO1: Catering to career needs involves building personal and professional competence, contributing to a moderate level of alignment.

CO7: The goal of building a progressive and successful career, aligning directly with personal and professional competence.

PO8 **Environment and Sustainability:**

CO3: Inculcating a sense of responsibilities and awareness explicitly aligns with environmental sustainability.

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

CO1: Catering to career needs involves continuous learning.

CO2: Training in core microbiology encourages continuous learning, aligning strongly with life-long learning..

CO6: Acquiring skills in cultivating microorganisms involves continuous learning and improvement, aligning strongly with life-long learning.

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

(2023 Pattern)

Name of the Programme	**:B.Sc. Microbiology**
Program Code	**: USMIB**
Class	**: F.Y.B.Sc.**
Semester	**: I**
Course Type	**: IKS (Theory)**
Course Code	**: MIB-137-IKS**
Course Title	**: Ethno-Microbiology**
No. of Credits	**02**
No. of Teaching Hours	**30**

Bhārata has a very rich and versatile knowledge system and cultural heritage. The Bhāratīya knowledge system was developed during the Vedic period, the Saraswatī-Sindhu Civilization, the Middle ages and practiced till the conditions of modern times. In this course, a special attention is given to the reasons of ideas occurrence in the ancient society, and connection with the concept of material world, and religious, social, and cultural beliefs. On the closer examination religion, culture and science have appeared epistemological very rigidly connected in the Bhāratīya knowledge system. As such, this and has provided invaluable knowledge stuff to the society and the world in all the spheres of life; e.g. aeronautics, science, astronomy, mathematics, life science, medical science, architecture, art, music, dance, literature, and drama. Over the period, most of the works were either lost or confined to the libraries or personal possessions. However, some of the activities are still in practice of the masses unknowing the scientific and practical values. Given the nature of course and diversity of the learners' fields, the course is designed to provide a broad-spectrum of the Bhāratīya knowledge system. The main objectives of this course are as follows:
1.Creating awareness amongst the youths about the true history and rich culture of thecountry;
2. Understanding the scientific value of the tradition and culture of the Bhārata;
3.Promoting the youths to do research in the various fields of Bhāratīya knowledge tradition;
4. Converting the Bhāratīya wisdom into the applied aspect of the modern scientific paradigm;
5. Adding career, professional and business opportunities to the youths.

Course Objective:

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 situations and apply acquired competencies in new/unfamiliar contexts
6. To allow students to preserve and pass on the knowledge of ethnic fermented food.
7. To enrich students' knowledge about usage of fermentation in food preparation.

Course Outcome:

CO1. The student should be able to apply the knowledge fermentation in food preparation.
CO2. Graduates should be able to demonstrate the acquisition of capacity to extrapolate from what has been learned about fermentation, translate concepts to real-life situations and

apply acquired competencies in new/unfamiliar contexts, rather than merely replicate curriculum content knowledge, to generate solutions to specific problems.

CO3. Graduates should be able to demonstrate the acquisition of comprehensive knowledge and coherent understanding of ethnic fermented food.

CO4. Graduates should be able to demonstrate the acquisition of comprehensive knowledge and coherent understanding of fermentation process.

CO5. Graduates should be able to demonstrate the acquisition of comprehensive knowledge and coherent understanding of microorganism's role in fermentation.

CO6. Graduates should be able to demonstrate the acquisition of comprehensive knowledge and coherent understanding of benefits of ethnic fermented food.

CO7. Graduates should be able to preserve and pass on the knowledge of ethnic fermented food.

CO8. Awareness amongst the youths about the true history and rich culture of the country.

CO9. The youth will be an individual with a great sense of patriotism and nation-pride.

CO10. The youths will be self-motivated to do research in the various fields of Bhāratīya knowledge tradition.

CO11. The students would be able to convert Bhāratīya wisdom into the applied aspect of the modern scientific paradigm.

Topic & Learning Points **Teaching Hours**

UNIT 1: Ancient Bhartiya Contribution towards Science & Mathematics (4L)

Concept of Matter, Life and Universe, Gravity, Sage Agastya's Model of Battery,Velocity of Light, Vimāna: Aeronautics, Vedic Cosmology and Modern Concepts,BhāratīyaKāla-gaṇanā, Kerala School for Mathematics and Astronomy, History andCulture of Astronomy, Sun, Earth, Moon, and Eclipses, Earth is Spherical andRotation of Earth, Archaeostronomy; Concepts of Zero and Pi, Number System,Pythagoras Theorem, and Vedic Mathematics

UNIT 2: Ancient Bhartiya Contribution in Environment & Health (4L)

Ethnic Studies, Life Science in Plants, Anatomy, Physiology, Agriculture, Ecology andEnvironment, Āyurveda, Integrated Approach to Healthcare, Medicine,Microbiology, Medicine, Surgery, and Yoga, etc.

UNIT 3: Introduction to Ethno-microbiology (4L)

- Definition of Ethno-microbiology
- Definition of Fermentation
- Historic and cultural heritage of Indian fermented foods
- Types of ethnic fermented foods
- Benefits of fermented food

UNIT 4: Curd Fermentation (6L)

- Procedure of curd setting
- Microorganisms present in curd
- Role of microbes in setting curd
- Benefits of consuming curd

UNIT 5: Idli Fermentation (6L)

- Preparation of idli batter and idli
- Microorganisms present in idli batter
- Role of microbes in fermenting idli batter
- Benefits of consuming idli

UNIT 6: Jilebi Fermentation **(6L)**

- Preparation of Jilebi batter and Jilebi
- Microorganisms present in Jilebi batter
- Role of microbes in fermenting Jilebi batter
- Benefits of consuming Jilebi

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6. Marianne,D., MiliotisdanJefrey,W.B. 2003. International Handbook of foodborne pathogens. Marcell & Decker Inc.
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Mapping of course outcomes and programme outcomes:

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

Justification for the mapping

PO1: Disciplinary Knowledge

CO3: Graduates should be able to demonstrate the acquisition of comprehensive knowledge and coherent understanding of ethnic fermented food.
CO4: Graduates should be able to demonstrate the acquisition of comprehensive knowledge and coherent understanding of fermentation process.
CO5: Graduates should be able to demonstrate the acquisition of comprehensive knowledge and coherent understanding of microorganism's role in fermentation.

PO2: Critical Thinking and Problem-solving

CO2: Graduates should be able to demonstrate the acquisition of capacity to extrapolate from what has been learned about fermentation, translate concepts to real-life situations, and apply acquired competencies in new/unfamiliar contexts, rather than merely replicate curriculum content knowledge, to generate solutions to specific problems.

PO3: Social Competence

CO7: Graduates should be able to preserve and pass on the knowledge of ethnic fermented food.

PO4: Research-related Skills and Scientific Temper

CO6: Graduates should be able to demonstrate the acquisition of comprehensive knowledge and coherent understanding of benefits of ethnic fermented food.