DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,
CHHATRAPATI SAMBHAJINAGAR.

NAAC- 'A $^{+}$' Grade

CIRCULAR NO.SU/ B.Sc./NEP-2020/91/2026

It is hereby inform to all concerned that, the Revised syllabi prepared by the Board of Studies/Ad-hoc Boards/Committees and recommended by the Faculty of Science & Technology, **Academic Council at its meeting held on 02nd June 2026 has accepted** the following **Revised syllabi of Bachelor of Science & Basket** under the Faculty of Science & Technology **as per Norms of National Education Policy-2020 and as per Government Letter dated 13 March 2024** run at the Affiliated Colleges, Dr.Babasaheb Ambedkar Marathwada University as appended herewith.

Sr.No.	Courses	Semester
1.	B.Sc.Botany	Vth and VIth semester
2.	B.Sc.Biotechnology	Vth and VIth semester
3.	B.Sc.Zoology	Vth and VIth semester
4.	B.Sc.Agrochemical and Fertilizer	Vth and VIth semester
5.	B.Sc.Geology	Vth and VIth semester
6.	B.Sc.Environmental Science	Vth and VIth semester
7.	B.Sc.Home Science	Vth and VIth semester
8.	B.Sc.Diary Science and Technology	Vth and VIth semester
9.	B.Sc.Automobile Technology	Vth and VIth semester
10.	B.Sc.Physics	Vth and VIth semester
11.	B.Sc.Chemistry	Vth and VIth semester
12.	B.Sc.Analytical Chemistry	Vth and VIth semester
13.	B.Sc.Polymer Chemistry	Vth and VIth semester
14.	B.Sc.Electronics	Vth and VIth semester
15.	B.Sc.Forensic Science & Cyber Security	Vth and VIth semester
16.	B.Sc.Microbiology	Vth and VIth semester
17.	B.Sc.Fisheries Science	Vth and VIth semester
18.	B.Sc.Mathematics	Vth and VIth semester
19.	B.Sc.Forensic Science	Vth and VIth semester
20.	B.Sc.Information Technology	Vth and VIth semester
21.	B.Sc.Horticulture	Vth and VIth semester
22.	B.Sc.Networking & Multimedia	Vth and VIth semester
23.	B.Sc.Biochemistry	Vth and VIth semester
24.	B.Sc.Industrial Chemistry	Vth and VIth semester
25.	B.Sc.Bioinformatics	Vth and VIth semester

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26.	**B.Sc.Instrumentation Practice**	**Vth and VIth semester**
27.	**B.Sc.Non-Conventional and Conventional Energy**	**Vth and VIth semester**
28.	**B.Sc.Statistics**	**Vth and VIth semester**
29.	**B.Sc.Computer Science**	**Vth and VIth semester**
30.	**Bachelor of Computer Application**	**Vth and VIth semester**

This is effective from the Academic Year 2026-27 and onwards.

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,
Aurangabad-431 004.
REF.NO.SU/AC.No.06/4498-113
Date:- 12.06.2026.

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Deputy Registrar,
Syllabus Section

Copy forwarded with compliments to :-

1] **The Principal of all concerned Colleges,**
Dr. Babasaheb Ambedkar Marathwada University,
2] **The Director, University Network & Information Centre, UNIC, with a request to upload this Circular on University Website.**

Copy to :-

1] **The Director, Board of Examinations & Evaluation,** Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
2] The Section Officer,[B.Sc.Unit] Examination Branch, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
3] The Programmer [Computer Unit-1] Examinations, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
4] The Programmer [Computer Unit-2] Examinations, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
5] The In-charge,[E-Suvidha Kendra], Rajarshi Shahu Maharaj Pariksha Bhavan, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
6] The Public Relation Officer, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
7] The Record Keeper, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.

DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY
CHHATRAPATI SAMBHAJINAGAR (M.S.) – 431001

FACULTY OF SCIENCE AND TECHNOLOGY

B.Sc. Degree Programme

(Three Year / Four Years (Honors) /Four Years (Honors with Research)

Course Structure and Curriculum

(Revised)

(AS PER NEP-2020)

Subject (Major): MICROBIOLOGY

For

B.Sc. Third Year

(Semester – V and VI)

Effective from
Academic Year 2026-27

(Chairman B.O.S.)

Professor Dr. Bhaskar S. Sathe,
Dean,
Faculty of Science & Technology,
Dr.Babasaheb Ambedkar
Marathwada University,
Chhatrapati Sambhajinagar

Structure of B. Sc. (Three/Four Years Honours/Honours with Research Degree) Program with Multiple Entry and Exit Options

B. Sc. Third Year: 5th Semester Subject: Microbiology

Students will have to select/declare a choice of **one major subject** and **one minor subject** from three major options M1, M2 and M3 (which were opted in the first year)

Type	Course Code	Examination Code	Course Name	Teaching Scheme (Hrs / Week)		Credits Assigned		Total Credits
				Theory	Practical	Theory	Practical	
Major (Core) Mandatory DSC	MIC/DSC/T/300	SAC00123005T	Enzymology and microbial metabolism	2		2		2+2+2+2 = 08
	MIC/DSC/T/301	SAC00123015T	Microbial Genetics	2		2		
	MIC/DSC/P/ 326	SAC00123265P	Practicals Based on MIC/DSC/T/300		4		2	
	MIC/DSC/P/ 327	SAC00123275P	Practicals Based on MIC/DSC/T/301		4		2	
Discipline Specific Electives (DSE) (Choose any one from MIC/DSE/T/300 and MIC/DSE/T/301) and corresponding practicals.	MIC/DSE/T/300	SBC00123005T	Agriculture Microbial Biotechnology	2		2		2+2=04
	MIC/DSE/T/301	SBC00123015T	Bioinformatics and biostatistics	2		2		
	MIC/DSE/P/ 326	SBC00123265P	Practicals Based on MIC/DSE/T/300		4		2	
	MIC/DSE/P/ 327	SBC00123275P	Practicals Based on MIC/DSE/T/301		4		2	
Minor (Choose any two from pool of courses) **It is from different disciplines of the same faculty.**	MIC/Mn/T/ 300	SCC00123005T	Vaccination and its importance	2		2		2+2 = 04
	MIC/Mn/T/ 301	SCC00123015T	Water Microbiology	2		2		
VSC (Vocational Skill Courses) (Choose any one from MIC/VSC/T/ 300 and MIC/VSC/T/ 301) and corresponding Practical's	MIC/VSC/T/ 300	SEC00123005T	GMP – Microbial aspect	2		2		2+2 =04
	MIC/VSC/T/ 301	SEC00123015T	Biobased products for a sustainable future	2		2		
	MIC/VSC/P/ 326	SEC00123265P	Practicals Based on MIC/VSC/T/301		4		2	
	MIC/VSC/P/ 327	SEC00123275P	Practicals Based on MIC/VSC/T/301		4		2	
OJT/ FP/CEP/CC/RP (Choose any one from the pool of courses)	MIC/RP/P/326	SOC00123265P	Research Project		4		2	02

B. Sc. III Year V Semester (Microbiology)

SAC00123005T

MIC/DSC-1/T/300 Enzymology and Microbial Metabolism

Total Contact Hours : 30 Hrs **Total Credits :02** **Maximum Marks :50**

Learning Objectives:

1. Introduce students to the fundamental concepts of enzymology, including enzyme classification, structure, mechanism of action, and enzyme kinetics.
2. Explain the principles of bioenergetics and thermodynamics governing microbial metabolic processes.
3. Develop understanding of major carbohydrate metabolic pathways involved in microbial energy generation.
4. Familiarize students with the electron transport system and ATP generation mechanisms in microorganisms.
5. Provide knowledge of microbial degradation of biomolecules such as lipids, proteins, and nucleic acids.
6. Highlight the practical and industrial applications of microbial enzymes in sectors such as food, agriculture, pharmaceuticals, and biotechnology.
7. Introduce students to basic experimental approaches in enzymology, including enzyme assays and factors affecting enzyme activity

Course Outcomes (COs):

- **CO1:** Identify the structure, classification, and catalytic mechanisms of enzymes and the types of enzyme inhibition.
- **CO2:** Interpret enzyme kinetics and determine enzyme activity parameters such as Km and Vmax using enzyme assays.
- **CO3:** Apply basic thermodynamic principles and bioenergetics concepts in understanding microbial metabolic reactions.
- **CO4:** Illustrate major carbohydrate metabolic pathways, including glycolysis, pentose phosphate pathway, Entner–Doudoroff pathway, and TCA cycle.
- **CO5:** Analyse the role of the electron transport chain, proton motive force, and oxidative phosphorylation in microbial energy generation.
- **CO6:** Identify microbial catabolic pathways of lipids, proteins, and nucleic acids, including β-oxidation and amino acid metabolism

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**Module 1 Enzymology** **1.1 Introduction to enzymes** a) Definition b) Properties c) Enzyme structure: Holoenzyme, Apoenzyme, Cofactors, Coenzymes, Prosthetic groups, d) Types of enzymes – Intracellular, Extracellular, Inducible, Constitutive e) Classification (IUB system), **1.2 Enzyme Mechanism** a) Lock and Key model b) Induced Fit model **1.3 Enzyme kinetics** a) Michaelis-Menten equation, Km and Vmax b) Lineweaver-Burk plot **1.4 Enzyme inhibition** a) Irreversible Inhibition b) Reversible Inhibition: i. Competitive ii. Non-competitive iii. Uncompetitive inhibition **1.4 Practical applications:**	**12**

	Microbial enzymes in industries a)Food industry b) Pharmaceutical c) Detergents d) Agriculture, **1.5 *Immobilized enzymes and their applications*** **1.6 Introduction to enzyme research** a) Enzyme assays b) Factors affecting enzyme activity- Temperature, pH, Enzyme Concentration, Substrate Concentration, Metal Ions	
II	**Module II: Microbial Metabolism – Carbohydrate Metabolism and Energy Generation** **2.1 Bioenergetics and Thermodynamic Principles** a) Laws of thermodynamics b) Free energy change (ΔG) and standard free energy (ΔG°) c) Exergonic and endergonic reactions, **2.2 Overview of Microbial Metabolism** a) Catabolism and anabolism, b) Energy coupling in biological systems, c) Role of ATP, NADH, $FADH_2$ as an energy currency a) **Carbohydrate Metabolism:** b) Glycolysis (EMP pathway) c) Entner–Doudoroff pathway d) Pentose phosphate pathway e) Tricarboxylic Acid (TCA) Cycle- i. Major steps ii. Metabolic significance, iii. Amphibolic nature of the TCA cycle e) Alcohol fermentation f) Lactic acid fermentation 2.3 **Electron Transport Chain and Oxidative Phosphorylation** a) Components of ETC b) Proton motive force, c) ATP synthesis	**12**
III	Module 3: Catabolism of **Lipid and Protein** **3.1 Lipids:** β- oxidation of fatty acids **3.2 Proteins:** a) Deamination b) Ammonification c) Transamination of amino acids **3. 3 Autotrophic Metabolism**: A brief look at Chemolithotrophy (e.g., Nitrifying bacteria) and Phototrophy (Bacterial photosynthesis)	**06**

Textbooks

1. Nelson D.L. & Cox M.M. (2021). *Lehninger Principles of Biochemistry*. W.H. Freeman, Macmillan Learning.
2. Willey J.M., Sherwood L.M., Woolverton C.J. (2017). *Prescott's Microbiology*. McGraw-Hill Education.
3. Moat A.G., Foster J.W., Spector M.P. (2002). *Microbial Physiology*. Wiley-Liss.
4. Jain, J. L., Jain, S., and Jain, N. *Fundamentals of Biochemistry*. S. Chand Publication
5. Dr. Balkrishna M. Sandikar. *Basic Biochemistry and Microbial Metabolism. (Himalaya Publishing House).*

Reference Books

1. Berg J.M., Tymoczko J.L., Stryer L. (2019). *Biochemistry*. W.H. Freeman.
2. Voet D., Voet J. (2016). *Principles of Biochemistry*. Wiley.
3. Cohen G.N. (2011). *Microbial Biochemistry*. Springer.
4. Madigan M.T. et al. (2021). *Brock Biology of Microorganisms*. Pearson.
5. Gottschalk, G. *Bacterial Metabolism (Springer).*
6. Trevor Palmer and Philip Bonner. *Enzymes: Biochemistry, Biotechnology, Clinical Chemistry*
7. Madigan, M. T., and Martinko, J. M. Brock Biology of Microorganisms

B. Sc. III Year V Semester (Microbiology)

SAC00123275P

MIC/DSC/P/327: Microbial Genetics

Total Contact Hours : 30 Hrs **Total Credits :02** **Maximum Marks :50**

Objectives:

- Equipping microbiology majors with foundational knowledge of genetic mechanisms in microorganisms.
- Emphasize understanding DNA structure, replication, mutations, gene regulation, and genetic exchange processes like transformation and conjugation.
- Develop a skill-oriented approach for practical applications in microbial research and biotechnology.

Course Outcome:

Upon successful completion, students will be able to:

- Explain the organization of microbial genomes, DNA replication, and repair mechanisms, including UV-induced damage repair.
- Describe gene regulation models such as the Lac and Trp operons, and their role in microbial adaptation.
- Analyze horizontal gene transfer methods (transformation, transduction, conjugation) and their significance in microbial evolution and antibiotic resistance.
- Apply concepts of mutations, recombination, and genetic mapping to design experiments for studying microbial traits.

Module No	Topics/Actual content of syllabus	Contact Hours
I	Study of spontaneous mutation by the Replica Plate Technique. Study the effect of chemical (HNO2/5Bromouracil) and physical (UV) mutagens on bacterial cells.	10
II	Study the survival curve of bacteria after exposure to ultraviolet (U V) light Isolation of Plasmid DNA from E.coli Study different conformations of plasmid DNA through Agarose gel electrophoresis.	10
III	Demonstration of Bacterial Conjugation Demonstration of bacterial transformation and transduction	10

Text Books:

1. KJug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
2. Krebs J, Goldstein E, Kilpatrick S (20131. Lewin's Essential Genes, 3rd Ed- Jones and Bartlett Learning
3. Pierce RA (2011) Genetics: A Conceptual Approach, 4th P.d., Macmillan Higher Education Learning
4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Hd., Benjamin Cummings
5. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
6. Russell PJ. (2009). i Genetics- A Molecular Approach. 3rd Ed, Benjamin Curamings
7. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
8. Maloy SR, Cronan JE and Fnefelder D(2004) Microbial Genetics 2nd EDITION.. Jones and Barlett Publishers

B. Sc. III Year V Semester (Microbiology)

SBC00123005T

MIC/DSE/T/300 : Agriculture Microbial Biotechnology

Total Contact Hours : 30 Hrs | **Total Credits :02** | **Maximum Marks :50**

Objectives:

- Understand Basic Concepts
- Learn the fundamentals of agricultural microbiology and biotechnology
- Understand the importance of microorganisms in agriculture
- Study Microbial Diversity
- Identify different agricultural microbes (bacteria, fungi, algae)

Course Outcome:

Upon successful completion, students will be able to:

- Understand Agricultural Microorganisms
- Describe types of microorganisms (bacteria, fungi, algae) used in agriculture
- Explain their role in plant growth and soil health
- Explain Soil Microbiology & Nutrient Cycles
- Understand soil microflora and rhizosphere interactions
- These topics are essential because microbes improve soil fertility and crop yield
- Important for sustainable and organic farming.
- Includes modern biotech approaches used in agriculture.

Module No	Topics/Actual content of syllabus	Contact Hours
I	**A. Introduction to Agricultural Microbial Biotechnology** • Scope and importance in agriculture • Role of microorganisms in agriculture • Types of agricultural microbes (bacteria, fungi, algae) • Microbial diversity and classification • Microbe–plant interactions **B. Soil Microbiology & Nutrient Cycling** • Soil microflora and the rhizosphere concept • Biogeochemical cycles: o Carbon cycle o Nitrogen cycle o Phosphorus & sulphur cycles • Biological nitrogen fixation: o Symbiotic (*Rhizobium*) o Non-symbiotic (*Azotobacter, Azospirillum*) • Mycorrhiza and cyanobacteria	10
II	**A. Biofertilizers & Biopesticides** • Definition and types of biofertilizers • Production and mass cultivation • Carrier materials and quality control • Application methods in agriculture • Biopesticides: o Microbial pesticides (*Bacillus thuringiensis*, fungi, viruses) • Advantages over chemical fertilizers/pesticides **B. Microbial Biotechnology in Agriculture** • Genetic engineering of microbes • Strain improvement techniques (mutation, recombination) • Use of microbes in: o Crop protection o Disease resistance • Microbial enzymes and metabolites • Use of genetically modified microorganisms	10

	5. Study of degradation of straw, leaves, and crop residues.	
III	6. Production of *Rhizobium* Biofertilizer 7. Production of *Azotobacter* Biofertilizer 8. Preparation of vermicompost using earthworms. 9. Isolation of microorganisms from compost and agricultural waste.	**10**

References

1. **Microbial Biotechnology: Applications in Agriculture and Environment**
   Editors: Jayanta Kumar Patra, Chethala N. Vishnuprasad, Gitishree Das
2. **Microbial Biotechnology for Sustainable Agriculture (Vol. 1)**
   Editors: Naveen Kumar Arora, Brahim Bouizgarne
3. **Advances in Agricultural and Industrial Microbiology (Vol. 1)**
   Editors: Suraja Kumar Nayak, Bighneswar Baliyarsingh, Ilaria Mannazzu, Ashutosh Singh, Bibhuti Bhusan Mishra
4. **Advances in Agricultural and Industrial Microbiology (Vol. 2)**
   Editors: Suraja Kumar Nayak, Bighneswar Baliyarsingh, Ashutosh Singh, Ilaria Mannazzu, Bibhuti
   Microbial Biotechnology: Applications in Agriculture and Environment
   Editors: Jayanta Kumar Patra, Chethala N. Vishnuprasad, Gitishree Das

B. Sc. III Year V Semester (Microbiology)

SBC00123015T

MIC/DSE/T/301 : Bioinformatics & Biostatistics

Total Contact Hours : 30 Hrs **Total Credits :02** **Maximum Marks :50**

Objectives:

- *Develop proficiency in using statistical software and tests to analyze microbiological datasets, such as growth rates and population variability.*
- Train students to navigate bioinformatics databases and perform sequence-based analyses relevant to microbial genomics.
- Foster integration of biostatistics with bioinformatics for real-world applications like pathogen identification and data visualization.**Course Outcome:**

Upon successful completion, students will be able to:

- Perform and interpret basic statistical tests on microbial data using Excel or R.
- Conduct sequence retrieval, similarity searches, and alignments using NCBI tools and BLAST.
- Generate phylogenetic trees and reports combining statistical and bioinformatics outputs for microbiology research.

Module No	Topics/Actual content of syllabus	Contact Hours
I	**Basic Biostatistics** • Introduction to biostatistics: Definition, scope in microbiology, types of data (qualitative/quantitative), data collection, sampling methods (random, stratified), and representation (graphs, tables). • Measures of central tendency and dispersion: Mean, median, mode; variance, standard deviation.	**10**
II	**Introduction to Bioinformatics** • Overview and history: Goals of bioinformatics in microbiology; databases (primary: GenBank; secondary: UniProt, PDB; composite: NCBI). • Sequence analysis tools: FASTA/BLAST for similarity searches; pairwise/multiple sequence alignment; microbial genome assembly basics. • Microbial applications: NCBI tools for pathogen identification, 16S rRNA analysis, and metagenomics data handling .	**10**
III	**Advanced Bioinformatics and Integration** • Protein structure prediction: PDB visualization, homology modeling; tools like SWISS-MODEL for microbial enzymes. • Phylogenetics and genomics: Phylogenetic trees (Clustal Omega, MEGA); next-generation sequencing (NGS) overview for microbiomes. • - Integration with *biostatistics: Statistical analysis of genomic data (e.g., ANOVA on* expression levels); Python/R basics for bioinformatics pipelines, aligned with NEP 2020's computational skills emphasis.	**10**

Text Books:

1. KJug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
2. Krebs J, Goldstein E, Kilpatrick S (20131. Lewin's Essential Genes, 3rd Ed- Jones and Bartlett Learning
3. Pierce RA (2011) Genetics: A Conceptual Approach, 4th P.d., Macmillan Higher Education Learning
4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Hd., Benjamin Cummings
5. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
6. Russell PJ. (2009). i Genetics- A Molecular Approach. 3rd Ed, Benjamin Curamings

B. Sc. III Year V Semester (Microbiology)

SBC00123015P

MIC/DSE/P/327: Bioinformatics & Biostatistics (Lab Course)

Total Contact Hours : 30 Hrs **Total Credits :02** **Maximum Marks :50**

Objectives:

- Introduce core concepts in biostatistics for analyzing microbiological datasets, including measures of central tendency, variability, and hypothesis testing relevant to microbial populations.
- Develop proficiency in bioinformatics tools for sequence analysis, database navigation, and microbial genomics, aligning with NEP 2020's focus on skill-based, interdisciplinary learning.
- Enable students to apply these skills in microbiology research, such as analyzing microbial diversity, antibiotic resistance patterns, and genomic data.
- **Course Outcome:**

Upon successful completion, students will be able to:

- Compute and interpret basic statistical parameters for biological data and perform simple hypothesis tests on microbial samples.
- Retrieve, analyze, and visualize biological sequences using bioinformatics databases and tools like BLAST for microbial studies.
- Integrate biostatistics and bioinformatics in solving real-world microbiology problems, preparing for advanced research or industry roles.

Module No	Topics/Actual content of syllabus	Contact Hours
I	**Basic Biostatistics** - Collection and representation of microbial data (colony counts, OD readings), Bar Diagram, Pi Chart, etc.; calculate mean, median, mode	10
II	**Introduction to Bioinformatics** Introduction to NCBI; retrieve nucleotide/protein sequences of microbial genes (e.g., 16S rRNA of Bacillus subtilis) from GenBank. FASTA format conversion and database search using Entrez.	10
III	**Advanced Bioinformatics and Integration** BLASTn/p searches; perform a similarity search for a microbial virulence gene against nr database Protein structure visualization: explore the PDB entry of a microbial enzyme (e.g., beta-lactamase/catalase/oxidase).	10

Text Books:

1. KJug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
2. Krebs J, Goldstein E, Kilpatrick S (20131. Lewin's Essential Genes, 3rd Ed- Jones and Bartlett Learning
3. Pierce RA (2011) Genetics: A Conceptual Approach, 4th P.d., Macmillan Higher Education Learning
4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Hd., Benjamin Cummings
5. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
6. Russell PJ. (2009). i Genetics- A Molecular Approach. 3rd Ed, Benjamin Curamings
7. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
8. Maloy SR, Cronan JE and Fnefelder D(2004) Microbial Genetics 2nd EDITION.. Jones and Barlett Publishers

B. Sc. III Year V Semester (Microbiology)

SCC00123005T

MIC/Minor/T/300 Vaccination and its importance

(This course is designed for students from other disciplines)

Total Contact Hours : 30 Hrs **Total Credits :02** **Maximum Marks :50**

Learning Objectives: -

- To define vaccination and explain its immunological basis.
- To classify different types of vaccines.
- To explain the role of immunization programs and the World Health Organization in disease prevention.
- To evaluate the importance of vaccination in public health and herd immunity.

Course Outcomes (COs): -

At the end of this course, the students will be able to:

- **CO1:** Explain the basic concepts of vaccination, immunization, and herd immunity.
- **CO2:** Describe different types of vaccines and their mechanisms of action.
- **CO3:** Illustrate the immunological basis of vaccine-induced protection.
- **CO4:** Evaluate the role of national and global immunization programs, including initiatives by the World Health Organization, in disease prevention and public health improvement.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**Module 1: Introduction to Immunization and Vaccination** **1.1 Definitions –** Vaccine, Vaccination, Immunization, Booster dose **1.2 History of Vaccination -** Contribution of Edward Jenner, Development of Vaccines by Louis Pasteur **1.3 Basic Concepts** • Immunity: Innate and Adaptive immunity • Active vs Passive Immunization • Natural vs Artificial Immunity • Herd immunity	**10**
II	**Module 2: Types of Vaccines** 2.1 Live Attenuated Vaccines - 2.2 Killed/Inactivated Vaccines 2.3 Toxoid Vaccines 2.4 Subunit and Conjugate Vaccines 2.5 Recombinant and DNA Vaccines 2.6 COVID-19 vaccines	**10**
III	**Module 3: Importance of Vaccination and** National Immunization Programs 3.1 Prevention of infectious diseases 3.2 Reduction in morbidity and mortality 3.3 Eradication and elimination of diseases 3.4 Economic and social benefits 3.5 Community protection (Herd immunity) 3.6 Universal Immunization Programme (UIP) – India 3.7 Recommended Immunization Schedule (India) 3.8 Role of WHO in Vaccination	**10**

Text books

1) **Plotkin's Vaccines** – Stanley A. Plotkin, Paul Offit, Walter Orenstein & Kathryn M. Edwards. W. B. Saunders Company (2023 edition), Elsevier. (A comprehensive book on vaccinology and vaccine development.)
2) **Textbook of Microbiology and Immunology** – Subhash Chandra Parija. Springer publication. Springer publication. https://link.springer.com/book/10.1007/978-981-19-3315-8?utm.com (Covers both basic microbiology and immunology with sections relevant to vaccines and immune responses.)
3) **Basic Immunology** – B. J. Wadher & G. L. Bhoosreddy (Himalaya Publishing House).

https://himpub.com/product/basic-immunology/?utm.com (Simple and student-friendly coverage of immune system fundamentals, immunoprophylaxis, and vaccination concepts.)

4) **General Microbiology and Immunology** – Ch. Lavanya, T. Neeraja & Supradhnya Meshram. Kripa Drishti Publication. https://books.kdpublications.in/index.php/kdp/about.com (Good for foundational understanding of immune responses and immunization basics.)
5) **Vaccines: A Biography** – Andrew W. Artenstein. https://link.springer.com/book/10.1007/978-1-4419-1108-7?utm.com (Explains the history and impact of vaccines in a narrative style)
6) **Immunization Handbook for Medical Officers –** Ministry of Health and Family Welfare, Government of India. https://www.mohfw.gov.in/?q=en%2Fbasicpage%2Fimmunization-handbook-medical-officers2017&utm.com.
7) **Partha's Immunization Digest** – Jaypeebrothers. https://jaypeebrothers.com/products/9789389776362?utm.com (A useful text focusing on immunization schedules including National Immunization Programme details, vaccine administration practices and WHO/IAP schedules.)

Reference Books

1) **Roitt's Essential Immunology** – Peter J. Delves et al. https://www.roitt.com/reading12.asp?utm.com (A classic immunology reference with sections on vaccines and immune mechanisms.)
2) **Immunology and Immunotechnology** – M. Rajasekara Pandian & B. Senthil Kumar. Vedams books. https://www.vedamsbooks.com/books/immunology_and_immunotechnology (Covers immunological concepts and laboratory techniques relevant to vaccine study.)
3) **Mims' Medical Microbiology and Immunology** – Goering, Dockrell, Zuckerman, Chiodini. Elsevier publications. (Well-illustrated text combining clinical microbiology with immunology fundamentals.)
4) **Vaccinology and Methods in Vaccine Research** – Edited by Rebecca Ashfield, Angus N. Oli & Charles Esimone. Mitpressbookstore. https://mitpressbookstore.mit.edu/book/9780323911467?utm.com (A research-oriented book focusing on vaccine development methods.)
5) **Vaccines: A Clinical Overview and Practical Guide** – Joseph Domachowske & Manika Suryadevara. Springer publications. https://link.springer.com/book/10.1007/978-3-030-58414-6?utm.com (Offers a practical medical perspective on vaccines and their use.)

B. Sc. III Year V Semester (Microbiology)

SCC00123015T

MIC/Min/T/301: Water Microbiology

(This course is designed for students from other disciplines)

Total Contact Hours : 30 Hrs **Total Credits :02** **Maximum Marks :50**

Objectives:

- To familiarize students with microbial diversity in water sources and their public health implications.
- To impart knowledge on water quality testing, purification, and wastewater treatment methods.
- To develop skills in basic microbiological techniques for water analysis

Course Outcome:

Upon successful completion, students will be able to:

- Identify key waterborne pathogens and indicators of contamination.
- Perform standard tests like MPN and coliform detection for potability assessment.
- Understand sustainable water management practices and apply them in real-world contexts.

Module No	Topics/Actual content of syllabus	Contact Hours
I	**Introduction to Water Microbiology** - Types of water: Surface, ground, potable, wastewater; sources of contamination (sewage, industrial effluents). - Microbial diversity: Bacteria (coliforms, E. coli, Vibrio), viruses (enteroviruses), protozoa (Giardia, Cryptosporidium). - Waterborne diseases: Cholera, typhoid, dysentery; epidemiological significance	10
II	**Water Quality Assessment** - Potability standards: WHO/BIS guidelines (MPCB's role); physical, chemical, bacteriological parameters. - Indicator organisms: Total coliforms, fecal coliforms, fecal streptococci. - Testing techniques: Presumptive, MPN, membrane filtration, plate count methods.	10
III	**Treatment and Applications** - Purification methods: Filtration, chlorination, UV, ozonation; role of microbes in biofiltration. - Wastewater treatment: Primary, secondary (activated sludge), tertiary processes; anaerobic digestion. -Advanced methods - SBR/MBBR/RBC	10

Text Books:

1. Water Microbiology: An Indian Perspective- by Dr. Nikhilesh Kulkarni and Dr. Shiva C. Aithal (2016) - Comprehensive coverage of water resources, pollution sources, sewage microbiology, and Indian case studies.
2. Water Microbiology (Revised Edition)- by Dr. Nikhilesh S. Kulkarni and Dr. Shiva C. Aithal (2017) - Updated with marine microbiology, eutrophication, and bioaugmentation relevant to Indian contexts [8].
3. -Microbial Aspects of Drinking Water- by Namita Aslish Singh, Naresh Kumar, and H.V. Raghu (MLSU publication) - Focuses on pathogens in potable water, detection methods, and public health in Rajasthan/India.
4. -Advances in Microbiology Volume II- edited by Dr. M. Poornima (ICAR-CIBA, 2022) - Includes chapters on aquatic microbiology, water-borne microbes, and environmental remediation by Indian researchers.
5. -Text Book of Microbiology- by Indian authors (RLMC edition) - Basic water microbiology section with Indian water quality standards and lab protocols.
6. -Environmental Microbiology: Water and Wastewater- by P.D. Sharma (Indian author) - Emphasizes microbial indicators of water pollution and treatment processes in tropical climates.

B. Sc. III Year V Semester (Microbiology)

SEC00123005T

MIC/VSC-1/T/300 Good Manufacturing Practices- Microbial Aspects

Total Contact Hours : 30 Hrs **Total Credits :02** **Maximum Marks :50**

Learning Objectives: -

- *To introduce the principles and importance of Good Manufacturing Practices (GMP) in the pharmaceutical and biotechnology industries.*
- To explain the sources and types of microbial contamination in pharmaceutical manufacturing environments.
- To develop an understanding of cleanroom classification, facility design, and environmental control systems used for microbial contamination control.
- To describe the methods of sterilization, cleaning, sanitation, and disinfection employed in GMP facilities.
- To provide knowledge of microbiological quality control tests, such as environmental monitoring, sterility testing, and microbial limit tests.
- To familiarize students with documentation practices, Standard Operating Procedures (SOPs), and regulatory compliance related to microbiological quality assurance.

Course Outcomes (COs): -

At the end of this course, the students will be able to:

- **CO1:** Explain the principles and importance of Good Manufacturing Practices (GMP) in pharmaceutical and biotechnology industries.
- **CO2:** Describe sources of microbial contamination and strategies for contamination control in manufacturing environments.
- **CO3:** Discuss cleanroom classification, facility design and environmental control systems used in GMP-regulated facilities.
- **CO4:** Interpret microbiological quality assurance practices and documentation requirements involved in pharmaceutical production.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**Module 1: Fundamentals of Microbial GMP** 1.1. Role of Good Manufacturing Practices (GMP) in the pharmaceutical and biotechnology industries. 1.2. Sources of microbial contamination in manufacturing environments (air, water, personnel, equipment, and raw materials). 1.3. Principles of aseptic techniques and contamination control in microbiology laboratories and production areas.	**06**
II	**Module 2: Microbial Control in GMP Facilities** 2.1. Cleanroom concepts and classification (Grades A, B, C, and D) and basic cleanroom practices. 2.2. Facility design and layout considerations for prevention of microbial contamination. 2.3. Environmental control systems: cleanrooms, HVAC systems, HEPA filtration, and pressure differentials. 2.4. Cleaning, sanitation, and disinfection procedures in pharmaceutical environments. 2.5. Sterilization methods used in GMP include moist heat sterilization, dry heat sterilization, and membrane filtration.	**14**
III	**3. Module 3: Microbiological Quality Assurance and Compliance** 3.1. Environmental monitoring programs: air monitoring, surface monitoring and personnel monitoring. 3.2. Microbiological testing in pharmaceutical industries: sterility testing, microbial limit tests, and bioburden determination. 3.3. Documentation and Standard Operating Procedures (SOPs) in microbiology laboratories. 3.4. Investigation of microbial contamination events and corrective actions (CAPA).	**10**

Text books

1) **Hugo and Russell's Pharmaceutical Microbiology**. Edited by Stephen Denyer, Norman Hodges and Sean Gorman. Wiley-Blackwell.
2) **Pharmaceutical Microbiology**. Edited by W. B. Hugo and A. D. Russell. CBS Publishers & Distributors.
3) **Good Manufacturing Practices for Pharmaceuticals**. CRC Press.
4) **Pharmaceutical Quality Assurance**. CBS Publishers & Distributors.
5) **Pharmaceutical Microbiology: Essentials for Quality Assurance and Quality Control**. Woodhead Publishing.

Reference Books

6) **Pharmaceutical Microbiology**. Blackwell Scientific Publications.
7) **Quality Assurance of Pharmaceuticals: A Compendium of Guidelines**. WHO Press.
8) **Principles and Practice of Sterilization in Health Sciences**. Charles C. Thomas Publishers.
9) **Cleanroom Microbiology for the Non-Microbiologist**. Woodhead Publishing.
10) **Guide to Good Manufacturing Practice for Medicinal Products.**

B. Sc. III Year V Semester (Microbiology)

SEC00123265P

MIC/VSC-1/P/ 326 Good Manufacturing Practices- Microbial Aspects (Lab Course)

Total Contact Hours : 30 Hrs **Total Credits :02** **Maximum Marks :50**

Learning Objectives: -

- To understand cleanroom practices and potential sources of microbial contamination through observation and.
- To introduce students to environmental monitoring techniques used for detecting microbial contamination in controlled areas.
- To familiarize students with the Microbial Limit Test (MLT) for estimation of microbial load in pharmaceutical or cosmetic samples.
- To train students in preparing Standard Operating Procedures (SOPs) for microbiological laboratory activities in accordance with GMP practices.

Course Outcomes (COs): -

At the end of this course, the students will be able to:

- **CO1:** Identify contamination sources and follow good laboratory practices for contamination control.
- **CO2:** Perform basic environmental monitoring methods such as air and surface monitoring.
- **CO3:** Carry out microbial limit testing and determine microbial load in test samples.
- **CO4:** Prepare a basic SOP for microbiological procedures following GMP documentation principles.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	Study of cleanroom practices and contamination sources through observation and documentation of good laboratory practices (GLP) and contamination control measures in the microbiology laboratory.	10
II	Environmental monitoring in controlled areas • Settle plate method (air monitoring) • Surface monitoring using a swab or contact plate.	10
III	Microbial Limit Test (MLT) for pharmaceutical or cosmetic samples • Total viable count • Detection of microbial contamination. Preparation of a Standard Operating Procedure (SOP) for a microbiological procedure (e.g., environmental monitoring or sterilization).	10

Text books

1) **Hugo and Russell's Pharmaceutical Microbiology**. Edited by Stephen Denyer, Norman Hodges and Sean Gorman. Wiley-Blackwell.
2) **Pharmaceutical Microbiology: Essentials for Quality Assurance and Quality Control**. Woodhead Publishing.
3) **Pharmaceutical Microbiology**. Edited by W. B. Hugo and A. D. Russell. CBS Publishers & Distributors.
4) **Good Manufacturing Practices for Pharmaceuticals**. CRC Press.
5) **Pharmaceutical Quality Assurance**. CBS Publishers & Distributors.

Reference Books

1) **Quality Assurance of Pharmaceuticals: A Compendium of Guidelines**. WHO Press.
2) **Cleanroom Microbiology for the Non-Microbiologist**. Woodhead Publishing.
3) **Guide to Good Manufacturing Practice for Medicinal Products**. PIC/S.
4) **Principles and Practice of Sterilization in Health Sciences**. Charles C. Thomas Publishers.
5) **Microbiological Quality Control for Pharmaceutical and Medical Device Manufacturers**. Woodhead Publishing.

B. Sc. III Year V Semester (Microbiology)

SEC00123015T

MIC/VSC-2/T/301 Biobased Products for a Sustainable Future

Total Contact Hours : 30 Hrs **Total Credits :02** **Maximum Marks :50**

Learning Objectives: -

- To understand cleanroom practices and potential sources of microbial contamination through observation and.
- To introduce students to environmental monitoring techniques used for detecting microbial contamination in controlled areas.
- To familiarize students with the Microbial Limit Test (MLT) for estimation of microbial load in pharmaceutical or cosmetic samples.
- To train students in preparing Standard Operating Procedures (SOPs) for microbiological laboratory activities in accordance with GMP practices.

Course Outcomes (COs): -

At the end of this course, the students will be able to:

- **CO1:** Identify contamination sources and follow good laboratory practices for contamination control.
- **CO2:** Perform basic environmental monitoring methods such as air and surface monitoring.
- **CO3:** Carry out microbial limit testing and determine microbial load in test samples.
- **CO4:** Prepare a basic SOP for microbiological procedures following GMP documentation principles.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**Biocolours** a. Introduction b. **Fungal Mycotoxins :** c. Methods of Production i. Submerged fermentation ii. Solid state fermentation a. **Microbial anthraquinoes: Arpink Red from *P.oxalicum*** b. Other microbial anthraquinones c. **Riboflavin – a yellow food colourant** d. **Fluorescent pink from red microalga Porphyridium, phycobilliproteins** e. **Phycocyanin- Marine blue from Porphyridium,** f. **Carotenoid production using microorganisms: Beta carotene, lycopene and astaxanthin**	**10**
II	**Bioplastics** a. Introduction b. Bioplastic- A sustainable alternative to plastics c. Main groups of bioplastics d. Applications e. Challenges	**10**
III	**Bioinsecticides** **a.** History and concept of biopesticides, Importance, scope, and potential of biopesticides **b.** Definitions, concepts, and classification of biopesticides, viz., pathogen, botanical pesticides, and biorationales **c.** Virulence, pathogenicity, and symptoms of entomopathogenic pathogens and nematodes. **d.** Methods of application of biopesticides **e.** Methods of quality control and techniques of biopesticides **f.** Limitations in the production and use of biopesticides	**10**

REFERENCES:

1) Biotechnology in Agriculture and Food Processing:Opportunities and Challenges Editors - Parmjit S. Panesar & Satwinder S. Marwaha
2) Degnan T (2015) Bioplastics – Plenty of room to grow. Focus onCatalysts 2015:1-2. doi:10.1016/j.focat.2015.07.001.
3) European Bioplastics (2011) Fact sheet. European Bioplastics. Accessedat http://en.european-bioplastics.org/wp-content/uploads/2011/04/fs/
4) Bioplastics_eng.pdf.
5) European Bioplastics (2016) Accessed at https://www.europeanbioplastics.org/
6) Lackner M (2015) Bioplastics. Kirk-Othmer Encyclopedia of Chemical
7) Technology 1-41. doi:10.1002/0471238961.koe00006Ross G, Ross S, Tighe B (2017) Bioplastics. Brydson's Plastics Materials 631-652. doi:10.1016/b978-0-323-35824-8.00023-2.
8) Rujnić-Sokele M, Pilipović A (2017) Challenges and opportunities of biodegradable plastics: A mini review. Waste Management &Research 35:132-140. doi: 10.1177/0734242x16683272.
9) Soroudi A, Jakubowicz I (2013) Recycling of bioplastics, their blendsand biocomposites: A review. European Polymer Journal 49:2839-2858.doi: 10.1016/j.eurpolymj.2013.07.025
10) Ajeet Kumar, Sanjay Kumar Singh. An Instructional Material On ASS-307- Biopesticides and Biofer- tilizers Production

B. Sc. III Year V Semester (Microbiology)

SEC00123275P

MIC/VSC-2/P/327 Biobased Products for a Sustainable Future (Lab Course)

Total Contact Hours : 30 Hrs **Total Credits :02** **Maximum Marks :50**

Learning Objectives: -

- To learn screening techniques
- To design experiments for the production and applications of biocolours, bioplastics, and bioinsecticides.
- To learn extraction techniques.
- To study the applicability of the product
- To compare synthetic and biological products

Course Outcomes (COs): -

At the end of this course, the students will be able to:

- **CO1:** Learn screening techniques.
- **CO2:** Learn how to design the experiment.
- **CO3:** Learn different extraction techniques.
- **CO4:** Use the product to confirm their applicability.
- **CO5:** Learn the sustainable nature of bioproducts

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	1. Study of natural dyes from bacteria and fungi (one example each) 2. Isolation of pigment-producing microorganisms.	10
II	1. Preparation of starch-based bioplastic. 2. Demonstration of bioinsecticide activity.	10
III	Large-scale production of bioinsecticides	10

References:

1. **Crueger & Crueger** – Biotechnology: A Textbook of Industrial Microbiology
2. **Stanbury, Whitaker & Hall** – *Principles of Fermentation Technology*
3. **B.D. Singh** – Biotechnology: Expanding Horizons
4. **A.K. De** – Environmental Chemistry
5. **Glick, Pasternak & Patten** – Molecular Biotechnology
6. Biotechnology in Agriculture and Food Processing: Opportunities and Challenges Editors - Parmjit S. Panesar & Satwinder S. Marwaha
7. Degnan T (2015) Bioplastics – Plenty of room to grow. Focus on Catalysts 2015:1-2. doi:10.1016/j.focat.2015.07.001.
8. European Bioplastics (2011) Fact sheet. European Bioplastics. Accessed at http://en.european-bioplastics.org/wp-content/uploads/2011/04/fs/Bioplastics_eng.pdf.
9. European Bioplastics (2016) Accessed https://www.europeanbioplastics.org/
10. Lackner M (2015) Bioplastics. Kirk-Othmer Encyclopedia of Chemical Technology 1-41. doi:10.1002/0471238961.koe00006Ross G, Ross S, Tighe B (2017) Bioplastics. Brydson's

Journals:

- Journal of Industrial Microbiology & Biotechnology
- Bioresource Technology
- Applied Microbiology and Biotechnology

B. Sc. III Year V Semester (Microbiology)

SOC00123265P

MIC/RP/P/326: Research Project

Total Contact Hours: 60 **Credit 02** **Marks 50 (CIA:20, SEE:30)**

Learning Objectives: *By the end of this course, students will be able to:*

- Identify and formulate a research problem in a selected area of Microbiology.
- Apply appropriate experimental/computational/theoretical methods to investigate the problem.
- Develop skills in literature survey, data collection, and scientific analysis.
- Interpret results and correlate them with existing theories and research findings.
- Enhance abilities in scientific writing, presentation, and communication.

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

- Design and execute a mini research project independently or in a group.
- Analyze experimental/simulation data using scientific tools and methods.
- Demonstrate understanding of advanced concepts beyond the prescribed syllabus.
- Prepare a structured project report following the scientific format.
- Present and defend the work effectively through a seminar/viva voce.

Short Guidelines for Research Project:

1. **Project Type:** Experimental / Theoretical / Computational / Review-based.
2. **Group Size:** 1–3 students per project.
3. **Duration:** One semester (60 hours of work).
4. **Selection of Topic:** Should be related to core Microbiology areas and should be approved by the guide/department.

Report Format:

1. **Title, Abstract**
2. **Introduction & Literature Review**
3. **Aim and Objectives**
4. **Methodology**
5. **Results & Discussion**
6. **Conclusion & Future Scope**
7. **References**

Evaluation scheme and Assessment Method: Continuous internal assessment + final evaluation by external/internal examiner (as per university norms).

NOTE (For Research Project – RP):

For the Research Project (RP), the guidelines prescribed in Circular No. Acad-SU/UG/NEP-2020/Scheme of Exam. /77/2024 dated 26.04.2024 shall be followed. The detailed provisions regarding Continuous Internal Assessment (CIA) and Semester End Evaluation (SEE) are specified in the said circular (Page Nos. 18 to 21).

However, as the evaluation scheme in the above circular is based on a 60:40 marks distribution, the same shall be suitably modified to a 30:20 marks distribution for Semester End Evaluation (SEE) and Continuous Internal Assessment (CIA), respectively. Accordingly, all evaluation sheets shall be revised proportionately to reflect this modification.

Semester - VI

Structure of B. Sc. (Three/Four Years Honours/Honours with Research Degree) Program with Multiple Entry and Exit Options
B. Sc. Third Year: 6th Semester Subject: Microbiology

Students will have to select/declare a choice of **one major subject** and **one minor subject** from three major options M1, M2 and M3 (which were opted in the first year)

Type	Course Code	Examination Code	Course Name	Teaching Scheme (Hrs / Week)		Credits Assigned		Total Credits
				Theory	Practical	Theory	Practical	
Major (Core) Mandatory DSC	MIC/DSC/T/350	SAC00123506T	Industrial Microbial Technology	2		2		2+2+2+2 = 08
	MIC/DSC/T/351	SAC00123516T	Molecular microbiology & RDT	2		2		
	MIC/DSC/P/ 376	SAC00123766P	Practicals Based on MIC/DSC/T/350		4		2	
	MIC/DSC/P/ 377	SAC00123776P	Practicals Based on MIC/DSC/T/351		4		2	
Discipline Specific Electives (DSE) (Choose any one from MIC/DSE/T/300 and MIC/DSE/T/301) and corresponding practical's.	MIC/DSE/T/350	SBC00123506T	Microbial diversity	2		2		2+2=04
	MIC/DSE/T/351	SBC00123516T	Food and Dairy Microbiology	2		2		
	MIC/DSE/P/ 376	SBC00123766P	Practicals Based on MIC/DSE/T/350		4		2	
	MIC/DSE/P/ 377	SBC00123776P	Practicals Based on MIC/DSE/T/351		4		2	
IKS	MIC/SIKS/T/350	SIC00123506T	Indian Traditional Farming and Role of Microorganisms					
	MIC/SIKS/T/351	SIC00123516T	Role of Microorganisms in Agriculture					
Minor (Choose any two from pool of courses) **It is from different discipline of the same faculty.**	MIC/Mn/T/ 350	SCC00123006T	Biotechnology and its importance in life	2		2		2+2 = 04
	MIC/Mn/T/ 351	SCC00123016T	Microbial Diseases and its control	2		2		
VSC (Vocational Skill Courses) (Choose any one from MIC/VSC/T/ 300 and MIC/VSC/T/ 301) and corresponding Practical's	MIC/VSC/T/ 350	SEC00123006T	Recent trend in molecular Biology	2		2		2+2 =04
	MIC/VSC/T/ 351	SEC00123016T	Microbial tools and tech. in industries	2		2		
	MIC/VSC/P/ 376	SEC00123766P	Practicals Based on MIC/VSC/T/350		4		2	
	MIC/VSC/P/ 377	SEC00123776P	Practicals Based on MIC/VSC/T/351		4		2	
OJT/ FP/CEP/CC/RP (Choose any one from pool of courses)	MIC/OJT/P/376	SHC00123766P	On Job training (OJT)		4		2	02

B. Sc. III Year VI Semester (Microbiology)

SAC00123506T

MIC/DSC/T/350 Industrial Microbial Technology (Theory)

Total Contact Hours : 30 Hrs **Total Credits :02** **Maximum Marks :50**

Learning Objectives:

- Understand the basic concepts of industrial microbiology and fermentation technology.
- Learn the role of microorganisms in industrial production (pharma, food, agriculture, environment)
- Gain knowledge about design and operation of fermenters/bioreactors.
- Study screening, isolation, and strain improvement techniques of industrial microbes.
- Understand production of important industrial products like antibiotics, organic acids,enzymes, alcohols, etc.
- Learn downstream processing and quality control (GMP, QA, QC) in industries.

Course Outcomes (COs):

Students can isolate and identify industrially important microbes.

- **CO1** : Explain principles of fermentation and industrial processes.
- **CO2:** Identify and select industrially important microorganisms.
- **CO3:** Describe types of fermentations and bioreactors used in industries
- **CO4:** Understand industrial production processes of antibiotics, enzymes, organic acids, etc.
- **CO5:** Apply knowledge of strain improvement and recombinant DNA technology in industries.
- **CO6:** Demonstrate understanding of quality control, GMP, and regulatory standards.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**Introduction to Industrial Microbiology** • Brief history and development of Industrial Microbiology • Design of a typical fermenter, types of fermenters-single stage, multiple stage, recycle stage, air lift fermenters, bubble cap fermenters • Types of fermentation processes- solid state, liquid state- batch, fed batch and continuous fermentations. • Layout of a fermentation industry- Different units and functions, Sterilization	10
II	**Screening techniques and fermentation media.** • Sources of industrially important microorganisms , primary and • secondary screening. • Stock culture maintenance • Strain improvement • Fermentation media- crude & synthetic media- molasses, CSL, SWL, whey • Inoculum development	10
III	**Downstream processing and industrial production** • Down stream processing- cell disruption, filtration, centrifugation, solvent extraction and precipitation • Microbial production of industrial products- microorganisms involved, media, fermentation conditions, downstream processing and uses of - Penicillin, Ethanol and Citric acid. • GMP (Brief account of all aspects) QA and QC	10

REFERENCE BOOKS:

8. Industrial Microbiology – L.E. Casida
9. Principles of Fermentation Technology – P.F. Stanbury, A. Whitaker, S.J. Hall
10. Industrial Microbiology – Prescott & Dunn
11. Biotechnology: A Textbook of Industrial Microbiology – Wulf Crueger & Anneliese Crueger
12. Industrial Microbiology and Biotechnology – M.J. Waites et al.
13. Bioprocess Engineering Principles – Pauline M. Doran

B. Sc. III Year VI Semester (Microbiology)

SAC00123766P

MIC/DSC/P/376 Industrial Microbial Technology (Lab Course)

Total Contact Hours : 30 Hrs **Total Credits :02** **Maximum Marks :50**

Learning Objectives:

- To understand methods of isolation of useful microorganisms from natural sources.
- To study primary screening methods for enzyme-producing microbes
- To design and study different factors of industrial production of microbial products
- To learn antimicrobial susceptibility testing methods (e.g., disc diffusion).
- To learn techniques for product recovery and purification.
- To learn basics of documentation and validation.

Course Outcomes (COs):

Students can isolate and identify industrially important microbes.

- **CO1:** Students can isolate and identify industrially important microbes.And develop skills in microbial purification and maintenance
- **CO2:** Identify microorganisms producing industrial enzymes
- **CO3:** Analyse fermentation efficiency
- **CO 4:** Perform Kirby-Bauer method effectively.
- **CO5:** Understand importance of product purification.
- **CO6:** Prepare basic documentation records.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	• Isolation of industrially important microorganisms • Screening for enzyme production (amylase, protease, lipase) • Study of fermenter (demonstration/model)	10
II	• Production, estimation, and detection of of ethanol using yeast and citric acid production using *Aspergillus niger* • Bioassay of penicillin	10
III	• Downstream processing methods –Filtration, Centrifugation, solvent extraction. Precipitation. Cell disruption (Any Two) • Basic QC and GMP documentation	10

REFERENCE BOOKS:

1. Industrial Microbiology – L.E. Casida
2. Principles of Fermentation Technology – P.F. Stanbury, A. Whitaker, S.J. Hall
3. Industrial Microbiology – Prescott & Dunn
4. Biotechnology: A Textbook of Industrial Microbiology – Wulf Crueger & Anneliese Crueger
5. Industrial Microbiology and Biotechnology – M.J. Waites et al.
6. Bioprocess Engineering Principles – Pauline M. Doran
7. Industrial Microbiology – A.H. Patel
8. Pharmaceutical Quality Assurance by B.P. Nagori, Ajay Gaur, Renu Solanki

B. Sc. III Year VI Semester (Microbiology)

SAC00123516T

MIC/DSC-4/T/351 : Molecular Microbiology & Recombinant DNA Technology (Theory)

Total Contact Hours : 30 Hrs **Total Credits :02** **Maximum Marks :50**

Learning Objectives:

To provide students with a deep understanding of gene expression in microbes and the tools used to manipulate genetic material for industrial and medical applications.

Course Outcomes (COs):

Students can isolate and identify industrially important microbes.

- **CO1** : Evaluate Microbial Genetic Mechanisms
- **CO2:** Design and Execute Molecular Protocols
- **CO3:** Appraise Biotechnological & Ethical Frameworks

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**Molecular Basis of Microbial Life** • **Genome Structure:** Organization of bacterial chromosome; structure and function of plasmids (F, R, and Ti); concept of the metagenome. • **DNA Replication & Repair:** Semi-conservative replication; detailed mechanism of DNA synthesis in *E. coli*; overview of SOS repair and Photoreactivation. • **Gene Expression:** Transcription in prokaryotes (initiation, elongation, and termination); the Genetic Code; Translation mechanism. • **Genetic Regulation:** Fine structure of the gene (Cistron, Recon, Muton); Regulation via the **Lac Operon** (Positive vs. Negative control) and the **Trp Operon** (Attenuation).	**10**
II	**Recombinant DNA Technology & Methodology** • **The RDT Toolkit: Enzymes:** Restriction Endonucleases (Classification and Nomenclature), Ligases, Polynucleotide Kinase, and Terminal Transferase. .1. **Vectors:** Properties of an ideal vector; pBR322, pUC series, and YAC (Yeast Artificial Chromosomes). • **Core Techniques: PCR:** Principles, primer design, and variations (RT-PCR). .1. **Electrophoresis:** Principles of Agarose and SDS-PAGE. • **Cloning Process:** Ligation strategies; methods of gene transfer (Transformation, Conjugation, Biolistics); Selection and Screening using Chromogenic substrates (Blue-White screening) and Colony Hybridization.	**10**
III	**Applied Molecular Biology & Bio-Security** • **Medical & Industrial Applications:** Production of recombinant proteins (Human Insulin, Interferons); Synthesis of recombinant vaccines (Hepatitis B); Engineering microbes for bioremediation. • **Agricultural Biotechnology:** *Agrobacterium*-mediated transformation; Development of Transgenic plants (Bt-Cotton and Golden Rice). • **Genomics & Libraries:** Construction of Genomic and cDNA libraries; basic introduction to DNA Sequencing (Sanger's Method). • **Biosafety & Ethics:** Guidelines for recombinant DNA research; Patenting life forms (IPR); Biosafety levels (BSL 1-4) and the ecological impact of GMOs.	**10**

REFERENCE BOOKS:

1. **Molecular Biology of the Gene** – Watson, J.D. *et al.*
2. **Gene Cloning and DNA Analysis** – T.A. Brown.
3. **Principles of Gene Manipulation and Genomics** – Primrose and Twyman.
4. **Molecular Biology** – David Freifelder.
5. **Microbiology** – Prescott, Harley, and Klein.

B. Sc. III Year VI Semester (Microbiology)

SAC00123776P

MIC/DSC-3/P/377 Molecular Microbiology & Recombinant DNA Technology (Lab Course)

Total Contact Hours : 30 Hrs **Total Credits :02** **Maximum Marks :50**

Learning Objectives:

To provide students with a deep understanding of gene expression in microbes and the tools used to manipulate genetic material for industrial and medical applications.

Course Outcomes (COs):

After course completion students will be able to:.

- **CO1** : Evaluate Microbial Genetic Mechanisms
- **CO2:** Design and Execute Molecular Protocols
- **CO3:** Appraise Biotechnological & Ethical Frameworks.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	• Isolation of *E.coli* chromosomal DNA • Hypochromacity study of chromosomal DNA using UV spectrophotometer	10
II	• Restriction digestion of DNA • Isolation of plasmid DNA • Separation of plasmid from chromosomal DNA • Study of DNA uptake in *E.coli* using $CaCl_2$ treatment	10
III	• Selection of recombinant clones on suitable medium • Measurement of β-galactosidase activity *E. coli* • Demonstration of Polymerase Chain Reaction • Visit to molecular biology Laboratory	10

REFERENCE BOOKS:

1. Gardner Elden, Simmon Michael and Sncustad Octer; Principles of Genetics, John Wily and Sons, Newyork
2. Avinash and Kakoli Upadhyay. MOLBIO, Himalays Publications
3. James D. Walson; Molecular Biology of Genes, W.A. Benjamin Inc.
4. Alert L. Lehninger, David L. Nelson and Michael M. Cox: Biochemistry. Kalyani Publishers. New Delhi
5. B.D. Singh; Biotechnology Expanding Horizons, Kalyani Publishers
6. S.N. Jogdand, Gene Biotechnology, Himalaya Publishing House
7. Avinash and Kakoli Upadhyay; Molecular Biology and Genetic Engineering, Himalay Publisliing House

B. Sc. III Year VI Semester (Microbiology)

SBC00123506T

MIC/DSE-3/T/350 Microbial Diversity

Total Contact Hours : 30 Hrs **Total Credits :02** **Maximum Marks :50**

Learning Objectives: -

- To define microbial diversity and explain its importance in nature.
- To describe different systems of microbial classification including the three-domain concept proposed by Carl Woese.
- To differentiate between Bacteria and Archaea based on structural and physiological characteristics.
- To classify major groups of microorganisms including bacteria, fungi, algae, protozoa, and viruses.
- To explain the ecological roles of microorganisms in various environments.
- To describe methods used for studying microbial diversity including microscopy, culture techniques, and molecular methods.

Course Outcomes (COs): -

At the end of this course, the students will be able to:

- **CO1:** Explain the concept, scope, and importance of microbial diversity in different ecosystems.
- **CO2:** Classify microorganisms based on morphological, physiological, and molecular characteristics, including the three-domain system proposed by Carl Woese.
- **CO3:** Differentiate major groups of microorganisms such as Bacteria, Archaea, fungi, algae, protozoa, and viruses.
- **CO4:** Describe the ecological roles and environmental distribution of microorganisms.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**Module 1: Introduction to Microbial Diversity** **1.1** Definition and concept of microbial diversity **1.2** Historical development of microbial classification **1.3** Contributions of Carl Linnaeus and Carl Woese **1.4** Five-kingdom and three-domain classification systems **1.5** Importance of microbial diversity in ecosystem	**06**
II	**Module 2:** Diversity of Prokaryotic, Eukaryotic microorganisms and viruses 2.1 Diversity of Prokaryotes (Bacteria) • General characteristics • Classification based on morphology, staining, oxygen requirement • Gram-positive and Gram-negative bacteria • Extremophiles (thermophiles, halophiles, acidophiles) 2.2 Diversity of Prokaryotes (Archaea) • General characteristics • Differences between Archaea and Bacteria • Methanogens, halophiles, thermoacidophiles 2.3 Diversity of Eukaryotes (Fungi) • General characteristics • Yeasts, molds, dimorphic fungi • Economic and medical importance B. Diversity of Eukaryotes (Algae) • General characteristics • Major groups (green, brown, red algae) • Ecological importance C. Diversity of Eukaryotes (Protozoa) • General characteristics • Classification based on locomotion	**14**

	• Pathogenic protozoa **Diversity of Viruses** • General characteristics of viruses • Structure and classification of viruses • DNA and RNA viruses • Bacteriophages • Viroids and prions	
III	Module 3: **Microbial Ecology and Environmental Diversity** • Microbial habitats (soil, water, air, extreme environments) • Microbial interactions (symbiosis, mutualism, parasitism) • Role of microbes in biogeochemical cycles • Biofilms	**10**

Text books

1) **A Textbook of Microbiology** – *R. C. Dubey & D. K. Maheshwari — S. Chand Publishing* (Comprehensive undergraduate microbiology text with sections on classification and microbial ecology.)
2) **Brock Biology of Microorganisms** – *by Madigan, Martinko & Parker — Pearson* (Standard microbiology textbook often recommended for general microbial diversity and ecology
3) **Principles of Microbial Diversity** – *James W. Brown — John Wiley & Sons Ltd. Wiley & Sons Ltd.* https://www.wiley-vch.de/en/areas-interest/medicine-health-care/medical-science-14md/infectious-disease-microbiology-14mdd/microbiology-14mdd3/principles-of-microbial-diversity-978-1-55581-442-7?utm.com (Provides a solid overview of microbial diversity, phylogeny, and the microbial "tree of life.")
4) **Bergey's Manual of Systematic Bacteriology** – *Edited by David R. Boone, George M. Garrity, et al. — Springer / Wiley* (Authoritative reference for bacterial classification and diversity.)
5) **Textbook of Microbial Diversity** – *Dipak Kewalramji Koche & Rupali Prakash Shirsat — BP International.* https://bookstore.bookpi.org/product/textbook-of-microbial-diversity/?utm.com (Focused on microbial groups, classification, ecology and roles in ecosystems.)

Reference Books

11) **Microbial Diversity in Ecosystem Sustainability and Biotechnological Applications (Vol. 1 & 2)** – *Tulasi Satyanarayana, Bhavdish Narain Johri & Subrata Kumar Das — Springer Nature Singapore.* https://link.springer.com/book/10.1007/978-981-13-8315-1?utm.com (Comprehensive coverage of microbial diversity in various environments and their ecological importance.)
12) **Basic Concepts and Recent Advances in Microbial Diversity, Taxonomy, Speciation and Evolution** – *Suchitra Godbole & Dhara P. Sachdev — Cambridge Scholars Publishing.* https://cambridgescholars.com/product/978-1-5275-7597-4/?utm.com (Combines basic concepts with modern techniques in microbial taxonomy and diversity.)
13) **Microbial Diversity: Exploration & Bioprospecting** – *S. Ram Reddy, M.A. Singaracharya & S. Girisham — Scientific Publishers.* https://www.scientificpubonline.com//bookdetail/microbial-diversity-exploration-bioprospecting/9788172337827/561?utm.com (Detailed reference on microbial diversity and its exploration, valuable for deeper reading.)

B. Sc. III Year VI Semester (Microbiology)
SBC00123766P
MIC/DSE-3/T/376 Microbial Diversity (Lab Course)

Total Contact Hours : 30 Hrs **Total Credits :02** **Maximum Marks :50**

Learning Objectives (LOs)

Upon completion of this practical course, students will be able to:

- Understand the concept of microbial diversity and its significance in nature.
- Demonstrate knowledge of the historical development of microbial classification systems.
- Differentiate between Five-Kingdom and Three-Domain classification systems.
- Identify and classify microorganisms based on morphological, physiological, and staining characteristics.
- Perform basic microbiological techniques such as sample collection, staining, microscopy, isolation, and cultivation of microorganisms.
- Distinguish between Gram-positive and Gram-negative bacteria using Gram staining.
- Recognize the diversity of bacteria, archaea, fungi, algae, protozoa, and viruses through laboratory observations.
- Observe and identify extremophilic microorganisms and understand their ecological significance.
- Isolate microorganisms from environmental samples such as soil, water, and air.
- Study microbial interactions and ecological relationships including mutualism, symbiosis, and parasitism.
- Understand the role of microorganisms in biogeochemical cycles and ecosystem functioning.
- Demonstrate knowledge of biofilm formation and its importance in natural and clinical environments.
- Develop skills in observation, recording, analysis, and interpretation of microbiological data.
- Follow laboratory safety procedures and maintain proper laboratory records.

Course Outcomes (COs)

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

- **CO1:** Explain the concept of microbial diversity and the principles of microbial classification, including the contributions of Carl Linnaeus and Carl Woese.
- **CO2:** Apply microbiological techniques such as staining, microscopy, culturing, and isolation for the study of diverse microorganisms.
- **CO3:** Identify and differentiate major groups of microorganisms including bacteria, archaea, fungi, algae, protozoa, and viruses based on their characteristic features.
- **CO4:** Analyze microbial diversity present in different environmental habitats such as soil, water, air, and extreme environments.
- **CO5:** Interpret microbial ecological interactions and evaluate the role of microorganisms in maintaining ecosystem balance through nutrient cycling and biofilm formation.
- **CO6:** Demonstrate laboratory competency in handling microbial cultures, recording observations, and preparing scientific reports.
- **CO7:** Evaluate the ecological, industrial, agricultural, and medical importance of microbial diversity and its applications in environmental sustainability.
- **CO8:** Develop scientific temperament, critical thinking, teamwork, and problem-solving skills through practical investigations related to microbial diversity.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	• To observe the diversity of microorganisms present in different environmental samples. Airborne / Waterborne / soil borne microorganisms • Study of Microbial Diversity Using Colony Morphology • To understand the evolution of microbial classification.	06
II	• To differentiate Gram-positive and Gram-negative bacteria. • To study bacterial shapes, cocci / rods / spirals • To isolate and study characteristics of thermophiles, halophiles and acidophiles bacteria.	14
III	• To isolate algae from water. • To Isolate fungi from air/soil.	10

	• To Isolate yeast from different sources. • To isolate protozoa from different sources.	

Text books

6) **A Textbook of Microbiology** – *R. C. Dubey & D. K. Maheshwari — S. Chand Publishing* (Comprehensive undergraduate microbiology text with sections on classification and microbial ecology.)
7) **Brock Biology of Microorganisms** – *by Madigan, Martinko & Parker — Pearson* (Standard microbiology textbook often recommended for general microbial diversity and ecology
8) **Principles of Microbial Diversity** – *James W. Brown — John Wiley & Sons Ltd. Wiley & Sons Ltd.* https://www.wiley-vch.de/en/areas-interest/medicine-health-care/medical-science-14md/infectious-disease-microbiology-14mdd/microbiology-14mdd3/principles-of-microbial-diversity-978-1-55581-442-7?utm.com (Provides a solid overview of microbial diversity, phylogeny, and the microbial "tree of life.")
9) **Bergey's Manual of Systematic Bacteriology** – *Edited by David R. Boone, George M. Garrity, et al. — Springer / Wiley* (Authoritative reference for bacterial classification and diversity.)
10) **Textbook of Microbial Diversity** – *Dipak Kewalramji Koche & Rupali Prakash Shirsat — BP International.* https://bookstore.bookpi.org/product/textbook-of-microbial-diversity/?utm.com (Focused on microbial groups, classification, ecology and roles in ecosystems.)

Reference Books

14) **Microbial Diversity in Ecosystem Sustainability and Biotechnological Applications (Vol. 1 & 2)** – *Tulasi Satyanarayana, Bhavdish Narain Johri & Subrata Kumar Das — Springer Nature Singapore.* https://link.springer.com/book/10.1007/978-981-13-8315-1?utm.com (Comprehensive coverage of microbial diversity in various environments and their ecological importance.)
15) **Basic Concepts and Recent Advances in Microbial Diversity, Taxonomy, Speciation and Evolution** – *Suchitra Godbole & Dhara P. Sachdev — Cambridge Scholars Publishing.* https://cambridgescholars.com/product/978-1-5275-7597-4/?utm.com (Combines basic concepts with modern techniques in microbial taxonomy and diversity.)
16) **Microbial Diversity: Exploration & Bioprospecting** – *S. Ram Reddy, M.A. Singaracharya & S. Girisham — Scientific Publishers.* https://www.scientificpubonline.com//bookdetail/microbial-diversity-exploration-bioprospecting/9788172337827/561?utm.com (Detailed reference on microbial diversity and its exploration, valuable for deeper reading.)

B. Sc. III Year VI Semester (Microbiology)

SBC00123516T

MIC/DSE-3/T/351 Food and Dairy Microbiology

Total Contact Hours : 30 Hrs **Total Credits :02** **Maximum Marks :50**

Learning Objectives: -

- To analyze how food composition influences microbial growth and identify the primary sources of food contamination.
- To examine the chemical changes during food spoilage and distinguish between various food-borne infections and intoxications.
- To understand the technological processes in the food and dairy industries used to control undesirable microbial changes.
- To deeply focus on microbiological testing methods like SPC, MBRT, and Phosphatase tests for the quality assessment of dairy products.
- To familiarize students with national and international regulatory frameworks and safety standards, including HACCP, FSSAI, and ISO.

Course Outcomes (COs): -

At the end of this course, the students will be able to:

- **CO1:** Analyze the role of food and milk as microbial substrates to identify primary sources of contamination and the mechanisms of spoilage.
- **CO2:** Distinguish between foodborne infections and intoxications while evaluating the principles and methods used in food preservation.
- **CO3:** Assess the microbial composition and industrial significance of fermented foods and probiotic dairy products.
- **CO4:** Execute standard microbiological examinations of milk, including phosphatase and reductase tests, to determine quality and safety.
- **CO5:** Acquire information about national and international regulatory standards, such as FSSAI and CODEX, to ensure quality assurance in the food and dairy industries.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**Module 1. Food Microbiology:** **1.1 Food as a substrate for microorganisms.** **1.2 Sources of contamination of food** **1.3 Spoilage of Foods** a) Classification of foods by ease of spoilage b) Chemical changes caused by microorganisms in food. c) Types of spoilage of canned and non-canned foods with organisms involved. (Tabular form). **1.4 Food-borne diseases (in brief):** a) Food infections: Salmonellosis, Shigellopsis, Hepatitis A, Gastroenteritis viruses (Norovirus) b) Food intoxication: Staphylococcal, Clostridial, ***E. coli***, Mycotoxins (list with harmful effects) **1.5 Principles of food preservation:** **Microbiostatic and Microbiocidal methods:** Asepsis, Removal of Microorganisms, Anaerobic Conditions, High Temperature, Low Temperature, Drying, Chemical Preservatives, High Osmotic Pressure, Radiation, Smoking, Microbial **1.6 List of fermented foods, their significance, and microorganisms involved**	**10**
II	**Dairy Microbiology** **2.1 Definition and composition of milk**	**10**

	2.2 Sources of microorganisms in milk- Bovine and Human origin **2.3 Undesirable changes carried out by microorganism in milk** **2.4 Pasteurization and sterilization of milk:** **2.5 List of Dairy/ *Probiotic* Products, their significance and role microorganisms involved in industrial fermentations.**	
III	**Quality Assurance in Food and Dairy Industries** **3.1 Food safety- Relevance of microbial standards** **3.2 Indicators of food pathogens associated with food.** **3.3 Microbiological examination of milk:** a) SPC b) DMC c) Reductase tests -MBRT and Resazurin d) Phosphatase test **3.4 Introduction to microbiological standards at the national and International level-** a) **Food products:** FSSAI, BIS CODEX Alimentarius Commission b) **Dairy products:** FSSAI, BIS CODEX Alimentarius Commission	**10**

Text books

1) Food Microbiology-5, William C. Frazier, Dennis C. Westhoff, McGraw Hill Education (India) Pvt. Ltd., New Delhi
2) A Text book of Dairy Microbiology, Prajapati and Behare, Indian Council of Agricultural Research, New Delhi
3) Manual of methods of analysis - microbiological examination of food and water – fssai- https://fssai.gov.in/upload/uploadfiles/files/Manual%20on%20Microbiological%20Examination%20of%20Food%20and%20Water_compressed.pdf
4) Microbiological standards for dairy products- Food Safety and Standards- https://www.fssai.gov.in/upload/uploadfiles/files/Compendium_Food_Additives_Regulations_20_12_2022.pdf
5) Codex Alimentarius Commission, Procedural Manual 25e- https://fssai.gov.in/upload/uploadfiles/files/Codex_Working_Procedural_Manual_25_Edition_16_08_2018.pdf
6) Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2 by Joshi.
7) A Text book of Microbiology by Dubey and Maheshwari, S. Chand and Company Limited
8) Microbiology- Principles and Explorations 7e, Jacquelyn Black, John Wiley & Sons, Inc.
9) Microbiology: An Introduction 5e , Tortora, Funke, Case, Dorling Kindersley (India) Pvt. Ltd. License of Pearson Education in South Asia
10) Microbiology 5e, Pelczar Chan and Krieg, McGraw-Hill Inc.,US

Reference Books:

1) Food Microbiology by Adams and Moss, New Age International (P) Limited, Publishers
2) Basic Food Microbiology Banwart George J.
3) Food Microbiology: Fundamentals and Frontiers. 2nd Edition by Michaell P. Doyle, Larry R. Beuchat and Thomas I. Montville (Eds.), ASM Publications.
4) Applied dairy microbiology edited by Elmer Marth and James Steele
5) Essentials of Food Microbiology. Edited by John Garbult. Arnold International Students Edition.

B. Sc. III Year VI Semester (Microbiology)

SBC00123776P

MIC/DSE-3/T/377 Food and Dairy Microbiology

Total Contact Hours : 30 Hrs **Total Credits :02** **Maximum Marks :50**

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

1. Understand the principles of food spoilage, food-borne diseases, and factors influencing microbial growth in foods.
2. Identify microorganisms responsible for spoilage of canned and non-canned foods and explain the associated biochemical changes.
3. Acquire knowledge of milk microbiology, sources of contamination, preservation methods, and industrial dairy fermentations.
3. Understand the microbiological quality assessment of food and dairy products using standard analytical techniques.
4. Gain knowledge of food safety regulations, microbial standards, and quality assurance systems in food and dairy industries.
5. Develop skills for microbiological testing and interpretation of results relevant to food quality and safety.

Course Outcomes (COs):

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

CO1: Classify foods based on susceptibility to microbial spoilage and explain the chemical and microbiological changes associated with food deterioration.
CO2: Differentiate various food-borne infections and intoxications, their causative agents, transmission routes, and public health significance.
CO3: Explain the microbiology of milk, sources of microbial contamination, spoilage mechanisms, and preservation techniques used in the dairy industry.
CO4: Analyze the role of microorganisms in the production of dairy and probiotic products and evaluate their industrial significance.
CO5: Perform microbiological quality assessment of milk and dairy products using standard laboratory methods.
CO6: Interpret national and international food safety standards and apply quality assurance principles in food and dairy industries.

Module No.	Topics / actual contents of the syllabus	Contact Hours
1	i. Isolation and enumeration of microorganisms from spoiled food samples. ii. Isolation and identification of food-borne bacteria from food samples. iii. Detection of coliforms in food samples.	10
2	-Determination of microbial load in milk by Standard Plate Count (SPC). -Methylene Blue Reduction Test (MBRT) and Resazurin Reduction Test. - Phosphatase test for assessment of pasteurization efficiency.	10
3	-Detection of indicator organisms in food and milk samples. -Microbiological examination of packaged dairy products.	10

REFERENCE BOOKS:

-Frazier and Westhoff's Food Microbiology – W.C. Frazier & D.C. Westhoff.
-Modern Food Microbiology – James M. Jay, Martin J. Loessner & David A. Golden.
-Fundamental Food Microbiology – Bibek Ray & Arun Bhunia.
-Laboratory Methods in Food Microbiology – W.F. Harrigan.
-Dairy Microbiology Handbook – Richard K. Robinson.
-Standard Methods for the Examination of Dairy Products – APHA.
-Compendium of Methods for the Microbiological Examination of Foods – APHA.
-FSSAI Manual of Methods of Analysis of Foods: Milk and Milk Products.
-BIS Methods of Test for Dairy Industry (IS 1479 Series).

B. Sc. III Year VI Semester (Microbiology)

SIC00123506T

MIC/SIKS/T/350 Indian Traditional Farming and Role of Microorganism

Total Contact Hours : 30 Hrs **Total Credits :02** **Maximum Marks :50**

Learning Objectives: -

- Understand Farming Systems
- Differentiate between traditional farming and industrial (modern) farming
- Explain features, advantages, and limitations of both systems
- . Knowledge of Industrial Farming
- Understand use of chemical fertilizers, pesticides, and mechanization

Course Outcomes (COs): -

At the end of this course, the students will be able to understand farming systems

- **CO1:**Analyze industrial farming
- **CO2:**Understand traditional farming
- **CO3:**Explain role of microorganisms
- **CO4:**Apply biofertilizers and biopesticides
- **CO5:**Promote sustainable agriculture
- **CO6:**Environmental awareness

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**Introduction to Farming Systems** • Concept of agriculture and farming systems • Types of farming: o Traditional farming o Industrial (modern) farming • Characteristics, advantages, and limitations **Industrial Farming** • Mechanization in agriculture • Use of chemical fertilizers and pesticides • High-yielding varieties (HYVs) and irrigation techniques • Advantages: o Increased productivity • Disadvantages: o Soil degradation o Environmental pollution o Health hazards	10
II	**Traditional Farming** • Indigenous farming practices • Organic farming and natural farming • Crop rotation, mixed cropping, intercropping • Advantages: o Eco-friendly o Soil conservation • Limitations: o Lower yield compared to modern farming **Role of Microorganisms in Agriculture** • Types of agricultural microorganisms: o Bacteria, fungi, algae • Role in: o Soil fertility o Decomposition of organic matter o Nutrient cycling (Nitrogen, Carbon cycles) • Nitrogen fixation: Symbiotic and non-symbiotic	10

III	**Biofertilizers** • Definition and types: o *Rhizobium, Azotobacter, Azospirillum, Cyanobacteria* • Production and application methods • Advantages over chemical fertilizers **Biopesticides** • Definition and types • Microbial pesticides (bacteria, fungi, viruses) • Role in pest and disease control • Advantages over chemical pesticides **Sustainable Agriculture** • Concept of sustainable agriculture • Role of microorganisms in sustainable farming • Composting and vermicomposting c) Bioremediation of soil	**10**

Text books

1) Agricultural Microbiology – Rangaswami & Bagyaraj
2) Soil Microbiology – N. S. Subba Rao
3) Essentials of Agricultural Microbiology – Aithal & Kakde
4) Fundamentals of Plant Pathology – Mehrotra & Agarwal
5) Microbial Strategies for Crop Improvement – Khan et al.

B. Sc. III Year VI Semester (Microbiology)

SCC00123506T

MIC/Mn/T/350 Biotechnology And Its Importance In Life

Total Contact Hours : 30 Hrs **Total Credits :02** **Maximum Marks :50**

Learning Objectives: -

- To introduce the basic concepts and scope of microbial biotechnology and its importance in various sectors.
- To develop an understanding of the role of microorganisms in biotechnological processes and product formation.
- To explain the principles and mechanisms of microbial biotransformation reactions.
- To familiarize students with factors affecting microbial biotransformation and process efficiency.
- To provide knowledge of industrial applications of microbial biotechnology in the production of valuable products.
- To highlight the environmental applications of microorganisms, including bioremediation and waste bioconversion.

Course Outcomes (COs): -

At the end of this course, the students will be able to:

- **CO1:** Explain the basic concepts and scope of microbial biotechnology.
- **CO2:** Describe microbial biotransformation reactions and the factors influencing these processes.
- **CO3:** Illustrate industrial applications of microorganisms in the production of biotechnological products.
- **CO4:** Discuss environmental applications of microbes in bioremediation and sustainable processes.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**Module 1: Basic Principles of Microbial Biotechnology** 1.1. Microbial biotechnology: scope and importance in health care, agriculture, environment and industry. 1.2. Role of microorganisms in biotechnological processes and product formation. 1.3. Genetically engineered microorganisms for industrial applications (bacteria and yeast). 1.4. Applications of microbial biotechnology in biofertilizers, PGPR and mycorrhizae.	**06**
II	**Module 2: Application of microbes in biotransformation** 2.1. Concept of microbial biotransformation and advantages over chemical synthesis 2.2. Factors affecting microbial biotransformation 2.3. Industrial applications of microbial biotransformation (steroid transformation, drug modification, production of vitamins and fine chemicals.) 2.4. Environmental and industrial bioconversions (biodegradation of pollutants, microbial conversion of waste into useful products).	**14**
III	**Module 3: Industrial and Environmental Applications of Microbial Biotechnology** 3.1. Overview of microbial production of industrial products (penicillin, amylase, citric acid) 3.2. Overview of microbial production of biofertilizer (*Azotobacter)* and bioinsecticide (*Trichoderma)*. 3.3. Overview of microbial bioremediation and wastewater treatment. 3.4. Biofuels and renewable energy production (biogas, bioethanol, microbial biodiesel.)	**10**

Text books

1) **Microbial Biotechnology: Fundamentals of Applied Microbiology.** Alexander N. Glazer and Hiroshi Nikaido. Cambridge University Press. (Useful for: Module 1 – Fundamentals of microbial biotechnology; Module 2 – microbial biotransformation concepts)
2) **Microbial Biotechnology: Principles and Applications**. Yogesh Shouche, Archana Ghosh and N. V. Joshi. Universities Press. (Useful for: Module 1 – scope and principles; Module 3 – industrial and environmental applications)
3) **Biotechnology: A Textbook of Industrial Microbiology**. Wulf Crueger and Anneliese Crueger. Panima

Publishing. (Useful for: Module 2 – biotransformation reactions; Module 3 – microbial production of industrial products)

4) **Industrial Microbiology.** L. E. Casida Jr. New Age International. (Useful for: Module 3 – microbial production of antibiotics, enzymes, organic acids and biofuels)
5) **Principles of Microbial Biotechnology.** T. Satyanarayana and G. Johri. Springer. (Useful for: Module 1 – microbial biotechnology concepts; Module 2 – biotransformation and biocatalysis)

Reference Books

1) **Environmental Microbiology.** Ian L. Pepper, Charles P. Gerba and Terry J. Gentry. Academic Press. (Useful for: Module 3 – bioremediation, biodegradation and wastewater treatment)
2) **Biotechnology.** U. Satyanarayana. Books and Allied Publishers. (Useful for: Module 1 – introduction and scope; Module 3 – biofertilizers and biofuels)
3) **Microbial Biotechnology.** Rajesh Arora. CBS Publishers & Distributors.(Useful for: Module 2 – microbial biotransformation reactions and industrial applications)
4) **Biotechnology: Expanding Horizons.** B. D. Singh. Kalyani Publishers. (Useful for: Module 1 – fundamentals of biotechnology; Module 3 – environmental and agricultural biotechnology)
5) **Biotechnology for Beginners.** Reinhard Renneberg. Academic Press. (Useful for: Module 1 – basic concepts; Module 2 – industrial and pharmaceutical biotransformation examples)

B. Sc. III Year VI Semester (Microbiology)

SCC00123516T

MIC/Mn/T/351 Microbial; Diseases and its Control

Total Contact Hours : 30 Hrs **Total Credits :02** **Maximum Marks :50**

Learning Objectives: -

- To define microbial diseases and explain concepts of infection, pathogenicity, and virulence.
- To classify microbial diseases into bacterial, viral, fungal, and protozoal infections.
- To describe the pathogenesis, clinical features, and laboratory diagnosis of common microbial diseases.
- To explain the principles of epidemiology and modes of transmission of infectious diseases.
- To discuss various methods of disease prevention and control including sterilization, chemotherapy, and vaccination.
- To evaluate the role of public health agencies such as the World Health Organization in disease control programs.

Course Outcomes (COs): -

At the end of this course, the students will be able to:

- **CO1:** Explain the fundamental concepts of microbial diseases, including infection, pathogenicity, and host–pathogen interactions.
- **CO2:** Classify and describe major bacterial, viral, fungal, and protozoal diseases with reference to their causative agents and transmission.
- **CO3:** Illustrate the pathogenesis, clinical manifestations, and laboratory diagnosis of important infectious diseases.
- **CO4:** Apply principles of epidemiology to understand the spread and control of infectious diseases.
- **CO5:** Evaluate different preventive and control measures such as sterilization, disinfection, antimicrobial therapy, vaccination, and public health strategies.
- **CO6:** Analyze the role of national and international health agencies, including the World Health Organization, in disease surveillance and control programs.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**Module 1: Introduction to Microbial Diseases** **1.1** Definition and classification of microbial diseases **1.2** Types: Bacterial, Viral, Fungal, Protozoal diseases **1.3** Concept of infection, pathogenicity, virulence **1.4** Host–pathogen interaction **1.5** Normal flora and opportunistic infections	**10**
II	**Module 2: Bacterial, Fungal, protozoal and viral diseases** **General characteristics and transmission, clinical features, laboratory diagnosis and control of:** **2.1. Bacterial diseases** -Typhoid fever, Cholera, Tuberculosis and Tetanus. 2.2. Fungal Diseases – Candidiasis, Dermatophytosis 2.3 Protozoal Diseases –Malaria, Amoebiasis **2.4. Viral Diseases-** Hepatitis, Dengue, Rabies, HIV/AIDS, COVID-19	**10**
III	Module 3: **Control and Prevention of Microbial Diseases** 3.1 Sterilization and disinfection 3.2 Chemotherapy and antimicrobial agents 3.3 Mechanism of antibiotic resistance 3.4 Vaccination and immunization programs 3.5 Public health measures and sanitation 3.6 Personal hygiene and community awareness 3.7 Role of the World Health Organization in disease control	**10**

Text books

1) **Ananthanarayan & Paniker's *Textbook of Microbiology*-** R. Ananthanarayan, C.K. Jayaram Paniker, Universities Press (India) Pvt. Ltd. 13th Edition (2024/2025)
2) **A Textbook of Microbiology -** R.C. Dubey & D.K. Maheshwari, S. Chand Publishing
3) **Prescott, Harley & Klein – *Microbiology,*** McGraw Hill Education

4) **Clinical Microbiology Manuals** (e.g., *Bailey & Scott's Diagnostic Microbiology*), *Elsevier*

Reference Books

1) **Jawetz, Melnick & Adelberg's *Medical Microbiology,*** McGraw Hill Medical / Lange
2) **Medical Microbiology and Immunology**- S.M. Reddy & G. Narendra Babu, Scientific Publishers
3) **Control of Communicable Diseases Manual**- American Public Health Association
4) **Bergey's Manual of Systematic Bacteriology** - Springer / Williams & Wilkins

B. Sc. III Year VI Semester (Microbiology)
SEC00123506T
MIC/VSC/T/350 Recent Trends in Molecular Biology

Total Contact Hours : 30 Hrs **Total Credits :02** **Maximum Marks :50**

Learning Objectives: -

- To understand advanced genome editing and sequencing technologies.
- To explore the applications of transcriptomics and proteomics in modern medicine.
- To gain insight into the molecular basis of gene therapy and RNA-based vaccines.

Course Outcomes (COs): -

At the end of this course, the students will be able to:

- **CO1: Modern Sequencing:** Explain how new machines read an entire genome faster and cheaper than old methods.
- **CO2: DNA Editing:** Describe how "molecular scissors" like CRISPR are used to fix or change specific genes.
- **CO3: Gene Switches:** Understand how cells turn genes "on" or "off" without changing the actual DNA sequence (Epigenetics).
- **CO4: New Vaccines:** Discuss how mRNA technology is used to create modern vaccines and cancer treatments.
- **CO5: Smart Diagnostics:** Identify advanced ways to detect diseases early using liquid biopsies and digital testing.

Module No.	Topics / actual contents of the syllabus	Contact Hours
1	**Advanced Genomics and Genome Engineering** • **Next-Generation Sequencing (NGS):** Principles of Illumina and Ion Torrent; Introduction to Third-Generation Sequencing (Oxford Nanopore and Pacific Biosciences). • **Genome Editing Tools:** Mechanism of CRISPR-Cas9, Cas12, and Cas14; Base editing and Prime editing technologies. • **Synthetic Biology:** Synthesis of artificial genes and genomes; Minimal cell concept. • **Ethical Implications:** Biosafety and bioethics in human genome editing.	10
2	**Transcriptomics and Epigenomics** • The RNA World: Single-cell RNA Sequencing (scRNA-seq) and its importance in cellular heterogeneity. • **Non-coding RNAs:** Functional significance of microRNA (miRNA), long non-coding RNA (lncRNA), and Circular RNA in disease regulation. • **Epigenetic Modifications:** DNA methylation patterns, histone acetylation, and the "Histone Code." • **Epitranscriptomics:** Understanding m6A modifications and their role in mRNA stability and translation.	10
3	**Molecular Therapeutics and Diagnostics** • **RNA-Based Therapeutics:** Design and delivery of mRNA vaccines (e.g., COVID-19 vaccines); Antisense Oligonucleotides (ASOs) and siRNA. • **Molecular Diagnostics:** Digital PCR (dPCR), LAMP assays, and Liquid Biopsy for early cancer detection. • **Gene Therapy:** Viral (AAV, Lentivirus) and non-viral delivery systems; CAR-T cell therapy for cancer immunotherapy. • **Personalized Medicine:** Pharmacogenomics and tailoring treatments based on individual molecular profiles	10

Recommended Learning Resources

1. **Watson, J. D., *et al.*** *Molecular Biology of the Gene.* Pearson Education.
2. **Primrose, S. B., & Twyman, R.** *Principles of Gene Manipulation and Genomics.* Blackwell Publishing.
3. **Brown, T. A.** *Gene Cloning and DNA Analysis: An Introduction.* Wiley-Blackwell.
4. **Current Journals:** *Nature Reviews Molecular Cell Biology* and *Trends in Biotechnology* for recent case studies.

B. Sc. III Year VI Semester (Microbiology)

SEC00123766P

MIC/VSC/P/376 Recent Trends in Molecular Biology (Lab Course)

Total Contact Hours : 30 Hrs **Total Credits :02** **Maximum Marks :50**

Learning Objectives: -

- Introduce students to modern experimental approaches in molecular biology related to genomics, transcriptomics, diagnostics, and therapeutics.
- Provide hands-on exposure to simple molecular biology techniques and bioinformatics resources relevant to recent trends.
- Familiarize students with genome editing principles, RNA biology, molecular diagnostics, and personalized medicine through low-cost practical demonstrations and simulations.
- Develop analytical, interpretative, and technical skills in handling molecular biology data and experimental procedures.
- Encourage scientific understanding of ethical and biosafety issues in molecular biology research.

Course Outcomes (COs): -

At the end of this course, the students will be able to:

- **CO1:** Demonstrate basic molecular laboratory skills related to nucleic acid isolation and qualitative analysis.
- **CO2:** Explain and apply fundamental concepts of genome sequencing, genome editing, and bioinformatics tools in molecular biology.
- **CO3:** Analyze the significance of RNA biology, transcriptomics, epigenetic regulation, and non-coding RNAs in cellular functions and diseases.
- **CO4:** Interpret principles of molecular diagnostics, RNA therapeutics, gene therapy, and personalized medicine using practical demonstrations and case studies.
- **CO5:** Develop scientific reasoning, analytical skills, and awareness of biosafety and ethical concerns associated with modern molecular biology.

Module No.	Topics / actual contents of the syllabus	Contact Hours
1	**Experiment 1:** Isolation and Qualitative Analysis of Genomic DNA **Experiment 2:** Demonstration/Simulation of Genome Editing and Sequence Analysis using Open Bioinformatics Tools	10
2	**Experiment 3:** Isolation of RNA from Plant Tissue **Experiment 4:** Study of Gene Expression and Epigenetic Regulation using Case Studies/Bioinformatics Databases	10
3	**Experiment 5:** Demonstration of Molecular Diagnostics using PCR Principles, Paper-Based Models, and LAMP Concept **Experiment 6:** Case Study-Based Analysis of mRNA Vaccines, Gene Therapy, and Personalized Medicine	10

Recommended Laboratory Manuals / Reference Books

1. Molecular Cloning: A Laboratory Manual (4th Edition) Authors: **Michael R. Green and Joseph Sambrook** Publisher: **Cold Spring Harbor Laboratory Press, New York**
2. Gene Cloning and DNA Analysis: An Introduction Author: **T. A. Brown** Publisher: **Wiley-Blackwell**
3. Principles and Techniques of Biochemistry and Molecular Biology Editors: **Keith Wilson and John alker** Publisher: **Cambridge University Press**
4. Molecular Biology Techniques: A Classroom Laboratory Manual Author: **Heather Miller (Ed.)** Publisher: **Academic Press**
5. Introduction to Practical Molecular Biology Author: **P. D. Dabre** Publisher: **Nirali Prakashan**
6. Methods in Molecular Biology (Series) Editor: **John M. Walker** Publisher: **Humana Press / Springer Nature**
7. Bioinformatics: Sequence and Genome Analysis Author: **David W. Mount** Publisher: **Cold Spring Harbor Laboratory Press**
8. Essential Bioinformatics Author: **Jin Xiong** Publisher: **Cambridge University Press**
9. Molecular Biology of the Cell Authors: **Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, and Peter Walter** Publisher: **Garland Science / Taylor & Francis**
10. Lewin's Genes Authors: **Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, and Eric S. Lewin** Publisher: **Jones & Bartlett Learning**

Suggested Online Resources for Practical Demonstrations

- NCBI Database Resources – For nucleotide sequences, genome data, and molecular biology databases.
- Benchling Educational Platform – For simple genome editing visualization and sequence handling.
- Ensembl Genome Browser – Genome browsing and comparative genomics.
- PubMed – Literature and case-study support for therapeutics and diagnostics

B. Sc. III Year VI Semester (Microbiology)

SEC00123516T

MIC/VSC/T/351 Microbial Tools & Techniques in Industries

Total Contact Hours : 30 Hrs **Total Credits :02** **Maximum Marks :50**

Learning Objectives: -

- Evaluate the operating principles of industrial sterilization hardware and "Clean Room" ISO standards.
- Formulate specialized synthetic and complex media using industrial additives to maximize microbial yield in large-scale batches.
- Identification of microbial strains and their metabolic by-products using advanced methods.
- Learn the functioning of stirred-tank bioreactors and cryopreservation techniques
- Perform bioassays and environmental monitoring in accordance with Good Manufacturing Practices (GMP) and industrial waste management protocols.

Course Outcomes (COs): -

At the end of this course, the students will be able to:

- **CO1:** Explain the principles of industrial sterilization systems and the architectural requirements for ISO-classified clean rooms.
- **CO2:** Differentiate between synthetic and complex culture media formulations while evaluating the role of chemical additives.
- **CO3:** Analyze microbial strains and metabolites by applying the theoretical frameworks of 16S rRNA sequencing, automated cell counting, and chromatographic techniques like HPLC and GC-MS.
- **CO4:** Describe the design and sensor-based monitoring systems of stirred-tank bioreactors and the maintenance of Master Cell Banks.
- **CO5:** Evaluate quality management protocols and environmental safety standards,

Module No.	Topics / actual contents of the syllabus	Contact Hours
1	Foundational Tools- Sterilization, Asepsis, and Culture Media. **Sterilization Technology:** • Operating principles of industrial autoclaves • Hot air ovens • Membrane filtration (HEPA) **1.2 Aseptic Techniques:** • Design of Laminar Air Flow (LAF) workstations • "Clean Room" classifications (ISO standards) **1.3 Culture Media Engineering:** • Media for Inoculum Development • Formulation of synthetic vs. complex media • Use of antifoaming agents and precursors in large-scale batches.	10
2	Analytical Techniques and Characterization **2.1 Staining & Imaging:** • Differential staining- Gram staining • Use of automated cell counters. **2.2 Molecular Tools:** Basics of • PCR (Polymerase Chain Reaction) for rapid molecular detection • 16S rRNA sequencing for strain identification **2.3 Chromatography & Spectroscopy:** Introduction to HPLC and GC-MS for • Detecting microbial metabolites • Fermentation by-products. **2.4 Preservation Techniques for maintaining industrial Master Cell Bank (MCB):** • Lyophilization (freeze-drying) • Cryopreservation for maintaining industrial Master Cell Banks (MCB).	14

3	Industrial Applications and Quality Control (QC) **3.1 Fermentation Hardware** • Anatomy of a Stirred-Tank Bioreactor • Sensors for pH, Dissolved oxygen), and temperature. **3.2 Bioassays & Toxicity Testing** Methods for testing • Antibiotic potency • Vitamins • Microbial limit tests (MLT) **3.3 Quality Management** • Introduction to Good Manufacturing Practices (GMP) • Environmental Monitoring (EM) **3.4 Waste Management:** • Tools for BOD/COD analysis • Microbial treatment of industrial effluents	**10**

Text books

1) Biotechnology: A Textbook of Industrial Microbiology, Wulf Crueger, Anneliese Crueger, and K.R. Aneja, Medtech Science Press (Indian Edition)
2) Industrial Microbiology: An Introduction, Michael J. Waites, Neil L. Morgan, et al., Wiley-India / CBS Publisher
3) A Textbook of Microbiology, R.C. Dubey & D.K. Maheshwari, S .Chand & Company
4) Industrial Microbiology, A.H. Patel, Macmillan India / Perfect Patel
5) Bioprocess Technology, P.T. Kalaichelvan & I. Arul Pandi, Arul PandiMJP Publishers
6) A Textbook of Industrial Microbiology, Wulf Crueger & Anneliese Crueger, Panima Publishing (India)

Reference Books

1) Principles of Fermentation Technology, P.F. Stanbury, A. Whitaker, and S.J. Hall, Aditya Books / Elsevier India
2) Industrial Pharmaceutical Microbiology: Standards and Controls, N. Hodges and G. Hanlon, Saujanya Books (Indian Reprint)
3) Brock Biology of Microorganisms, Madigan, Bender, et al., Pearson India
4) Cryopreservation and Freeze-Drying Protocols, John G. Day & Glyn N. Stacey, Humana Press (Springer)
5) Quality Control and Regulatory Affairs for Biopharmaceuticals, A. Singh et al., Narendra Publishing House
6) Principles of Fermentation Technology, Fermentation TechnologyP.F. Stanbury, A. Whitaker, & S.J. Hall, Elsevier / Aditya Books (India)
7) Hand Book of Environmental Biotechnology, S.C. Bhatia, Atlantic Publishers

B. Sc. III Year VI Semester (Microbiology)

SEC00123776P

MIC/VSC/P/377 Microbial Tools & Techniques in Industries (Lab Course)

Total Contact Hours : 30 Hrs **Total Credits :02** **Maximum Marks :50**

Learning Objectives: -

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

- Understand the principles and applications of sterilization, aseptic processing, and culture media engineering in industrial microbiology.
- Acquire knowledge of analytical, staining, molecular, and preservation techniques used for characterization and maintenance of industrial microorganisms.
- Familiarize themselves with modern instrumentation such as bioreactors, chromatographic systems, and spectroscopy-based analytical tools employed in industrial processes.
- Understand quality control, quality assurance, GMP requirements, and environmental monitoring practices in microbial industries.
- Develop knowledge of microbial testing, bioassays, waste management, and regulatory aspects associated with industrial microbiology.
- **Course Outcomes (COs): -**

At the end of this course, the students will be able to:

CO1: Explain the principles and applications of sterilization technologies, aseptic techniques, clean-room operations, and culture media engineering used in industrial microbiology.

CO2 : Apply staining, imaging, molecular, and preservation techniques for identification, characterization, and maintenance of industrially important microorganisms.

CO3 : Interpret the role of chromatographic and spectroscopic tools in the analysis of microbial metabolites, fermentation products, and industrial bioprocesses.

CO4 : Analyze the design and operation of industrial fermentation systems, including bioreactors and process monitoring sensors.

CO5 : Evaluate bioassays, microbial limit tests, and quality management systems for ensuring product quality and regulatory compliance in microbial industries.

CO6 :Assess environmental monitoring, waste treatment technologies, and microbial approaches for industrial effluent management and sustainability.

Module No.	Topics / actual contents of the syllabus	Contact Hours
1	i. Study of Laminar Air Flow (LAF) workstation and aseptic handling practices. ii. Environmental monitoring of laboratory air using settle plate method. iii. Preparation of synthetic and complex media for microbial cultivation.	10
2	i. Preservation of microbial cultures by glycerol stock preparation and cryopreservation techniques. ii. Demonstration of lyophilization process for microbial preservation.	10
3	i.Antibiotic potency assay using agar diffusion method. ii.Microbial Limit Test (MLT) for pharmaceutical or food samples. iii.Determination of Biological Oxygen Demand (BOD) and chemicall Oxygen Demand COD	10

Text books

1. Aneja, K.R. (2017). Experiments in Microbiology, Plant Pathology and Biotechnology (5th Ed.). New Age International Publishers.
2. Pelczar, M.J., Chan, E.C.S. & Krieg, N.R. Microbiology: Concepts and Applications. McGraw-Hill.
3. Sutton, S. (2011). Microbiology and Environmental Monitoring in Pharmaceutical Manufacturing. PDA/DHI Publishing.
4. Tim Sandle (2016). Pharmaceutical Microbiology: Essentials for Quality Assurance and Quality Control. Woodhead Publishing.
5. Atlas, R.M. (2010). Handbook of Microbiological Media (4th Ed.). CRC Press.
6. Malik, K.A. & Claus, D. (1988). Culture Collection and Preservation of Microorganisms. University of Agriculture Press.
7. Stanbury, P.F., Whitaker, A. & Hall, S.J. Principles of Fermentation Technology (3rd Ed.). Elsevier.

B. Sc. III Year VI Semester (Microbiology)
SJC00123766P
MIC/OJT/P/376 OJT: On Job Training

Total Contact Hours: 120 **Credit 04** **Marks 100 (CIA:40, SEE:60)**

Learning Objectives: *By the end of this course, students will be able to:*

- Understand the working environment of industry/research laboratories related to Microbiology.
- Apply theoretical knowledge to real-life practical situations in industry or field settings.
- Develop technical and problem-solving skills relevant to instrumentation, measurement, and analysis.
- Gain experience in handling equipment, safety practices, and professional ethics.
- Enhance communication, teamwork, and professional behavior in a workplace environment.

Course Outcomes: *After successful completion of this course students will be able to:*

- Demonstrate practical understanding of industrial/research processes related to Microbiology.
- Apply experimental and analytical skills in real-world applications.
- Prepare a training report documenting observations, work carried out, and learning outcomes.
- Exhibit professional skills, including teamwork, time management, and workplace ethics.
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Short Guidelines for On Job Training:

1. **Nature of Training:** Industry / Research Laboratory / Technical संस्था / Field-based organization
2. **Duration:** As prescribed by the university (typically 4–6 weeks or equivalent hours)
3. **Placement:** Arranged by department or student (with prior approval of the institution)
4. **Supervision:** Internal guide (faculty) + External supervisor (industry/organization)

- Assessment Components: Training Performance (by external supervisor)
- Report Submission
- Presentation & Viva Voce
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- Report Format: Organization Profile
- Objectives of Training
- Work Done / Observations
- Skills Acquired
- Conclusion
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NOTE (For On-Job Training - OJT):
For the On Job Training (OJT), the guidelines prescribed in Circular No. Acad-SU/UG/NEP-2020/Scheme of Exam./77/2024 dated 26.04.2024 shall be followed. The detailed provisions regarding Continuous Internal Assessment (CIA) and Semester End Evaluation (SEE) are specified in the said circular (Page Nos. 13 to 17).