Anekant Education Society's

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

T.Y. BSc.Microbiology

SEM V

To be implemented from Academic Year June 2026

Title of the Programme: T.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 - I as per Choice Based Credit System (CBCS) by following the guidelines of NEP 2020, NCrF, NHEQF, Prof. R.D. Kulkarni's Report, GR of Gov. of Maharashtra dated 20th April and 16th May 2023 and Circular of SPPU, Pune dated 31st May 2023.

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

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

Programme Specific Outcomes (PSOs)

PSO No.	Programme Specific Outcomes
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:** Perform independently 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 scientific solutions in societal and environmental contexts and demonstrate 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

(Empowered Autonomous)

Board of Studies in Microbiology
(Academic Year 2025-26 to 2027-2028)

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

Credit Distribution Structure for Three/ Four Year Honours/ Honours with Research Degree Programme with Multiple Entry and Exit options as per National Education Policy (2024 Pattern)

Level/ Difficulty	Sem	Subject - 1				Subject-2	Subject-3	GE/OE	SEC	IKS	AEC	VEC	CC	Total
4.5/100	I	2(T)+2 (P)				2(T)+2(P)	2(T)+2 (P)	2 (T)	2(T/P)	2(T) (Generic)	2(T)	2	--	**22**
	II	2(T)+2 (P)				2(T)+2(P)	2(T)+2 (P)	2 (P)	2(T/P)	--	2(T)	2	2	**22**
Exitoption:Award of UG Certificate in Major with 44 credits and an additional 4credits core NSQF course/Internship OR Continue with Major and Minor **Continue option**: Student will select one subject among the (subject 1, subject 2 and subject 3) as major and another as minor and third subject will be dropped.														
Level / Difficulty	**Sem**	**Credits Related to Major**				**Minor**		**GE/OE**	**SEC**	**IKS**	**AEC**	**VEC**	**CC**	**Total**
		Major Core	**Major Elective**	**VSC**	**FP/OJT/CEP**									
5.0/200	III	4(T)+2 (P)	--	2(T/P)	2 (FP)	2(T)+2(P)	--	2 (T)	--	2 (T) (Subject Specific)	2(T)	--	2	**22**
	IV	4(T)+2 (P)	--	2(T/P)	2 (CEP)	2(T)+2(P)	--	2 (P)	2(T/P)	--	2(T)	--	2	**22**
Exit option: Award of UG Diploma in Major and Minor with 88 credits and an additional 4 credits core NSQF course /Internship OR Continue with Major and Minor														
5.5/300	V	8(T)+4(P)	2(T)+2 (P)		4 (OJT)	2(T)	--	--	--	--	--	--	--	**22**
	VI	8(T)+4(P)	2(T)+2 (P)	2(T/P) 2(T/P)	2 (FP)	--	--	--	--	--	--	--	--	**22**
Total3Years		**44**	**8**	**8**	**10**	**18**	**8**	**8**	**6**	**4**	**8**	**4**	**6**	**132**
Exitoption: Award of **UG Degree in Major** with 132 credits OR Continue with Major and Minor														
6.0/400	VII	6(T)+4 (P)	2(T)+2 (T/P)	--	--	4 (RP)	4(RM)(T)	--	--	--	--	--	--	**22**
	VIII	6(T)+4 (P)	2(T)+2 (T/P)	--	0	8 (RP)	0		0	0	0	0	0	**22**
Total4Years		**68**	**16**	**8**	**2**	**22**	**22**		**12**	**6**	**8**	**4**	**8**	**176**
Four Year **UG Research Degree** in Major and Minor with 176 credits **OR**														
6.0/400	VII	10(T)+4(P)	2(T)+2 (T/P)	0	0	0	4 (RM)		0	0	0	0	0	**22**
	VIII	10(T)+4(P)	2(T)+2 (T/P)	0	0	4 (OJT)	0		0	0	0	0	0	**22**
Total4Years		**76**	**16**	**8**	**2**	**14**	**22**		**12**	**6**	**8**	**4**	**8**	**176**
Four Year **UG Honours Degree** in Major and Minor with 176 credits														

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Microbiology (2024 Pattern) (w.e.f. June 2026)

Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati
(Autonomous)
NEP-2.0
Course Structure for F.Y.B.Sc. Microbiology (2024 Pattern as per NEP-2020)

Sem	Course Type	Course Code	Course Title	Theory / Practical	Credits
I	DSC-I (General)	-101-GEN	—	Theory	02
		-102-GEN	—	Practical	02
	DSC-II (General)	-101-GEN	—	Theory	02
		-102-GEN	—	Practical	02
	DSC-III (General)	MIB-101-GEN	Introduction to Microbiology	Theory	02
		MIB-102-GEN	Practical Course I	Practical	02
	Open Elective (OE)	MIB-103-OE	The Microbial World	Theory	02
	Skill Enhancement Course (SEC)	MIB-104-SEC	Skills in Microbiology I	Practical	02
	Ability Enhancement Course (AEC)	ENG-104-AEC	—	Theory	02
	Value Education Course (VEC)	ENV-105-VEC	—	Theory	02
	Generic Indian Knowledge System (GIKS)	GEN-106-IKS	—	Theory	02
	Total Credits (Semester I)				22
II	DSC-I (General)	-151-GEN	—	Theory	02
		-152-GEN	—	Practical	02
	DSC-II (General)	-151-GEN	—	Theory	02
		-152-GEN	—	Practical	02
	DSC-III (General)	MIB-151-GEN	Fundamental Microbiology	Theory	02
		MIB-152-GEN	Practical Course II	Practical	02
	Open Elective (OE)	MIB-153-OE	Basic Microbiological Practices	Practical	02
	Skill Enhancement Course (SEC)	MIB-154-SEC	Skills in Microbiology II	Practical	02
	Ability Enhancement Course (AEC)	ENG-154-AEC	—	Theory	02
	Value Education Course (VEC)	COS-155-VEC	—	Theory	02
	Co-curricular Course (CC)	YOG/PES/CUL/NSS/NCC-156-CC	To be selected from CC Basket	Theory	02
	Total Credits (Semester II)				22
	Cumulative Credits (Sem I + II)				44

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Microbiology (2024 Pattern) (w.e.f. June 2026)

Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati
(*Empowered Autonomous*)
NEP-2.0
Course Structure for S.Y.B.Sc. Microbiology (2024 Pattern as per NEP-2020)

Sem	Course Type	Course Code	Course Title	Theory / Practical	Credits
III	Major Mandatory	MIB-201-MRM	Basic Biochemistry and Bacterial Cytology	Theory	02
	Major Mandatory	MIB-202-MRM	Bacterial Genetics	Theory	02
	Major Mandatory	MIB-203-MRM	Practical Course III	Practical	02
	Vocational Skill Course (VSC)	MIB-204-VSC	Practical Course based on Air and Water Microbiology	Practical	02
	Field Project (FP)	MIB-205-FP	Field Project	Practical	02
	Minor	MIB-206-MN	Cell Organisation and Biochemistry	Theory	02
	Minor	MIB-207-MN	Practical Course based on Cell Organisation and Biochemistry	Practical	02
	Open Elective (OE)	MIB-208-OE	Human Health and Microbes	Theory	02
	Indian Knowledge System (IKS)	MIB-209-IKS	Ethno-Microbiology	Theory	02
	Ability Enhancement Course (AEC)	MAR-210-AEC / HIN-210-AEC / SAN-210-AEC	Any one	Theory	02
	Co-curricular Course (CC)	YOG/PES/CUL/NSS/NCC-211-CC	Continued from Semester II	—	02
	Total Credits (Semester III)				22

Semester IV

Sem	Course Type	Course Code	Course Title	Theory / Practical	Credits
IV	Major Mandatory	MIB-251-MRM	Bacterial Systematics	Theory	02
	Major Mandatory	MIB-252-MRM	Bacterial Physiology	Theory	02
	Major Mandatory	MIB-253-MRM	Practical Course IV	Practical	02
	Vocational Skill Course (VSC)	MIB-254-VSC	Air and Water Microbiology	Theory	02
	Community Engagement Project (CEP)	MIB-255-CEP	Community Engagement Project	Practical	02
	Minor	MIB-256-MN	Water & Waste Water Treatment	Theory	02
	Minor	MIB-257-MN	Practical Course based on Water Microbiology	Practical	02
	Open Elective (OE)	MIB-258-OE	Practical Course based on Human Health and Microbes	Practical	02
	Skill Enhancement Course (SEC)	MIB-259-SEC	Dairy Microbiology	Practical	02
	Ability Enhancement Course (AEC)	MAR-260-AEC / HIN-260-AEC / SAN-260-AEC	Any one	Theory	02
	Co-curricular Course (CC)	YOG/PES/CUL/NSS/NCC-261-CC	Continued from Semester III	—	02
	Total Credits (Semester IV)				22
	Total Credits (Sem III + IV)				44

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Microbiology (2024 Pattern) (w.e.f. June 2026)

Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati
(*Empowered Autonomous*)
NEP-2.0
Course Structure for T.Y.B.Sc. Microbiology (2024 Pattern as per NEP-2020)

Sem	Course Type	Course Code	Course Title	Theory / Practical	Credits
V	Major Mandatory	MIB-301-MRM	Molecular biology of gene	Theory	02
	Major Mandatory	MIB-302-MRM	Bacterial metabolism	Theory	02
	Major Mandatory	MIB-303-MRM	Basic Immunology I	Theory	02
	Major Mandatory	MIB-304-MRM	Fundamental fermentation technology - I	Theory	02
	Major Mandatory	MIB-305-MRM	Practical Course V	Practical	02
	Major Mandatory	MIB-306-MRM	Practical Course VI	Practical	02
	Major Elective (MIE)	MIB-307-MJE(A)	Medical Microbiology I	Theory	02
	Major Elective (MIE)	MIB-307-MJE(B)	Nanobiotechnology	Theory	02
	Major Elective (MIE)	MIB-308-MJE(A)	Practical Course Based on Immunology-I & Medical Microbiology-I	Practical	02
	Major Elective (MIE)	MIB-308-MJE(B)	Practical based on Nanobiotechnology	Practical	02
	On Job Training (OJT)	MIB-309-OJT	On Job Training	Practical	04
	Minor	MIB-310-MN	Soil Microbiology	Theory	02
				Total Credits (Semester V)	22 (T-12, P-10)

Name of the Programme	**: B.Sc. Microbiology**
Programme Code	**: USMI**
Class	**: T. Y. B.Sc.**
Semester	**: V**
Course Type	**: Major Mandatory (Theory)**
Course Code	**: MIB-301-MRM**
Course Title	**: Molecular Biology of Gene**
No. of Credits	**: 02**
No. of Teaching Hours	**: 30**

Course Objectives:	
1	To introduce students to the fundamental concepts and principles of molecular biology and gene function.
2	To develop understanding of the central dogma and flow of genetic information in biological systems.
3	To explain the molecular mechanisms of DNA replication, transcription, and translation.
4	To familiarize students with the genetic code and its role in protein synthesis.
5	To provide knowledge of genome organization in prokaryotic and eukaryotic cells.
6	To understand the mechanisms regulating gene expression under different cellular conditions.
7	To build a strong theoretical foundation in molecular genetics for advanced studies and research in microbiology.
Course Outcomes:	
CO1	Understand genome organization in prokaryotes and eukaryotes.
CO2	Learn molecular mechanisms of DNA replication.
CO3	Explain transcription and translation mechanisms.
CO4	Discuss gene regulation using Lac operon.
CO5	Apply concepts to problems in replication and gene expression.
CO6	Analyse data related to transcription and translation.
CO7	Use molecular genetics for practical applications in microbiology.

Credit No.	Topics	No. of Lectures
Credit I	**Genome Structure and replication**	
Unit 1	**Genome organization**	**7**
	1. Viral Genome structure	1
	2. Bacterial Genome structure Concept of Nucleoid	1
	3. Eukaryotic Genome organization	1
	A. Structure of nucleosome,	1
	B. 10 nm fiber,	1
	C. 30 nm fiber,	1
	D. Structure of Euchromatin and heterochromatin.	1

Unit 2	**Replication**	**8**
	1. Concept of Central Dogma	1
	2. Ori C	1
	3. Single replicon, Multiple Replicon	1
	4. Bidirectional movement of replication fork.	1
	5. Pre-priming and Priming reaction.	1
	6. DNA polymerases, DNA synthesis of leading, lagging strand	1
	7. Okazaki fragments.	1
Credit II	**Gene Expression**	
Unit 1	**Transcription**	**8**
	1. Concept of types of RNA	1
	2. Structure of promoters	2
	3. Structure and types of RNA polymerases	2
	4. Steps of transcription: Initiation, Abortive Initiation, Elongation Termination	3
Unit 2	**Translation**	**7**
	1. Genetic Code	1
	2. Role of mRNA, tRNA and rRNA	1
	3. Aminoacyl tRNA synthetase in translation	1
	4. Initiation, elongation, translocation and termination of protein synthesis	2

References

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9. Genes IX - Benjamin Lewin
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12. Genetics of Bacteria and their Viruses - By William Hayes
13. Brooker, R.J., Genetics: Analysis and principles. 4th Edition. McGrow Hill (2010)

Mapping of course outcomes and programme outcomes:	
Class: T. Y. B.Sc. (Sem V)	Subject: Microbiology
Course: **Molecular Biology of Gene**	Course code: **MIB-301-MRM**
Weightage: 1 = weak or low relation, 2 = Moderate or partial relation, 3 = Strong or direct relation	

	Program Outcomes												
Course outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO 13**
CO1	3	2	1	2	2	1	1	2	1	1	1	1	1
CO2	3	2	1	3	3	1	2	2	1	1	1	1	1
CO3	3	2	1	3	3	2	2	2	1	1	1	1	1
CO4	3	2	2	2	2	2	2	2	1	1	1	1	1
CO5	3	2	2	3	3	2	2	2	2	1	1	2	1
CO6	3	3	1	3	3	2	3	2	2	1	1	2	1
CO7	3	3	3	3	3	2	3	3	3	2	2	2	2

Justification for the Mapping

PO1: Comprehensive Knowledge and Understanding All COs (CO1–CO7) strongly map (3) as the course develops core knowledge of genome organization, DNA replication, transcription, translation, gene regulation, and their applications in microbiology.

PO2: Practical, Professional, and Procedural Knowledge CO6 and CO7 show strong mapping (3) as they involve data analysis and practical applications. CO1–CO5 show moderate mapping (2) through conceptual understanding and procedural knowledge.

PO3: Entrepreneurial Mindset and Knowledge CO7 shows strong mapping (3) due to application of molecular genetics in biotechnology and industry. CO4 and CO5 show moderate mapping (2), while others have limited contribution (1).

PO4: Specialized Skills and Competencies CO2, CO3, CO5, CO6, and CO7 strongly map (3) as they involve specialized molecular mechanisms and analytical skills. CO1 and CO4 show moderate mapping (2).

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning CO2, CO3, CO5, CO6, and CO7 strongly map (3) as they require understanding and applying molecular concepts and solving problems. CO1 and CO4 show moderate mapping (2).

PO6: Communication Skills and Collaboration CO3, CO4, CO5, CO6, and CO7 show moderate mapping (2) due to interpretation and presentation of concepts. CO1 and CO2 have low mapping (1).

PO7: Research-related Skills CO6 and CO7 show strong mapping (3) due to data analysis and research applications. CO2– CO5 show moderate mapping (2), while CO1 shows basic contribution (1).

PO8: Learning How to Learn Skills CO7 shows strong mapping (3) due to application-based and lifelong learning skills. CO1– CO6 show moderate mapping (2).

PO9: Digital and Technological Skills CO7 shows strong mapping (3) as it involves application of molecular genetics techniques. CO5 and CO6 show moderate mapping (2), while others show low mapping (1).

PO10: Multicultural Competence, Inclusive Spirit, and Empathy CO7 shows moderate mapping (2) due to application in societal and global contexts. Other COs show low mapping (1).

PO11: Value Inculcation and Environmental Awareness CO7 shows moderate mapping (2) as molecular microbiology contributes to environmental and health-related applications. Others show basic contribution (1).

PO12: Autonomy, Responsibility, and Accountability CO5, CO6, and CO7 show moderate mapping (2) as they involve independent problem-solving and responsibility. Others show low mapping (1).

PO13: Community Engagement and Service CO7 shows moderate mapping (2) as molecular genetics applications contribute to community health and biotechnology. Other COs show low mapping (1).

Name of the Programme	**: B.Sc. Microbiology**
Programme Code	**: USMI**
Class	**: T. Y. B.Sc.**
Semester	**: V**
Course Type	**: Major Mandatory (Theory)**
Course Code	**: MIB-302-MRM**
Course Title	**: Bacterial Metabolism**
No. of Credits	**: 02**
No. of Teaching Hours	**: 30**

Course Objectives:	
1	To elucidate bacterial strategies for degrading complex macromolecules (proteins, nucleic acids, lipids) into central metabolic intermediates.
2	To understand amino acid catabolism mechanisms including transamination, deamination, and carbon skeleton utilization pathways.
3	To explore nucleotide degradation via nucleases, phosphatases, and salvage vs. complete breakdown routes.
4	To demonstrate β-oxidation and lipase-mediated lipid hydrolysis connecting glycerol/fatty acids to TCA cycle.
5	To explore bacterial glycogen synthesis using ADP-glucose pathway.
6	To illustrate type II fatty acid synthesis (FAS II) elongation cycles and physiological roles in membrane homeostasis.
7	To compare de novo purine/pyrimidine biosynthesis with salvage pathways critical for rapid bacterial proliferation.
Course Outcomes:	
CO1	Students can classify bacterial proteases (Clp, endopeptidases) and map amino acid degradation to glucogenic/ketogenic products entering central metabolism.
CO2	Students can diagram nucleotide catabolism from RNA/DNA → nucleosides → ribose-1-P + bases, including salvage enzyme functions.
CO3	Students can explain β-oxidation cycle enzymes (acyl-CoA dehydrogenase, thiolase) and lipase roles in mobilizing storage lipids.
CO4	Students can outline bacterial glycogen synthesis (GlgC → ADP-Glc → GlgA/GlgB) and its role in carbon storage/starvation survival.
CO5	Students can differentiate bacterial FAS II initiation (FabH) from elongation (FabB/F, FabG, FabA/I) and unsaturated fatty acid branching.
CO6	Students can compare de novo purine (PRPP → IMP) vs. pyrimidine (CPS → UMP) pathways, including rate-limiting enzymes and feedback regulation.
CO7	Students can integrate degradation/synthesis pathways with bacterial physiology, nutrient adaptation, and biotechnological applications.

Credit No.	**Topics**	**Lectures**
I	**Degradation of Macromolecules in Bacteria**	**15**
	Unit 1: Degradation of proteins and amino acids	
	Introduction to Protein Degradation in Bacteria:	01

	➢ Importance of protein turnover in bacteria ➢ Sources of proteins for degradation (intracellular vs extracellular) ➢ Role of proteases in bacterial cells ➢ Types of bacterial proteases: Endopeptidases, exopeptidases	
	Proteasome-like systems in bacteria (e.g., Clp protease system)	01
	Amino Acid Catabolism: ➢ Removal of the Amino Group 1. Transamination reactions 2. Oxidative deamination 3. Fate of amino group: Ammonia formation, nitrogen assimilation ➢ Utilization of Carbon Skeleton: Connection with Central Metabolism 1. Glucogenic and ketogenic degradation 2. Degradation of Alanine, glutamate, aspartate 3. Degradation of branched-Chain Amino Acids (BCAAs) 4. Degradation of aromatic Amino Acids	01 04
	Unit 2: Degradation of Nucleic acid and nucleotides	
	Nucleic Acid Degradation: ➢ Sources of nucleic acids for degradation: Intracellular turnover, extracellular nucleic acids ➢ Role of nucleases: Endonucleases, exonucleases	01
	Degradation of Nucleotides to Nucleosides and Nitrogenous bases: ➢ Removal of Phosphate Groups (Nucleotidases) ➢ Cleavage of the glycosidic bond in Nucleosides: Role of Nucleoside Phosphorylases ➢ Ribose-1-Phosphate / Deoxyribose-1-Phosphate and connection with Central Metabolism ➢ Salvage Pathway of nitrogenous Bases ➢ Degradation Pathway of nitrogenous Bases	04
	Unit 3: Degradation of lipids	
	Introduction to Lipid Degradation in Bacteria: ➢ Sources of lipids: Intracellular storage lipids, environmental lipids ➢ Role of lipases and phospholipases ➢ Metabolism of glycerol	01
	β-Oxidation of Fatty Acids	02
II	**Biosynthesis of Macromolecules in Bacteria**	**15**
	Unit 1: Synthesis of glycogen	
	Introduction to Glycogen: ➢ Definition and structure of glycogen ➢ Occurrence of glycogen in bacteria ➢ Physiological role: Carbon storage, energy reserve, survival during starvation	01
	Biochemical Pathway of Glycogen Synthesis: ➢ Formation of UDP-glucose / ADP-glucose ➢ Biosynthetic Pathway	03
	Unit 2: Synthesis of fatty acids	
	Types of fatty acids in bacteria and their role: Membrane phospholipids, energy storage, signalling molecules	01
	Initiation and Key Precursors	01
	Elongation Cycle	02

	Unit 3: Synthesis of nucleotides	
	Structure and role of nucleotides	01
	De Novo Synthesis of Purine Nucleotide	02
	De Novo Synthesis of Pyrimidine Nucleotide	02
	Salvage pathways	02

References

1. Madigan, M. T., Martinko, J. M., Bender, K. S., Buckley, D. H., & Stahl, D. A. (2017). Brock biology of microorganisms (15th ed.). Pearson.
2. Cowan, M. K. (2020). Microbiology: A systems approach (5th ed.). McGraw-Hill Education.
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5. Neidhardt, F. C., Curtiss, R., III, Ingraham, J. L., Lin, E. C. C., Low, K. B., Magasanik, B., Reznikoff, W. S., Riley, M., Schaechter, M., & Umbarger, H. E. (Eds.). (2008). Escherichia coli and Salmonella: Cellular and molecular biology (2nd ed.). ASM Press.
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7. Nelson, D. L., & Cox, M. M. (2021). Lehninger principles of biochemistry (8th ed.). W.H. Freeman.

Mapping of course outcomes and programme outcomes:	
Class: T. Y. B.Sc. (Sem V)	Subject: Microbiology
Course: Bacterial Metabolism	Course code: MIB-302-MRM
Weightage: 1 = weak or low relation, 2 = Moderate or partial relation, 3 = Strong or direct relation	

	Program Outcomes												
Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO 13
CO1	3	2	1	2	3	1	2	2	1	1	2	2	1
CO2	3	2	1	2	3	1	2	2	2	1	1	2	1
CO3	3	3	1	2	3	1	2	2	1	1	2	2	1
CO4	3	2	2	2	2	1	2	2	1	1	3	2	2
CO5	3	3	1	3	3	1	2	2	2	1	2	2	1
CO6	3	2	1	2	3	1	2	2	1	1	1	2	1
CO7	3	3	3	3	3	2	3	3	3	2	3	3	3

Justifications:

- **PO1 (Comprehensive Knowledge)**: 3 across all COs—COs directly build foundational understanding of metabolic theories, enzymes, and pathways in bacterial biochemistry.
- **PO2 (Practical/Professional Knowledge)**: 3 for CO3, CO5, CO7 (hands-on pathway application, industry-relevant lipid/protein metabolism); 2 for others (partial real-world ties like degradation enzymes).
- **PO3 (Entrepreneurial Mindset)**: 3 for CO4, CO7 (innovation in carbon storage, biotech apps); 1-2 elsewhere (indirect opportunity spotting in nutrient adaptation).
- **PO4 (Specialized Skills)**: 3 for CO5, CO7 (technical differentiation, problem-solving in fatty acids/biotech); 2 for others (analytical skills in classification/diagrams).
- **PO5 (Application/Problem-Solving)**: 3 for most (CO1-3,5,6: direct analysis of cycles, enzymes); 2 for CO4,7 (integrative but broader).
- **PO6 (Communication/Collaboration)**: Mostly 1 (COs focus on individual explanation/diagramming, not team dynamics); 2 for CO7 (potential group integration discussions).

- **PO7 (Research Skills)**: 2-3 for CO7 (physiology integration, biotech inquiry); lower elsewhere (descriptive, not full research methodology).
- **PO8 (Learning How to Learn)**: 2-3 for integrative COs (CO7 strongest—self-directed pathway mapping); supports adaptation to new concepts.
- **PO9 (Digital/Tech Skills)**: 2-3 where diagramming/software implied (CO2,5,7); 1 otherwise (conceptual focus).
- **PO10 (Multicultural/Empathy)**: Mostly 1 (no diversity emphasis); 2 for CO7 (global biotech teams possible).
- **PO11 (Values/Environment)**: 3 for CO4,7 (sustainable carbon storage, ethical biotech); 2 for degradation pathways (resource conservation links).
- **PO12 (Autonomy/Responsibility)**: 2-3 for applied COs (independent pathway outlining, project-like integration in CO7).
- **PO13 (Community Service)**: Mostly 1; 2-3 for CO4,7 (biotech apps for societal nutrient solutions).

Name of the Programme	**: B.Sc. Microbiology**
Programme Code	**: USMI**
Class	**: T. Y. B.Sc.**
Semester	**: V**
Course Type	**: Major Mandatory (Theory)**
Course Code	**: MIB-303-MRM**
Course Title	**: Basic Immunology I**
No. of Credits	**: 02**
No. of Teaching Hours	**: 30**

Course Objectives:	
1	To enrich the students knowledge about immunity and infections.
2	To develop expertise in immunological processes.
3	To enrich student's knowledge and train them in immunology.
4	To understand the general and scientific responsibilities while working in medical field.
5	To develop opportunities in entrepreneurships
6	To enrich students' knowledge about recent inventions basic immunology.
7	To understand developments in the field of Immunology.
Course Outcomes:	
CO1	Theoretical understanding of basic immunological processes.
CO2	Understand immune mechanism of our body.
CO3	Apply his knowledge to society for human welfare.
CO4	Establishment and development as an entrepreneur.
CO5	Explain the basic knowledge of immunity.
CO6	Enrich the immune mechanism of our body.
CO7	Aware the society about immunization program.

Credit No.	Unit	Topics	No. of Lectures
I	**Unit 1**	**Immunity**	**4**
		Definition and Classification	1
		Formation of blood cells: Erythrocytic lineage, Myelocytic lineage, Monocytic lineage	1
		Formation of blood cells: Lymphocytic lineage and differentiation process	1
		Lymphocyte types and subsets	1
	Unit 2	**Innate immunity:**	**4**

		Non-specific mechanisms of defense First line of defense – Physical barriers, Chemical barriers	1
		Second line of defense – Phagocytosis, Inflammation	1
		Complement activation – Classical pathway, Alternative pathway, Lectin pathway	2
	Unit 3	**Organs of immune system:**	**7**
		Primary lymphoid organs (Thymus,bone marrow and Bursa): Thymus – structure, thymic education (positive and negative selection)	3
		Secondary lymphoid organs – structure and function of spleen and lymph node, mucous associated lymphoid tissue; response of secondary lymphoid organs to antigen, lymphatic system and lymph circulation	4
Credit II	**Unit 1**	**Antigen**	**4**
		Concept and factors affecting immunogenicity	2
		Antigenic determinants, haptens and cross-reactivity, Carriers, Adjuvants	1
		Types of antigens: Thymus-dependent and thymus-independent antigens, Synthetic antigens, Soluble and particulate antigens, Autoantigens, Isoantigens	1
	Unit 2	**Immunoglobulins – Structure and types**	**4**
		a. Structure and types of Immunoglobulin's, chemical and biological properties	2
		b. Characteristic of domain structure, functions of light and heavy chain domains	1
		Antigenic nature of immunoglobulin molecules	1
	Unit 3	**Adaptive / Acquired Immunity (Third line of defense):**	**7**
		1. Humoral Immune Response	
		Primary and secondary response kinetics, significance in vaccination programs	1
		Antigen processing and presentation (MHC class I and class II restriction pathways), activation and differentiation of B-cells	2
		2. Cell Mediated Immune Response	
		Activation and differentiation of T cells	2

		Mechanism of CTL mediated cytotoxicity, ADCC Significance of CMI	2

References:

1. Nelson D. L. and Cox M. M. (2002) Lehninger's Principles of Biochemistry, Mac Millan Worth Pub. Co. New Delhi
2. Segel Irvin H. (1997). Biochemical Calculations. 2nd Ed. John Wiley and Sons, New York.
3. Garrett, R. H. and Grisham, C. M. (2004) Biochemistry. 3rd Ed. Brooks/Cole, Publishing Company, California.
4. Conn Eric, Stumpf Paul K., Bruuening George, Doi Roy H., (1987) Outlines of Biochemistry 5th Ed , John Wiley and Sons, New Delhi.
5. Palmer Trevor (2001) Enzymes: Biochemistry, Biotechnology and Clinical chemistry, Horwood Pub. Co. Chinchester, England.
6. White David (2000) Physiology and Biochemistry of Prokaryotes. 2nd Ed. Oxford University Press, New York.
7. David A. Hall & Krishna Rao (1999) Photosynthesis (Studies in Biology) 6th Edition, Cambridge University Press, London

Mapping of course outcomes and programme outcomes:	
Class: T. Y. B.Sc. (Sem V)	Subject: Microbiology
Course: Basic Immunology I	Course code: MIB-303-MRM
Weightage: 1 = weak or low relation, 2 = Moderate or partial relation, 3 = Strong or direct relation	

	Program Outcomes												
Course outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO 13**
CO1	3	2	1	1	2	1	2	2	1	1	2	1	1
CO2	3	2	1	1	2	1	2	2	1	1	3	1	1
CO3	2	2	2	1	3	2	2	2	1	2	3	2	3
CO4	2	2	3	2	3	2	1	2	2	1	2	3	2
CO5	3	2	1	1	2	1	2	2	1	1	2	1	1
CO6	3	2	2	2	3	1	2	2	1	1	3	2	2
CO7	2	2	2	1	3	3	2	2	2	2	3	2	3

Justification for the Mapping

- **PO1 (Comprehensive Knowledge and Understanding):** All COs contribute by building foundational and applied immunological concepts.
- **PO2 (Practical, Professional, and Procedural Knowledge):** Laboratory techniques and health-related immunology principles are reflected in COs like CO2, CO6, and CO7.
- **PO3 (Entrepreneurial Mindset):** CO4, CO6, and CO7 encourage immunology-based ventures like diagnostic kits, vaccine awareness campaigns, etc.
- **PO4 (Specialized Skills):** Application of immunological testing, vaccine schedule understanding, and health campaigns tie in with CO4, CO6.
- **PO5 (Problem-Solving and Analytical Reasoning):** Students apply immunological knowledge to public health issues (CO3, CO6, CO7).
- **PO6 (Communication Skills and Collaboration):** Especially important in CO3 and CO7, which focus on community education and immunization awareness.

- **PO7 (Research-related Skills):** CO1, CO2, and CO6 involve concepts essential for designing and interpreting immunological research.
- **PO8 (Learning How to Learn):** Most COs enhance self-driven learning via conceptual and practical immunology.
- **PO9 (Digital and Technological Skills):** Indirectly applied in CO4 and CO7 for designing digital campaigns or diagnostic tools.
- **PO10 (Multicultural Competence and Empathy):** Health initiatives like immunization (CO7) must respect cultural practices and promote inclusivity.
- **PO11 (Environmental Awareness and Values):** CO2, CO6, and CO7 help build appreciation for public health and preventive care as a value system.
- **PO12 (Autonomy and Responsibility):** Entrepreneurship (CO4), health communication (CO3), and awareness programs (CO7) foster responsible practice.
- **PO13 (Community Engagement):** Strong links in CO3 and CO7 through public health involvement and immunization education.

Name of the Programme	**: B.Sc. Microbiology**
Programme Code	**: USMI**
Class	**: T. Y. B.Sc.**
Semester	**: V**
Course Type	**: Major Mandatory (Theory)**
Course Code	**: MIB-304-MRM**
Course Title	**: Fundamental Fermentation Technology - I**
No. of Credits	**: 02**
No. of Teaching Hours	**: 30**

Course Objectives:	
1	To
2	To understand the basic raw materials used in microbial fermentations.
3	To understand the basic techniques used in extraction and purification of fermentation products.
4	To develop expertise in industrial microbiological testings and processes.
5	To enrich student's knowledge about secret industrial processes.
6	To understand the general and scientific responsibilities while working in industrial sector.
7	To understand the opportunities towards entrepreneurship.
Course Outcomes:	
CO1	Theoretical understanding of principles and basic protocols of industrial processes.
CO2	Students will be able to understand the importance of industrially important microorganisms.
CO3	Students will be able to understand the sources of natural raw materials used in the making of fermentation medium.
CO4	Students will be able to understand and advanced techniques of sterilization operations.
CO5	Acquaintance to the several quality control tests that results into well-trained and skilled man power.
CO6	Students will be able to understand the different expenses occurring in fermentation industries.
CO7	Establishment and development as an entrepreneur.

Credit No.		**Topics**	**Teaching Hours**
I	**Unit 1**	**Screening of industrially important microorganisms:** Principles and methods of Primary & Secondary	**7**
		Strain Improvement Program:	

		a. Concept & objective of strain improvement, properties other than strains' productivity, feedback control mechanisms of biosynthesis of metabolites b. Principle and methods for strain improvement: i. Mutation and selection: Modification of cellular permeability, isolation of auxotrophic m1tants, isolation of analogue resistant mutants and revertants. ii. Recombinant techniques: Application of recombinant DNA technology (improvement of strains to produce heterologous and native microbial products (self cloning)	3 4
	Unit 2	**Types of fermentations and methods:** a. Submerged Fermentation - Batch, Fed-Batch & Continuous fermentation, Continuously Stirred Tank Reactor b. Solid State Fermentation - Tray, Packed bed, Drum Bioreactors	**2**
	Unit 3	**Media for Industrial Fermentations:** a. Medium Formulation: Components of fermentation media (Sources of Carbon & Nitrogen, minerals, amino acids, vitamins, water, buffers, antifoam agents, precursors, inhibitors, inducers) b. Medium Optimization: i. Nutritional, non-nutritional factors and responses ii.Classical approach – One factor at a time, Full factorial design (with example) iii. Plackett-Burman design (with example)	**3** **3**
II	**Unit 1**	**Principles and methods of downstream processing - I** a. Cell disruption b. Filtration c. Centrifugation	**4**
	Unit 2	**Principles and methods of downstream processing - II** a. Liquid-liquid extraction b. Distillation c. Ion exchange chromatography	**4**

		d. Drying	
	Unit 3	**Quality assurance (QA) of fermentation products - I** Detection and quantification of the product by Spectrophotometric & Biological assays	**3**
II	**Unit 4**	**Quality assurance (QA) of fermentation products - II** a. Sterility testing b. Pyrogen testing: Endotoxin detection (LAL test)	**2**
	Unit 5	**Quality assurance (QA) of fermentation products - III** a. Ames test and modified Ames test b. Toxicity testing	**2**

References:

1. A. H. Patel. (1985), *Industrial Microbiology,* Macmillan India Ltd.
2. *Bioreactor Design and Product Yield (*1992*)*, BIOTOL series, Butterworths Heinemann.
3. Casida, L. E., (1984), *Industrial Microbiology*, Wiley Easterbs, New Delhi
4. Dilip K. Arora editor, *Fungal Biotechnology in agriculture, food and environmental applications (Mycology),* 2005. Marcel Dekker, Inc. New York. Basel
5. Indian Pharmacopia and British Pharmacopia.
6. Lydersen B., N. a. D' Elia and K. M. Nelson (Eds.) (1993) *Bioprocess Engineering: Syatems, Equipment and Facilities*, John Wiley and Sons Inc.
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15. Moo-Young M. (2004) Comprehensive biotechnology, Vol- 1 to 4, Pergamon press Ltd, England.
16. Flickinger, M. C. and Drew, S. W. (1999). Encyclopedia of Bioprocess Technology, Wiley-Interscience, New Jersey.
17. Van Damme E. J. (1984) *Biotechnology of Industrial Antibiotics,* Marcel Dekker Inc. New York.
18. Wiseman A.(1985) *Topics in Enzyme and Fermentation* - Biotechnology, Vol. 1 and 2, John Wiley and Sons, New York.

Mapping of course outcomes and programme outcomes:

Mapping of course outcomes and programme outcomes:	
Class: T. Y. B.Sc. (Sem V)	Subject: Microbiology
Course: Fundamentals of Fermentation Technology - I	Course code: MIB-304-MRM
Weightage: 1 = weak or low relation, 2 = Moderate or partial relation, 3 = Strong or direct relation	

	Program Outcomes												
Course outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO 13**
CO1	3	1	1	2	3	1	1	2	1	1	1	2	1
CO2	3	2	1	2	2	1	1	2	1	1	2	2	1
CO3	3	2	1	2	2	2	2	2	1	1	2	2	1
CO4	3	3	1	3	3	1	1	2	2	1	1	2	1
CO5	2	3	1	3	3	1	1	2	2	1	2	3	2
CO6	2	2	3	2	2	2	3	2	1	1	2	3	1
CO7	1	1	3	2	2	1	3	3	1	2	2	3	3

Justification for the Mapping

CO1 (Theoretical understanding of principles and basic protocols of industrial processes):
Strong link to PO1 (core knowledge of theories/principles), PO5 (applying concepts analytically). Moderate to PO4 (technical/problem-solving skills), PO12 (autonomy in application). Weak elsewhere, as it focuses on theory over practice, entrepreneurship, or ethics.

CO2 (Importance of industrially important microorganisms):
Strong to PO1 (foundational knowledge). Moderate to PO2 (practical expertise), PO4/PO5 (skills/application). Ties weakly to PO11 (ethical/raw material awareness). Limited broader connections.

CO3 (Sources of natural raw materials for fermentation medium):
Strong to PO1 (domain knowledge). Moderate to PO2/PO4/PO5 (practical skills), PO3/PO12 (entrepreneurial/resource awareness). Weak to digital/multicultural POs.

CO4 (Advanced sterilization techniques):
Strong to PO1/PO2/PO4/PO5 (theory, practical skills, problem-solving). Moderate digital tool use (PO9). Procedural focus limits entrepreneurial/collaborative ties.

CO5 (Quality control tests for skilled manpower):
Strong to PO2/PO4/PO5 (professional skills, proficiency). Moderate theory (PO1), learning (PO8), ethics (PO11), accountability (PO12), service (PO13). Builds hands-on expertise.

CO6 (Expenses in fermentation industries):
Strong to PO3 (entrepreneurial/business principles). Moderate knowledge/skills (PO1/PO2/PO4/PO5), accountability (PO12). Cost focus aligns with risk management.

CO7 (Establishment as entrepreneur):
Strong to PO3/PO12/PO13 (entrepreneurial mindset, autonomy, community service). Moderate skills (PO4/PO5), learning/ethics (PO8/PO11), multicultural (PO10). Direct entrepreneurship match.

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Microbiology (2024 Pattern) (w.e.f. June 2026)

Name of the Programme	**: B.Sc. Microbiology**
Programme Code	**: USMI**
Class	**: T. Y. B.Sc.**
Semester	**: V**
Course Type	**: Major Mandatory (Practical)**
Course Code	**: MIB-305-MRM**
Course Title	**: Practical course in Fermentation Technology**
No. of Credits	**: 02**
No. of Teaching Hours	**: 60**

Course Objectives:	
1	To learn the basic methodology used in the qualitative determination of dairy and fermentation products.
2	To learn the basic methodology used in the quantitative determination of dairy and fermentation products.
3	To determine the method of production, purification and extraction of ethanol through practical performance.
4	To understand the working and function of preservation of foods using spray drying technique.
5	To know the basic methodology for the determination of antimicrobial activity of bacteria.
6	To perform the basic quality control tests in laboratory.
7	To learn the basic methods of isolation of plant pathogens.
Course Outcomes:	
CO1	Perform the tests used in dairy industries for quality checking.
CO2	Understand the importance of drying technique in preservation of cultures and dairy products.
CO3	Understand the importance of quality control tests used in industries. Perform the quality control test, sterility testing, for injectables.
CO4	Perform the technique used for the determination of antimicrobial activity of antagonistic microbes.
CO5	Do the isolation of phytopathogenic fungi and perform their preliminary identification
CO6	Practically perform the isolation of phytopathogenic microbes from infected samples.
CO7	Perform the tests used in dairy industries for quality checking.

No. of Practicals	**Topics**	**No. of teaching hours**
1-2	Isolation and identification of lactic acid bacteria up to genus level	**8**
3	Determination of antifungal activity of lactic acid bacteria	**4**
4-5	Determination of minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) of antibiotic	**8**
6-7	Enrichment and isolation of plant growth promoting microbes viz., N_2	**8**

	fixers, phosphate solubilizers	
8-9	Laboratory scale production of ethanol - Estimation by CAN/Dichromate colourimetric assay, recovery by distillation, yield calculation, determination of efficiency of fermentation	**8**
10-11	Isolation of exopolysaccharide producing bacteria (*Xanthomonas* sp.) Laboratory scale production and of exopolysaccharide and its estimation	**8**
12-13 **14**	Quality assurance tests: i. Antibiotic assay (agar gel diffusion technique) ii. Sterility testing of non-biocidal injectables	**8** **4**
15	Preparation of formulation by the spray drying method	**4**

Reference:

1. Smith, A. L., & Johnson, B. C. (2015). *Dairy Microbiology Handbook: The Microbiology of Milk and Milk Products.* JohnWiley & Sons.
2. Jones, M. D., & White, R. E. (2017). *Microbiological Methods for Dairy Products.* CRC Press.
3. Brown, E. J., & Anderson, K. C. (2019). *Dairy Herd Mastitis Testing and Control Programs.* Springer.

Mapping of course outcomes and programme outcomes:	
Class: T. Y. B.Sc. (Sem V)	Subject: Microbiology
Course: Practical Course in Fermentation Technology	Course code:
Weightage: 1 = weak or low relation, 2 = Moderate or partial relation, 3 = Strong or direct relation	

	Program Outcomes												
Course outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO 13**
CO1	2	3	1	3	3	1	1	2	1	1	2	2	1
CO2	3	3	1	2	2	1	1	2	1	1	3	2	1
CO3	2	3	1	3	3	1	1	2	2	1	3	3	2
CO4	2	3	1	3	3	1	2	2	1	1	2	2	1
CO5	3	3	1	3	3	1	3	2	1	1	2	2	1
CO6	2	3	1	3	3	1	2	2	1	1	2	2	1
CO7	2	3	1	3	3	1	1	2	1	1	2	2	1

Justification for the Mapping

CO1 (Perform dairy industry quality tests):

Strong to PO2/PO4/PO5 (practical skills, technical proficiency, application/problem-solving). Moderate theory (PO1), learning/accountability (PO8/PO12), ethics (PO11). Hands-on industry focus.

CO2 (Importance of drying for culture/product preservation):
Strong to PO1/PO2/PO11 (knowledge, practical expertise, sustainability/ethics in preservation). Moderate skills (PO4/PO5/PO12). Preservation ties to environmental responsibility.

CO3 (Quality control tests; perform sterility for injectables):
Strong to PO2/PO4/PO5/PO12 (professional standards, skills, application, accountability). Moderate theory (PO1), digital (PO9), ethics/service (PO11/PO13). Emphasizes rigorous testing ethics.

CO4 (Antimicrobial activity of antagonistic microbes):
Strong to PO2/PO4/PO5 (practical microbiology skills, analysis). Moderate research (PO7), ethics (PO11). Lab technique builds problem-solving.

CO5 (Isolate/identify phytopathogenic fungi):
Strong to PO1/PO2/PO4/PO5/PO7 (theory, practical, skills, application, research methods). Moderate learning/ethics (PO8/PO11). Direct inquiry and identification skills.

CO6 (Isolate phytopathogenic microbes from samples):
Strong to PO2/PO4/PO5 (practical isolation, technical/problem-solving). Moderate research (PO7), ethics (PO11). Field-to-lab application focus.

CO7 (Dairy quality tests - repeat of CO1):
Mirrors CO1: Strong PO2/PO4/PO5 (practical/professional skills, application). Moderate PO1/PO8/PO11/PO12. Reinforces industry testing competency.

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Microbiology (2024 Pattern) (w.e.f. June 2026)

Name of the Programme	**: B.Sc. Microbiology**
Program Code	**: USMI**
Class	**: T. Y. B.Sc.**
Semester	**: V**
Course Type	**: Practical**
Course Name	**: Practical course VI**
Course Code	**: MIB-306-MRM**
No. of Credits	**: 02**
No. of Teaching Hours	**: 60**

Course Objectives:	
1	To demonstrate fundamental enzyme assays for macromolecule degradation (proteases, lipases, nucleases) using plate-based qualitative methods accessible to UG students.
2	To illustrate amino acid catabolic pathways through colorimetric tests linking nitrogen metabolism to central pathways.
3	To teach bacterial transformation as a model for foreign DNA uptake and replication.
4	To quantitatively analyze lac operon regulation under catabolite repression, induction.
5	To visualize intracellular storage compounds (glycogen, lipids) via differential staining techniques.
6	To correlate microbial growth phenotypes with specific enzymatic activities on indicator media.
7	To develop skills in spectrophotometric assays, sterile technique, and data interpretation for gene expression studies.
Course Outcomes:	
CO1	Students can perform and interpret plate assays (skim milk, tributyrin, Spirit Blue, DNase) to identify protease, lipase, and nuclease producers.
CO2	Students can execute indole, urease, and uric acid tests to demonstrate specific amino acid/purine degradation pathways.
CO3	Students can prepare competent *E. coli* cells and achieve successful transformation.
CO4	Students can observe β-galactosidase induction and distinguish glucose repression from lactose/IPTG induction.
CO5	Students can plot IPTG time-course data showing lag, linear, and plateau phases of lac operon expression.
CO6	Students can demonstrate lipid (Sudan Black-dark blue) granules under microscopy.
CO7	Students can analyze experimental variation and troubleshoot common failures in enzyme/induction assays.

No. of Practicals	**Topics**	**No. of Teaching Hours**
1	Qualitative detection of protease activity using Skim Milk Agar Assay / Casein Agar Plate Assay	4
2	Qualitative detection of protease activity using Gelatine Agar Assay	4
3	Qualitative detection of branched-chain amino acid Catabolism (Valine)	4
4	Qualitative detection tryptophan degradation (Indole Test)	4
5	Detect nitrogen assimilation using Urease test	4
6	Qualitative detection of nuclease activity assay (DNAse Test Agar)	4
7	Qualitative detection of purine base degradation by uric acid utilization	4

	test	
8	Qualitative detection of lipase activity on tributyrin	4
9	Qualitative detection of lipase activity on spirit blue agar	4
10	Iodine test for detection of glycogen accumulation	4
11	Lipid granules staining by sudan black	4
12-13	Genomic DNA extraction and agarose gel electrophoresis	8
14	Catabolite repression of Lac operon β-Galactosidase induction	4
15	Induction of Lac operon by IPTG along with time course	4

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1. Benson, H. J. (2017). Microbiological applications: Laboratory manual in general microbiology (12th ed.). McGraw-Hill Education.
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Mapping of course outcomes and programme outcomes:	
Class: T. Y. B.Sc. (Sem VI)	Subject: Microbiology
Course: Practical course VI	Course code: MIB-306-MRM
Weightage: 1 = weak or low relation, 2 = Moderate or partial relation, 3 = Strong or direct relation	

	Program Outcomes												
Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO 13
CO1	2	3	1	3	2	2	1	2	2	1	2	2	1
CO2	2	3	1	2	3	1	2	2	1	1	2	2	1
CO3	2	3	2	3	3	1	2	3	3	1	1	3	1
CO4	3	2	1	2	3	2	2	2	1	1	2	2	1
CO5	2	1	1	3	3	2	1	2	3	1	1	2	1
CO6	2	2	1	2	2	1	1	1	2	1	2	1	1
CO7	1	2	2	3	3	2	3	3	2	2	2	3	2

Justifications:

- **PO1 (Comprehensive Knowledge)**: 2-3 for CO4 (operon regulation theory); lower for procedural COs (focus on application over theory).
- **PO2 (Practical/Professional Knowledge)**: 3 for CO1-3 (direct lab standards, best practices in assays/transformation); reflects biotech industry skills like enzyme detection.
- **PO3 (Entrepreneurial Mindset)**: 1-2; highest in CO3,7 (innovation in genetic engineering, market-relevant troubleshooting).
- **PO4 (Specialized Skills)**: 3 for CO1,3,5,7 (technical proficiency in assays, microscopy, data plotting, problem-solving).
- **PO5 (Application/Problem-Solving)**: 3 for CO2-5,7 (real-world analysis of degradation, induction, graphing lag phases).

- **PO6 (Communication/Collaboration)**: 1-2; implied in lab reporting (CO1,4,5,7), but not explicit team leadership.
- **PO7 (Research Skills)**: 2-3 for CO2,3,7 (inquiry in tests, transformation as mini-experiment, ethics in handling E. coli).
- **PO8 (Learning How to Learn)**: 3 for CO3,7 (self-directed competence prep, adapting to failures).
- **PO9 (Digital/Tech Skills)**: 3 for CO3,5 (transformation tech, plotting software); 2 for microscopy.
- **PO10 (Multicultural/Empathy)**: Mostly 1 (lab-individual); 2 for CO7,10 (diverse lab teams).
- **PO11 (Values/Environment)**: 1-2 (biosafety ethics in CO1-3; sustainability in lipid assays).
- **PO12 (Autonomy/Responsibility)**: 3 for CO3,7 (independent execution, accountability in troubleshooting).
- **PO13 (Community Service)**: Mostly 1; 2 for CO7 (societal biotech applications).

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Microbiology (2024 Pattern) (w.e.f. June 2026)

Name of the Programme	**: B.Sc. Microbiology**
Programme Code	**: USMI**
Class	**: T. Y. B.Sc.**
Semester	**: V**
Course Type	**: Elective (Theory)**
Course Code	**: MIB-307-MJE(A)**
Course Title	**: Medical Microbiology-I**
No. of Credits	**: 02**
No. of Teaching Hours	**: 30**

Course Objectives:	
1	Understand the basic concepts of infectious diseases affecting major human body systems (respiratory, gastrointestinal and central nervous system).
2	Explain common pathogens, symptoms, and host defense mechanisms involved in infectious diseases.
3	Describe the classification, morphology, biochemical characteristics and antigenic structure of important bacterial pathogens such as *Salmonella, Vibrio, Pseudomonas, Clostridium tetani* and *Mycobacterium tuberculosis*.
4	Understand pathogenicity, pathogenesis, laboratory diagnosis and epidemiology of major bacterial infections.
5	Discuss preventive measures, prophylaxis and chemotherapy of infectious diseases.
6	Explain the principles and scope of epidemiology, including types of epidemiological studies.
7	Understand clinical trial designs and epidemiological methods used in disease prevention, control and public health management.
Course Outcomes:	
CO1	Identify and describe infectious diseases associated with different human body systems and correlate them with causative agents.
CO2	Analyze host-pathogen interactions and explain mechanisms of infection and immune defense.
CO3	Differentiate major bacterial pathogens based on morphological, biochemical and antigenic characteristics.
CO4	Interpret laboratory diagnostic approaches used for identification of bacterial infections.
CO5	Evaluate epidemiological data based on time, place and person distribution of diseases.
CO6	Compare different epidemiological study designs, including case-control, cohort and randomized controlled trials.
CO7	Apply principles of disease prevention and control in public health and community settings.

Credit	**Unit**	**Topic**	**No. of Lectures**
I		**Introduction to infectious diseases of following human body systems:** (Common diseases, pathogens, symptoms, defense mechanisms)	**15**

	Unit1	**Respiratory system**	2
	Unit2	**Gastrointestinal system**	2
	Unit3	**Central nervous system**	2
	Unit4	**Study of following bacterial pathogens:** **(with respect to –Classification, Morphological and Biochemical characters, Antigenic structure, Viability characteristics, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis, Epidemiology, Prophylaxis and Chemotherapy):** 1. *Salmonella typhi* 2. *Vibrio cholerae* 3. *Pseudomonas aeruginosa* 4. *Clostridium tetani* 5. *Mycobacterium tuberculosis*	 1 2 2 2 2
II	**Epidemiology:**		**15**
	Unit1	**Introduction and scope of epidemiology**	1
	Unit2	**Types of epidemiological studies** 1. Disease distribution basedon time,place and person 2. Case control and cohort studies–study design and application	 2 3
	Unit3	**Principle and methods–Clinical trials of drugs and vaccines** 1. Randomized control trials 2. Concurrent parallel and 3. Cross-over trials	4
	Unit4	**Epidemiology of infectious diseases** 1. Sources and reservoirs of infection 2. Modes of transmission of infections 3. Disease prevention and control measures	 1 2 2

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1. Tortora,G.J.,Funke,B.R.,Case,C.L,1992.Microbiology:An introduction 5th Edition, Roitt, P.I: Mims, C.J.Medical Microbiology

2. Chakraborty,P.,2003 A textbook of Microbiology, 2nd Edition New Central BookAgency,India.

3. Medical Microbiology edited by Samuel Baron. Fourth Edition.(University of Texas Medical Branch of Galvesion)
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Mapping of course outcomes and programme outcomes:	
Class: T. Y. B.Sc. (Sem V)	Subject: Microbiology
Course: **Medical Microbiology-I**	Course code: **MIB-307-MJE(A)**
Weightage: 1 = weak or low relation, 2 = Moderate or partial relation, 3 = Strong or direct relation	

	Program Outcomes												
Course outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO 13**
CO1	3	1	-	1	2	1	-	2	-	1	1	-	1
CO2	3	1	-	2	3	1	1	2	-	1	1	-	1
CO3	3	2	-	3	2	-	1	2	1	-	-	-	-
CO4	2	3	-	3	3	1	2	2	2	-	-	1	-
CO5	2	2	-	2	3	1	2	2	1	1	2	1	2
CO6	2	2	1	2	3	1	3	2	1	1	1	1	1
CO7	2	2	1	2	3	2	2	2	1	3	3	2	3

Justification of Mapping

PO1: Comprehensive Knowledge and Understanding: Strongly mapped because the course builds fundamental knowledge of infectious diseases, pathogens, epidemiology, and prevention strategies

PO2: Practical, Professional, and Procedural Knowledge: Mapped through laboratory diagnosis, epidemiological study design understanding, and application of prevention and control methods.

PO3: Entrepreneurial Mindset and Knowledge: Moderately mapped through understanding of vaccine trials, diagnostics, and public health interventions which can inspire biotech, diagnostic lab or healthcare entrepreneurship.

PO4: Specialized Skills and Competencies: Developed via pathogen differentiation, laboratory interpretation, and epidemiological data analysis.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning: Highly mapped as students analyze infection mechanisms, interpret epidemiological data, and evaluate study designs.

PO6: Communication Skills and Collaboration: Mapped through presentation of epidemiological data, discussion of clinical trials, and group-based analytical learning.

PO7: Research-related Skills: Strongly connected through understanding of cohort studies, case-control studies, and randomized controlled trials.

PO8: Learning How to Learn Skills: Encourages self-directed learning in emerging infectious diseases and

evolving public health strategies.
PO9: Digital and Technological Skills: Moderately mapped via use of diagnostic technologies, epidemiological data tools, and statistical interpretation.
PO10: Multicultural Competence, Inclusive Spirit, and Empathy: Linked through understanding disease burden in diverse populations and ethical aspects of clinical trials.
PO11: Value Inculcation and Environmental Awareness: Connected to disease prevention, sanitation, vaccination awareness, and public health responsibility.
PO12: Autonomy, Responsibility, and Accountability: Students understand ethical responsibilities in disease reporting, clinical trials, and public health decision-making.
PO13: Community Engagement and Service Strongly mapped as epidemiology and disease control directly relate to community health programs and awareness campaigns.

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Microbiology (2024 Pattern) (w.e.f. June 2026)

Name of the Programme	**: B.Sc. Microbiology**
Programme Code	**: USMI**
Class	**: T. Y. B.Sc.**
Semester	**: V**
Course Type	**: Elective (Theory)**
Course Code	**: MIB-307-MJE (B)**
Course Title	**: Nanobiotechnology**
No. of Credits	**: 02**
No. of Teaching Hours	**: 30**

Course Objectives:	
1	To introduce the fundamental concepts, history, and development of nanotechnology and nanoparticles.
2	To provide knowledge about biological methods of nanoparticle synthesis using microorganisms.
3	To understand the role of bacteria, fungi, and actinomycetes in nanoparticle production.
4	To study specialized microbial systems such as magnetotactic bacteria for nanoparticle synthesis.
5	To familiarize students with different types of nanoparticles such as gold and silver nanoparticles and their applications.
6	To understand various physical and chemical methods (top-down and bottom-up approaches) used for nanoparticle synthesis.
7	To develop understanding of advanced techniques used for characterization and analysis of nanoparticles.
Course Outcomes:	
CO1	Explain the concept, history, and scope of nanotechnology and nanoparticle synthesis.
CO2	Describe biological methods for nanoparticle synthesis using microorganisms.
CO3	Analyze the role of bacteria, fungi, actinomycetes, and magnetotactic bacteria in nanoparticle production.
CO4	Compare different types of nanoparticles such as gold nanoparticles (AuNPs) and silver nanoparticles (AgNPs) along with their applications.
CO5	Differentiate between top-down and bottom-up approaches for nanoparticle synthesis. **CO6:** Describe various physicochemical methods such as ball milling, plasma arching, sol-gel, and electrodeposition used for nanoparticle synthesis.
CO6	Interpret results obtained from nanoparticle characterization techniques such as UV-Vis spectroscopy, FTIR, SEM, TEM, XRD, and XRF.
CO7	Explain the concept, history, and scope of nanotechnology and nanoparticle synthesis.

Credit No.	Unit	Topic	Lectures
I	**Introduction and microbial synthesis of nanoparticles:**		**15**
	Unit 1	**Introduction and microbial synthesis:** a) Definition, history, time-line b) Biological Methods of Synthesis c) Use of microorganisms for nanoparticle synthesis - bacteria, fungi, Actinomycetes d) Magnetotactic bacteria for natural synthesis of magnetic nanoparticles e) Microbial synthesis of**:** Gold nanoparticles (AuNPs), Silver nanoparticles (AgNPs) f) Applications of Nanoparticles	**1** **1** **2** **1** **2** **1**
	Unit 2	**Microbial mediated metallic nanoparticles synthesis methods**: a) Top-down: Ball milling, Plasma arching, Laser sputtering, Vapour deposition b) Bottoms-up: Sol-gel, Colloidal, Electrodeposition, Solution phase reductions	**4** **3**
II	**Techniques in nanotechnology**		**15**
	Unit 1	**Techniques of characterization of nanoparticles** a) Optical spectroscopy b) UV-visual spectroscopy, c) Fourier transform infrared (FTIR), d) Scanning electron microscopy (SEM), e) Transmission electron microscopy (TEM) f) X-ray Fluorescence (XRF) g) X-ray diffraction (XRD**)**	**2** **2** **3** **2** **2** **2** **2**

References:

1. Characterization of Nanophase materials – Z.L Wang (ed), Wiley-VCH, New York 2000.
2. Nanoparticles: From theory to applications – G. Schmidt, Wiley Weinheim 2004.
3. Nanostructured Silicon – based powders and composites – Andre P Legrand, ChristianeSenemaud, Taylor and Francis, London New York 2003.
4. Processing & properties of structural naonmaterials - Leon L. Shaw (editor)Elements
5. Nanomaterials and Nanochemistry by Brechignac C., P. Houdy, M. Lahmani, Springer publication, 2007.
6. Nanoscale materials in chemistry by Kenneth J. Klabunde, Wiley Interscience Publications,2001
7. Nanochemistry by Sergeev G.B., Elseiver publication,2006.
8. Nanostructures and Nanomaterials, synthesis, properties and applications by Guozhong Cao, Imperial College Press, 2004.

9. Nanomaterials – Handbook by YuryGogotsi, CRC Press, Taylor & Francis group, 2006.

Mapping of course outcomes and programme outcomes:	
Class: T. Y. B.Sc. (Sem V)	Subject: Microbiology
Course: **Nanobiotechnology**	Course code: **MIB-307-MJE(B)**
Weightage: 1 = weak or low relation, 2 = Moderate or partial relation, 3 = Strong or direct relation	

Course Outcomes (COs)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PO13
CO1	3	1	-	1	2	-	1	2	1	-	-	-	-
CO2	3	2	-	2	2	-	2	2	1	-	1	-	-
CO3	3	2	-	2	3	1	2	2	1	-	1	-	-
CO4	3	2	1	2	3	1	2	2	1	-	2	-	-
CO5	3	2	1	2	3	-	2	2	1	-	1	-	-
CO6	3	3	1	3	3	1	2	2	2	-	1	-	-
CO7	3	3	-	3	3	1	3	2	3	-	1	1	-

Justification for the Mapping

PO1: Comprehensive Knowledge and Understanding

All course outcomes (CO1–CO7) strongly contribute to PO1 as the course provides fundamental and advanced knowledge of nanotechnology, microbial nanoparticle synthesis, synthesis methods, and characterization techniques, ensuring a comprehensive understanding of the subject.

PO2: Practical, Professional, and Procedural Knowledge

CO2, CO3, CO4, CO5, CO6, and CO7 contribute moderately to strongly to PO2 by developing understanding of biological and physicochemical methods of nanoparticle synthesis and characterization techniques, which are essential for laboratory and professional applications.

PO3: Entrepreneurial Mindset and Knowledge

CO4, CO5, and CO6 contribute at a basic level to PO3 by introducing industrial and commercial applications of nanoparticles, encouraging students to think about entrepreneurial opportunities in nanotechnology and biotechnology fields.

PO4: Specialized Skills and Competencies

CO2, CO3, CO4, CO5, CO6, and CO7 moderately to strongly contribute to PO4 by developing specialized knowledge and skills related to microbial synthesis, nanoparticle production, and analytical techniques used in nanotechnology.

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

All course outcomes (CO1–CO7) contribute to PO5, with CO3, CO4, CO5, CO6, and CO7 showing strong alignment as they involve analysis, comparison, differentiation, and interpretation of nanoparticle synthesis methods and characterization results.

PO6: Communication Skills and Collaboration

CO3, CO4, CO6, and CO7 contribute at a basic level to PO6 as students are required to communicate scientific concepts, discuss methods, and interpret results effectively in academic and laboratory settings.

PO7: Research-related Skills
CO2, CO3, CO4, CO5, CO6, and CO7 contribute moderately to strongly to PO7 by introducing research-oriented concepts such as microbial nanoparticle synthesis, experimental approaches, and analytical techniques, thereby enhancing research aptitude.
PO8: Learning How to Learn Skills
All course outcomes (CO1–CO7) moderately contribute to PO8 by encouraging students to explore advanced and emerging areas in nanotechnology, fostering independent learning and adaptability.
PO9: Digital and Technological Skills
CO1 to CO7 contribute to PO9 by involving the use of technological tools and analytical instruments such as UV-Vis spectroscopy, FTIR, SEM, TEM, XRD, and XRF, enhancing students' digital and technical competencies.
PO10: Multicultural Competence, Inclusive Spirit, and Empathy
This course has minimal or no direct contribution to PO10 as it primarily focuses on scientific and technical aspects of nanotechnology rather than social or cultural dimensions.
PO11: Value Inculcation and Environmental Awareness
CO2, CO3, CO4, CO5, CO6, and CO7 contribute moderately to PO11 by highlighting eco-friendly biological synthesis methods and applications of nanoparticles in environmental protection and sustainability.
PO12: Autonomy, Responsibility, and Accountability
CO7 contributes slightly to PO12 as students learn to interpret scientific data responsibly and understand the importance of accuracy and accountability in research and reporting.
PO13: Community Engagement and Service
This course has limited contribution to PO13, as it is mainly focused on theoretical and technical aspects, though indirect relevance may exist through environmental and biomedical applications of nanotechnology.

Name of the Programme	**: B.Sc. Microbiology**
Programme Code	**: USMI**
Class	**: T. Y. B.Sc.**
Semester	**: V**
Course Type	**: Elective (Practical)**
Course Code	**: MIB-308-MJE(A)**
Course Title	**: Practical Course Based on Immunology-I & Medical Microbiology-I**
No. of Credits	**: 02**
No. of Teaching Hours	**: 60**

Course Objectives:	
1	To understand the principles and procedures involved in the physical, chemical, and microscopic examination of various clinical samples such as urine, stool, and pus.
2	To develop practical skills in isolation and identification of pathogenic microorganisms from clinical specimens using selective and differential media.
3	To demonstrate knowledge of culture characteristics of pathogens on specialized media such as Mannitol Salt Agar, Wilson Blair Agar, Salmonella-Shigella Agar, Cetrimide Agar, TSI Agar, and Glucose Azide Medium.
4	To perform and interpret Antibiotic Sensitivity Testing (AST) for both Gram-positive and Gram-negative bacterial isolates.
5	To understand and apply fundamental hematological techniques including blood grouping and hemoglobin estimation.
6	To gain knowledge of antigen–antibody reactions through Widal test and immunoprecipitation techniques for diagnostic purposes.
7	To familiarize students with clinical laboratory practices and blood bank operations through institutional visits and demonstrations.
Course Outcomes:	
CO1	Examine and analyze clinical samples (urine, stool, pus) using physical, chemical, and microscopic methods for diagnostic interpretation.
CO2	Isolate and identify pathogenic microorganisms from clinical specimens using appropriate culture media and biochemical tests.
CO3	Differentiate pathogens based on colony morphology and growth characteristics on selective and differential media.
CO4	Perform
CO5	Conduct hematological investigations including blood grouping and hemoglobin estimation accurately.
CO6	Apply immunological techniques such as Widal and immunoprecipitation tests for detection of infectious diseases.
CO7	Demonstrate professional laboratory skills, biosafety practices, and clinical diagnostic competency applicable to hospital and research laboratories.

No of Practicals	Topic	Teaching Hours
	Clinical Microbiology:	
1-3	Physical, Chemical and Microscopic examination of Clinical samples – urine, stool, pus	12
4-5	Isolation and Identification of Pathogen From Urine Sample	8
6-7	Isolation and Identification of Pathogen From Pus Sample.	8
8-9	Isolation and Identification of Pathogen From Stool Sample.	8
10-11	Demonstration of Growth of Pathogens on Different Media. (Mannitol Salt Agar, Wilson Blair agar, Salmonella Shigella agar,Glucose azide medium, Cetrimide agar, TSI agar)	8
	Immunohaematological Techniques:	
12	Blood Grouping	4
13	Estimation of Haemoglobin by Acid Hematin or Cyanmethaemoglobin Method.	4
14	Agglutination (Widal test) / Immunoprecipitation Test	4
15	Visit to blood bank	4

References:

1. Forbes, B. A., Sahm, D. F., & Weissfeld, A. S. (2018). *Bailey & Scott's diagnostic microbiology* (14th ed.). Elsevier.
2. Cheesbrough, M. (2006). *District laboratory practice in tropical countries* (2nd ed.). Cambridge University Press.
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Owen, J. A., Punt, J., & Stranford, S. A. (2018). *Kuby immunology* (8th ed.). W. H. Freeman.

Mapping of course outcomes and programme outcomes:	
Class: T. Y. B.Sc. (Sem V)	Subject: Microbiology
Course: **Practical Course Based on Basic Immunology-I & Medical Microbiology-I**	Course code: **MIB-308-MJE(A)**
Weightage: 1 = weak or low relation, 2 = Moderate or partial relation, 3 = Strong or direct relation	

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

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding
All course outcomes build strong theoretical and conceptual understanding of clinical microbiology, diagnostic techniques, hematology, and immunology.

PO2: Practical, Professional, and Procedural Knowledge
Students gain hands-on experience in clinical sample analysis, pathogen identification, AST, hematological and immunological procedures.

PO3: Entrepreneurial Mindset and Knowledge
Knowledge of diagnostic procedures and laboratory management supports establishment of diagnostic laboratories and healthcare services.

PO4: Specialized Skills and Competencies
Develops specialized laboratory skills in isolation, identification, drug sensitivity testing, and immunodiagnostic techniques.

PO5: Application, Problem-Solving, and Analytical Reasoning
Students interpret laboratory results, identify pathogens, and analyze antibiotic susceptibility patterns for clinical decision-making.

PO6: Communication Skills and Collaboration
Enhances teamwork in laboratory work and ability to report and communicate diagnostic findings effectively.

PO7: Research-related Skills
Promotes scientific observation, data interpretation, and understanding of diagnostic research methodologies.

PO8: Learning How to Learn Skills
Encourages independent laboratory learning, SOP adherence, and continuous skill development.

PO9: Digital and Technological Skills
Students become familiar with laboratory instruments, diagnostic technologies, and data recording systems.

PO10: Multicultural Competence and Empathy
Promotes ethical handling of patient samples and understanding of healthcare responsibilities.

PO11: Value Inculcation and Environmental Awareness
Instills biosafety practices, biomedical waste management, and responsible antibiotic use.

PO12: Autonomy, Responsibility, and Accountability Develops accountability in handling pathogens, performing tests, and reporting accurate results.

PO13: Community Engagement and Service
Exposure to blood bank operations and clinical diagnostics enhances awareness of community health services.

Name of the Programme : **B.Sc. Microbiology**
Class : **T.Y.B.Sc.**
Semester **V**
Course Type : **Practical**
Course Code : **MIB-308-MJE (B)**
Course Title : **Practical based on Nanobiotechnology**
No. of Credits **02**
No. of Practical **15**

Course Objectives

1. Understand the fundamental principles of nanoparticle synthesis using physical, chemical, biological, and green methods.
2. Demonstrate various synthesis techniques such as chemical reduction, microbial synthesis, and plant-mediated synthesis of nanoparticles.
3. Develop skills in isolation and handling of microorganisms for biosynthesis of nanoparticles.
4. Gain knowledge of characterization techniques such as UV–Visible spectroscopy and FTIR analysis.
5. Analyze the influence of physicochemical parameters (pH, temperature, metal ion concentration) on nanoparticle synthesis.
6. Interpret spectral data for confirmation and analysis of nanoparticle formation.
7. Evaluate the applications of nanoparticles, especially their antimicrobial potential in microbiology.

Course Outcomes

After successful completion of this course, students will be able to:

CO1: Explain the principles and methods of nanoparticle synthesis including physical, chemical, biological, and green synthesis approaches.

CO2: Perform synthesis of nanoparticles using chemical reduction and plant-mediated green synthesis methods.

CO3: Isolate, culture, and utilize microorganisms (bacteria, fungi, yeast, actinomycetes) for intracellular and extracellular nanoparticle synthesis.

CO4: Characterize synthesized nanoparticles using UV–Visible spectroscopy and interpret Surface Plasmon Resonance (SPR) data.

CO5: Analyze FTIR spectra for identification of functional groups associated with nanoparticle synthesis and stabilization.

CO6: Evaluate the effect of various physicochemical parameters such as pH, temperature, and metal ion concentration on nanoparticle synthesis.

CO7: Assess the antimicrobial activity of nanoparticles using microbiological techniques such as agar well diffusion method.

Sr. No.	Practical Name	Teaching Hours
1	Laboratory safety and handling of nanomaterials; preparation of reagents and media	4
A. Chemical Synthesis of Nanoparticles		
2	Chemical synthesis of silver nanoparticles (chemical reduction method)	4
3	Characterization of chemically synthesized nanoparticles using UV–Visible spectroscopy (SPR analysis)	4
B. Biological (Microbial) Synthesis of Nanoparticles		
4	Isolation of bacteria/ fungi/ yeast/ actinomycetes from environmental samples	4

5	Preparation of microbial culture filtrate / biomass for nanoparticle synthesis	4
6	Synthesis of nanoparticles using microbial culture filtrate	4
7	Characterization of biologically synthesized nanoparticles using UV–Visible spectroscopy	4
C. Plant-mediated Green Synthesis of Nanoparticles		
8	Preparation of plant extracts for nanoparticle synthesis	4
9	Green synthesis of nanoparticles using plant extracts	4
10	Characterization of green synthesized nanoparticles using UV–Visible spectroscopy	4
D. Optimization and Analysis		
11	Study of factors affecting nanoparticle synthesis (pH, temperature, metal ion concentration)	4
E. Advanced Characterization (Demonstration / Interpretation)		
12	FTIR analysis of nanoparticles (functional group identification) – Demonstration/Interpretation	4
13	Interpretation of SEM/TEM images for size, shape, and morphology analysis of nanoparticles	
F. Applications of Nanoparticles		
14	Study of antimicrobial activity of nanoparticles (agar well diffusion method)	4
15	Dye degradation assay using nanoparticles (environmental application)	4

References:

1. Rai, M., Yadav, A., & Gade, A. (2009). Silver nanoparticles as a new generation of antimicrobials. *Biotechnology Advances*, 27(1), 76–83.
2. Iravani, S. (2011). Green synthesis of metal nanoparticles using plants. *Green Chemistry*, 13(10), 2638–2650.
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Course Outcomes (COs)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PO13
CO1	3	2	2	2	2	1	2	2	1	1	1	1	1
CO2	3	3	2	3	3	1	2	2	2	1	1	2	1
CO3	3	3	2	3	3	2	3	2	2	1	1	2	1
CO4	3	3	1	3	3	2	3	2	3	1	1	2	1
CO5	3	3	1	3	3	2	3	2	3	1	1	2	1
CO6	3	3	2	3	3	2	3	2	2	1	1	2	1
CO7	3	3	3	3	3	2	3	2	2	2	2	2	2

Justification for the Mapping

PO1: Comprehensive Knowledge and Understanding

All COs (CO1–CO7) strongly map (3) as the course provides in-depth knowledge of nanoparticle synthesis methods, microbial involvement, characterization techniques, and applications in microbiology.

PO2: Practical, Professional, and Procedural Knowledge

CO2–CO7 strongly map (3) due to hands-on laboratory work such as nanoparticle synthesis, microbial isolation, characterization techniques, and antimicrobial testing. CO1 has moderate mapping (2).

PO3: Entrepreneurial Mindset and Knowledge

CO7 strongly maps (3) as nanoparticle antimicrobial applications are relevant for product development. CO1, CO2, CO3, and CO6 show moderate mapping (2), while CO4 and CO5 have limited relation (1).

PO4: Specialized Skills and Competencies

CO2–CO7 strongly map (3) as they involve advanced laboratory skills including nanoparticle synthesis, microbial techniques, and spectroscopic analysis. CO1 shows moderate mapping (2).

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

CO2–CO7 strongly map (3) as students apply concepts, analyze FTIR and SPR data, and evaluate parameters affecting synthesis. CO1 shows moderate mapping (2).

PO6: Communication Skills and Collaboration

CO3–CO7 show moderate mapping (2) due to teamwork in laboratory work and reporting results. CO1 and CO2 have low mapping (1).

PO7: Research-related Skills

CO3–CO7 strongly map (3) as they involve experimental design, microbial utilization, data interpretation, and antimicrobial studies. CO1 and CO2 show moderate mapping (2).

PO8: Learning How to Learn Skills

All COs show moderate mapping (2) as students develop independent learning skills through experimentation and interpretation of results.

PO9: Digital and Technological Skills

CO4 and CO5 strongly map (3) due to use of analytical instruments (UV-Vis, FTIR). CO2, CO3, and CO6 show moderate mapping (2), while CO1 has basic relation (1).

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

CO7 shows moderate mapping (2) due to applications in healthcare and society. Other COs show low mapping (1).

PO11: Value Inculcation and Environmental Awareness

CO7 shows moderate mapping (2) due to eco-friendly nanoparticle applications and green synthesis. Other COs have low mapping (1).

PO12: Autonomy, Responsibility, and Accountability

CO2–CO7 show moderate mapping (2) as students perform independent laboratory work and handle responsibilities. CO1 shows low mapping (1).

PO13: Community Engagement and Service

CO7 shows moderate mapping (2) due to application of nanoparticles in antimicrobial treatments benefiting society. Other COs show low mapping (1).

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Microbiology (2024 Pattern) (w.e.f. June 2026)

Name of the Programme	**: B.Sc. Microbiology**
Programme Code	**: USMI**
Class	**: T. Y. B.Sc.**
Semester	**: V**
Course Type	**: Practical**
Course Code	**: MIB-309-OJT**
Course Title	**: On Job Training**
No. of Credits	**: 04**
No. of Teaching Hours	**: 120**

The National Education Policy 2020 emphasize Practical Assignments and Skill Development to the students across institutes of higher learning in various streams.
In view of this, Tuljaram Chaturchand College, Baramati has come up with a concept to provide Field Project/On-Job Training Program to all students.
The On-Job Training Program will provide valuable work experience to the students, help them explore a career path and develop and refine skills that will eventually give themselves an edge in the job market

Nature of On-Job Training Program:

A student has to undergo 120 hours of practical training in suitable establishments in consultation with the concerned teacher.

Framework of the On-Job Training:

The area in which a student has to undergo On-Job Training Program will be finalized by the concerned teacher in consultation with the On-Job Training Program providing organization.
This will help a student to have hands - on experience of the important aspects of the Discipline Specific Special Subject chosen by him / her.
The contents of the On-Job Training Program should be adequate and a students should be able to understand various concepts and put it into practice within a time frame of 120 hours.
On-Job Training Program is of 120 hours net.
Guidelines of On-Job Training will be as per the guidelines uploaded on website.

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Microbiology (2024 Pattern) (w.e.f. June 2026)

Name of the Programme	**: B.Sc. Microbiology**
Programme Code	**: USMI**
Class	**: T. Y. B.Sc.**
Semester	**: V**
Course Type	**: Minor (Theory)**
Course Code	**: MIB-310-MN**
Course Title	**: Soil Microbiology**
No. of Credits	**: 02**
No. of Teaching Hours	**: 30**

Course Objectives:	
1	Understand the basic concepts of soil microbiology and soil composition.
2	Describe different types of soil microorganisms and their functions.
3	Explain the role of rhizosphere microflora in plant growth and soil fertility.
4	Understand the role of microorganisms in composting and humus formation.
5	Explain microbial degradation of organic matter such as cellulose, lignin, hemicellulose, and pectin.
6	Understand ecological functions of soil microorganisms and microbial interactions.
7	Explain the role of microorganisms in elemental cycles such as carbon, nitrogen, and sulphur cycles.
Course Outcomes:	
CO1	Define soil microbiology and identify major groups of soil microorganisms. Explain the composition and types of soil and their influence on microbial life. Describe rhizosphere microflora and mycorrhizal associations in plant nutrition. Discuss microbial biomass and activity in soil ecosystems.
CO2	Illustrate different types of microbial interactions such as symbiosis, competition, parasitism, and predation.
CO3	Explain the influence of environmental factors on soil microbial communities.
CO4	Describe the role of microorganisms in carbon, nitrogen, and sulphur cycles
CO5	Define soil microbiology and identify major groups of soil microorganisms. Explain the composition and types of soil and their influence on microbial life. Describe rhizosphere microflora and mycorrhizal associations in plant nutrition. Discuss microbial biomass and activity in soil ecosystems.
CO6	Illustrate different types of microbial interactions such as symbiosis, competition, parasitism, and predation.
CO7	Explain the influence of environmental factors on soil microbial communities.

Credit		**Topic & Learning Points**	**Teaching hours**
I	**Unit 1**	**Introduction to soil microbiology**	**15**
		1. Soil microorganisms, composition and types of soil.	3
		2. Rhizosphere microflora and its role in the rhizosphere.	3
		3. Role of microorganisms in composting and humus formation.	2

		4. Role of microorganisms in degradation of cellulose, hemicelluloses, lignin and pectin.	4
		5. Microbial biomass and activity in soil ecosystems.	3
II	**Unit 1**	**Ecological Functions of Soil Microorganisms**	**8**
		1. Influence of environmental factors on soil microbial communities.	3
		2. Mycorrhizal associations and their significance in plant nutrition	2
		3. Types of microorganisms in soil and its role.	3
	Unit 2	**Microbial Interactions**	**7**
		1. Different Types of Microbial interactions: Symbiosis, Neutralism, Commensalism, Competition, Ammensalism, Synergism, Parasitism, and Predation	4
		1. Role of microorganisms in following elemental cycles in nature i. Carbon ii. Nitrogen iii. Sulphur	3
		Total	**30**

References :

1. **Principles and Applications of Soil Microbiology** – David M. Sylvia, Jeffry J. Fuhrmann, Peter G. Hartel & David A. Zuberer. Pearson Education.
2. **Soil Microbiology, Ecology and Biochemistry** – Eldor A. Paul. Academic Press.
3. **Introduction to Soil Microbiology** – Martin Alexander. Wiley Eastern.
4. **Agricultural Microbiology** – N. S. Subba Rao. Oxford & IBH Publishing.
5. **Soil Microbiology** – G. Rangaswami & D. J. Bagyaraj. PHI Learning.
6. **Microbiology** – M. J. Pelczar, E. C. S. Chan & N. R. Krieg. McGraw-Hill Education.

Mapping of course outcomes and programme outcomes:	
Class: T. Y. B.Sc. (Sem V)	Subject: Microbiology
Course: **Soil Microbiology**	Course code: **MIB-310-MN**
Weightage: 1 = weak or low relation, 2 = Moderate or partial relation, 3 = Strong or direct relation	

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

CO 5	3	1		2	3	1	1	1			2		
CO 6	3	2		2	3		2	1	1		3		
CO 7	3	2	1	2	3	1	2	1	1		3	1	2

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding
Mapped COs: **CO1, CO2, CO3, CO4, CO5, CO6, CO7**
Justification:
All course outcomes build strong theoretical understanding of soil microorganisms, soil composition, microbial interactions, environmental factors, and biogeochemical cycles. Hence, PO1 shows strong alignment with all COs.

PO2: Practical, Professional and Procedural Knowledge
Mapped COs: **CO2, CO3, CO4, CO6, CO7**
Justification:
Students develop applied understanding of soil analysis, rhizosphere studies, biomass estimation, environmental influence assessment, and nutrient cycling processes, contributing to procedural and professional knowledge.

PO3: Entrepreneurial Mindset and Knowledge
Mapped COs: **CO3, CO7**
Justification:
Knowledge of mycorrhiza, biofertilizers, and nutrient cycling provides scope for agricultural entrepreneurship and sustainable farming practices.

PO4: Specialized Skills and Competencies
Mapped COs: **CO1, CO2, CO3, CO4, CO5, CO6, CO7**
Justification:
The course develops subject-specific competencies in soil microbial identification, ecological interpretation, interaction analysis, and understanding nutrient cycles.

PO5: Application, Problem-Solving and Analytical Reasoning
Mapped COs: **CO2, CO3, CO4, CO5, CO6, CO7**
Justification:
Students analyze soil–microbe relationships, environmental impacts, microbial interactions, and nutrient transformations, strengthening analytical and problem-solving abilities.
PO6: Communication Skills and Collaboration
Mapped COs: **CO3, CO5, CO7**
Justification:
Topics like plant–microbe interaction and ecological processes encourage scientific discussion, presentation, and collaborative learning.

PO7: Research-related Skills

Mapped COs: **CO3, CO4, CO5, CO6, CO7**

Concepts such as microbial biomass estimation, ecological interactions, and nutrient cycles form the foundation for research orientation in environmental and agricultural microbiology.

PO8: Learning How to Learn Skills

Mapped COs: **CO1–CO7 (All COs)**

The course promotes continuous learning through conceptual understanding of dynamic soil ecosystems and evolving ecological knowledge.

PO9: Digital and Technological Skills

Mapped COs: **CO4, CO6, CO7**

Understanding microbial biomass measurement, environmental monitoring, and nutrient cycling may involve use of laboratory instruments and digital tools.

PO10: Multicultural Competence, Inclusive Spirit and Empathy

Mapped COs: **No strong direct mapping**

The course is primarily scientific and does not directly address multicultural or social inclusion competencies.

PO11: Value Inculcation and Environmental Awareness

Mapped COs: **CO1, CO2, CO3, CO4, CO5, CO6, CO7**

All topics emphasize soil health, sustainability, ecological balance, and environmental conservation, strongly supporting environmental awareness.

PO12: Autonomy, Responsibility and Accountability

Mapped COs: **CO7**

Understanding nutrient cycles and environmental sustainability promotes responsible scientific thinking and accountability toward ecosystem conservation.

PO13: Community Engagement and Service

Mapped COs: **CO3, CO7**

Applications of rhizosphere microbiology, biofertilizers, and nutrient cycling directly benefit agricultural communities and sustainable farming practices.