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)

T. Y. B. Sc. Microbiology

To be implemented from Academic Year 2025-2026

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 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 specificbranches 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 inthe area of work.
PSO2	**Critical Thinking and Problem solving:** Exhibit the skills of analysis, inference, interpretation and problem-solving by observing the situation closelyand 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 knowledgeof 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 andCommerce, Baramati

(Autonomous)

Board of Studies (BoS) in Microbiology

From 2025-26 to 2027-28

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

Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

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Course Structure for T.Y. B. Sc. Microbiology (2023 Pattern)

Sem	Course Type	Course Code	Course Title	Theory/Practical	Credits	Marks (I + E)
V	Major Mandatory	MIB-301-MJM	Genetics and Molecular Biology I	Theory	02	20 +30
	Major Mandatory	MIB-302-MJM	Biochemistry I	Theory	02	20 +30
	Major Mandatory	MIB-303-MJM	Immunology I	Theory	02	20 +30
	Major Mandatory	MIB-304-MJM	Fermentation Technology I	Theory	02	20 +30
	Major Mandatory	MIB-305-MJM	Practical course based on Medical Microbiology and Immunology	Practical	02	25 +25
	Major Elective (MJE)	MIB-306-MJE(A)	Medical Microbiology I	Theory (Any Two)	02 + 02 = 04	20 +30
	Major Elective (MJE)	MIB-306-MJE(B)	Food and Dairy Microbiology			20 +30
	Major Elective (MJE)	MIB-306-MJE(C)	Nanotechnology			20 +30
	Minor	MIB-341-MN	Agriculture Microbiology	Theory	02	20 +30
	Minor	MIB-342-MN	Practical Course based on Agriculture Microbiology	Practical	02	25 +25
	Vocational Skill Course (VSC)	MIB-321-VSC	Industrial Microbiology	Practical	02	25 +25
	Field Project (FP)	MIB-335-FP	Field Project	Practical	02	25 +25
				Total Credits (Semester-V)	22	
VI	Major Mandatory	MIB-351-MJM	Genetics and Molecular Biology II	Theory	02	20 +30
	Major Mandatory	MIB-352-MJM	Biochemistry II	Theory	02	20 +30
	Major Mandatory	MIB-353-MJM	Immunology II	Theory	02	20 +30
	Major Mandatory	MIB-354-MJM	Fermentation Technology II	Theory	02	20 +30
	Major Mandatory	MIB-355-MJM	Practical course based on Biochemistry Genetics	Practical	02	25 +25
	Major Elective (MJE)	MIB-356-MJE(A)	Medical Microbiology II	Theory (Any Two)	02 + 02 = 04	20 +30
	Major Elective (MJE)	MIB-356-MJE(B)	Agriculture and Environmental Microbiology			20 +30
	Major Elective (MJE)	MIB-356-MJE(C)	Microbial Technology			20 +30
	Minor	MIB-361-MN	Dairy Microbiology	Theory	02	20 +30
	Minor	MIB-362-MN	Practical course based on Dairy Microbiology	Practical	02	25 +25
	On Job Training (OJT)	MIB-385-OJT	On Job Training	Practical	04	50 +50
				Total Credits (Semester-VI)	22	
				Total Credits (Semester V + VI)	44	

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Microbiology (2023 pattern)

Name of the Programme : B.Sc. Microbiology
Program Code : USMI
Class : T. Y. B.Sc.
Semester : V
Course Type : Theory
Course Name : Genetics and Molecular Biology I
Course Code : MIB-301-MJM
No. of Credits : 02
No. of Lectures : 30

Course Objectives

1. Explore the structural features and organization of viral, bacterial, and eukaryotic genomes.
2. Learn the concept of nucleoid in prokaryotes and its role in genome organization.
3. Investigate the structure of nucleosomes, chromatin fibers (10 nm and 30 nm), and their organization in eukaryotic cells.
4. Study DNA replication mechanisms, including OriC, replicons, and bidirectional replication forks.
5. Understand transcription processes in prokaryotes and eukaryotes, focusing on RNA polymerases and promoter structures.
6. Learn the molecular machinery of translation, including the roles of mRNA, tRNA, ribosomes, and aminoacyl tRNA synthetase.
7. Compare key molecular processes (replication, transcription, translation) between prokaryotic and eukaryotic systems.

Course Outcomes

CO1: Students will understand the structural differences in viral, bacterial, and eukaryotic genomes.
CO2: Students will describe nucleoid organization in bacteria and chromatin structure in eukaryotes.
CO3: Students will explain the process of DNA replication, including OriC, bidirectional replication, and key proteins like DNA polymerases.
CO4: Students will compare transcription processes, including RNA polymerases and promoter structure.
CO5: Students will describe the roles of mRNA, tRNA, and ribosomes in protein synthesis and the steps involved in translation.
CO6: Students will contrast replication, transcription, and translation mechanisms between prokaryotic and eukaryotic systems.
CO7: Students will apply their understanding of genome structure and molecular processes in genetic and molecular biology research.

Credit No.		Topic and Learning Points	No. of Teaching Hours
I	**Genome structure and replication**		
	Unit 1	**Genome organization**	**7**
		Viral Genome structure	1
		Bacterial Genome structure Concept of Nucleoid	1
		Eukaryotic Genome organization	2
		Structure of nucleosome,10 nm fiber,30 nm fiber,	2
		Structure of Euchromatin and heterochromatin.	1
	Unit 2	**Replication**	**8**
		Ori C	1
		Single replicon, Multiple Replicon	1
		Bidirectional movement of replication fork.	1
		Pre-priming and Priming reaction.	2
		DNA polymerases, DNA synthesis of leading, lagging strand Okazaki fragments.	2
		Termination- Ter sequence, Tus protein	1
II	**Gene expression**		
	Unit 1	**Transcription**	**7**
		Structure of promoters (Prokaryotic and eukaryotic)	1
		Structure and types of RNA polymerases	2
		Steps of transcription: Initiation, Abortive Initiation, Elongation and Termination	2
		Comparison of prokaryotic and eukaryotic transcription	2
	Unit 2	**Translation**	**8**
		Role of m-RNA, t-RNA and Ribosomes and Aminoacyl tRNA synthetase in translation	3
		Initiation, elongation, translocation and termination of protein synthesis	3
		Comparative account of prokaryotic and Eukaryotic translation mechanism	2

References:

1. R.J.BROOKER (2012) Genetics: Analysis and Principles , 4 th edition,McGraw-Hill publication
2. Strickberger, M.W. (1985), Genetics, 3rd Edition Macmillan Pub. Co. N
3. Gardner, Simmons and Snustad (1991)Principles of Genetics, 8 th edition John Wiley and Sons Publication
4. Russel Peter. (2009), Genetics: A Molecular Approach, 3rd Edn. Publisher Benjamin Cummings
5. Russel, Peter, (1990), Essential Genetics, 7thEdn. Blackwell Science Pub. 12
6. Lodish H. et al. (2012), Molecular Cell Biology, 7th Edn. W. H. Freeman & Company. New York.
7. Russel Peter. (2009), iGenetics: A Molecular Approach, 3rd Edn. Publisher Benjamin Cummings 11. Russel, Peter, (1990), Essential Genetics, 7thEdn. Blackwell Science Pub. 12
8. Watson J.D., Baker, T.A., Bell, S.P., Molecular Biology of the gene, 7th edition. Pearson (2013)
9. Genes IX-Benjamin Lewin
10. Russel P.J., iGenetics: A molecular Approach 3rd edition. Pearson(2010)
11. Fundamentals of Molecular Biology –By J K Pal and Saroj Ghaskadabi
12. Brooker, R.J., Genetics: Analysis and principles. 4th Edition. McGrow Hill (2010)
13. Principles of Genetics-By Gardner

Mapping of course outcomes and programme outcomes

Class : TYBSc (Sem V) **Subject : Microbiology**
Course : Genetics and Molecular Biology I **Course code : MIB-301-MJM**

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

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

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding
CO1, CO2, and CO3 contribute by providing fundamental knowledge of genome structures, nucleoid organization, and DNA replication.
CO4, CO5, and CO6 explain transcription, translation, and molecular differences between prokaryotes and eukaryotes.
CO7 applies genome structure knowledge to research applications.
PO2: Practical, Professional, and Procedural Knowledge
CO3, CO4, and CO5 contribute by explaining detailed molecular biology techniques.
CO6 and CO7 emphasize laboratory techniques for studying genetic material.
PO3: Entrepreneurial Mindset and Knowledge
CO7 is moderately related, as understanding molecular biology supports biotechnology startups in genetic engineering.
PO4: Specialized Skills and Competencies
CO3, CO4, and CO5 contribute by teaching key molecular processes.
CO6 and CO7 provide deeper insights into experimental methods used in genetic research.
PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO3, CO4, CO5, and CO6 involve problem-solving in molecular processes and experimental design.
CO7 requires analysis and application of genetic information in research.
PO6: Communication Skills and Collaboration
CO7 involves discussing genetic research findings.
CO1 and CO2 contribute to effectively communicating genome-related concepts.
PO7: Research-related Skills
CO6 and CO7 strongly support research by applying genome knowledge to molecular biology studies.
PO8: Learning How to Learn Skills
CO3, CO4, CO5, and CO6 ensure students develop continuous learning skills in molecular biology.
PO9: Digital and Technological Skills
CO6 and CO7 involve bioinformatics tools for genome analysis.
CO3, CO4, and CO5 contribute by incorporating modern sequencing techniques.
PO10: Multicultural Competence, Inclusive Spirit, and Empathy
CO1 and CO2 provide insights into the genetic diversity of different organisms.
PO11: Value Inculcation and Environmental Awareness
CO6 and CO7 address ethical concerns in genetic research and genome modifications.
PO12: Autonomy, Responsibility, and Accountability
CO6 and CO7 emphasize ethical handling of genetic materials and experimental responsibility.
PO13: Community Engagement and Service
CO6 and CO7 support outreach in genetic literacy and biotechnology awareness.

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Microbiology (2023 pattern)

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-MJM
Course Title : Biochemistry I
No. of Credits : 02
No. of Teaching Hours : 30

Course Objective:

1. Understand the role of cofactors in metabolic pathways.
2. Investigate enzyme purification methods.
3. Learn enzyme kinetics principles.
4. Examine metabolic regulation mechanisms.
5. Explore enzyme compartmentalization.
6. Understand enzyme inhibition mechanisms.
7. Analyze complex enzyme systems.

Course Outcome:

CO1 Students will be able to explain the importance of vitamins (Niacin, Riboflavin, Thiamine, Pantothenic acid, Pyridoxal) and metal ions in metabolic reactions.
CO2 Students will gain the skills to isolate and purify enzymes using techniques like dialysis, ultrafiltration, size-exclusion chromatography, and affinity chromatography.
CO3 Students will be able to interpret kinetic data using various plots such as the Michaelis-Menten, Lineweaver-Burk, and Eadie-Hofstee plots.
CO4 Students will understand how allosteric regulation, feedback mechanisms, and covalent modifications control enzyme activity and metabolic pathways.
CO5 Students will be able to identify different types of enzyme inhibitors (competitive, non-competitive, uncompetitive, etc.) and explain their effects on enzyme activity.
CO6 Students will understand the role of enzyme localization in cellular processes and its impact on overall metabolic efficiency.
CO7 Students will gain insight into the function of multienzyme complexes, such as the pyruvate dehydrogenase complex, and how they contribute to metabolic processes.

Credit		Learning and Teaching Points	Teaching Hours
I	Unit 1	**Role of cofactors in metabolism** Occurrence, Structure and Biochemical functions of the following: 1. Nicotinic Acid (Niacin) and the Pyrimidine nucleotides 2. Riboflavin (Vitamin B_2) and the Flavin nucleotides 3. Thiamine (Vitamin B_1) and Thiamine Pyrophosphate 4. Pantothenic acid and coenzyme- A 5. Pyridoxal phosphate (Vitamin B_6) 6. Metal ions	**06** 01 01 01 01 01 01

	Unit 2	**Enzyme purification** 1. Methods of Cell Lysis 2. Principles and methods of enzyme purification based on molecular size a) Dialysis and Ultrafiltration b) Size-Exclusion Chromatography (SEC) or Gel Filtration c) Centrifugation 3. Principles and methods of enzyme purification based on charge a) Ion Exchange Chromatography (IEC) b) Electrophoresis 4. Principles and methods of enzyme purification based on solubility differences a) Salting Out b) Solvent Fractionation 5. Principles and methods of enzyme purification based on specific binding property and selective adsorption a) Affinity Chromatography	**11** 01 01 01 02 01 02 01 01 01
II	**Unit 3**	**Enzyme Kinetics** a) Concept and use of initial velocity b) Michaelis Menten equation for the initial velocity of single substrate enzyme catalyzed reaction c) Brigg's Haldane modification of Michaelis Menten equation d) Michaelis Menten plot e) Definition with significance of K_m, K_s, V_{max} f) Different plots for plotting Kinetic data: Lineweaver and Burk plot ii. Hanes plot iii. Eadie Hofstee plot iv. Eisanthal, Cornish-Bowden plot g) Concepts and types of Enzyme Inhibitions.	**08** 01 02 01 01 02 01
	Unit 4	**Metabolic Regulations** a) Enzyme compartmentalization at cellular level b) Allosteric enzymes c) Feedback mechanisms d) Covalently modified regulatory enzymes (e.g. Glycogen phosphorylase) e) Proteolytic activation of zymogens f) Isozymes - concept and examples g) Multienzyme complex e.g. Pyruvate dehydrogenase complex (PDH).	**07** 01 01 01 01 01 01 01
		Total	**30**

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

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

CO1: Explain the importance of vitamins and metal ions in metabolic reactions
PO1 (Comprehensive Knowledge): Strong relation, as this outcome involves understanding key metabolic reactions, which requires a solid foundation in biochemical principles.
PO5 (Application and Problem-Solving): Strong relation, as applying knowledge of vitamins and ions requires solving biological and metabolic problems.

CO2: Isolate and purify enzymes using techniques like dialysis, ultrafiltration, etc.
PO2 (Practical Knowledge): Strong relation, as this outcome is highly practical and requires expertise in biochemical techniques.
PO4 (Specialized Skills): Strong relation, as enzyme isolation and purification involve specialized skills in laboratory techniques.
PO5 (Application and Problem-Solving): Strong relation, as purifying enzymes is a practical task that involves troubleshooting and problem-solving in the lab.

CO3: Interpret kinetic data using various plots (Michaelis-Menten, Lineweaver-Burk, etc.)
PO1 (Comprehensive Knowledge): Strong relation, as understanding enzyme kinetics involves deep knowledge of biochemistry and statistical analysis.

PO4 (Specialized Skills): Strong relation, as interpreting kinetic data requires specialized analytical and statistical skills.
PO5 (Application and Problem-Solving): Strong relation, as interpreting kinetic data involves solving complex problems related to enzyme activity.
PO9 (Digital and Technological Skills): Strong relation, as digital tools and software are often used to analyze kinetic data.

CO4: Understand how allosteric regulation, feedback mechanisms, and covalent modifications control enzyme activity
PO1 (Comprehensive Knowledge): Strong relation, as understanding regulation mechanisms is a

core part of biochemistry.
PO4 (Specialized Skills): Strong relation, as understanding enzyme regulation requires specialized knowledge in biochemistry and cellular biology.
PO5 (Application and Problem-Solving): Strong relation, as applying this knowledge involves solving problems related to enzyme behavior and regulation.
PO6 (Communication and Collaboration): Moderate relation, as this understanding may be communicated and discussed in collaborative research environments.

CO5: Identify different types of enzyme inhibitors and explain their effects on enzyme activity
PO1 (Comprehensive Knowledge): Strong relation, as understanding enzyme inhibitors is crucial to biochemistry and requires a solid theoretical foundation.
PO4 (Specialized Skills): Strong relation, as identifying enzyme inhibitors requires specialized biochemical knowledge and laboratory skills.
PO5 (Application and Problem-Solving): Strong relation, as enzyme inhibitors play a key role in many applied biochemistry problems, such as drug development and enzyme kinetics.

CO6: Understand the role of enzyme localization in cellular processes
PO1 (Comprehensive Knowledge): Strong relation, as understanding enzyme localization requires comprehensive knowledge of cellular biochemistry and molecular biology.
PO4 (Specialized Skills): Strong relation, as understanding enzyme localization is a specialized skill important for cellular biologists and biochemists.
PO5 (Application and Problem-Solving): Strong relation, as this knowledge can help solve complex problems related to cellular functions and dysfunctions.

CO7: Gain insight into the function of multienzyme complexes (e.g., pyruvate dehydrogenase complex)
PO1 (Comprehensive Knowledge): Strong relation, as this outcome involves understanding complex biochemical processes that are foundational to biochemistry and metabolism.
PO4 (Specialized Skills): Strong relation, as understanding multienzyme complexes requires specialized knowledge and skills in biochemistry.
PO5 (Application and Problem-Solving): Strong relation, as applying this knowledge is essential for solving biochemical problems, particularly in metabolic disorders or drug design.

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Microbiology (2023 pattern)

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-MJM
Course Title : Immunology I
No. of Credits : 02
No. of Teaching Hours : 30

Course Objective:

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 Outcome:

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	Unit	Topic	Teaching Hours
I	**Unit 1**	**Immunity:** Definition and Classification **Formation of blood cells:** Erythrocytic, myelocytic, monocytic and lymphocytic lineages anddifferentiation process, lymphocyte types and subsets	**4**
	Unit 2	**Innate immunity: Non specific mechanisms of defense** a. **First line of defense** – Physical, chemical barriers b. **Second line of defense**: Phagocytosis, Complement activation (Classical, Alternative and lectin pathway), Inflammation	**4**

	Unit 3	**Organs of immune system:** a. Primary lymphoid organs (Thymus,bone marrow and Bursa): Thymus – structure, thymic education (positive and negative selection) b. 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	**7**
II	**Unit 1**	**Antigen:** a. Concepts and factors affecting Immunogenicity b. Antigenic determinants, haptens and cross-reactivity, Carriers, Adjuvants Types of antigens: Thymus-dependent and thymus-independent antigens, Synthetic antigens, Soluble and particulate antigens, Autoantigens, Isoantigens	**4**
	Unit 2	**Immunoglobulins:** a. Structure and types of Immunoglobulin's, chemical and biological properties b. Characteristic of domain structure, functions of light and heavy chain domains Antigenic nature of immunoglobulin molecules	**4**
	Unit 3	**Adaptive / Acquired Immunity (Third line of defense):** **1. Humoral Immune Response** a. Primary and secondary response kinetics, significance in vaccination programs b. Antigen processing and presentation (MHC class I and class II restriction pathways), activation and differentiation of B-cells **2. Cell Mediated Immune Response** a. Activation and differentiation of T cells b. Mechanism of CTL mediated cytotoxicity, ADCC Significance of CMI	**7**

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.
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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 : TYBSc (Sem V) **Subject : Microbiology**

Course : Immunology I **Course code : MIB-303-MJM**

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

	Programme Outcomes (POs)												
Course outcomes (COs)	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**
CO1	3	2	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

Justifications for 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.

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Microbiology (2023 pattern)

Name of the Programme : B.Sc. Microbiology
Class : T.Y.B.Sc.
Semester : V
Course Type : Theory
Course Code : MIB-304-MJM
Course Title : Fermentation Technology - I
No. of Credits : 02
No. of Teaching Hours : 30

Course Objectives:

1 To cater the needs of students for building up their careers in pharmaceutical and fermentation industries.
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 Outcome:

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.		Topic and Learning Points	Teaching Hours
I	**Unit 1**	**Strain Improvement** 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 mutants, 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)	**8**

	Unit 2	**Medium optimization:** a. Nutritional, non-nutritional factors and responses b. Methods of medium optimization : i. Classical approach – One factor at a time, Full factorial design (with example) ii. Plackett-Burman design (with example)	**3**
	Unit 3	**Principles and methods of downstream processing - I** a. Cell disruption b. Filtration c. Centrifugation	**4**
II	**Unit 1**	**Principles and methods of downstream processing - II** a. Liquid-liquid extraction b. Distillation c. Ion exchange chromatography d. Drying	**6**
	Unit 2	**Quality assurance (QA) of fermentation products - I** a. Sterility testing b. Pyrogen testing: Endotoxin detection (LAL test)	**2**
	Unit 3	**Quality assurance (QA) of fermentation products - II** a. Ames test and modified Ames test b. Toxicity testing c. Shelf-life determination	**4**
	Unit 4	**Quality assurance (QA) of fermentation products - III** Detection and quantification of the product by Spectrophotometric & Biological assays	**3**

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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**	**PO10**	**PO11**	**PO12**	**PO13**
CO1	3	2	1	2	3	1	2	2	2	1	1	2	1
CO2	3	2	2	2	3	1	2	2	1	1	2	2	1
CO3	2	2	2	2	2	1	1	2	1	1	2	1	2
CO4	2	3	1	3	3	1	2	2	2	1	2	2	1
CO5	2	3	2	3	3	2	3	2	2	1	3	3	2
CO6	2	2	3	2	3	1	2	2	2	1	2	2	2
CO7	2	2	3	3	3	2	2	3	2	2	3	3	3

PO1: Comprehensive Knowledge and Understanding
All COs provide foundational understanding of industrial processes, fermentation, and microbial roles in industry.

PO2: Practical, Professional, and Procedural Knowledge
Students gain lab-based and process knowledge like sterilization (CO4), QC (CO5), and industrial protocols.

PO3: Entrepreneurial Mindset and Knowledge
Especially strong in CO6 & CO7 which promote understanding of industrial budgeting and entrepreneurship .

PO4: Specialized Skills and Competencies
Skills in QC (CO5), use of raw materials (CO3), and understanding of process operations (CO4) develop technical expertise.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO1, CO2, and CO5 promote problem-solving through understanding of microbial selection and fermentation design.

PO6: Communication Skills and Collaboration

Group activities, industry visits, and lab teamwork help build communication (more relevant in CO5, CO7).

PO7: Research-related Skills
Medium mapping across COs where exploration of new organisms or optimization is encouraged.

PO8: Learning How to Learn Skills
Students learn dynamic industrial processes and adapt to new protocols and industry standards.

PO9: Digital and Technological Skills
Includes instrumentation in fermentation monitoring, QC tools, and documentation processes.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy
Exposure to industrial workforce diversity promotes respect and inclusivity. Moderate weight.

PO11: Value Inculcation and Environmental Awareness
CO3 and CO5 stress natural resources and quality ethics. Also CO7 in relation to sustainable industrial models.

PO12: Autonomy, Responsibility, and Accountability
Students understand sterilization, costing, QC, etc., enhancing accountability and work ethics.

PO13: Community Engagement and Service
Application of microbial processes to industry and society promotes outreach and service potential (e.g., CO7).

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Microbiology (2023 pattern)

Program Code	**: USMI**
Class	**:T.Y.B.Sc.**
Semester	**V**
Course Type	**:Practical**
Course Name	**:Practical based on Medical Microbiology & Immunology**
Course Code	**:MIB-305-MJM**
No. of Credits	**:02**
No. of Practicals	**: 15**

Course Objectives:

1.To enrich the students knowledge about Clinical Microbiology.

2.To develop expertise in clinical practices.

3.To enrich student's knowledge and train them in Clinical Microbiology.

4.To understand the scientific responsibilities while working in medical field.

5.To develop opportunities in entrepreneurships

6.To enrich students knowledge about clinical Microbiology.

7.To understand developments in the field of Clinical microbiology

Course Outcomes:

On completion of the course, the students will be able to

CO1: Conduct physical, chemical, and microscopic examinations of clinical samples, including urine, stool, and pus.

CO2: Isolate and identify common pathogens from clinical samples up to the genus level using appropriate identification keys and Bergey's Manual.

CO3: Perform antibiotic sensitivity testing of isolates, understanding the differences between Gram-negative and Gram-positive pathogens.

CO4: Analyze growth characteristics of isolated pathogens on various media, including Mannitol Salt Agar and Salmonella Shigella agar.

CO5: Apply the double immunodiffusion technique to assess antigen-antibody reactions.

CO6: Execute the Widal test for the direct agglutination of typhoid antibodies in patient serum samples.

CO7: Interpret experimental results from microbiological procedures, demonstrating the ability to communicate findings effectively.

Credit No.	Topic	Number of Practicals
I &II	a. Physical, Chemical and Microscopic examination of Clinical samples – urine, stool, pus	**4**
	b. Isolation, identification of following pathogens from clinical samples upto genus level (anyone pathogen from each sample). *E. coli*, *Salmonella* spp., *Pseudomonas* spp., *Proteus* spp., *Klebsiella* spp., *Shigella* spp., *Staphylococcus* spp., *Streptococcus* spp. (for identification use of keys as well as Bergey's Manual is recommended) Antibiotic sensitivity testing of the isolates (for Gram negative and Gram Positive)	**7**
	c. Study of growth characters of isolated pathogens on following media: Mannitol Salt Agar, Wilson Blair agar, Salmonella Shigella agar, Glucose azide medium, Cetrimide agar, TSI agar	**2**
	d. Double immunodiffusion technique	**1**
	e. Widal test (Direct agglutination)	**1**

Mapping of course outcomes and programme outcomes:

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

Class : TYBSc (Sem V) **Subject : Microbiology**
Course : Practical based on Medical Microbiology & Immunology
Course code : MIB-306-MJM

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

Justification for the mapping

- **PO1: Comprehensive Knowledge and Understanding**
  Strongly relates to CO1, CO2, CO3, CO4, CO6, and CO7 as these objectives require in-depth understanding of microbiological techniques, pathogen identification, and clinical implications.
- **PO2: Practical, Professional, and Procedural Knowledge**
  Moderate relation for CO1, CO2, CO3, CO4, CO5, and CO6 as they involve applying theoretical knowledge in practical scenarios in a laboratory setting.
- **PO3: Entrepreneurial Mindset and Knowledge**
  Weak relation across all COs since entrepreneurship is not a focus of the practical microbiology curriculum.
- **PO4: Specialized Skills and Competencies**
  Strong correlation with CO2, CO3, CO4, CO6, and CO7 as they require specialized skills in laboratory techniques such as isolation, identification, and testing of microbial pathogens.
- **PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning**
  Strongly related to CO2, CO3, and CO4 since these COs involve analyzing data from practical experiments and making informed decisions based on those analyses.
- **PO6: Communication Skills and Collaboration**
  Weak to moderate relation overall, though CO7 addresses the need for effectively communicating findings, which is essential in shared lab work.
- **PO7: Research-related Skills**
  Moderate to strong relation for CO3, CO4, and CO6, given that these outcomes involve research methods and techniques applicable in microbiological studies.
- **PO8: Learning How to Learn Skills**
  Weak relation as specific methodologies for self-directed learning are not explicitly addressed in the COs.
- **PO9: Digital and Technological Skills**
  Weak relation since the practical skills mainly focus on traditional laboratory techniques rather than digital or technological proficiencies.
- **PO10: Multicultural Competence, Inclusive Spirit, and Empathy**
  Weak relation as COs do not have a focus on multicultural aspects or inclusive practices in microbiology.
- **PO11: Value Inculcation and Environmental Awareness**
  Weak relation, although understanding infectious agents can lead to awareness, it is not expressly tied to the COs.
- **PO12: Autonomy, Responsibility, and Accountability**
  Weak relation; COs don’t emphasize responsibility or accountability within the context of practical work.
- **PO13: Community Engagement and Service**
  Weak relation overall; while microbiology has community health implications, the practical outcomes do not directly engage

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Microbiology (2023 pattern)

Name of the Programme :B.Sc. Microbiology
Program Code : USMI
Class :T.Y.B.Sc.
Semester : V
Course Type : Major Elective Theory
Course Name : Medical Microbiology-I
Course Code : MIB-306-MJE(A)
No.of Credits : 02
No.of Lectures : 30

Course Objectives

Students will:

1. Acquired a strong foundation in the principles of infectious disease, enabling them to contribute to public health initiatives and disease prevention strategies.
2. Be proficient in analyzing and interpreting epidemiological data, supporting evidence-based decision-making in healthcare.
3. Possess research skills, including the ability to design and conduct studies related to infectious diseases, contributing to advancements in the field.
4. Demonstrate critical thinking and problem-solving skills in evaluating clinical trials of drugs and vaccines, promoting ethical practices in research.
5. Exhibit effective communication skills in presenting information on bacterial pathogens, facilitating collaboration with healthcare professionals and researchers.
6. Understand the importance of interdisciplinary approaches in addressing infectious diseases, contributing to a holistic understanding of public health challenges.
7. Be equipped with knowledge and skills to contribute to the development and implementation of effective measures for the prevention and control of infectious diseases in diverse populations.

Course Outcomes :

Students will able to:

CO1 Demonstrate a comprehensive understanding of common infectious diseases affecting the respiratory, gastrointestinal, urogenital, and central nervous systems, including knowledge of causative pathogens, symptoms, and host defense mechanisms.

CO2 Analyze and interpret epidemiological data, showcasing the ability to identify patterns of disease distribution based on time, place, and person

CO3 Demonstrate proficiency in designing and conducting case-control and cohort studies, applying these study designs to investigate infectious diseases and their transmission dynamics.

CO4 Understand the principles and methods involved in clinical trials of drugs and vaccines, including randomized control trials, concurrent parallel trials, and cross-over trials.

CO5 Comprehend the epidemiology of infectious diseases, including sources and reservoirs of infection, modes of transmission, and measures for disease prevention and control.

CO6 Develop the skills to critically evaluate the role of epidemiological monitoring organizations and their contribution to public health

CO7 Analyze and present information on various bacterial pathogens, discussing their classification,biochemicalcharacteristics,antigenicstructure,viability, pathogenicity, pathogenesis, symptoms, laboratory diagnosis, epidemiology, prophylaxis, and chemotherapy.

Credit	Unit	Topic	No. of Lectures
I	**Introduction to infectious diseases of following human body systems:** (Common diseases, pathogens, symptoms, defense mechanisms)		**15**
	Unit 1	**Respiratory system**	2
	Unit 2	**Gastrointestinal system**	2
	Unit 3	**Urogenital system**	2
	Unit 4	**Central nervous system**	2
	Unit 5	**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* 2. *Vibrio* 3. *Pseudomonas* 4. *Clostridium tetani* 5. *Mycobacterium tuberculosis*	7
II	**Epidemiology:**		**15**
	Unit 1	**Introduction and scope of epidemiology**	1
	Unit 2	**Types of epidemiological studies** 1. Disease distribution based on time, place and person 2. Case control and cohort studies– study design and application	5
	Unit 3	**Principle and methods– Clinical trials of drugs and vaccines** 1. Randomized control trials 2. Concurrent parallel and 3. cross-over trials	4
	Unit 4	**Epidemiology of infectious diseases** 1. Sources and reservoirs of infection 2. Modes of transmission of infections 3. Disease prevention and control measures	5

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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

Class : TYBSc (Sem V) **Subject : Microbiology**

Course : Medical Microbiology-I **Course code : MIB-306-MJE(A)**

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

Justification for the mapping

- **PO1: Comprehensive Knowledge and Understanding**

  Strongly relates to CO1, CO2, CO3, CO4, CO5, and CO7 as these objectives directly require in-depth knowledge of infectious diseases, epidemiology, and clinical practices.

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

  Moderate relation for CO1, CO3, CO4, and CO5 as they involve professional application of knowledge in practical scenarios like disease management and clinical trials.

- **PO3: Entrepreneurial Mindset and Knowledge**

  Weak relation across all COs, as entrepreneurial knowledge is not a primary focus of the course objectives.

- **PO4: Specialized Skills and Competencies**

  Strongly correlates with CO3, CO4, and CO7 due to the specific competencies related to research design and clinical methodologies.

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

  Strongly related to CO2 and CO5 since they focus on analyzing epidemiological data and applying knowledge to solve problems in public health.

- **PO6: Communication Skills and Collaboration**

  Weak relation overall; while communication might be involved, it is not a primary focus of the

course outcomes.

- **PO7: Research-related Skills**

  Strongly relates to CO3, CO4, and CO7 as designing studies and understanding clinical trials are critical components of research skills.

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

  Weak relation as the course outcomes do not specifically address self-directed or lifelong learning skills.

- **PO9: Digital and Technological Skills**

  Weak relation, since course outcomes do not explicitly incorporate technology or digital skills.

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

  Weak relation since these elements are not directly addressed in the COs focusing on technical knowledge.

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

  Weak relation since the course objectives focus on technical and clinical aspects rather than values or environmental issues.

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

  Weak relation as the focus is in specific knowledge areas rather than broader responsibilities or accountability.

- **O13: Community Engagement and Service**

  Weak relation overall, although understanding infectious diseases can indirectly lead to community service, it is not explicitly tied to the COs.

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Microbiology (2023 pattern)

Name of the Programme : B.Sc. Microbiology
Program Code : USMI
Class : T.Y.B.Sc.
Semester : V
Course Type : Major Elective Theory
Course Name : Food and Dairy Microbiology
Course Code :MIB-306-MJE(B)
No. of Credits : 02
No. of Lectures : 30

Course Objectives

1. Learn the basics of food microbiology and the role of microorganisms in food safety.
2. Understand the classification of foods (perishable, non-perishable, stable) and microbial growth factors.
3. Explore intrinsic and extrinsic factors that influence microbial growth in food.
4. Study methods of food preservation using temperature, chemicals, and radiation.
5. Examine food poisoning and infections caused by microbes like *Clostridium botulinum* and *Salmonella*.
6. Learn about milk chemistry, microbiology, and spoilage.
7. Apply Milk Quality Tests: Perform tests to assess milk quality, including pasteurization and microbial analysis.

Course Outcomes

CO1: Define food microbiology and microbial roles in food safety.
CO2: Classify foods and understand factors affecting microbial growth.
CO3: Use preservation methods like temperature, chemicals, and radiation.
CO4: Identify pathogens responsible for foodborne illnesses.
CO5: Understand the microbiology of milk and spoilage.
CO6: Assess methods like pasteurization for milk preservation.
CO7: Perform milk quality tests such as bacterial counts and pasteurization checks.

Credit No.	Topic and learning point	Teaching hour
I	**Food Microbiology**	
Unit 1	**Introduction to food microbiology**	**15**
	Definition and Classification of food (Perishable, non- perishable, and stable).	01
	Factors affecting Microbial growth in food	
	Intrinsic factors- pH, water activity, O-R potential, nutrient content, biological structure of food, inhibitory substances in food.	01
	Extrinsic factors-Temperature of storage, Relative humidity, concentration of gases.	01
	Sources of food spoilage microorganisms.	01
Unit 2	**Principles of food preservation**	
	Importance of TDP, TDT, D, F, Z values Use of low and high temperature for food preservation.	02
	Use of chemicals and antibiotics in food preservation,	01
	Method of Canning	01
	Methods of Dehydration	01
	Use of radiation	01
	Tetra pack technology	01
Unit 3	**Microbial food poisoning and food infection**	
	Food poisoning - *Clostridium botulinum, Staphylococcus aureus, Aspergillus flavus*	02
	Food infection - *Salmonella typhimurium, Vibrio parahaemolyticus*	02
II	**Dairy Microbiology**	**15**
Unit 1	**Milk chemistry and constituents**	
	Definition and composition of milk	01
	Types of milk (skimmed, toned and homogenized)	01
	Sources of contamination of milk Concept of clean milk	01
	Factors affecting quality and quantity of milk	01
	Nutritive value of milk	01
	Physico-chemical properties of milk	01
Unit 2	**Microbiology of milk:**	
	Common micro-organisms found in milk	01
	Fermentation and spoilage of milk	01
	Milk borne diseases	01
	Preservation of milk by pasteurization and its storage	
	Methods of Pasteurization – LTH, HTST, UHT	01
	Phosphatase test and its significance	01
Unit 3	**Microbial analysis of milk**	
	Dye reduction test (using methylene blue and resazurin)	01
	Total bacterial count	01
	Brucella ring test and tests for mastitis	01
	Somatic cell count	01

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Mapping of course outcomes and programme outcomes

Class : TYBSc (Sem V) **Subject : Microbiology**

Course : Food and Dairy Microbiology **Course code : MIB-306-MJE(B)**

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

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

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding

All COs contribute to fundamental knowledge in food microbiology, including foodborne pathogens (CO1, CO4), microbial growth (CO2), food preservation techniques (CO3), dairy microbiology (CO5), and milk quality testing (CO7).

CO1 and CO4 are directly related as they cover food microbiology concepts and foodborne illness pathogens.

PO2: Practical, Professional, and Procedural Knowledge

CO3, CO6, and CO7 strongly relate to practical applications, as they involve hands-on techniques like food preservation, pasteurization, and bacterial testing in milk.
CO5 supports procedural knowledge related to dairy microbiology.

PO3: Entrepreneurial Mindset and Knowledge

CO2 and CO3 help students explore business opportunities in food storage and preservation industries.
CO5 and CO6 are valuable for dairy-related entrepreneurship, especially in milk processing and quality assurance.

PO4: Specialized Skills and Competencies

CO3, CO6, and CO7 develop specialized skills in food preservation and microbiological analysis of milk.
CO4 contributes by enhancing pathogen identification skills, essential for food safety professionals.

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

CO3, CO5, and CO6 require analytical reasoning to assess microbial growth, food spoilage, and preservation techniques.
CO7 strengthens problem-solving by applying milk testing techniques to ensure safety.

PO6: Communication Skills and Collaboration

CO1, CO4, and CO7 encourage students to effectively communicate findings related to foodborne illnesses and milk quality testing.
CO6 supports collaboration in dairy processing industries where microbiologists work in teams.

PO7: Research-related Skills

CO4 and CO7 develop research skills in identifying pathogens and performing microbiological tests.
CO3 encourages research into new food preservation techniques.

PO8: Learning How to Learn Skills

CO1, CO2, and CO5 promote lifelong learning by introducing evolving concepts in food safety, microbial growth, and dairy microbiology.
CO6 and CO7 encourage adapting to new quality control techniques in food and dairy industries.

PO9: Digital and Technological Skills

CO3, CO6, and CO7 involve the use of digital tools in microbial testing, food preservation, and pasteurization monitoring.
CO4 supports the use of pathogen detection technology in food safety.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

CO1, CO4, and CO5 highlight the impact of foodborne diseases and food safety on diverse populations.
CO3 and CO6 discuss culturally relevant food preservation and dairy processing practices.

PO11: Value Inculcation and Environmental Awareness

CO3 and CO5 encourage sustainable food preservation and dairy microbiology practices.
CO1 and CO4 promote awareness of food safety to prevent outbreaks and public health issues.

PO12: Autonomy, Responsibility, and Accountability

CO6 and CO7 emphasize responsibility in handling food safety and dairy product testing.
CO4 encourages accountability in pathogen detection and foodborne illness prevention.

PO13: Community Engagement and Service

CO1, CO4, and CO7 promote food safety awareness in the community.
CO3 and CO6 contribute by educating communities on proper food preservation and milk hygiene.

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Microbiology (2023 pattern)

Name of the Programme : B.Sc. Microbiology
Class : T.Y.B.Sc.
Semester : V
Course Type : Theory
Course Code : MIB-306-MJE (C)
Course Title : Nanobiotechnology
No. of Credits : 02
No. of Teaching Hours : 30

Course Objectives:

1. Understanding Microbial Nanoparticle Synthesis: To provide students with a comprehensive understanding of the fundamental concepts, history, and biological methods involved in the microbial synthesis of nanoparticles.

2. Exploring Microorganisms in Nanotechnology: To examine the role of various microorganisms, including bacteria, fungi, and Actinomycetes, in synthesizing nanoparticles, with a special focus on magnetotactic bacteria for natural magnetic nanoparticle production.

3. Analyzing Synthesis Methods: To delve into the various methods of microbial-mediated metallic nanoparticle synthesis, distinguishing between top-down and bottom-up approaches.

4. Characterization Techniques Proficiency: To equip students with the knowledge and skills to use different techniques for characterizing nanoparticles, such as optical spectroscopy, UV-visual spectroscopy, FTIR, SEM, TEM, XRF, and XRD.

5. Applications of Nanoparticles: To explore the diverse applications of nanoparticles in various fields, including agriculture, medicine, environmental remediation, textile nanofibre production, and the food industry.

6. Critical Thinking and Problem Solving: To develop students' critical thinking and problem-solving skills in applying nanotechnology techniques to real-world scenarios in diverse industries.

7. Research and Development: To encourage students to engage in research and development, promoting the innovative application of microbial synthesis methods and nanotechnology in solving global challenges.

Course Outcomes:

CO1 Comprehensive Understanding: Students will be able to demonstrate a thorough understanding of the history, definition, and biological methods involved in the microbial synthesis of nanoparticles.

CO2 Microbial Role in Nanotechnology: Students will be able to explain the role of different microorganisms, including bacteria, fungi, and Actinomycetes, in synthesizing nanoparticles and describe specific examples like magnetotactic bacteria for magnetic nanoparticle production.

CO3 Methodology Proficiency: Students will gain proficiency in distinguishing between top-down and bottom-up approaches for microbial-mediated metallic nanoparticle synthesis and understanding their practical applications

CO4 Technical Expertise: Students will be able to utilize and interpret data from various nanoparticle characterization techniques such as optical spectroscopy, SEM, TEM, and XRD.

CO5 Application Awareness: Students will be able to identify and explain the applications of nanoparticles across multiple industries, including agriculture, medicine, environment, textiles, and food.

CO6 Problem-Solving: Students will develop the ability to apply nanotechnology concepts to solve practical problems in industry, healthcare, and environmental sectors.

CO7 Research Skills: Students will be able to design and execute research projects related to microbial nanoparticle synthesis and its applications, contributing to advancements in nanotechnology

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 Program Outcomes with Course Outcomes

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

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

Justification for the Mapping

PO1: Comprehensive Knowledge and Understanding
Strongly relevant for all COs as students gain deep knowledge of microbial synthesis, characterization, and application of nanoparticles .

PO2: Practical, Professional, and Procedural Knowledge
Students perform experiments and learn professional techniques for nanoparticle synthesis and characterization (CO3, CO4, CO7).

PO3: Entrepreneurial Mindset and Knowledge
Applications in fields like agriculture and medicine foster innovation and entrepreneurship (CO2, CO3, CO5).

PO4: Specialized Skills and Competencies
Development of practical and analytical skills in nanotechnology research and applications (CO3, CO4, CO7).

PO5: Application, Problem-Solving, and Analytical Reasoning
Students learn to solve real-world problems using microbial nanotechnology, especially in CO3, CO4, CO6, and CO7.

PO6: Communication Skills and Collaboration
Moderate relevance as students present their research work and collaborate on projects.

PO7: Research-related Skills
Strongly addressed in CO1, CO3, CO6, CO7 through literature review, experimental design, and data interpretation.

PO8: Learning How to Learn Skills
Encouraged throughout the course as students work independently and in groups to explore new nanotech methodologies.

PO9: Digital and Technological Skills
Use of instrumentation and computational tools for nanoparticle analysis (CO4, CO7).

PO10: Multicultural Competence, Inclusive Spirit, and Empathy
Moderate contribution where students understand the global relevance and ethical issues in nanotech applications.

PO11: Value Inculcation and Environmental Awareness
Highlighted in applications of nanotech for environmental remediation (CO5, CO6).

PO12: Autonomy, Responsibility, and Accountability
Students carry out independent experiments and projects with responsibility (CO6, CO7).

PO13: Community Engagement and Service
Nanotechnology applications in healthcare, agriculture, and environment reflect social responsibility (CO5, CO6, CO7).

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Microbiology (2023 pattern)

Name of the Programme : B.Sc. Microbiology
Program Code : USMI
Class : T.Y.B.Sc.
Semester : V
Course Type : Minor (Theory)
Course Code : MIB-341-MN
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 plantmicrobe 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.

Credits No.	Unit	Topics and Learning Points	Teaching Hours
I	**Plant Pathology and Agricultural Technology**		**15**
	Unit 1	**Plant growth improvement with respect to:** a. Disease resistance b. Environmental tolerance	**5**
	Unit 2	**Methods of plant disease control** a. Chemical control b. Eradication c. Biological control (employing bacterial and fungal cultures) d. Integrated pest management e. Application of viral proteins in controlling plant pathogens **f.** Mycoviruses acting against fungal plant pathogens	**10**
II	**Biofertilizers and Biopesticides**		**15**
	Unit 1	**Production, Methods of applications and uses of following biofertilizers:** *a. Azotobacter* *b. Rhizobium* c. Blue green algae d. Phosphate solubilizing microorganisms e. Mycorrhiza	**6**
	Unit 2	**Mechanism of:** a. Nitrogen fixation b. Phosphate solubilization c. Potassium mobilization	**5**
	Unit 3	**Biopesticides** a. Introduction b. Types of biopesticides c. Advantages	**4**

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.
3. David S. Ingram, N.F. Robertson (1999). Plant Disease.1 st Edn.: Collins George Nicholas Agrios (2005).Plant Pathology.5 th Edn. Academic Press Inc.
4. Dixon, G. R., & Tilston, E. L. (Eds.). (2010). Soil microbiology and sustainable crop production. Springer Science & Business Media.
5. Kaur, T., Kour, D., & Yadav, A. N. (2022). Trends of agricultural microbiology for sustainable

crops production and economy: An introduction. In Trends of Applied Microbiology for Sustainable Economy (pp. 1-44). Academic Press.
6. Mahanta, K. C. (1970). Fundamentals of agricultural microbiology. Fundamentals of agricultural microbiology.
7. Mosttafiz, S., Rahman, M., & Rahman, M. (2012). Biotechnology: role of microbes in sustainable agriculture and environmental health. The Internet Journal of Microbiology, 10(1)
8. Nayak, S. K., Baliyarsingh, B., Singh, A., Mannazzu, I., & Mishra, B. B. (Eds.). (2022). Advances in Agricultural and Industrial Microbiology: Volume-2: Applications of Microbes for Sustainable Agriculture and in-silico Strategies. Springer Nature.
9. N. S. Subba Rao. (1995). Soil Microorganisms and Plant growth. 3 rd Edn. Science Pub Inc
10. Pareek, R. P., & Pareek, N. (2019). Agricultural microbiology. Scientific Publishers.
11. Rao, N. S. (Ed.). (2016). Advances in agricultural microbiology. Elsevier
12. Schäfer, T., & Adams, T. (2014). The importance of microbiology in sustainable agriculture. In Principles of Plant-Microbe Interactions: Microbes for Sustainable Agriculture (pp. 5-6). Cham: Springer International Publishing.
13. Subba, R. (2017). Soil microbiology. Oxford and IBH Publishing.
14. Tikhonovich, I. A., & Provorov, N. A. (2011). Microbiology is the basis of sustainable agriculture: an opinion. Annals of Applied Biology, 159(2), 155-168.
15. Verma, D. K. (Ed.). (2019). Microbiology for sustainable agriculture, soil health, and environmental protection. CRC Press.

Mapping of Program Outcomes with Course Outcomes

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

	Programme Outcomes (POs)												
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				3							3	
CO2	3						3	3					
CO3					3		3						
CO4	3				3								
CO5	3			3								3	
CO6		3			3								
CO7		3	3								3	3	

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding:

CO1: This CO directly links to students' foundational knowledge of soil science. Understanding the physical and chemical properties of soil is fundamental to building comprehensive knowledge in the field of soil microbiology and agricultural science.

CO2: This CO requires students to understand the microbial community in soil, which is a key element of agricultural microbiology and environmental science. This aligns with comprehensive knowledge in the subject area.

CO4: This CO addresses core concepts in soil microbiology and agronomy, ensuring that students understand essential processes contributing to soil fertility.

CO5: Understanding nitrogen fixation is critical for agricultural microbiology, and this CO ensures students grasp the biochemical and ecological processes involved.

PO2: Practical, Professional, and Procedural Knowledge:

CO6: This CO enables students to integrate their knowledge into practical situations, distinguishing between beneficial and harmful microorganisms and using this understanding in professional agricultural settings.

CO7: This CO develops practical knowledge about biofertilizers, which students can apply in professional agricultural settings, contributing to sustainable farming practices.

PO3: Entrepreneurial Mindset and Knowledge:

CO7: Knowledge of biofertilizers can encourage entrepreneurial thinking in students, particularly in developing or marketing new biofertilizer products for sustainable agriculture.

PO4: Specialized Skills and Competencies:

CO5: This CO directly contributes to specialized knowledge and skills, particularly regarding nutrient cycling and soil fertility management in agricultural contexts.

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

CO6: Integrating knowledge of agricultural microbiology into real-world scenarios enhances students' problem-solving abilities and their capacity to address agricultural challenges.

CO3: This CO enhances students' ability to analyze and assess microbial populations in practical agricultural settings, directly contributing to solving real-world problems related to plant health.

CO4: This CO addresses core concepts in soil microbiology and agronomy, ensuring that students understand essential processes contributing to soil fertility.

CO1: By identifying and classifying different types of soil, students will develop the ability to apply their theoretical knowledge to solve practical problems related to soil management and classification.

PO7: Research-related Skills:

CO3: Assessing microbial populations in these environments prepares students for research in plant-microbe interactions, which is essential for innovations in sustainable agriculture.

CO2: This CO requires students to understand the microbial community in soil, which is a key element of agricultural microbiology and environmental science. This aligns with comprehensive knowledge in the subject area.

PO8: Learning How to Learn Skills:

CO2: This CO enhances students' comprehensive understanding of the microbial community, which is a crucial aspect of agricultural microbiology and soil ecology.

PO11:Value Inculcation and Environmental Awareness:

CO7: Understanding the impact of microorganisms on both the environment and agricultural productivity encourages environmental awareness and responsible practices.

PO12:Autonomy, Responsibility, and Accountability:

CO1, CO5, CO7 Provide Students learn to apply biofertilizer knowledge responsibly in sustainable farming practices, taking accountability for minimizing the environmental impact of conventional fertilizers.

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Microbiology (2023 pattern)

Name of the Programme : B.Sc. Microbiology
Class : T.Y.B.Sc.
Semester : V
Course Type : Practical
Course Code : MIB-342-MN
Course Title : Practical course based on Agriculture Microbiology
No. of Credits : 02
No. of Practicals : 15

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 Outcome:

On completion of the course, the students will be able to -

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.
CO4 Perform the quality control test, sterility testing, for injectables.
CO5 Perform the technique used for the determination of antimicrobial activity of antagonistic microbes.
CO6 Do the isolation of phytopathogenic fungi and perform their preliminary identification.
CO7 Practically perform the isolation of phytopathogenic microbes from infected samples.

Sr. No.	Topic and Learning Points	No. of teaching hours
1-3	Enrichment, Isolation and characterization of nitrogen fixers – *Azotobacter*, *Rhizobium*	**3**
4-5	Enrichment, Isolation and characterization of Phosphate solubilizers	**2**
6-7	Enrichment, Isolation and characterization of Lactic acid bacteria (from aerial plant surfaces)	**2**
8	Preparation and application of biofertilizer	**1**
9	Enumeration of microbial flora of rhizospheric soil samples	**1**
10	Antifungal activity of Lactic acid bacteria/Biocontrol agent	**1**

11-12	Isolation and morphological characterization of *Aspergillus* spp. from onions infected with black mold	**2**
13	Observation of samples of smut and rust diseases of crops: Symptoms and causative agents	**1**
14-15	Isolation and characterization of *Xanthomonas* sp. from infected sample (lemon / pomegranate)	**2**

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: TYBSc (Sem V)

Subject: Microbiology **Course: Practical course based on Agriculture Microbiology**

Course code: MIB-342-MNs

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

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

Justification for Mapping

PO1: Comprehensive Knowledge and Understanding

All COs involve understanding core concepts of microbiology, quality control, microbial identification, and dairy microbiology techniques.

PO2: Practical, Professional, and Procedural Knowledge

Strongly mapped as most COs involve lab-based hands-on experiments and industrial microbiology practices.

PO3: Entrepreneurial Mindset and Knowledge
Moderately relevant in COs related to industrial processes (CO1–CO3) and antimicrobial screening (CO5), which have application in startups or product development.

PO4: Specialized Skills and Competencies
All COs involve specialized skills such as sterility testing, microbial isolation, or identification, supporting this mapping.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
High for COs involving interpretation of results (antagonism, sterility testing, QC, etc.) and problem-solving during microbiological diagnostics.

PO6: Communication Skills and Collaboration
Important while documenting, reporting, and working collaboratively during experiments and observations.

PO7: Research-related Skills
Isolation of microbes, mutation detection, and antimicrobial testing are essential parts of experimental and applied microbiological research.

PO8: Learning How to Learn Skills
Each lab activity and interpretation promotes independent learning and enhancement of critical thinking.

PO9: Digital and Technological Skills
Involves usage of lab equipment, sometimes supported by software in analysis/reporting.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy
While indirectly involved, teamwork and awareness of food safety/public health touch on inclusive and social responsibility.

PO11: Value Inculcation and Environmental Awareness
Sterility, pathogen control, and food safety awareness foster environmental and health-related responsibility.

PO12: Autonomy, Responsibility, and Accountability
Experiments require accurate recordkeeping, safe practices, and individual accountability for results.

PO13: Community Engagement and Service
Food safety, phytopathogen identification, and public health microbiology knowledge promote service to community needs

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Microbiology (2023 pattern)

Name of the Programme : B.Sc. Microbiology
Class : T.Y.B.Sc.
Semester : V
Course Type : Practical
Course Code : MIB-321-VSC
Course Title : Industrial Microbiology
No. of Credits : 02
No. of Practicals : 15

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 Outcome:

On completion of the course, the students will be able to -

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.
CO4 perform the quality control test, sterility testing, for injectables.
CO5 perform the technique used for the determination of antimicrobial activity of antagonistic microbes.
CO6 do the isolation of phytopathogenic fungi and perform their preliminary identification.
CO7 practically perform the isolation of phytopathogenic microbes from infected samples.

No. of Practicals	Topic and Learning Points	No. of teaching hours
1-2	Isolation and identification of lactic acid bacteria upto 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., N2 fixers, phosphate solubilizers	**8**
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**
12-14	Quality assurance tests: 1. Antibiotic assay (agar gel diffusion technique) 2. Sterility testing of non-biocidal injectables	**8** **4**
15	Preparation of formulation by the spray drying method	**4**

Reference:

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

Mapping of course outcomes and programme outcomes:

Class: TYBSc (Sem V)
Subject: Microbiology **Course: Industrial Microbiology**
Course code: MIB-321-VSC
Weightage: 1= weak or low relation, 2= Moderate or partial relation, 3= Strong or direct relation

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

Justification for the mapping

PO1 – Comprehensive Knowledge and Understanding

Students gain foundational knowledge of microbiological techniques used in food, pharma, and agricultural microbiology.

PO2 – Practical, Professional, and Procedural Knowledge

All COs involve lab-based skill development aligned with industry practices (e.g., dairy tests,

sterility checks, isolation techniques).

PO3 – Entrepreneurial Mindset and Knowledge

Understanding quality control and antimicrobial screening fosters innovation in dairy and bio-control product development.

PO4 – Specialized Skills and Competencies

High mapping for CO1–CO7 as students acquire specialized microbiology skills relevant to dairy, pharma, and agriculture.

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

Analytical tasks like checking antimicrobial activity, interpreting sterility, and identifying phytopathogens support PO5.

PO6 – Communication Skills and Collaboration

Moderate mapping: Students engage in recording, reporting, and discussing microbiological findings in lab or team settings.

PO7 – Research-related Skills

Practical skills such as microbial isolation, identification, and assay methods promote inquiry-based learning and mini-research.

PO8 – Learning How to Learn Skills

Lab-based exploration and documentation develop self-directed learning and experimental troubleshooting skills.

PO9 – Digital and Technological Skills

Moderate mapping in COs involving instruments (e.g., UV exposure, antibiotic resistance assays) and microscopy.

PO10 – Multicultural Competence, Inclusive Spirit, and Empathy

Low to moderate mapping; awareness of food safety and pathogen control affects community health and equity in services.

PO11 – Value Inculcation and Environmental Awareness

Especially in CO5–CO7, students learn environmentally responsible approaches to pathogen control and bio-resources.

PO12 – Autonomy, Responsibility, and Accountability

Students develop accountability in aseptic technique, culture handling, and reporting lab results accurately.

PO13 – Community Engagement and Service

Techniques like pathogen identification and food quality tests indirectly contribute to public health and community welfare.

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Microbiology (2023 pattern)

Name of the Programme : B.Sc. Microbiology
Program Code : USMI
Class : T.Y.B.Sc.
Semester : V
Course Type : Practical
Course Code : MIB-335-FP
Course Title : Field Project
No. of Credits : 02
No. of Teaching Hours : 60

Guidelines for Field Project (FP)

In NEP 2020 (2023 Pattern) we are offering to UG students **Field Project (FP)** for **TWO (2)** credits i.e. **50 Marks**. The total time allocation for the student to carry out field project is **60 hours**. The actual field work should be carried out after college hours or on holidays.

To carry out the field project work following guidelines should be used:

1. Field-based learning: Students should participate in field-based learning/projects under the supervision of faculty.
2. A minimum of **30 hours of learning per credit** in a semester is required.
3. Assignment of project topics to individual student or groups of students (2 or 3 students in one group/ Commerce faculty can have 5 students per group) and one faculty member from the department will act as GUIDE for the student or group of students.
4. If the project is related to survey type work, then prepare a questionnaire (20 -30 questions or more) related to their project topic (in Marathi or English). If the project is related to work that does not involve SURVEY work, then the questionnaire part can be replaced accordingly.
5. The departmental coordinator/guide should check the questions and finalize the questionnaire. The question that may create unnecessary complications should be avoided. The questions should be qualitative as well as quantitative. If the project is related to other type work (e.g. Data collection, sample collection etc.), then the guide should discuss with student and finalise the methodology for the same.
6. Students should go to their chosen field with the questionnaire and collect the information regarding the questions asked to the concerned people. Collect as much information as possible by collecting 25 or more questionnaires or enough number of samples or reasonable amount of data. The more the data, the better it will be for analysis.
7. The student should compile all the relevant data and carry out its analysis.
8. Write a project report in the standard format (2 Copies): Index, Chapter-1, Chapter-2, ….. Conclusion, References etc. The report should mention the clear **OUTPUT** drawn from the study. The typed project report should have minimum 25 pages (excluding title, Certificate, index and acknowledgement pages etc.), in Times New Roman with font size 12, and line spacing of 1.5.
9. Submit the project report with the Guide's signature to the department.
10. The Oral presentation for all the projects in the department should be arranged in the department. To evaluate the project, TWO examiners should be appointed by HoD (The details about

appointment of examiners, weightage to internal and external marks etc. will be provided by examination section).

11. The total project work including preparation of questionnaire or sample/data collection to oral presentation should be evaluated for 2 credits (50 Marks). The details about the allocation of time, marks and scheme of examination for field project is given in Table. The departmental FP coordinator/HoD should submit the marks as per regular procedure to the examination section.
12. Since it is a compulsory subject in our syllabus, passing students in this **field project** is **MUST** to complete their degree.

Typical Time and marks allocation for the different stages of the field project is:

Step of Project	**Individual students work in hours**	**Marks**
Topic Selection/ Study Design	05	05
Survey preparation / Fieldwork	25	20
Analysis	10	05
Report writing	20	10
Oral Presentation		10
Total	60	50