



SEMESTER 4

MOLECULAR BIOLOGY (Theory)

Program: B. Sc. in Microbiology	Year, Semester: 2 nd Yr., 4 th Sem
Course Title: MOLECULAR BIOLOGY (Theory)	Subject Code: TIU-UMB-MJ-T22201
Contact Hours/Week: 2-1-0 (L-T-P)	Credit: 3

COURSE OBJECTIVE :

Enable the student to:

1. To understand the different types of genetic material, focusing on DNA and RNA (mRNA, tRNA, rRNA, miRNA, snRNA).
2. To understand the mechanisms of DNA replication, with a focus on the semi-conservative model, as evidenced by the Meselson-Stahl experiment.
3. To define transcription and distinguish it from DNA replication.
4. To understand the molecular machinery involved in translation, including the structure and function of tRNA and aminoacyl tRNA synthetases.
5. To understand the principles of transcriptional regulation in both prokaryotes and eukaryotes.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Understand What is Central Dogma	K2
CO-2:	Briefly outlined the Nature and Organization of Genetic Material	K1
CO-3:	Explain DNA Replication Mechanisms	K4
CO-4:	Comprehend Transcription in Prokaryotes and Eukaryotes	K5
CO-5:	Explain the Process of Translation	K3
CO-6:	Understand the Regulation of Gene Expression	K2

COURSE CONTENT :

MODULE 1:	GENETIC MATERIAL AND ITS FEATURES	8 Hours
Types of Genetic material: DNA and RNA (mRNA, tRNA, rRNA, miRNA, snRNA etc.). Denaturation and Renaturation of DNA: Hyperchromic effect, T _m , Cot curves. DNA topology and topoisomerase enzyme- linking number, twist number, writhing number. Organization of DNA in Prokaryotes (nucleoid), Eukaryotes (nucleosome-10 nm model, 30 nm model, scaffold arrangement). Organelle DNA - mitochondrial and chloroplast DNA. The Central Dogma.		
MODULE 2:	REPLICATION OF PROKARYOTIC DNA	10 Hours
DNA replication - Meselson-Stahl experiment as evidence of semi-conservative replication, Bidirectional and unidirectional replication, Semi- discontinuous replication. Mechanism of DNA replication: Enzymes and proteins involved in DNA replication, differences with eukaryotic replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends. Various models of DNA replication including θ (theta), rolling circle mode of replication and other accessory proteins, fidelity of DNA replication.		
MODULE 3:	TRANSCRIPTION IN PROKARYOTES AND EUKARYOTES	10 Hours
Transcription: Definition, difference from replication, promoter - concept and strength of Promoter, RNA Polymerase and the transcription unit. Mechanism of transcription (initiation, elongation and termination). Transcription in Eukaryotes: major difference with prokaryotic system, important modifications of eukaryotic RNA: concept of introns and exons, RNA splicing, concept of alternative splicing, Polyadenylation and capping, Processing of rRNA and tRNA.		
MODULE 4:	TRANSLATION (PROKARYOTES AND EUKARYOTES)	7 Hours
Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, genetic code and its features, mechanism of initiation, elongation and termination of translation in both prokaryotes and eukaryotes, Fidelity of translation, Inhibitors of protein synthesis in prokaryotes and eukaryote.		
MODULE 5:	REGULATION OF GENE EXPRESSION IN PROKARYOTES AND EUKARYOTES	10 Hours
Principles of transcriptional regulation, regulation at initiation with examples from lac and trp operons, Yeast mating type switching, changes in chromatin structure: DNA methylation and Histone acetylation mechanisms		
TOTAL LECTURES		45 Hours**

Books:

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco
3. Burton E. Tropp Molecular Biology Genes to Proteins, 3rd Edition, Jones and Bartlett Publishers
4. Robert F. Weaver, Molecular Biology, Fourth Edition, McGraw-Hill International Publishers.
5. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
6. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
7. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
8. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
9. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)												PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO-1	3	-	2	-	-	-	-	-	-	-	-	2	3	2	2
CO-2	3	-	2	-	-	-	-	-	-	-	-	2	3	2	2
CO-3	3	2	3	2	2	-	-	-	-	-	2	3	3	3	3
CO-4	3	2	3	2	3	-	-	-	-	-	2	3	3	3	3
CO-5	3	2	3		2	-	-	-	-	-	2	3	3	3	3
CO-6	3	2	3	2	2	-	-	-	-	-	2	3	3	3	3

MOLECULAR BIOLOGY (Practical)

Program: B. Sc. in Microbiology	Year, Semester: 2 nd Yr., 4 th Sem
Course Title: MOLECULAR BIOLOGY (Practical)	Subject Code: TIU-UMB-MJ-L22201
Contact Hours/Week: 0-0-1 (L-T-P)	Credit: 1

COURSE OBJECTIVE :

Enable the student to:

1. To understand and apply the methods for isolating high-quality genomic DNA (gDNA) from E. coli.
2. To learn the principles of DNA quantification using a UV spectrophotometer, focusing on absorbance at 260 nm (A₂₆₀).
3. To understand the principles of RNA quantification using a UV spectrophotometer, focusing on absorbance at 260 nm (A₂₆₀) and its relationship to RNA concentration.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Understand the Isolation and Visualization of Genomic DNA from E. coli	K3
CO-2:	Estimation of DNA Concentration Using UV Spectrophotometry	K3
CO-3:	Estimation of RNA Concentration Using UV Spectrophotometry	K4
CO-4:	Gain hands-on experience in DNA and RNA quantification techniques critical for molecular biology experiments.	K4
CO-5:	Develop an understanding of electrophoresis and spectrophotometry as essential tools for genetic analysis.	K4
CO-6:	Apply the knowledge in research applications such as gene cloning, expression analysis, and molecular diagnostics.	K4

COURSE CONTENT :

MODULE 1:	Molecular characterization of Genetic material	15 Hours
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Isolation of genomic DNA from <i>E. coli</i> and visualization of gDNA in Agarose gel electrophoresis
2. Estimation of salmon sperm / calf thymus DNA using UV spectrophotometer (A260 measurement)
3. Estimation of RNA using UV spectrophotometer (A260 measurement)
TOTAL LECTURES
15 Hours**

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)												PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO-1	3	2	2	-	2	-	-	-	-	-	2	3	3	3	2
CO-2	3	2	2	-	2	-	-	-	-	-	2	3	3	3	2
CO-3	3	2	3	2	3	-	-	-	-	-	2	3	3	3	3
CO-4	3	3	3	2	3	-	-	-	-	-	2	3	3	3	3
CO-5	3	3	3	2	3	-	-	-	-	-	2	3	3	3	3
CO-6	3	3	3	3	3	-	-	-	-	-	2	3	3	3	3

CELL BIOLOGY (Theory)

Program: B. Sc. in Microbiology	Year, Semester: 2 nd Yr., 4 th Sem
Course Title: CELL BIOLOGY (Theory)	Subject Code: TIU-UMB-MJ-T22202
Contact Hours/Week: 2-1-0 (L-T-P)	Credit: 3

COURSE OBJECTIVE :

Enable the student to:

1. To introduce and compare the structural organization of prokaryotic and eukaryotic cells, highlighting the key differences between plant and animal cells
2. To introduce the roles of ribosomes in protein synthesis and their association with the endoplasmic reticulum (ER) in protein sorting and transport.

3. To define signaling molecules and their types, including hormones, neurotransmitters, and growth factors, and their interactions with cell surface receptors.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Recall the differences in organization between prokaryotic and eukaryotic cells.	K2
CO-2:	Explain the structure and function of the plasma membrane, including mechanisms of transport.	K2
CO-3:	Explain the role of the nuclear pore complex and nucleoporins in nuclear transport.	K2
CO-4:	Analyse the process of protein targeting and insertion into the ER.	K4
CO-5:	Identify common signaling molecules and their corresponding receptors.	K1
CO-6:	Explain the processes of mitosis and meiosis.	K3

COURSE CONTENT :

MODULE 1:	STRUCTURE AND ORGANIZATION OF CELL	10 Hours
Cell Organization – Prokaryotic and Eukaryotic (Plant and animal cells) Plasma membrane: Structure and transport of small molecules Cell Wall: Eukaryotic cell wall, extracellular matrix and cell matrix interactions, Cell-Cell Interactions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects) Mitochondria, chloroplasts and peroxisomes Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with plasma membrane, cell surface protrusions, intermediate filaments, microtubules		
MODULE 2:	NUCLEUS	7 Hours
Nuclear envelope, nuclear pore complex, nucleoporins and nuclear lamina, nuclear transport Nucleolus-composition and functions		
MODULE 3:	PROTEIN SORTING AND TRANSPORT AND TARGETING	8 Hours
Ribosomes, Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus Protein targeting to Lysosomes		
MODULE 4:	CELL SIGNALING	10 Hours
Signaling molecules and their receptors Function of cell surface receptors Pathways of intra-cellular receptors – Cyclic AMP pathway, cyclic GMP and MAP kinase pathway		

MODULE 5:	CELL CYCLE, CELL DEATH AND CELL RENEWAL	10 Hours
Eukaryotic cell cycle and its regulation, Mitosis and Meiosis, Development of cancer, causes and types, Programmed cell death, Stem cells: Embryonic stem cell, induced pluripotent stem cells		
TOTAL LECTURES		45 Hours**

Books:

1. Alberts, B. et al. (2008) Molecular Biology of the cell. 5th edition. Garland Science
2. Hardin J, Bertoni G and Kleinsmith LJ. (2010). Becker's World of the Cell. 8th edition. Pearson.
3. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
4. De Robertis, EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition, Lipincott Williams and Wilkins, Philadelphia.
5. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th Edition, ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
6. Watson JD. et al. (2008) Molecular Biology of the Gene. 6th edition, Cold Spring Harbor Laboratory Press

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)												PROGRAM SPECIFIC OUTCOMES (PSO)		
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CO-3	3	-	2	-	-	-	-	-	-	-	2	3	3	2	2
CO-4	3	2	3	2	2	-	-	-	-	-	2	3	3	3	3
CO-5	3	-	2	-	-	-	-	-	-	-	-	3	3	2	3
CO-6	3	2	2	-	-	-	-	-	-	-	2	3	3	2	3

CELL BIOLOGY (Practical)

Program: B. Sc. in Microbiology	Year, Semester: 2 nd Yr., 4 th Sem
Course Title: CELL BIOLOGY (Practical)	Subject Code: TIU-UMB-MJ-L22202

CO-1	3		2							2	2	3		2	2
CO-2	3		2								3	3		2	2
CO-3	3	2	3	2	2					2	3	3		3	3
CO-4	3	2	3		2					2	3	3		2	3
CO-5	3		2								3	3		2	3
CO-6	3	2	3	2	2					2	3	3		2	3

MICROBIAL GENETICS (Theory)

Program: B. Sc. in Microbiology	Year, Semester: 2 nd Yr., 4 th Sem
Course Title: MICROBIAL GENETICS (Theory)	Subject Code: TIU-UMB-MJ-T22203
Contact Hours/Week: 2-1-0 (L-T-P)	Credit: 3

COURSE OBJECTIVE :

Enable the student to:

1. Understand the role of nucleic acids (DNA and RNA) as genetic material.
2. Understand the molecular mechanisms involved in each genetic exchange process.
3. Explore various DNA repair systems, including mismatch repair, nucleotide excision repair, photoreactivation, SOS repair, and error-prone repair.
4. Explore the types and functions of plasmids in bacteria and yeast.
5. Understand the mechanisms of transposition in prokaryotes and eukaryotes.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	To remember the genome organization in prokaryotic and eukaryotic cells	K1
CO-2:	To describe the different mechanisms of gene transfer.	K3
CO-3:	To demonstrate different mechanisms of mutations and repair	K4
CO-4:	To analyse different plasmids and its applications.	K4
CO-5:	To analyse phage genetics	K4
CO-6:	To interpret different transposable elements in prokaryotic and eukaryotic systems	K4

COURSE CONTENT :

MODULE 1:	NUCLEIC ACID AS GENETIC MATERIAL	7 Hours
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Experimental evidence for DNA and RNA as genetic material: experiments of Griffith, Avery MacLeod and McCarthy, Hershey and Chase, Fraenkel and Conrat.		
MODULE 2:	MECHANISMS OF GENETIC EXCHANGE	8 Hours
Transformation - Discovery, mechanism of natural competence Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers		
MODULE 3:	MUTATIONS, REPAIR AND RECOMBINATION	15 Hours
Mutations and mutagenesis: Definition and types of Mutations (tautomeric shift, base analog, alkylating agent, UV radiation and thymine dimers, replicational error). Mutagenic agents: Physical and chemical mutagens Molecular basis of mutations, Functional mutants (loss and gain of function mutants), Uses of mutations. Repair of DNA: Mismatch and nucleotide excision repair, photoreactivation, SOS repair, error prone repair Reversion and suppression: True revertant; Intra- and inter-genic suppression; Ames test; Mutator genes Recombination: Homologous recombination (Holiday structure-RecBCD system).		
MODULE 4:	PLASMIDS	8 Hours
Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids. Yeast plasmids- 2 μ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, Regulation of plasmid copy number, curing of plasmids		
MODULE 5:	TRANSPOSABLE ELEMENTS	7 Hours
Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon Eukaryotic transposable elements - Maize (Ac/Ds), LTR and Non-LTR transposons, LINES and SINES. Uses of transposons and transposition		
TOTAL LECTURES		45 Hours**

Books:

1. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
3. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings
5. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
6. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
7. Russell PJ. (2009). i Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings

8. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.

9. Maloy SR, Cronan JE and Friefelder D (2004) Microbial Genetics 2nd Ed., Jones and Barlett Publishers

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)												PROGRAM SPECIFIC OUTCOMES (PSO)		
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CO-1	3	-	2	-	-	-	-	-	-	-	-	2	3	2	2
CO-2	3	2	3	-	2	-	-	-	-	-	2	3	3	3	3
CO-3	3	2	3	-	3	-	-	-	-	-	2	3	3	3	3
CO-4	3	2	3	2	3	-	-	-	-	-	2	3	3	3	-
CO-5	3	2	3	2	3	-	-	-	-	-	2	3	3	3	3
CO-6	3	2	3	-	3	-	-	-	-	-	2	3	3	3	3

MICROBIAL GENETICS (Practical)

Program: B. Sc. in Microbiology	Year, Semester: 2 nd Yr., 4 th Sem
Course Title: MICROBIAL GENETICS (Practical)	Subject Code: TIU-UMB-MJ-L22203
Contact Hours/Week: 0-0-1 (L-T-P)	Credit: 1

COURSE OBJECTIVE :

Enable the student to:

1. Understand the impact of UV radiation on bacterial survival.
2. Learn how to plot survival curves.
3. Demonstration of Master and Replica Plate Preparation

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Understand about microbial genes	K2
CO-2:	Analyse the effect of UV in bacteria	K4
CO-3:	Analyse the growth pattern of bacteria	K4
CO-4:	Conduct experiments of plasmid isolation	K3
CO-5:	Analyse the principles of agarose gel electrophoresis	K4
CO-6:	Analyse different bacterial conjugation processes	K4

COURSE CONTENT :

MODULE 1:	STUDY AND VISUALIZATION OF BACTERIAL GENETIC MATERIAL	15 Hours
<ol style="list-style-type: none"> 1. Effect of UV on bacteria and plotting of survival curve 2. Demonstration of Master and Replica plate preparation 3. Isolation of Plasmid DNA from <i>E. coli</i> and study of different conformations of plasmid DNA through Agarose gel electrophoresis 4. Bacterial Conjugation 		
TOTAL LECTURES		15 Hours**

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)												PROGRAM SPECIFIC OUTCOMES (PSO)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
CO-1	3		2	-	-	-	-	-	-	-	-	2	3	2	2	
CO-2	3	2	3	2	3	2	-	-	-	-	2	3	3	3	3	
CO-3	3	2	3	-	2	-	-	-	-	-	2	3	3	3	3	
CO-4	3	2	3	-	3	-	-	-	-	-	2	3	3	3	3	
CO-5	3	2	3	-	3	-	-	-	-	-	2	3	3	3	3	

CO-6	3	2	3	-	3	-	-	-	-	-	2	3	3		3		3
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Virology (Theory)

Program: B. Sc. in Microbiology	Year, Semester: 2 nd Yr., 4 th Sem
Course Title: Virology (Theory)	Subject Code: TIU-UMB-MJ-T22204
Contact Hours/Week: 2-1-0 (L-T-P)	Credit: 3

COURSE OBJECTIVE :

Enable the student to:

1. Explore the concepts of viroids, virusoids, satellite viruses, and prions, and their biological significance.
2. Study the structure of viruses, focusing on capsid symmetry, and the differences between enveloped and non-enveloped viruses.
3. Understand the interaction of viruses with cellular receptors and the mechanisms by which viruses enter host cells.
4. Understand the concepts of oncogenes and proto-oncogenes, their roles in cancer development, and how they can be activated or inactivated by viral infections.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Understand the fundamental characteristics and nature of viruses	K2
CO-2:	Analyze the genetic basis of lytic vs. lysogenic switches, particularly focusing on the lambda phage.	K4
CO-3:	Understand genomic features like terminal cohesive ends	K2
CO-4:	Explore the link between viruses and cancer.	K5
CO-5:	Apply the understanding of viral genetics, replication, and transmission	K3
CO-6:	Analyze and understand complex viral genetic features, their transmission, and the mechanisms they use to infect and replicate in host cells.	K4

COURSE CONTENT :

MODULE 1:	NATURE AND PROPERTIES OF VIRUSES	10 Hours
Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Theories of viral origin Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses Isolation, purification and cultivation of viruses Viral taxonomy: Classification and nomenclature of different groups of viruses		
MODULE 2:	BACTERIOPHAGES	10 Hours

Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda phage) concept of early and late proteins, regulation of transcription in lambda phage, genetic basis of lytic vs lysogenic switch of lambda phage		
MODULE 3:	VIRAL TRANSMISSION, SALIENT FEATURES OF VIRAL NUCLEIC ACIDS AND REPLICATION	15 Hours
Modes of viral transmission: Persistent, non-persistent, vertical and horizontal Salient features of viral Nucleic acid : Unusual bases (TMV, T4 phage), overlapping genes (ϕ X174, Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (Influenza virus), and non-segmented genomes (picornavirus), capping and tailing (TMV) Viral multiplication and replication strategies: Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses as per Baltimore classification (ϕ X 174, Retroviridae, Vaccinia, Picorna) , Assembly, maturation and release of virions		
MODULE 4:	VIRUSES AND CANCER	10 Hours
Introduction to oncogenic viruses, types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes		
TOTAL LECTURES		45 Hours**

Books:

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
2. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
3. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
4. Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.
5. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
6. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
7. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
7. Bos L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
8. Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)	PROGRAM SPECIFIC OUTCOMES (PSO)
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	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO-1	3		2	-	-	-	2	-	3	3	-	2	3	2	2
CO-2	3	2	3	2	3	2	-	-	-	-	2	3	3	3	3
CO-3	3	2	3	-	2	-	-	2	-	2	2	3	3	3	3
CO-4	3	2	3	-	3	-	1	-	3	-	2	3	3	3	3
CO-5	3	2	3	-	3	-	-	-	-	2	2	3	3	3	3
CO-6	3	2	3	-	3	-	-	-	1	-	2	3	3	3	3

VIROLOGY (Practical)

Program: B. Sc. in Microbiology	Year, Semester: 2 nd Yr., 4 th Sem
Course Title: VIROLOGY (Practical)	Subject Code: TIU-UMB-MJ-L22204
Contact Hours/Week: 0-0-1 (L-T-P)	Credit: 1

COURSE OBJECTIVE :

Enable the student to:

1. Study of the Structure of Important Animal Viruses (Rhabdo, Influenza, Paramyxo, Hepatitis B, and Retroviruses) Using Electron Micrographs
2. Study of the Structure of Important Plant Viruses (Caulimo, Gemini, Tobacco Ringspot, Cucumber Mosaic, and Alpha-Alpha Mosaic Viruses) Using Electron Micrographs
5. Isolation of Bacteriophages from Water/Sewage Sample Using Double Agar Layer Technique

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Recall the basic concepts and structures of animal viruses, plant viruses, and bacteriophages.	K3
CO-2:	Understand the significance of the structural components of viruses and how they contribute to viral function.	K3
CO-3:	Apply knowledge of virus structures to analyze electron micrographs and distinguish between various viruses.	K3
CO-4:	Compare and contrast the structural features of animal, plant, and bacterial viruses based on electron microscopy images.	K2

CO-5:	Evaluate the importance of electron microscopy in virus identification and classification.	K5
CO-6:	Design a method for isolating bacteriophages from sewage water and apply the double-layer technique for bacteriophage isolation.	K4

COURSE CONTENT :

MODULE 1:	NATURE AND PROPERTIES OF VIRUSES												15 Hours		
Study of the structure of important animal viruses (rhabdo, influenza, paramyxo hepatitis B and retroviruses) using electron micrographs 2. Study of the structure of important plant viruses (caulimo, Gemini, tobacco ringspot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs 3. Study of the structure of important bacterial viruses (ϕ X 174, T4, λ) using electron micrograph 4. Isolation of bacteriophages from water/sewage sample using double agar layer technique 5. Phage Titration 6. Isolation of Nucleic Acid from Phage															
TOTAL LECTURES												15 Hours**			
	PROGRAM OUTCOMES (PO)												PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO-1	3	-	2	-	-	-	-	-	-	-	-	2	3	2	2
CO-2	3	2	3	-	2	-	-	-	-	-	2	3	3	3	3
CO-3	3	2	3	-	3	-	-	-	-	-	2	3	3	3	3
CO-4	3	2	3	2	3	-	-	-	-	-	2	3	3	3	-
CO-5	3	2	3	2	3	-	-	-	-	-	2	3	3	3	3
CO-6	3	2	3	-	3	-	-	-	-	-	2	3	3	3	3

AGRICULTURAL MICROBIOLOGY (Theory)

Program: B. Sc. in Microbiology	Year, Semester: 2 nd Yr., 4 th Sem
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Course Title: AGRICULTURAL MICROBIOLOGY (Theory)	Subject Code: TIU-UBT-MI-T22201
Contact Hours/Week: 2-1-0 (L-T-P)	Credit: 3

COURSE OBJECTIVE :

Enable the student to:

1. Understand the fundamental concepts of microbiology and its applications in agriculture.
2. Explore the diversity and functions of soil microorganisms.
3. Examine the role of microbes in nutrient cycling and soil fertility.
4. Study plant-microbe interactions, including beneficial and pathogenic relationships.
5. Learn about biofertilizers, biopesticides, and their applications in sustainable agriculture.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Recall the fundamental concepts, scope, and historical development of agricultural microbiology.	K1
CO-2:	Explain the diversity, distribution, and functional roles of soil microorganisms in organic matter decomposition and nutrient cycling	K2
CO-3:	Apply knowledge of plant-microbe interactions to evaluate the role of Rhizobium, mycorrhizae, and PGPR in plant growth and soil health.	K3
CO-4:	Analyze the mechanisms of microbial infections in plants and assess their impact on plant health and disease development	K4
CO-5:	Evaluate the effectiveness of biofertilizers and biopesticides in sustainable agriculture and integrated pest management (IPM).	K5
CO-6:	Design sustainable agricultural strategies incorporating biofertilizers, biopesticides, and beneficial microbes for improved crop productivity.	K6

COURSE CONTENT :

MODULE 1:	INTRODUCTION TO AGRICULTURAL MICROBIOLOGY	10 Hours
Definition and scope of agricultural microbiology. Historical development and significance in agriculture. Classification and characteristics of soil microorganisms. Microbial ecology and its relevance to agriculture.		
MODULE 2:	SOIL MICROORGANISMS AND THEIR FUNCTIONS	10 Hours
Diversity of soil microorganisms: bacteria, fungi, actinomycetes, and algae. Microbial populations and their distribution in soil. Role of microorganisms in organic matter decomposition. Microbial involvement in nutrient cycling: nitrogen, phosphorus, and sulfur cycles. Soil enzymes and their agricultural significance.		
MODULE 3:	PLANT-MICROBE INTERACTIONS	15 Hours

Symbiotic relationships: Rhizobium-legume symbiosis. Mycorrhizal associations and their impact on plant growth. Endophytes and their role in plant health. Plant growth-promoting rhizobacteria (PGPR) and their mechanisms. Microbial pathogens: types, mechanisms of infection, and disease development.

MODULE 4: BIOFERTILIZERS AND BIOPESTICIDES	10 Hours
Definition, types, and production of biofertilizers. Application methods and benefits in agriculture. Biopesticides: classification, modes of action, and examples. Integrated pest management (IPM) and the role of biopesticides. Regulatory aspects and quality control of biofertilizers and biopesticides.	
TOTAL LECTURES	45 Hours**

Books:

1. Rangaswamy, N., & Bagyaraj, D. J. (2015). Agricultural Microbiology. Scientific Publishers.
2. Dubey, R. C., & Maheswari, D. K. (2013). A Textbook of Microbiology. S. Chand Publishing.

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)												PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO-1	3	-	2	-	-	-	-	-	-	-	-	2	3	2	2
CO-2	3	2	3	-	2	-	-	-	-	-	2	3	3	3	3
CO-3	3	2	3	-	3	-	-	-	-	-	2	3	3	3	3
CO-4	3	2	3	2	3	-	-	-	-	-	2	3	3	3	-
CO-5	3	2	3	2	3	-	-	-	-	-	2	3	3	3	3
CO-6	3	2	3	-	3	-	-	-	-	-	2	3	3	3	3

AGRICULTURAL MICROBIOLOGY (Practical)

Program: B. Sc. in Microbiology	Year, Semester: 2 nd Yr., 4 th Sem
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Course Title: AGRICULTURAL MICROBIOLOGY (Practical)	Subject Code: TIU-UBT-MI-L22201
Contact Hours/Week: 0-0-1 (L-T-P)	Credit: 1

COURSE OBJECTIVE :

Enable the student to:

1. Apply aseptic techniques to isolate and enumerate bacteria, fungi, and actinomycetes from agricultural soil using serial dilution and plate count methods.
2. Isolate and identify nitrogen-fixing bacteria, specifically Rhizobium, from root nodules, demonstrating an understanding of symbiotic relationships.
3. Prepare and examine microscopic observations of phosphate-solubilizing microorganisms isolated from soil, correlating morphological characteristics with functional capabilities.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Recall the principles and techniques used in the isolation of bacteria, fungi, and actinomycetes from agricultural soil	K1
CO-2:	Explain the importance of serial dilution techniques in microbial enumeration and soil microbiome analysis	K2
CO-3:	Perform serial dilution and plate count methods to determine the total viable count of soil microbial populations	K3
CO-4:	Analyze soil microbial diversity by isolating and characterizing nitrogen-fixing bacteria such as Rhizobium from root nodules	K4
CO-5:	Evaluate the efficiency of phosphate-solubilizing microorganisms through microscopic observation and biochemical tests.	K5
CO-6:	Design an optimized protocol for microbial isolation, enumeration, and identification from soil samples for agricultural applications.	K6

COURSE CONTENT :

MODULE 1:	NATURE AND PROPERTIES OF VIRUSES	15 Hours
<ol style="list-style-type: none"> 1. Isolation of bacteria, fungi, and actinomycetes from agricultural soil. 2. Enumeration using the serial dilution technique. 3. Total viable count of Soil Microbial Population using serial dilution and plate count. 4. Isolation of nitrogen-fixing bacteria like Rhizobium from root nodules. 5. Isolation and observation under a microscope of Phosphate Solubilizing Microorganisms 		
TOTAL LECTURES		15 Hours**

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)												PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO-1	3	-	2	-	3	-	2	-	-	2	-	2	3	2	2
CO-2	3	2	3	-	2	-	-	-	3	-	2	3	3	3	3
CO-3	3	2	3	-	3	-	-	-	1	-	2	3	3	3	3
CO-4	3	2	3	2	3	-	1	-	-	3	2	3	3	3	-
CO-5	3	2	3	2	3	-	-	-	2	-	2	3	3	3	3
CO-6	3	2	3	-	3	-	-	-	-	-	2	3	3	3	3

SCIENTIFIC COMMUNICATION AND WRITING SKILLS

Program: B. Sc. in Microbiology	Year, Semester: 2 nd Yr., 4 th Sem
Course Title: SCIENTIFIC COMMUNICATION AND WRITING SKILLS	Subject Code: TIU-UMB-AEC-T2201
Contact Hours/Week: 2-0-0 (L-T-P)	Credit: 2

COURSE OBJECTIVE :

Enable the student to:

1. To develop a strong foundation in scientific communication by understanding the principles, ethics, and importance of clear and effective communication in research and academia.
2. To enhance technical writing and documentation skills by learning the structure and format of scientific papers, reports, proposals, and dissertations.
3. To improve proficiency in oral and visual communication through the development of presentation skills, research posters, and public speaking techniques for scientific discussions.
4. To familiarize students with publication processes and ethical considerations in scientific writing, including plagiarism, citation styles, peer review, and journal selection.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Understand the principles of scientific communication and explain its significance in research and academia.	K2
CO-2:	Analyze and apply ethical standards in scientific writing, including plagiarism prevention, citation formats, and responsible authorship.	K4
CO-3:	Demonstrate proficiency in technical writing by structuring research papers, proposals, and reports according to standard scientific formats.	K3
CO-4:	Develop effective oral and visual presentation skills by preparing research posters, slide decks, and delivering academic presentations.	K6
CO-5:	Critically evaluate and review scientific literature to synthesize information and construct well-supported arguments in writing.	K5
CO-6:	Remember and get knowledge of the publication process to select appropriate journals, format manuscripts, and understand peer review mechanisms.	K1

COURSE CONTENT :

MODULE 1:	NATURE AND PROPERTIES OF VIRUSES	15 Hours
6. Isolation of bacteria, fungi, and actinomycetes from agricultural soil. 7. Enumeration using the serial dilution technique. 8. Total viable count of Soil Microbial Population using serial dilution and plate count. 9. Isolation of nitrogen-fixing bacteria like Rhizobium from root nodules. 10. Isolation and observation under a microscope of Phosphate Solubilizing Microorganisms		
TOTAL LECTURES		15 Hours**

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)												PROGRAM SPECIFIC OUTCOMES (PSO)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
CO-1	3	-	2	-	3	-	2	-	-	2	3	2	3		2	2
CO-2	3	2	3	-	2	-	-	-	3	-	2	3	3		3	3
CO-3	3	2	3	-	3	-	-	-	1	-	2	3	3		3	3
CO-4	3	2	3	2	3	-	1	3	-	3	2	3	3		3	-
CO-5	3	2	3	2	3	-	2	-	2	-	2	3	3		3	3
CO-6	3	2	3	-	3	-	-	-	3	-	2	3	3		3	3