BSc
MICROBIOLOGY

2025 - 2026

Biotechnology I Microbiology I Bioinformatics

National College (Autonomous), Trichy

Programme Structure for BSc Microbiology
(For Students admitted from 2025-26)

Sl. No.	Course Code	Part	Hrs/ Wk	Credit	Course Type	Course Title	Course Kind	Hrs of Exam		Int. (25)	Ext. (75)
								T	P		
Semester - I											
1	U25T1	I	6	3	Theory	Language		3	-	25	75
2	U25E1	II	6	3	Theory	Professional English for Life Sciences - I		3	-	25	75
3	U25MB1	III	5	5	Theory	General Microbiology	Core I	3	-	25	75
4	U25MB2P	III	3	-	Practical	Lab in Microbiology	Core II	-	3	25	75
5	U25AMB1	III	5	4	Theory	Biochemistry – I: Biomolecules	Allied I	3	-	25	75
6	U25AMB2P	III	3	-	Practical	Lab in Biochemistry	Allied II	-	3	25	75
7	U25ES	IV	2	2	Theory	Environmental Studies		3	-	25	75
			30	17							
Semester - II											
8	U25T2	I	6	3	Theory	Language		3	-	25	75
9	U25E2	II	6	3	Theory	Professional English for Life Sciences - II		3	-	25	75
*4	U25MB2P	III	3	4	Practical	Lab in Microbiology	Core II	-	3	25	75
10	U25MB3	III	5	5	Theory	Microbial Physiology	Core III	3	-	25	75
*6	U25AMB2P	III	3	4	Practical	Lab in Biochemistry	Allied II	-	3	25	75
11	U25AMB3	III	5	4	Theory	Intermediary Metabolism	Allied III	3	-	25	75
12	U25MBSBE1	IV	2	2	Theory	Agricultural and Environmental Microbiology	SBE I	3	-	25	75
			30	25							

* Carry-over Practical: Practical exam for these Lab courses are conducted in the even semester.

Semester - III											
13	U25T3	I	6	3	Theory	Language		3	-	25	75
14	U25E3	II	6	3	Theory	English		3	-	25	75
15	U25MB4	III	4	4	Theory	Molecular Biology	Core IV	3	-	25	75
*16	U25MB5P	III	3	-	Practical	Lab in Molecular Biology and Microbial Genetics	Core V	-	3	25	75
17	U25AMB4	III	4	4	Theory	Immunology	Allied IV	3	-	25	75
*18	U25AMB5P	III	3	-	Practical	Lab in Immunology and Enzymology	Allied V	-	3	25	75
19	U25MBSBE2	IV	2	2	Theory	Food and Dairy Microbiology	SBE II	3	-	25	75
20	U25MBSBE3P	IV	2	2	Practical	Lab in Agricultural, Environmental, Food and Dairy Microbiology	SBE Practical	-	3	25	75
			30	18							

Semester - IV											
21	U25T4	I	6	3	Theory	Language		3	-	25	75
22	U25E4	II	6	3	Theory	English		3	-	25	75
*16	U25MB5P	III	3	4	Practical	Lab in Molecular Biology and Microbial Genetics	Core V	-	3	25	75
23	U25MB6	III	4	4	Theory	Microbial Genetics	Core VI	3	-	25	75
*18	U25AMB5P	III	3	4	Practical	Lab in Immunology and Enzymology	Allied V	-	3	25	75
24	U25AMB6	III	4	4	Theory	Enzymology	Allied VI	3	-	25	75
25	U25MBNME1	IV	2	2	Theory	Basics in Microbiology	NME I	3	-	25	75
26	U25VE	IV	2	2	Theory	Value Education		3	-	25	75
			30	26							

* Carry-over Practical: Practical exam for these Lab courses are conducted in the even semester.

Semester - V											
27	U25MB7	III	5	5	Theory	Clinical Bacteriology	Core VII	3	-	25	75
28	U25MB8	III	5	5	Theory	Virology	Core VIII	3	-	25	75
29	U25MB9P	III	6	4	Practical	Lab in Clinical Bacteriology, Virology, Medical Mycology & Parasitology and Genetic Engineering	Core IX	-	3	25	75
30	U25MB10E	III	5	4	Theory	Medical Mycology and Parasitology	Elective I	3	-	25	75
31	U25MB11E	III	5	4	Theory	Genetic Engineering	Elective II	3	-	25	75
32	U25MBNME2	IV	2	2	Theory	Microbiology and Human Health	NME II	3	-	25	75
33	U25SS	IV	2	2	Theory	Soft Skills		3	-	25	75
			30	26							

Semester VI											
34	U25MB12	III	6	6	Theory	Industrial Microbiology	Core X	3	-	25	75
35	U25MB13	III	6	6	Theory	Bioinstrumentation	Core XI	3	-	25	75
36	U25MB14	III	6	6	Theory	Bioinformatics and Biostatistics	Core XII	-	3	25	75
37	U25MB15P	III	6	4	Practical	Lab in Industrial Microbiology, Bioinstrumentation, Bioinformatics and Biostatistics	Core XIII	3	-	25	75
38	U25MB16E	III	5	4	Theory	IPR, Biosafety and Bioethics	Elective III	3	-	25	75
39	U25GS	V	1	1	Theory	Gender Studies		3	-	25	75
40	Extension Activity	V	-	1							
			30	28							
Grand Total			**180**	**140**							

PROGRAMME OUTCOMES (PO) FOR BSC DEGREE IN MICROBIOLOGY

PO 1: Disciplinary Knowledge
Graduates will demonstrate a robust understanding of core principles and concepts in microbiology, including microbial physiology, genetics, and ecology, enabling them to apply this knowledge to real-world challenges.

PO 2: Communication Proficiency
Graduates will effectively communicate scientific information related to microbiology both orally and in writing. They will be able to engage with diverse audiences, including peers, professionals, and the public.

PO 3: Critical Thinking and Problem-Solving
Graduates will apply critical thinking skills to analyze complex microbiological problems, evaluate experimental evidence, and develop innovative solutions to address challenges in the field.

PO 4: Collaboration and Teamwork
Graduates will work collaboratively within multidisciplinary teams, demonstrating leadership qualities while respecting and valuing diverse perspectives in scientific inquiry.

PO 5: Ethical and Social Responsibility
Graduates will understand the ethical, social, and environmental implications of microbiological research and advancements. They will be equipped to address these issues responsibly in their professional practice.

PO 6: Lifelong Learning and Adaptability
Graduates will cultivate a commitment to lifelong learning, adapting to the evolving landscape of microbiology and related technologies through continuous education and professional development.

PROGRAMME SPECIFIC OUTCOMES (PSO) FOR BSC DEGREE IN MICROBIOLOGY

These specific outcomes highlight the knowledge, skills, and attributes that graduates of the BSc Microbiology program should possess upon completion:

PSO 1: Microbiological Expertise
Graduates will attain comprehensive knowledge of fundamental and advanced concepts in microbiology, including microbial taxonomy, pathogenesis, immunology, and environmental microbiology.

PSO 2: Technical Proficiency
Graduates will develop hands-on skills in essential microbiological techniques such as culturing microorganisms, performing biochemical assays, and utilizing advanced instrumentation for data analysis.

PSO 3: Research and Innovation
Graduates will foster a research-oriented mindset that enables them to design experiments, interpret results critically, and contribute innovative solutions to contemporary microbiological challenges.

PSO 4: Industrial Microbiology Applications
Graduates will understand the principles of industrial microbiology, including fermentation technology, quality control processes, and regulatory requirements relevant to the biotechnology sector.

PSO 5: Bioethics and Biosafety
Graduates will demonstrate a strong understanding of bioethics and biosafety regulations pertaining to microbiological research and applications, ensuring responsible conduct in their professional endeavors.

PSO 6: Career Readiness and Professional Development
Graduates will be prepared for diverse career paths in microbiology-related fields such as healthcare, research institutions, environmental agencies, and industry. They will possess the skills necessary to thrive in various roles within the bioeconomy.

SEM- I	Prog. Code MIBUG2018	Core Course I	U25MB1
GENERAL MICROBIOLOGY			
CREDITS - 5		Theory	HOURS - 5

Course Description for General Microbiology

This course introduces students to the foundational principles of microbiology, covering the history, scope, and classification of microorganisms. It delves into microscopy techniques, microbial structure, growth, and environmental influences on microbial activity. The course emphasizes the identification, isolation, and maintenance of microbes, equipping students with essential theoretical and practical knowledge.

Objectives

1. To provide a comprehensive understanding of the historical developments and fundamental principles of microbiology.
2. To differentiate between prokaryotic and eukaryotic microorganisms based on their structural and functional characteristics.
3. To familiarize the diversity of microorganisms, including their unique characteristics and ecological roles.
4. To equip with the knowledge of various methods for controlling microbial growth and their mechanisms of action.
5. To understand basic techniques for isolating, cultivating, and identifying microorganisms.
6. To understand and appreciate broad applications of microbiology in medicine, agriculture, industry, and environmental science.

Units	Course Content	Hours per Week (5x15)*
Unit I	Introduction to Microbiology **History of Microbiology:** Contributions of Leeuwenhoek, Pasteur, Koch, Jenner, and others. **Scope of Microbiology:** Applications in medicine, agriculture, industry, and environmental science. **Classification of Microorganisms:** o Haeckel's three-kingdom concept. o Whittaker's five-kingdom concept. o Carl Woese's three-domain system (Archaea, Bacteria, Eukarya). o Bergey's Manual of Systematic Bacteriology: Overview and significance	15

	Microscopy: o Principles, applications, and limitations of: ▪ Light microscopy (bright-field, dark-field). ▪ Phase contrast microscopy. ▪ Fluorescence microscopy. ▪ Electron microscopy (TEM and SEM).	
Unit II	Diversity of Microorganisms 3.1. **General Characteristics of Microorganisms:** o Eubacteria: Morphology, physiology, and examples. o Cyanobacteria: Photosynthesis and ecological role. o Mycoplasmas, Rickettsiae, Chlamydiae: Unique features and pathogenicity. o Spirochaetes, Actinobacteria: Morphology and significance. o Archaea: Extremophiles and their adaptations. o Protozoa, Algae, Fungi: General characteristics and ecological roles. Viruses: Structure, classification, and replication.	15
Unit III	Prokaryotic and Eukaryotic Microorganisms **Differences between Prokaryotic and Eukaryotic Cells:** Structural and functional comparisons. **Structural Organization of Bacteria (also Archaebacterial):** o Size, shape, and arrangement of bacterial cells. o Ultrastructure of a bacterial cell: ▪ Cell wall (Gram-positive vs. Gram-negative). ▪ Cell membrane, ribosomes, nucleoid, plasmids, mesosomes. ▪ Surface structures: Capsule, slime layer, flagella, fimbriae, pili. *Specialized structures: Endospores, cysts, cytoplasmic inclusions.*	15
Unit IV	Control of Microorganisms **Sterilization and Disinfection:** o Principles and methods: ▪ Physical methods: Moist heat, dry heat, filtration, pasteurization, tyndallization, radiation. ▪ Chemical methods: Alcohols, aldehydes, phenols, halogens, hypochlorites. o Mode of action of disinfectants and antibiotics. **Culture Media:** o Types of media: Simple, defined, differential, selective, enriched, enrichment, and transport media. o Examples and applications of each type.	15
Unit V	Microbial Cultivation and Identification **Isolation Techniques:** o Aerobic and anaerobic culture techniques.	15

	○ Pure culture methods: Streak plate, pour plate, and spread plate. ○ Maintenance and preservation of microbial cultures. **Staining Techniques:** ○ Simple, differential, negative, acid-fast, flagella, and spore staining. **Methods of Bacterial Identification:** ○ Morphological, physiological, biochemical, and serological properties. ○ Modern techniques: PCR, MALDI-TOF, and genomic sequencing.	

Cognitive level	Course outcome	Knowledge Level
CO1	Recall the contributions of key figures in the history of microbiology and define basic microbiological terms and concepts.	K1
CO2	Compare and contrast the structural and functional features of prokaryotic and eukaryotic cells..	K2
CO3	Analyze microorganisms into major groups based on their characteristics and ecological roles	K3
CO4	Apply appropriate sterilization and disinfection techniques to control microbial growth in various settings.	K4
CO5	Perform basic microbiological techniques, including pure culture isolation and staining procedures.	K5
CO6	Evaluate the role of microorganisms in different fields and propose solutions to real-world problems related to microbiology.	K5

Textbooks

1. Dubey, R. C. (n.d.). *A Text Book of Microbiology*. S.Chand and Co. (Accn No: 44002379)
2. Tortora, J. G. (n.d.). *Microbiology an Introduction*. Addison-Wesley Publishing Co. (Accn No: 33012974)
3. Pomerville, J. (n.d.). *Fundamentals of Microbiology* (7th ed.). Jones and Bartlett Publishers. (Accn No: 33013120)
4. Arora, D. R. (n.d.). *Textbook of Microbiology* (5th ed.). Cbs Publication & Distribution. (Accn No: 33013166)
5. Black, G. J. (n.d.). *Microbiology* (8th ed.). John Wiley & Sons. (Accn No: 33013131)

Reference Books

1. Jay, J. M. (n.d.). *Modern Food Microbiology*. CBS Publishers & Distributors. (Accn No: 00057913)
2. Russell, H. L. (n.d.). *Dairy Bacteriology*. University Publication. (Accn No: 00063765)

3. Vijaya Ramesh, K. (n.d.). *Food Microbiology*. Mjp Publication. (Accn No: 00063766)
4. Kumari, M. S. (n.d.). *Microbal Physiology*. MJP PUBLICATION. (Accn No: 00063323)
5. Aneja, K. R. (n.d.). *Experiments in Microbiology Plant Pathology Tissue Culture and Microbial Biotechnolog* (6th ed.). New Age International Publishers. (Accn No: 55014790)

Weblink to Learning Resources

1. https://home.mednotes.in/subjects/microbiology
2. https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SMB1101.pdf
3. https://instruct.uwo.ca/biology/090b/1290b%201-7.pdf

Course Articulation Matrix (CO-PO Mapping)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	3	0	0	0	0
CO2	9	9	3	0	0	0
CO3	9	9	9	3	0	1
CO4	9	9	9	9	3	1
CO5	9	9	9	9	9	3
CO6	9	9	9	9	9	9
Weightage	**54**	**48**	**39**	**30**	**21**	**14**
Weighted Percentage Contribution	**34.62%**	**30.77%**	**25%**	**19.23%**	**13.46%**	**8.97%**

CO-K Level Mapping with PO Correlations

CO / K-Level	High Correlation	Medium Correlation	Low Correlation	Zero Correlation
CO1 / K1	PO1	PO2	-	PO3, PO4, PO5, PO6
CO2 / K2	PO1, PO2	PO3	-	PO4, PO5, PO6
CO3 / K3	PO1, PO2, PO3	PO4	PO6	-
CO4 / K4	PO1, PO2, PO3, PO4	PO5	PO6	-

CO / K-Level	High Correlation	Medium Correlation	Low Correlation	Zero Correlation
CO5 / K5	PO1, PO2, PO3, PO4, PO5	-	PO6	-
CO6 / K5	PO1, PO2, PO3, PO4, PO5	-	-	PO6

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

K Levels	CIA I (4 Marks)	CIA II (10 Marks)	Assignment 1 (3 Marks)	Assignment 2 (3 Marks)	Total Scholastic Marks	Non Scho. (Attendance - 5 Marks)	Total Marks	% of Assessment
K1	1	2	0.5	0.5	4	0	4	16%
K2	1	2	0.5	0.5	4	0	4	16%
K3	1	2	0.5	0.5	4	0	4	16%
K4	0.5	2	0.5	0.5	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0	1			1	0	1	4%
Non Scholastic	--	--	--	--	--	5	5	20%
Total	4	10	3	3	20	5	25	100%

The COs and POs for the course in **General Microbiology** in **BSc Microbiology** Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge Signature of the Head, BMB

SEM- I	Prog. Code MIBUG2018	Allied Course I	U25AMB1
BIOCHEMISTRY – I: BIOMOLECULES			
CREDITS - 4		Theory	HOURS – 5

Course Description for Biochemistry

This course in Biochemistry provides an in-depth exploration of biomolecules, focusing on their structure, function, and significance in biological systems. Students will study the fundamental building blocks of life, including carbohydrates, proteins, lipids, nucleic acids, and vitamins. The course emphasizes the chemical properties and biological roles of these biomolecules, equipping students with the knowledge necessary to understand complex biochemical processes.

Course Objectives

1. To describe the structural organization and properties of atoms, molecules, and bonds.
2. To understand the classification, structure, and functions of carbohydrates.
3. To analyse the general structure of amino acids and the levels of protein organization.
4. To classify lipids and understand biological functions.
5. To describe the structure and biological importance of nucleic acids.
6. To understand vitamins, their types, functions and deficiency conditions.

Units	Course Content	Hours per Week (5x15)*
Unit I	**Introduction to Biomolecules** • **Atoms and Molecules** o Atomic structure and chemical bonding. o Importance of carbon in biomolecules. • **Types of Bonds** o Covalent, ionic, hydrogen bonds, and van der Waals forces. o Role of bonds in biomolecular structure and function. • **Properties of Water** o Polarity, hydrogen bonding, and its role as a universal solvent.	15

	○ Importance of water in microbial metabolism and survival. • **Acids, Bases, and Buffers** ○ pH scale and microbial growth preferences (acidophiles, neutrophiles, alkaliphiles). ○ Buffer systems in microbial cultures (e.g., phosphate buffer). • **Chemistry of Carbohydrates** ○ Definition and classification: Monosaccharides, disaccharides, polysaccharides. ○ Structure of glucose, fructose, sucrose, lactose (linear and ring forms). ○ Properties: Isomerism, mutarotation, oxidation, reduction. ○ Functions: Energy source (glycolysis), structural components (peptidoglycan in bacterial cell walls).	
Unit II	**Amino Acids and Proteins** • **General Structure of Amino Acids** ○ Amino group, carboxyl group, and R-group variations. ○ Amino acid codes and their significance in microbial genetics. • **Classification of Amino Acids** ○ Based on R-group nature: Polar, non-polar, acidic, basic. ○ Modified amino acids in microbial proteins (e.g., peptidoglycan cross-linking). • **Levels of Protein Structure** ○ Primary structure: Peptide bonds and amino acid sequence. ○ Secondary structure: α-helix, β-pleated sheet (e.g., bacterial flagellin). ○ Tertiary structure: 3D folding (e.g., enzymes in microbial metabolism). ○ Quaternary structure: Multimeric proteins (e.g., haemoglobin in microbial symbionts). • **Ramachandran Plot** ○ Phi and psi angles and their role in protein folding. • **Biological Functions of Proteins** ○ Enzymes in microbial metabolism (e.g., catalase, amylase). ○ Structural proteins (e.g., bacterial flagella, pili).	15

Unit III	**Lipids** • **Chemical Nature and Classification** o Simple lipids (e.g., triglycerides). o Compound lipids (e.g., phospholipids in microbial membranes). o Derived lipids (e.g., sterols in fungi). • **Biological Functions of Lipids** o Energy storage (e.g., polyhydroxyalkanoates in bacteria). o Membrane structure (e.g., phospholipid bilayer in bacteria and archaea). • **Fatty Acids** o Structure and properties: Saturated vs. unsaturated fatty acids. o Role in microbial membrane fluidity and adaptation to temperature. • **Characterization of Fats** o Iodine value, saponification value, acid number. o Applications in microbial lipid analysis.	15
Unit IV	**Nucleic Acids** • **Structure of Nucleic Acids** o Purine and pyrimidine bases: Adenine, guanine, cytosine, thymine, uracil. o Nucleosides and nucleotides: Building blocks of DNA and RNA. • **Types of DNA** o A-DNA, B-DNA, Z-DNA: Structure and biological significance. o Superhelicity of DNA in bacterial plasmids. • **Properties of DNA** o Hypochromic and hyperchromic effects. o Melting temperature (Tm) and its significance in PCR. o Denaturation and renaturation: Applications in microbial genomics. • **Cot Curve and Viscosity** o Applications in microbial genome complexity analysis. •	15
Unit V	**Vitamins** • **Definition and Classification** o Water-soluble vitamins (B1, B2, B3, B6, B12). o Fat-soluble vitamins (A, D, E, K).	15

	• **Occurrence and Biochemical Roles**
	  ○ Role of B vitamins in microbial metabolism (e.g., coenzymes in glycolysis, TCA cycle).
	  ○ Microbial production of vitamins (e.g., vitamin B12 by *Propionibacterium*).
	• **Deficiency Diseases**
	  ○ Connection between microbial gut flora and vitamin synthesis (e.g., vitamin K).	

CO Level	Course outcome	K Level
CO1	Define the structure and properties of atoms, molecules, and the types of bonds that form biomolecules.	K1
CO2	Describe the classification, structure, and functions of carbohydrates, including their occurrence and various forms.	K2
CO3	Discuss the general structure of amino acids and analyze the levels of protein organization, including their biological functions.	K3
CO4	Interpret the classification and biological functions of lipids, including fatty acids and triglycerides and correlate it with health and disease.	K4
CO5	Evaluate the structure and biological importance of nucleic acids and their properties by analytical methods.	K5
CO6	Synthesize knowledge of vitamins, analyzing their biochemical roles and evaluating their impact on health and deficiency diseases.	K6

Textbooks

1 Dulsy Fathima. (n.d.). *Biochemistry* (7th ed.). Saras Publication. (Accn. No: 00064191)
2 Veerakumari, L. (n.d.). *Biochemistry*. Mjp Publication. (Accn. No: 00063764)
3 Lehninger. (n.d.). *Biochemistry*. Kalyani Publishers. (Accn. No: 33013012)
4 Mani Sharma. (n.d.). *Biochemistry A Short Course* (1st ed.). International Book Distributing Co. (Accn. No: 33013168)
5 Berg, J. M. (n.d.). *Biochemistry* (10th ed.). Macmillan Publish. (Accn. No: 33013190)

Reference Books

1 Weil, J. H. (n.d.). *General Biochemistry*. New Age International (p) Limited. (Accn. No: 1010)
2 Buchanan, B. B. (n.d.). *Biochemistry & Molecular Biology of Plants* (2nd ed.). Wiley Black Well. (Accn. No: 33013103)
3 Mathews, H. R. (n.d.). *Biochemistry A Short Course*. (Accn. No: 33013163)

4 Singh S. P. (n.d.). *Viva Voce in Biochemistry*. CBS Publishers & Distributors. (Accn. No: 55015155)
5 Boyer, R. F. (n.d.). *MODERN EXPERIMENTAL BIOCHEMISTRY* (3rd ed.). Pearson. (Accn. No: 33012996)

Weblink to Learning Resources

1 Lecturio Video Theorys https://app.lecturio.com/#/course/s/8060/5990
2. Biochemistry open source e-book https://open.umn.edu/opentextbooks/textbooks/866
3. https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SBC1101.pdf

Course Articulation Matrix (CO-PO Mapping)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	3	0	0	0	0
CO2	9	9	3	0	0	0
CO3	9	9	9	3	0	1
CO4	9	9	9	3	3	1
CO5	9	9	9	9	9	3
CO6	9	9	9	9	9	9
Weightage	**54**	**48**	**39**	**24**	**21**	**14**
Weighted Percentage Contribution	**35.7%**	**31.6%**	**25.7%**	**15.8%**	**13.8%**	**9.2%**

CO-K Level Mapping with PO Correlations

CO / K-Level	High Correlation	Medium Correlation	Low Correlation	Zero Correlation
CO1 / K1	PO1	PO2	-	PO3, PO4, PO5, PO6
CO2 / K2	PO1, PO2	PO3	-	PO4, PO5, PO6
CO3 / K3	PO1, PO2, PO3	PO4	PO6	-
CO4 / K4	PO1, PO2, PO3	PO4, PO5	PO6	-
CO5 / K5	PO1, PO2, PO3, PO4, PO5	PO6	-	-

CO / K-Level	High Correlation	Medium Correlation	Low Correlation	Zero Correlation
CO6 / K6	PO1, PO2, PO3, PO4, PO5, PO6	-	-	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (4 Marks)	CIA II (10 Marks)	Assignment 1 (3 Marks)	Assignment 2 (3 Marks)	Total Scholastic Marks	Non Scho. (Attendance - 5 Marks)	Total Marks	% of Assessment
K1	1	2	0.5	0.5	4	0	4	16%
K2	1	2	0.5	0.5	4	0	4	16%
K3	1	2	0.5	0.5	4	0	4	16%
K4	0.5	2	0.5	0.5	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0	1			1	0	1	4%
Non Scholastic	--	--	--	--	--	5	5	20%
Total	4	10	3	3	20	5	25	100%

The COs and POs for the course in **Biochemistry-I: Biomolecules** in **BSc Microbiology** Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge Signature of the Head, BMB

****** End of Semester I ******

SEM- II	Prog. Code MIBUG2018	Core Course III	U25MB3
MICROBIAL PHYSIOLOGY			
CREDITS – 5		Theory	HOURS – 5

Course Description for Microbial Physiology

This course gives basic understanding on the microbial growth and the nutritional requirements associated with it. Also it imparts strong knowledge on positive and negative effects of microbial interactions. It explains the interaction and association of microbes within plants and animals and their beneficial effects. In addition, this course helps to understand fundamental physiological processes that underlie microbial life.

Course Objectives:

1. To understand microbial nutrient requirements and classification.
2. To learn different phases of microbial growth and factors affecting the growth.
3. To know the microbial inter-cellular communication and significances associated with it.
4. To acquire knowledge on bacteriophages and their ecological importance.
5. To apply the concepts of microbial metabolism for environmental sustainability
6. To demonstrate the understanding of metabolic processes through practical experiments

Units	Course Content	Hours per Week (4x15)*
Unit I	**Unit I: Microbial Growth and Stress Physiology** • **Microbial Growth Dynamics** o Phases of microbial growth curve: Lag, log, stationary, and death phases o Measurement of microbial growth: Direct (cell counting, turbidity) and indirect methods (biomass, metabolic activity) o Calculations of growth rate and generation time • **Growth Patterns and Environmental Adaptations** o Synchronous, diauxic, batch, and continuous growth in microbes o Factors influencing bacterial growth: Temperature, pH, oxygen (aerobes, anaerobes, facultative anaerobes), carbon dioxide, humidity, and nutrient availability	15

	○ Starvation stress: Role of starvation-induced proteins (e.g., Dps, RpoS) in survival • **Growth of Key Microbial Groups** ○ Growth characteristics of Gram-positive bacteria: Streptococci and Bacilli ○ Growth characteristics of Gram-negative bacteria: Rods (e.g., *E. coli*, *Pseudomonas*)	
Unit II	**Unit II: Microbial Nutrition and Transport Mechanisms** • **Microbial Nutrition** ○ Major and minor nutrients: Carbon, nitrogen, phosphorus, sulfur, and trace elements ○ Growth factors: Vitamins, amino acids, and purines/pyrimidines ○ Nutritional classification of microbes: Autotrophs, heterotrophs, phototrophs, chemotrophs, copiotrophs, oligotrophs, and lithotrophs • **Membrane Transport Systems** ○ Passive transport: Simple diffusion and facilitated diffusion ○ Active transport: Primary (e.g., proton pumps) and secondary active transport (e.g., symport, antiport) ○ Group translocation: Phosphotransferase system (PTS) in sugar uptake ○ ABC transporters: Role in nutrient uptake and efflux of toxins	15
Unit III	**Microbial Communication and Quorum Sensing** • **Microbial Interactions** ○ Microbe-plant interactions: Rhizobium-legume symbiosis, mycorrhizal fungi, and phyllosphere microbes ○ Microbe-animal interactions: Termite gut microbiota, nematode-trapping fungi, and gut microbiome • **Quorum Sensing and Biofilm Formation** ○ Cell population-dependent communication: Biofilm formation and bioluminescence ○ Quorum sensing mechanisms: ▪ AHL-based QS in Gram-negative bacteria ▪ AIP-based QS in Gram-positive bacteria ▪ AI-2-based QS in both Gram-positive and Gram-negative bacteria ○ Quorum sensing inhibitors: AHL lactonases, molecularly imprinted polymers, and boronic acid derivatives as anti-biofilm agents ○ Applications of quorum sensing in biotechnology and medicine	15

Unit IV	**Ecologically Important Microbes and Sustainable Energy Production**
	• **Photosynthetic Microbes**
	  ○ Oxygenic photosynthesis: Cyanobacteria and algae
	  ○ Anoxygenic photosynthesis: Purple and green sulfur bacteria
	  ○ Autotrophic CO2 fixation: Calvin cycle and alternative pathways
	• **Ecologically Significant Microbes**
	  ○ Hydrogen bacteria, sulfur bacteria, and iron bacteria: Roles in biogeochemical cycles
	  ○ Methanogens and methanotrophs: Methane production and oxidation
	  ○ Nitrifying bacteria: Ammonia oxidation and nitrite oxidation
	  ○ Phosphate and oxidative stress responses: Phosphate starvation stimulon and oxidative stress regulators
	• **Sustainable Energy Production**
	  ○ Microbial production of biogas, biohydrogen, and bioelectricity
	  ○ Biofuel production from cyanobacteria, algae, and fungi
		15

Unit V	**Bacteriophage Genetics and Applications**
	• **Introduction to Bacteriophages**
	  ○ General characteristics and ecological significance of bacteriophages
	  ○ Classification of bacteriophages by the International Committee on Taxonomy of Viruses (ICTV)
	• **Bacteriophage Life Cycles**
	  ○ Lytic cycle: T4 phage structure, replication, and gene expression
	  ○ Lysogenic cycle: Lambda phage integration, excision, and regulation of lysis-lysogeny decision
	  ○ Lambda phage as a cloning vector in genetic engineering
	• **Applications of Bacteriophages**
	  ○ Phage therapy: Use of phages to combat bacterial infections
	  ○ Phages as research tools: Molecular biology and genomics
		15

Course Outcomes:

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

Cognitive level	Course outcome	Knowledge Level
CO1	To know the factors affecting microbial growth and growth stages.	K1
CO2	List out different terminologies associated with nutritional requirements of microorganisms	K2
CO3	Explain microbial cell-cell communication processes	K2
CO4	Acquire knowledge on different fermentation processes	K2
CO5	Apply microbial metabolism for sustainability	K3
CO6	Demonstrate understanding of metabolic processes through practical experiments such as glucose tolerance tests and enzyme action demonstrations.	K6

Textbooks

1. Kumari, M. S. (n.d.). Microbal Physiology. MJP PUBLICATION. (Accn No: 00063323)
2. Black, G. J. (n.d.). Microbiology (8th ed.). John Wiley & Sons. (Accn No: 33013131)
3. Tortora, J. G. (n.d.). Microbiology an Introduction. Addison-Wesley Publishing Co. (Accn No: 33012974)
4. Willey, J. (n.d.). Prescott's Microbiology (11th ed.). McGraw-Hill. (Accn No: 33013108)
5. Pomerville, J. (n.d.). Fundamentals of Microbiology (7th ed.). Jones and Bartlett Publishers. (Accn No: 33013120)

Reference Books

1. Jay, J. M. (n.d.). Modern Food Microbiology. CBS Publishers & Distributors. (Accn No: 00057913)
2. Russell, H. L. (n.d.). Dairy Bacteriology. University Publication. (Accn No: 00063765)
3. Vijaya Ramesh, K. (n.d.). Food Microbiology. Mjp Publication. (Accn No: 00063766)
4. Aneja, K. R. (n.d.). Experiments in Microbiology Plant Pathology Tissue Culture and Microbial Biotechnolog (6th ed.). New Age International Publishers. (Accn No: 55014790)
5. El-Mansi, E. M. T. (n.d.). Fermentation Microbiology and Biotechnology. CRC Press. (Accn No: 33013099)

Course Articulation Matrix (CO-PO Mapping)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	3	0	0	0	0
CO2	9	9	3	0	0	0
CO3	9	9	3	0	0	0
CO4	9	9	3	0	0	0
CO5	9	9	9	3	0	1
CO6	9	9	9	9	9	9
Weightage	**54**	**48**	**27**	**12**	**9**	**10**
Weighted Percentage Contribution	**39.7%**	**35.3%**	**19.9%**	**8.8%**	**6.6%**	**7.4%**

CO-K Level Mapping with PO Correlations

CO / K-Level	High Correlation	Medium Correlation	Low Correlation	Zero Correlation
CO1 / K1	PO1	PO2	-	PO3, PO4, PO5, PO6
CO2 / K2	PO1, PO2	PO3	-	PO4, PO5, PO6
CO3 / K2	PO1, PO2	PO3	-	PO4, PO5, PO6
CO4 / K2	PO1, PO2	PO3	-	PO4, PO5, PO6
CO5 / K3	PO1, PO2, PO3	PO4	PO6	-
CO6 / K6	PO1, PO2, PO3, PO4, PO5, PO6	-	-	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (4 Marks)	CIA II (10 Marks)	Assignment 1 (3 Marks)	Assignment 2 (3 Marks)	Total Scholastic Marks	Non Scho. (Attendance - 5 Marks)	Total Marks	% of Assessment
K1	1	2	0.5	0.5	4	0	4	16%
K2	1	2	0.5	0.5	4	0	4	16%
K3	1	2	0.5	0.5	4	0	4	16%
K4	0.5	2	0.5	0.5	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0	1			1	0	1	4%
Non Scholastic	--	--	--	--	--	5	5	20%
Total	4	10	3	3	20	5	25	100%

The COs and POs for the course in **Microbial Physiology** in **BSc Microbiology** Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEM- II	Prog. Code MIBUG2018	Core Course	U25MB2P
LAB IN MICROBIOLOGY			
CREDITS - 4		Practical	HOURS – 3+3

Course Description for lab in Microbiology

This course gives practical understanding on the microbial growth and the nutritional requirements associated with it. Also it imparts strong knowledge on positive and negative effects of microbial interactions. It explains the interaction and association of microbes within plants and animals and their beneficial effects. In addition, this course helps to understand fundamental physiological processes that underlie microbial life.

Objectives:

1. To perform subculturing accurately and explain the importance of aseptic techniques in microbiology.
2. To conduct catalase, oxidase, IMViC, TSI, and carbohydrate fermentation tests and use the results to differentiate bacterial species.
3. To measure optical density, plot growth curves, and explain the phases of bacterial growth.
4. To perform antibiotic sensitivity tests, measure zones of inhibition, and interpret results to assess antibiotic resistance.
5. To perform serial dilutions, count colonies, and calculate colony-forming units (CFUs) to quantify bacterial populations.
6. To demonstrate how varying environmental conditions influence bacterial growth and explain microbial adaptation strategies.

List of Laboratory Experiments

1. Growth of Bacteria on Liquid and Solid Media - Observe and record colony morphology, pigmentation, and growth characteristics.
2. Microbiology staining techniques – simple, Grams, Negative, Capsule, Acid-Fast
3. Subculture Techniques- for maintaining pure cultures and preventing contamination - in identifying bacteria based on their biochemical properties, a key skill in microbiology.
4. Biochemical Tests for Bacterial Identification
    - Catalase Test: Differentiate catalase-positive (e.g., *Staphylococcus*) and catalase-negative (e.g., *Streptococcus*) bacteria.
    - Oxidase Test: Identify oxidase-positive bacteria (e.g., *Pseudomonas*).
    - IMViC Test: Differentiate E. coli and Enterobacter based on indole, methyl red, Voges-Proskauer, and citrate utilization.
    - TSI Test: Determine sugar fermentation and hydrogen sulfide production.

- Gelatin Liquefaction: Assess proteolytic activity.
- Starch Hydrolysis: Detect amylase production.

5. Carbohydrate Fermentation: Test for acid and gas production using glucose, lactose, and sucrose.
6. Bacterial Growth Curve Using Turbidometry - To study the growth phases of bacteria (lag, log, stationary, and death phases) -to understand microbial growth dynamics and the factors influencing it.
7. Antibiotic Sensitivity Test (Kirby-Bauer Method) -to learn antibiotic resistance and its clinical significance.
8. Enumeration of Viable Bacteria Using Serial Dilution and Spread Plate Technique - to learn quantitative microbiology and the importance of viable cell counts (CFUs).
9. Demonstration of Bacterial Motility – to understand bacterial behavior and structural features like flagella.
10. Effect of Environmental Factors on Bacterial Growth-To study the impact of temperature, pH, and osmotic pressure on bacterial growth – Demonstrate, how environmental conditions influence microbial physiology.
11. Demonstration of Biofilm Formation-To observe biofilm formation by bacteria. – to highlight the importance of biofilms in microbial survival and antibiotic resistance.
12. Isolation of Bacteria from Environmental Samples (water, air, soil - identify colonies based on morphology and biochemical tests - to real-world applications of microbiology, such as environmental monitoring.

Course Outcomes:

At the completion of the course, the student would be able to:

CO Level	COURSE OUTCOMES	COGNITIVE LEVEL
CO1	Perform subculturing accurately and explain the importance of aseptic techniques in microbiology.	K3
CO2	Conduct catalase, oxidase, IMViC, TSI, and carbohydrate fermentation tests and use the results to differentiate bacterial species.	K4
CO3	Measure optical density, plot growth curves, and explain the phases of bacterial growth.	K4
CO4	Perform antibiotic sensitivity tests, measure zones of inhibition, and interpret results to assess antibiotic resistance.	K5
CO5	Perform serial dilutions, count colonies, and calculate colony-forming units (CFUs) to quantify bacterial populations.	K3
CO6	Demonstrate how varying environmental conditions influence bacterial growth and explain microbial adaptation strategies.	K5

Textbooks

1. Dubey, R. C. (n.d.). *A Text Book of Microbiology*. S.Chand and Co. (Accn No: 44002379)
2. Aneja, K. R. (n.d.). *Experiments in Microbiology Plant Pathology Tissue Culture and Microbial Biotechnolog* (6th ed.). New Age International Publishers. (Accn No: 55014790)
3. Arora, D. R. (n.d.). *Textbook of Microbiology* (5th ed.). Cbs Publication & Distribution. (Accn No: 33013166)
4. Black, G. J. (n.d.). *Microbiology* (8th ed.). John Wiley & sons. (Accn No: 33013131)
5. Prasad, M. M. (n.d.). *Laboratory Manual of Microbiology* New India Publishing Agency (Accn No: 00063771)

Reference Books

1. Jay, J. M. (n.d.). *Modern Food Microbiology*. CBS Publishers & Distributors. (Accn No: 00057913)
2. Vijaya Ramesh, K. (n.d.). *Food Microbiology*. Mjp Publication. (Accn No: 00063766)
3. Tortora, J. G. (n.d.). *Microbiology an Intrduction* (11th ed.). Addison-Wesley Publishing Co (Accn No: 33012974)
4. Kumari, M. S. (n.d.). *Microbal Physiology*. MJP PUBLICATION. (Accn No: 00063323)
5. Garg, F. C. (n.d.). *Experimental Microbilogy*. Cbs Publication & Distribution (Accn No: 55014647)

Course Articulation Matrix (CO-PO Mapping)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	9	3	3	3	1
CO2	9	9	9	3	3	1
CO3	9	9	9	3	3	1
CO4	9	9	9	9	3	1
CO5	9	9	9	9	9	1
CO6	9	9	9	9	9	3
Weightage	**54**	**54**	**48**	**36**	**30**	**8**
Weighted Percentage Contribution	**31.58%**	**31.58%**	**28.07%**	**21.05%**	**17.54%**	**4.68%**

CO-K Level Mapping with PO Correlations

CO / K-Level	High Correlation	Medium Correlation	Low Correlation	Zero Correlation
CO1 / K3	PO1, PO2	PO3, PO4, PO5	PO6	-
CO2 / K4	PO1, PO2, PO3	PO4, PO5	PO6	-
CO3 / K4	PO1, PO2, PO3	PO4, PO5	PO6	-
CO4 / K5	PO1, PO2, PO3, PO4	PO5	PO6	-
CO5 / K3	PO1, PO2, PO3, PO4	PO5	PO6	-
CO6 / K5	PO1, PO2, PO3, PO4, PO5	-	PO6	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (4 Marks)	CIA II (10 Marks)	Assignment 1 (3 Marks)	Assignment 2 (3 Marks)	Total Scholastic Marks	Non Scho. (Attendance - 5 Marks)	Total Marks	% of Assessment
K1	1	2	0.5	0.5	4	0	4	16%
K2	1	2	0.5	0.5	4	0	4	16%
K3	1	2	0.5	0.5	4	0	4	16%
K4	0.5	2	0.5	0.5	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0	1			1	0	1	4%
Non Scholastic	--	--	--	--	--	5	5	20%
Total	4	10	3	3	20	5	25	100%

The COs and POs for the Lab course in **Microbiology** in **BSc Microbiology** Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEM- II	Prog. Code MIBUG2018	Allied Course III	U25AMB3
Biochemistry II: Intermediary Metabolism			
CREDITS - 4		Theory	HOURS - 5

Course Description for Biochemistry II: Intermediary Metabolism

This Biochemistry course provides an in-depth exploration of the biochemical processes that underpin life. Students will study the thermodynamics of biological systems, metabolic pathways of carbohydrates, and the anabolic and catabolic mechanisms related to proteins. The course also covers the biological significance of nucleic acids, co-factors, and co-enzymes.

Objectives:

- To understand the thermodynamics of biological systems.
- To interpret the metabolic pathways of carbohydrates and their significance in energy production.
- To differentiate anabolic and catabolic pathways and to interpret the relative outcome.
- To understand and analyse the regulation of metabolic pathways.
- To differentiate the biological significance of nucleic acids, co-factors and co-enzymes.
- To evaluate the implications of biochemical processes in health and disease.

Units	Course Content	Hours per Week (4x15)*
Unit I	**Bioenergetics and Central Carbon Metabolism in Microbes** • **Introduction to Microbial Energy Metabolism** o Molecular basis of energy conservation in microbes o Role of ATP as the universal energy currency o Thermodynamics of microbial metabolism: Free energy, enthalpy, and entropy • **Carbohydrate Metabolism in Microbes** o Glycolysis: Embden-Meyerhof-Parnas (EMP) pathway and its regulation o Alternative glycolytic pathways in microbes: Entner-Doudoroff (ED) pathway and phosphoketolase pathway o Citric Acid Cycle (TCA cycle): Role in energy production and biosynthesis	15

	○ Pentose Phosphate Pathway (PPP): Role in NADPH production and nucleotide biosynthesis ○ Glyoxylate shunt: Importance in microbes utilizing acetate or fatty acids as carbon sources ○ Fermentation pathways: Lactic acid, ethanol, and mixed-acid fermentation in microbes • **Regulation of Central Carbon Metabolism** ○ Allosteric regulation and feedback inhibition in microbial pathways ○ Role of oxygen and redox balance in metabolic regulation ○ Anaplerotic reactions: Replenishing TCA cycle intermediates	
Unit II	**Amino Acid Metabolism and Nitrogen Assimilation in Microbes** • **Amino Acid Metabolism** ○ Transamination, deamination, and decarboxylation reactions in microbes ○ Biosynthesis of amino acids: Pathways and precursors ○ Catabolism of amino acids: Role in energy production and nitrogen recycling • **Nitrogen Metabolism** ○ Nitrogen fixation: Role of nitrogenase in diazotrophic bacteria ○ Ammonia assimilation: Glutamate dehydrogenase and glutamine synthetase pathways ○ Urea cycle: Occurrence and significance in microbial systems • **Photosynthesis in Microbes** ○ Light-dependent reactions: Photosystems in cyanobacteria and photosynthetic bacteria ○ Calvin cycle: Carbon fixation in photosynthetic microbes ○ Anoxygenic photosynthesis: Unique pathways in purple and green sulfur bacteria	15
Unit III	**Lipid Metabolism in Microbes** • **Introduction to Microbial Lipids** ○ Structure and function of lipids in microbial membranes ○ Hydrolysis of triacylglycerols: Role of lipases in microbial lipid degradation • **Fatty Acid Metabolism**	15

	○ Beta-oxidation of fatty acids: Energy production in aerobic and anaerobic microbes ○ Fatty acid biosynthesis: Role of acetyl-CoA carboxylase and fatty acid synthase ○ Regulation of lipid metabolism in response to environmental conditions • **Specialized Lipid Pathways** ○ Biosynthesis of polyhydroxyalkanoates (PHAs): Storage lipids in bacteria ○ Biosynthesis of hopanoids: Sterol-like molecules in bacteria	
Unit IV	**Nucleotide Metabolism and Nucleic Acid Biosynthesis in Microbes** • **Nucleotide Biosynthesis** ○ De novo synthesis of purines and pyrimidines in microbes ○ Salvage pathways: Recycling of nucleotides in microbial cells • **Regulation of Nucleotide Metabolism** ○ Feedback inhibition in nucleotide biosynthesis ○ Role of nucleotides in microbial growth and replication • **Inhibitors of Nucleic Acid Biosynthesis** ○ Antimicrobial agents targeting nucleotide metabolism: Examples and mechanisms • **Porphyrin Metabolism** ○ Biosynthesis of heme and cytochromes in microbes ○ Role of porphyrins in electron transport and oxygen metabolism	15
Unit V	**Coenzymes, Cofactors, and Enzymatic Reactions in Microbial Metabolism** • **Role of Coenzymes in Microbial Metabolism** ○ NAD+/NADP+: Role in redox reactions and energy transfer ○ FAD/FMN: Role in electron transport and oxidative phosphorylation ○ Lipoic acid: Role in decarboxylation reactions • **Vitamins as Coenzymes** ○ Thiamine pyrophosphate (TPP): Role in decarboxylation and transketolase reactions ○ Tetrahydrofolate: Role in one-carbon metabolism ○ Biotin: Role in carboxylation reactions	15

	○ Pyridoxal phosphate (PLP): Role in amino acid metabolism ○ Vitamin B12: Role in methyl group transfer and isomerization reactions • **Role of Metal Ions in Enzymatic Reactions** ○ Iron, magnesium, zinc, and copper: Roles in microbial enzymes ○ Metalloenzymes in microbial metabolism: Examples and significance	

Course Outcomes:

At the completion of the course, the student would be able to:

CO Level	COURSE OUTCOMES	COGNITIVE LEVEL
CO1	Interpret the thermodynamic principles in any biological system.	K2
CO2	Interpret the functions of carbohydrates relative to their structure and metabolic pathways.	K3
CO3	Describe the various mechanisms involved in the synthesis and degradation of amino acids.	K2
CO4	Utilize the structure of nucleic acids for the understanding of central dogma of life.	K3
CO5	Explain the mechanism of co-factors and co-enzymes in biological processes.	K3
CO6	Analyze regulatory mechanisms that control metabolic pathways in response to physiological changes.	K4

Textbooks

1. Veerakumari, L. (n.d.). *Biochemistry*. Mjp Publication. (Accn No: 00063764)
2. Dulsy Fathima. (n.d.). *Biochemistry* (7th ed.). Saras Publication. (Accn No: 00064191)
3. Berg, J. M. (n.d.). *Biochemistry* (10th ed.). Macmillan Publish. (Accn No: 33013190)
4. Lehninger. (n.d.). *Biochemistry*. Kalyani Publishers. (Accn No: 33013012)
5. Mani Sharma. (n.d.). *Biochemistry A Short Course* (1st ed.). International Book Distributing Co. (Accn No: 33013168)

Reference Books

1. Weil, J. H. (n.d.). *General Biochemistry*. New Age International (p) Limited. (Accn No: 1010)
2. Buchanan, B. B. (n.d.). *Biochemistry & Molecular Biology of Plants* (2nd ed.). Wiley Black Well. (Accn No: 33013103)

3. Boyer, R. F. (n.d.). *MODERN EXPERIMENTAL BIOCHEMISTRY* (3rd ed.). Pearson. (Accn No: 33012996)
4. Mathews Harry R. (n.d.). *Biochemistry A Short Course*. (Accn No: 33013163)
5. Singh, S. P. (n.d.). *Viva Voce in Biochemistry*. CBS Publishers & Distributors. (Accn No: 55015155)

Weblink to Learning Resources

1. https://bio.libretexts.org/Bookshelves/Biochemistry
2. https://open.umn.edu/opentextbooks/textbooks/866
3. https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SBB1202.pdf

Course Articulation Matrix (CO-PO Mapping)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	9	3	0	0	0
CO2	9	9	9	3	0	0
CO3	9	9	3	0	0	1
CO4	9	9	9	3	3	1
CO5	9	9	9	3	3	1
CO6	9	9	9	9	9	3
Weightage	**54**	**54**	**42**	**18**	**15**	**6**
Weighted Percentage Contribution	**38.3%**	**38.3%**	**29.8%**	**12.8%**	**10.6%**	**4.3%**

CO-K Level Mapping with PO Correlations

CO / K-Level	High Correlation	Medium Correlation	Low Correlation	Zero Correlation
CO1 / K2	PO1, PO2	PO3	-	PO4, PO5, PO6
CO2 / K3	PO1, PO2, PO3	PO4	-	PO5, PO6

CO / K-Level	High Correlation	Medium Correlation	Low Correlation	Zero Correlation
CO3 / K2	PO1, PO2	PO3	PO6	PO4, PO5
CO4 / K3	PO1, PO2, PO3	PO4, PO5	PO6	-
CO5 / K3	PO1, PO2, PO3	PO4, PO5	PO6	-
CO6 / K4	PO1, PO2, PO3, PO4, PO5	-	PO6	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (4 Marks)	CIA II (10 Marks)	Assignment 1 (3 Marks)	Assignment 2 (3 Marks)	Total Scholastic Marks	Non Scho. (Attendance - 5 Marks)	Total Marks	% of Assessment
K1	1	2	0.5	0.5	4	0	4	16%
K2	1	2	0.5	0.5	4	0	4	16%
K3	1	2	0.5	0.5	4	0	4	16%
K4	0.5	2	0.5	0.5	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0	1			1	0	1	4%
Non Scholastic	--	--	--	--	--	5	5	20%
Total	4	10	3	3	20	5	25	100%

The COs and POs for the course in Biochemistry-II: Intermediary Metabolism in BSc Microbiology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEM-II	Prog. Code MIBUG2018	Allied Course	U25AMB2P
Allied Course II: LAB IN BIOCHEMISTRY			
CREDITS – 4		Practical	HOURS – 3+3

Course Description for the Lab in Biochemistry

The Biochemistry Lab course provides hands-on experience in essential techniques and experiments that are fundamental to the study of biochemistry. Students will engage in a variety of experiments designed to enhance their understanding of biochemical principles, including basic calculations, buffer preparation, protein extraction, and chromatography techniques. The course emphasizes the application of theoretical knowledge in practical settings, enabling students to develop critical laboratory skills and analytical thinking.

Course Objectives

- To perform basic calculations in biochemistry, including normality, molarity, and percent solutions.
- To calibrate a pH meter and prepare biological buffers.
- To operate spectrophotometers and colorimeters for biochemical analysis.
- To extract and estimate proteins from biological materials using various methods.
- To separate and analyze biomolecules using chromatography techniques.
- To demonstrate key biochemical processes such as photosynthesis and enzyme action.

Basic Calculations in Biochemistry

1. Normality, Molarity, Molality, percent solutions (v/v, w/v):
2. Calibration of pH meter and pH measurements:
3. Preparation of biological buffers – phosphate, Acetate, citrate buffer:
4. Working of a Spectrophotometer and Colorimeter:
5. Verification of Beer's law: Understanding Beer's Law is essential for accurate spectrophotometric measurements.

Macromolecule Extraction and Analysis

6. Extraction and estimation of Proteins from biological materials (Biuret/Lowry/Spectrophotometric): Microbes produce a wide array of proteins (enzymes, structural proteins). Understanding how to extract and quantify protein is crucial in studying microbial physiology and biochemistry.
7. Purity check of DNA & RNA by UV Spectrophotometry - A260/280: Assessing the purity of nucleic acids.
8. Isolation and estimation of reducing sugars, total sugar from natural sources: Microbes utilize carbohydrates as a primary energy source.

Separation Techniques

9. 9. SDS PAGE – Group Experiment: SDS-PAGE is a fundamental technique to separate proteins based on their molecular weight. Use this to analyze protein profiles of different microorganisms or to check the purity of an enzyme preparation.
10. Separation of amino acids by Paper Chromatography:
11. Separation of sugars by Paper Chromatography:
12. Separation of plant pigments by paper chromatography:
13. Separation of sugars by Thin layer chromatography:

Enzymes and Metabolic Processes

14. Demonstration of enzyme action: Enzymes are essential for all biochemical reactions in microbes. This practical can involve studying the activity of a specific enzyme (e.g., amylase, catalase/protease) and how factors like pH and temperature affect its activity. studying their action helps students understand microbial physiology and industrial applications.
15. Demonstration of Photosynthesis: Relevant (for microbiology students) if studying cyanobacteria or other photosynthetic microorganisms.

Demonstration of Microbial Fermentation

16. Measurement of fermentation products like ethanol, lactic acid, or CO2.

Course Outcomes:

At the completion of the course, the student would be able to:

Cognitive level	Course outcome	Knowledge Level
CO1	To perform basic calculations in biochemistry, including normality, molarity, and percent solutions.	K1
CO2	To calibrate a pH meter and prepare biological buffers.	K2
CO3	Utilize spectrophotometric techniques to analyze biochemical substances and verify Beer's law.	K3
CO4	Extract and estimate proteins from biological samples using established methods like Biuret or Lowry assays.	K4
CO5	Separate biomolecules using chromatography techniques (paper and thin-layer chromatography) and analyze the results.	K5
CO6	Demonstrate understanding of metabolic processes through practical experiments such as glucose tolerance tests and enzyme action demonstrations.	K6

Textbooks

1. Veerakumari, L. (n.d.). *Biochemistry*. Mjp Publication. (Accn No: 00063764)
2. Dulsy Fathima. (n.d.). *Biochemistry* (7th ed.). Saras Publication. (Accn No: 00064191)

3. Mani Sharma. (n.d.). *Biochemistry A Short Course* (1st ed.). International Book Distributing Co. (Accn No: 33013168)
4. Boyer, R. F. (n.d.). *MODERN EXPERIMENTAL BIOCHEMISTRY* (3rd ed.). Pearson. (Accn No: 33012996)
5. Singh S. P. (n.d.). *Viva Voce in Biochemistry*. CBS Publishers & Distributors. (Accn No: 55015155)

Reference Books

1. Weil, J. H. (n.d.). *General Biochemistry*. New Age International (p) Limited. (Accn No: 1010)
2. Bajpai P K. (n.d.). *Biological Intrumentation and Methodology*. S.Chand and Co. (Accn No: 00061096)
3. Buchanan B Bob. (n.d.). *Biochemistry & Molecular Biology of Plants* (2nd ed.). Wiley Black Well. (Accn No: 33013103)
4. Berg Jeremy M. (n.d.). *Biochemistry* (10th ed.). Macmillan Publish. (Accn No: 33013190)
5. Mathews Harry R. (n.d.). *Biochemistry A Short Course*. (Accn No: 33013163)

Course Articulation Matrix (CO-PO Mapping)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	9	3	3	3	0
CO2	9	9	9	3	3	0
CO3	9	9	9	9	3	1
CO4	9	9	9	9	3	1
CO5	9	9	9	9	9	3
CO6	9	9	9	9	9	9
Weightage	**54**	**54**	**48**	**42**	**30**	**14**
Weighted Percentage Contribution	**30.68%**	**30.68%**	**27.27%**	**23.86%**	**17.05%**	**7.95%**

CO-K Level Mapping with PO Correlations

CO / K-Level	High Correlation	Medium Correlation	Low Correlation	Zero Correlation
CO1 / K1	PO1, PO2	PO3, PO4, PO5	-	PO6
CO2 / K2	PO1, PO2, PO3	PO4, PO5	-	PO6
CO3 / K3	PO1, PO2, PO3, PO4	PO5	PO6	-
CO4 / K4	PO1, PO2, PO3, PO4	PO5	PO6	-
CO5 / K5	PO1, PO2, PO3, PO4, PO5	PO6	-	-
CO6 / K6	PO1, PO2, PO3, PO4, PO5, PO6	-	-	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (4 Marks)	CIA II (10 Marks)	Assignment 1 (3 Marks)	Assignment 2 (3 Marks)	Total Scholastic Marks	Non Scho. (Attendance - 5 Marks)	Total Marks	% of Assessment
K1	1	2	0.5	0.5	4	0	4	16%
K2	1	2	0.5	0.5	4	0	4	16%
K3	1	2	0.5	0.5	4	0	4	16%
K4	0.5	2	0.5	0.5	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0	1			1	0	1	4%
Non Scholastic	--	--	--	--	--	5	5	20%
Total	4	10	3	3	20	5	25	100%

The COs and POs for the **Lab course in Biochemistry** in **BSc Microbiology** Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEM-II	Prog. Code MIBUG2018	SBE I	U25 MBSBE1
AGRICULTURAL & ENVIRONMENTAL MICROBIOLOGY			
CREDITS - 2		**Theory**	**HOURS - 2**

Course Description

This course provides a comprehensive introduction to the roles and applications of microorganisms in agriculture and environmental sustainability. It explores the fundamental principles of microbial ecology, diversity, and function, with a focus on their contributions to soil fertility, plant health, waste management, bioremediation, and climate change mitigation. Students will gain an understanding of how microorganisms drive nutrient cycling, decompose organic matter, and enhance sustainable agricultural practices.

Objectives:

1. To explain the role of microorganisms in agriculture and the environment.
2. To explore the diversity and functions of soil microorganisms and their contributions to soil fertility and plant health.
3. To demonstrate the applications of microorganisms in waste management, bioremediation, and sustainable practices..
4. To analyze the impact of climate change on microbial communities and their role in mitigating environmental challenges.
5. To equip students with practical skills in isolating, identifying, and utilizing beneficial microbes for agricultural and environmental applications.
6. To promote critical thinking and problem-solving skills in addressing real-world agricultural and environmental issues using microbial solutions

Units	Course Content	Hours per Week (2x15)*
Unit I	INTRODUCTION TO MICROBIOLOGY IN AGRICULTURE AND THE ENVIRONMENT **Overview of Microorganisms** o Types of microorganisms: Bacteria, fungi, viruses, algae, and protozoa - Unique characteristics and ecological roles of each group. **Role of Microorganisms in Agriculture** o Soil fertility: Microbial contributions to nutrient cycling (nitrogen, phosphorus, sulfur). o Plant growth promotion: Phytohormone production, nutrient solubilization, and stress tolerance. o Examples of plant-microbe interactions (e.g., rhizosphere, endophytes). **Role of Microorganisms in the Environment** o Decomposition of organic matter and humus formation. o Nutrient cycling: Carbon, nitrogen, sulfur, and phosphorus cycles.	6

	○ Microbial contributions to ecosystem stability and sustainability. **Importance of Microorganisms in Sustainable Practices** ○ Reducing chemical inputs in agriculture through microbial solutions. ○ Environmental conservation: Bioremediation, waste management, and carbon sequestration.	
Unit II	MICROORGANISMS IN SOIL AND PLANT HEALTH **Soil as a Microbial Habitat** ○ Physical, chemical, and biological properties of soil. ○ Factors influencing microbial diversity and activity in soil (pH, moisture, temperature, organic matter). **Beneficial Soil Microbes** ○ **Nitrogen-fixing bacteria**: Rhizobium, Azotobacter, and Azospirillum. ○ **Phosphate-solubilizing microbes**: Bacillus, Pseudomonas, and Aspergillus. ○ **Mycorrhizal fungi**: Arbuscular mycorrhizae and their role in nutrient uptake. **Microbial Contributions to Soil Fertility** ○ Organic matter decomposition and humus formation. ○ Role of microbes in soil aggregation and structure. **Microbial Biofertilizers** ○ Types of biofertilizers: Bacterial, fungal, and algal. ○ Applications in agriculture: Enhancing crop yield and reducing chemical fertilizer use. ○ Challenges and future prospects of biofertilizers. .	6
Unit III	APPLICATIONS OF MICROBES IN AGRICULTURAL INNOVATIONS **Microbial Inoculants for Crop Improvement** ○ Role of plant growth-promoting rhizobacteria (PGPR) and fungi (PGPF). ○ Case studies: Successful use of microbial inoculants in agriculture. **Microbes in Pest and Disease Management** ○ Biopesticides: Bacillus thuringiensis (Bt), Trichoderma, and Beauveria bassiana. ○ Mechanisms of action: Toxin production, parasitism, and competition. ○ Advantages over chemical pesticides: Environmental safety and specificity. **Microbial Solutions for Soil Health Restoration** ○ Role of microbes in reclaiming degraded soils. ○ Applications in organic farming and sustainable agriculture. **Emerging Trends in Agricultural Microbiology** ○ Use of omics technologies (genomics, metagenomics) to study soil microbiomes.	6

	○ Development of microbial consortia for multifunctional benefits.	
Unit IV	MICROORGANISMS IN WASTE MANAGEMENT AND BIOREMEDIATION **Role of Microorganisms in Waste Decomposition** ○ Composting: Microbial processes and factors affecting efficiency. ○ Sewage treatment: Primary, secondary, and tertiary treatment processes. ○ Anaerobic digestion: Biogas production and its applications. **Bioremediation** ○ Principles of bioremediation: Degradation of pollutants by microbes. ○ Types of bioremediation: In situ and ex situ methods. ○ Microbial degradation of: ▪ Oil spills (e.g., Pseudomonas, Alcanivorax). ▪ Heavy metals (e.g., bioaccumulation, biosorption). ▪ Pesticides and herbicides (e.g., biodegradation pathways). **Case Studies in Bioremediation** ○ Successful examples: Exxon Valdez oil spill, Deepwater Horizon, and heavy metal contamination. ○ Challenges and limitations of bioremediation.	6
Unit V	MICROBES IN CLIMATE CHANGE MITIGATION AND ADAPTATION **Impact of Climate Change on Soil and Environmental Microbiology** ○ Effects of rising temperatures, drought, and extreme weather on microbial communities. ○ Shifts in microbial diversity and function under climate stress. **Role of Microbes in Carbon Sequestration** ○ Microbial contributions to soil carbon storage. ○ Role of biochar and its interaction with soil microbes. **Microbial Solutions for Sustainable Agriculture** ○ Development of drought-resistant crops using microbial inoculants. ○ Microbial strategies for reducing greenhouse gas emissions (e.g., methane oxidation). **Future Prospects** ○ Harnessing synthetic biology for climate-resilient microbes. ○ Integrating microbial solutions into global climate change mitigation strategies.	6

Course Outcomes:

At the completion of the course, the student would be able to:

CO Level	COURSE OUTCOMES	COGNITIVE LEVEL
CO1	Describe the types of microorganisms and their significance in soil fertility, plant growth, and ecosystem balance.	K2
CO2	Explain how nitrogen-fixing bacteria, phosphate-solubilizing bacteria, and mycorrhizal fungi enhance soil fertility and plant health.	K3
CO3	Design and implement microbial solutions for waste decomposition, composting, and bioremediation of pollutants.	K4
CO4	Analyze the effects of climate change on microbial communities and evaluate microbial strategies for carbon sequestration and greenhouse gas reduction.	K5
CO5	Perform laboratory techniques to isolate, identify, and characterize microorganisms used in agriculture and environmental applications.	K4
CO6	Propose innovative microbial-based solutions to address challenges in sustainable agriculture and environmental conservation.	K6

Textbooks

1. Dubey, R. C. (n.d.). *A Text Book of Microbiology*. S.Chand and Co. (Accn No: 44002379)
2. Bhattacharyya, C. B. (n.d.). *Environmental Biotechnology*. Oxfrod University Press. (Accn No: 33009431)
3. Evans, M. G. (n.d.). *Environmental Biotechnology*. Wiley India Pvt. Ltd. (Accn No: 33013097)
4. Pomerville, J. (n.d.). *Fundamentals of Microbiology* (7th ed.). Jones and Bartlett Publishers. (Accn No: 33013120)
5. Durieux, A. (n.d.). *Applied Microbiology*. Springer (India) Pvt Ltd. (Accn No: 33013121)

Reference Books

1. Jay, J. M. (n.d.). *Modern Food Microbiology*. CBS Publishers & Distributors. (Accn No: 00057913)
2. Aneja, K. R. (n.d.). *Experiments in Microbiology Plant Pathology Tissue Culture and Microbial Biotechnolog* (6th ed.). New Age International Publishers. (Accn No: 55014790)
3. El-Mansi, E. M. T. (n.d.). *Fermentation Microbiology and Biotechnology*. CRC Press. (Accn No: 33013099)
4. Willey, J. (n.d.). *Prescott's Microbiology* (11th ed.). McGraw-Hill. (Accn No: 33013108)
5. Ouwehand, C. (n.d.). *Gastrointestinal Microbiology*. Taylor & Francis. (Accn No: 33013125)

Course Articulation Matrix (CO-PO Mapping)

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CO3	9	9	9	3	3	1
CO4	9	9	9	9	9	3
CO5	9	9	9	9	9	3
CO6	9	9	9	9	9	9
Weightage	**54**	**54**	**48**	**33**	**30**	**17**
Weighted Percentage Contribution	**32.93%**	**32.93%**	**29.27%**	**20.12%**	**18.29%**	**10.37%**

CO-K Level Mapping with PO Correlations

CO / K-Level	High Correlation	Medium Correlation	Low Correlation	Zero Correlation
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CO2 / K3	PO1, PO2, PO3	PO4	PO6	PO5
CO3 / K4	PO1, PO2, PO3	PO4, PO5	PO6	-
CO4 / K5	PO1, PO2, PO3, PO4, PO5	-	PO6	-
CO5 / K4	PO1, PO2, PO3, PO4, PO5	-	PO6	-
CO6 / K6	PO1, PO2, PO3, PO4, PO5, PO6	-	-	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

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K2	1	2	0.5	0.5	4	0	4	16%
K3	1	2	0.5	0.5	4	0	4	16%
K4	0.5	2	0.5	0.5	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0	1			1	0	1	4%
Non Scholastic	--	--	--	--	--	5	5	20%
Total	4	10	3	3	20	5	25	100%

The COs and POs for the course in **Agricultural and Environmental Microbiology** in **BSc Microbiology** Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge Signature of the Head, BMB

****** End of Semester II / I Year BSc Microbiology******