

SHRI GURU RAM RAI UNIVERSITY

[Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017 & recognized by UGC u/s (2f) of UGC Act 1956]



SYLLABUS FOR Master of Science (Microbiology) School of Basic & Applied Sciences REVISED (2025 onwards)

(w.e.f 2021-2022)
SHRI GURU RAM RAI UNIVERSITY, PATELNAGAR, DEHRADUN-
UTTARAKHAND-248001

Master of Science (Microbiology)

OUTCOME-BASED MICROBIOLOGY

Programme outcome (POs)

The student will be able to:

PO 1	Implement strong theoretical and practical knowledge of microbiology to solve complex scientific problems.
PO2	Identify the situation-based problem, formulation, and action is taken based on analytical thinking and principles of science.
PO3	Execute effective communication through interactive and presenting skills, technical report writings and proper documentation of ideas.
PO4	Formulate, design, experimental techniques, scientific tools, analysis of scientific data, interpretation of data and established hypothesis for various inter disciplinary research problems.
PO5	Create a conceptual, theoretical and operational approach to address various problems of inter disciplinary fields.
PO6	Enables individuals to function effectively in cross-cultural environments as an individual and as a member or leader.
PO7	Understand ethical issues, academics and research ethics need and value of life long learning, scientific misconduct of a scientist to serve society.
PO8	Understand the contribution of scientific knowledge in environmental concept for sustainable development.
PO9	Enhance and adopt employability skills through research, internship and dissertation.
PO10	Successfully compete in the state level, national level and international level or competition
PO11	Demonstrate ability for collaborative research and scientific communication through projects, internship and on site training.
PO12	Develop Skills required for higher education, professional development and employability.

Program Specific Outcome (PSOs)

PSO 1	Associate the fundamental and advanced concept in diverse branches of Microbiology including Medical Microbiology, Agricultural Microbiology, Food Microbiology, RDT, Bioinformatics and Industrial Microbiology.
PSO2	Formulate, design, experimental technique, scientific tools, analysis of scientific data interpretation of data and establish a hypothesis for various interdisciplinary research problems.
PSO3	Capable of executing short research projects / patent in cooperating various tools and techniques in any of the basic specializations of Microbiology.
PSO4	Acquire the ability to engage in independent and life-long learning in the broadest context socio technological changes.

Eligibility for admission:

Any candidate who has passed the Plus Two of the Higher Secondary Board of Examinations in any state recognized equivalent to the Plus Two of the Higher Secondary Board in with not less than 45 %-marks in aggregate is eligible for admission, However, SC/ST, OBC and other eligible communities shall be given

relaxation as per university rules. Eligibility for M.Sc. Microbiology course: Candidates must have completed a B.Sc. degree in CBZ (Chemistry, Botany, Zoology) or any science subject that includes Physics.

Duration of the Programme: 2 year (4 Semester)

STUDY & EVALUATION SCHEME
Choice Based Credit System
Master of Science (Microbiology)

First Semester

S. No	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	MMBC-101	Introductory microbiology	3	0	0	3	40	60	100
2	Core	MMBC C-102	Principles of biochemistry	3	0	0	3	40	60	100
3	Core	MMBC-103	Cell and molecular biology	3	0	0	3	40	60	100
4	Core	MMBC—104	Microbial genetics	3	0	0	3	40	60	100
Practical										
1	Core	MMBL-105	Lab Course-I (Based on paper 1 & 2)	0	0	3	4	40	60	100
2	Core	MMBL-106	Lab Course-II (Based on paper 3 & 4)	0	0	3	4	40	60	100
Total				12		6	18	240	360	600

L – Lecture, T – Tutorial, P – Practical, C – Credit

Second Semester

S. No.	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	MMBC 201	Microbial physiology and metabolism	3	0	0	3	40	60	100
2	Core	MMBC-202	Immunology	3	0	0	3	40	60	100
3	Core	MMBC-203	Biological techniques	3	0	0	3	40	60	100
4	Core	MMBC-204	Recombinant DNA Technology	3	0	0	3	40	60	100
Practical										
1	Core	MMBL 205	Lab Course I (Based on paper 1 & 2)	0	0	3	4	40	60	100
2	Core	MMBL 206	Lab Course II (Based on paper 3 & 4)	0	0	3	4	40	60	100

Total	12		6	18	240	360	600
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L – Lecture, T – Tutorial, P – Practical, C – Credit

* 5Week Industrial Training in Summer Break (June-July) and submission of report and presentation in III semester

Third Semester

S. No.	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	MMBC-301	Medical Microbiology	3	0	0	3	40	60	100
2	Core	MMBC-302	Industrial Microbiology AND PHARMACEUTICAL	3	0	0	3	40	60	100
3	Elective-I	MMBE-303	Elective – I a) food and dairy microbiology b) Drug designing and nano-Biotechnology c) Molecular virology And infection	3	0	0	3	40	60	100
4	Elective-II	MMBE-304	Elective – II a) Environmental microbiology b) Agricultural microbiology c) Ecosystem analysis and remote sensing d) Mushroom culture technology	3	0	0	3	40	60	100
Practical										
1	Lab	MMBL305	Lab Course-I (Based on paper 1 & 2)	0	0	3	4	40	60	100
2	Lab	MMBL-306	Lab Course-II (Based on Elective I & II)	0	0	3	4	40	60	100
3	Self-study	MMBS307	a) Bioinformatics & biological b) Biomedical technology	3	0	0	4	40	60	100
		MMBI308	Industrial Training Report/Presentation							
Total				12	0	6	18	240	360	600

L – Lecture, T – Tutorial, P – Practical, C – Credit

Self-study marks not to be included while calculating grades.

Core Credit = 09 + Elective Credit = 09 Total Credit = 18 with additional 3 credits of self-study &

3credits of Industrial Training.

Fourth Semester

S. No.	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	MMBE 401	Dissertation	0	0	9	9		180 + 60+60	300
2	Core	MMBC402	Epidemiology	3	0	0	3	40	60	100
3	Elective	MMBE 403	a. Beverages Biotechnology b. Bio-Entrepreneurship c. Intellectual Property Rights	3	0	0	3	40	60	100
4	Lab	MMBL404	Lab Course based on paper (C402)	0	0	3	4	40	60	100
5	Lab	MMBJ 405	Journal Club*	0	0	1	0			
6	Skill	MMBS406	a. Infection and Immunity. b. Research Methodology c. Tissue Biotechnology	3	0	0	3	40	60	100
Total										600

L – Lecture, T – Tutorial, P – Practical, C – Credit

Core Credit=6+ElectiveCredit=12 TotalCredit=18 with additional 3credits of self study & 01 credits of Journal club.

- Journal club will include the reading, presentation and to develop writing skills in view of thesis writing.
- The thesis evaluation will be of 180 marks and 60marks for academic performance and 60 for presentation/viva.

ExaminationScheme:

Components	I st Internal Assignment / Presentation	II nd Internal/ Written Exam Presentation	External (ESE)
Weightage (%) (Theory+Practical)	20	20	60
Dissertation			240

Master of Science (Microbiology)

Course code	: MMBC-101				
Course Name	: INTRODUCTORY MICROBIOLOGY				
Semester /Year	: I				
		L	T	P	C
		3	0	0	3

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To understand the history, scope, and fundamental concepts of microbiology.
2. To learn the structure, reproduction, and physiology of bacteria, viruses, fungi, and other microorganisms.
3. To explore microbial nutrition, growth, and the environmental factors affecting microbial activity.
4. To introduce basic laboratory techniques used in microbiology, including sterilization, culture methods, and microscopy.

Course Content

CREDITS: 03

Unit I: History and Classification

Discovery of microorganisms; Conflicts over spontaneous generation; Golden era of microbiology; Kingdom classification of microorganisms: Haeckel's three kingdom concept, Whittaker's five kingdom concept, Six kingdom classification, Eight kingdom classification, Three domain concept of Carl Woese; Differences between prokaryotes and eukaryotes; Techniques used in microbial classification (Morphological, chemotaxonomic and genetic methods); Tools for systematic (Phylogenetic, numerical and polyphasic taxonomy); Scope and relevance of microbiology.

Unit I: Basics of Microbiology

Microbial nutrition; Culture media; Culture techniques for isolation of pure culture; Cultivation of aerobic and anaerobic bacteria; Preservation methods; Microbial growth: Growth curve of batch and continuous cultivation, Diauxic growth curve, Generation time, Growth kinetics, Asynchronous and synchronous growth, Measurement of growth, Factors affecting growth; Control of microbial growth: Physical and chemical agents.

Unit III: General Bacteriology

Bergey's Brief Account of Gram-negative, Gram-positive Bacteria, bacteria Ultra structure of bacterial cell: Morphology of Bacteria, Structure and Properties of Cell Wall and Cell Membrane, Cell Wall Synthesis, Capsule (Types, Composition, and Function), Ultrastructure and Function of Flagella, Cilia, Pili, S-layer, Cytoplasmic Inclusions, Ribosomes, and Nucleoid; Bacterial Reproduction

Unit IV: General Virology and Mycology

Discovery of viruses; Characteristic features of viruses, viroids, virusoids, and prions; Baltimore scheme of classification; Morphology and ultrastructure: Capsids and their arrangements, Types and composition of envelopes, Viral genome (Types and structures); Isolation and cultivation of viruses, experimental animals, and cell culture; Infectivity assay (Plaque method, pock method, and endpoint methods); lytic and Lysogenic cycle; Mycology: General features, Mycelial organization and structure, Nutrition, Cultivation, Reproduction, Classification (Basis and general outline), Salient features of Ascomycetes, Basidiomycetes, Zygomycetes, and Deuteromycetes.

Unit V: Extremophiles

General introduction to archaea, bacteria, and applications. Tools used for studying extremophiles, culturable and non-culturable microbial diversity, Characteristic features, physiology, applications of acidophiles, alkaliphiles, psychrophiles, thermophiles, barophiles, halophiles, oligotrophs, osmophilic, radiophiles, metallophilic, and xerophilic.

Text Books:

1. Mehrotra, R.S., and Aneja, K.R. An introduction to mycology. New Age International (P)Limited, New Delhi.
2. Vashishta, B.R. Algae. S. Chand and Company, New Delhi.
3. Sharma, O.P. Textbook of algae. Tata McGraw-Hill Education, New Delhi.
4. Kumar, H.D. Introductory psychology. East-West Press, New Delhi.
5. Pelczar, M.J., Chan, E.C.S., and Kreig, N.R. Microbiology. McGraw-Hill, New York

Reference Books:

1. Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. Prescott, Harley and Klein's microbiology. McGraw-Hill, New York.
2. Black, J.G. Microbiology: Principles and exploration. John Wiley and Sons, New Jersey.
3. Madigan, M.T., Martinko, J.M. and Parker, J. Brock biology of microorganisms. Prentice Hall, New Jersey.
4. Pommerville, J.C. Alcamo's fundamentals of microbiology. Jones and Bartlett Learning, Sudbury.
5. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter, P.R. General microbiology. MacMillan Press, London.
6. Wheelis, M. Principles of modern microbiology. Jones and Bartlett Learning, Sudbury.

Course outcomes (COs):**Upon successful completion of the course, a student will be able to**

CO1	Explain the historical milestones in microbiology, including the discovery of microorganisms, debates over spontaneous generation, and the golden era of microbiology.
CO2	Compare and contrast the classification systems of microorganisms, including Haeckel's three kingdom concept, Whittaker's five kingdom concept, six kingdom classification, eight kingdom classification, and Carl Woese's three domain concept.
CO3	Analyze the differences between prokaryotic and eukaryotic microorganisms and describe the techniques used in microbial classification, such as morphological, chemotaxonomic, and genetic methods.
CO4	Demonstrate knowledge of microbial nutrition, growth, and cultivation techniques, including aerobic and anaerobic methods, preservation strategies, and factors affecting microbial growth.
CO5	Describe the ultrastructure and functions of bacterial cell components, including the cell wall, membrane, capsule, flagella, pili, ribosomes, and nucleoid, and explain bacterial reproduction mechanisms.
CO6	Generalize the characteristics, classification, and reproduction of viruses, viroids, prions, and fungi, and explain the physiological adaptations and applications of extremophiles in various environments..

CO-PSO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO1 1	PO 12	PSO1	P S O 2	PS O3	PSO 4
CO1	3	2	3	3	3	3	2	2	2	2	2	2	2	2	2	2
CO2	2	2	2	2	1	1	2	2	2	2	2	2	2	2	3	2
CO3	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2
CO4	2	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO5	2	2	1	2	1	1	2	2	2	2	2	2	2	2	2	2
CO6	2	2	2	1	1	1	2	2	2	2	2	2	2	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MMBC-102			
Course Name	: PRINCIPLES OF BIOCHEMISTRY			
Semester /Year	: I			
	L	T	P	C
	3	0	0	3

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:The objectives of this course are

1. To Understand the structure and function of biomolecules
2. To Analyse metabolic pathways
3. To Explore enzyme kinetics and mechanisms
4. To Examine the principles of bioenergetics

Course Content

Unit I: Biomolecules:

Structure and classification of carbohydrates, lipids, proteins, and nucleic acids, Chemical properties and biological roles, Water and pH: buffers and their significance in biological systems

Unit II: Enzymology

Enzyme classification and nomenclature, Mechanism of enzyme action and factors affecting activity, Enzyme kinetics: Michaelis-Menten equation, inhibition types, Coenzymes and cofactors

Unit III: Bioenergetics and Metabolic Pathways

Principles of thermodynamics in biological systems, ATP as energy currency, Overview of metabolic pathways: glycolysis, TCA cycle, oxidative phosphorylation, Electron transport chain, and chemiosmotic theory

Unit IV Metabolism of Biomolecules

Carbohydrate metabolism: gluconeogenesis, glycogen metabolism, Lipid metabolism: β -oxidation, fatty acid synthesis, Protein and amino acid metabolism: transamination, urea cycle, Integration and regulation of metabolism

Unit V- Advances in Biochemistry

Techniques in genetic engineering, cloning, and gene editing (CRISPR-Cas9), High-throughput sequencing, protein profiling, and functional genomics, Nanobiotechnology, and biochemical Basis of Disease

Structure and function of DNA and RNA, DNA replication, transcription, and translation, Genetic code and protein synthesis, Regulation of gene expression in prokaryotes and eukaryotes

Text Books:

1. Voet, D. and Voet, J.G. Biochemistry. John Wiley and Sons, New York.
2. Nelson D.L. and Cox, M.M. Lehninger principles of biochemistry. W.H. Freeman and Company, New York.
3. Berg, J.M., Tymoczko, J.L. and Stryer, L. Biochemistry. W.H. Freeman and Company, New York.

Reference Books:

1. Conn, E.E., Stumpf, P.K., Bruening, G., and Doi, R.Y. Outlines of biochemistry. John Wiley and Sons, New York.
2. Robert, M., Bender, D., Botham, K.M., Kennelly, P.J., Rodwell, V. and Weil, P.A. Harper's illustrated biochemistry. McGraw-Hill, New York
3. White, A., Handler, P., Smith, E., Hill, R. and Lehman, J. Principles of Biochemistry. McGraw-Hill, New York.
4. Jain, J.L. Fundamentals of biochemistry. S. Chand and Company, New Delhi.
5. Palmer, T. Enzymes: Biochemistry, biotechnology, and clinical chemistry. Horwood Publishing Company, Chichester.

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Describe the major biomolecules—carbohydrates, proteins, and lipids—concerning enzyme structure, function, and mechanism, and explain the fundamental concepts of bioenergetics.
CO2	Understand the principles of free energy, ATP synthesis, and the types and biological functions of carbohydrates, proteins, lipids, and enzymes.
CO3	Illustrate key biochemical concepts such as free energy, amino sugars, peptide bonds in proteins, nitrogen fixation, and the nomenclature of enzymes using appropriate diagrams and examples.
CO4	Compare the structural and functional properties of carbohydrates, amino acids, and lipids, and analyse the mechanisms of enzyme action.
CO5	Explain the structure and functions of nucleotides and the physiological process of nitrogen fixation in living organisms
CO6	Justify the classification and nomenclature of enzymes, the features and classification of amino acids, the biological roles of lipids, and the foundational principles of bioenergetics.

CO-POS- PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	2	3	3	3	3	2	2	2	2	2	2	2	2	2	2
CO2	2	2	2	2	1	1	2	2	2	2	2	2	2	2	3	2
CO3	2	2	1	2	2	2	2	2	2	2	2	2	3	3	2	2
CO4	2	3	2	2	2	2	2	2	2	2	2	2	2	2	3	2
CO5	2	2	1	2	1	1	2	2	2	2	2	2	2	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MMBC-103			
Course Name	: CELL AND MOLECULAR BIOLOGY			
Semester /Year	: I			
	L	T	P	C
	3	0	0	3

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To gain comprehensive knowledge of cellular components and their functions
2. To study the mechanisms of DNA replication, transcription, and translation.
3. To understand gene regulation and expression in prokaryotes and eukaryotes.
4. To study the processes of cell cycle regulation

Course Content

Unit I: Intracellular Compartmentalization of the Cell

Structure, organization, and function of the nucleus, mitochondria, chloroplasts, endoplasmic reticulum, Golgi body, peroxisome, lysosome, and endosomes; Molecular mechanism of vesicular trafficking. Fluid mosaic model, Membrane fluidity, Membrane Dynamics

Unit II: Cell Signalling

Basic signaling mechanisms (Paracrine, endocrine, and autocrine signaling); Mechanism of signal transduction: Signaling molecules, Ligand-receptors interaction, Trans membrane and intracellular signaling, Cell-surface receptors (G protein-coupled, enzyme-linked, and ion-channel-linked receptors), Second messengers and their role in signal transduction, Signal integration, Signaling amplification.

Unit III: Replication and Transcription

DNA replication in prokaryotes and eukaryotes: Experimental evidence, Modes of replication, Mechanism of replication, Inhibitors of replication; Transcription in prokaryotes and eukaryotes: RNA polymerases, Mechanism of transcription, Posttranscriptional modification of mRNA, rRNA, and tRNA, Inhibitors of transcription; Structural features and functions of mRNA, tRNA, and rRNA.

Unit IV: Translation and Regulation of Gene Expression

Basic features of the genetic code; Translation in prokaryotes and eukaryotes: Structure of ribosomes, Mechanism of translation, Post-translational modifications, Protein degradation, Non-ribosomal polypeptide synthesis, Inhibitors of translation; Regulation of gene expression: Structure and regulation of *lac* and *trp*, operon. RNA interference, and antisense RNA.

Unit V: Cell Cycle and Cell Death

Cell cycle, Molecular events, Cyclin, CDKs, Checkpoints in cell cycle, Intracellular control of cell cycle events, Mitosis and meiosis, Apoptosis: Mechanisms of apoptosis, Signals triggering

apoptosis, Apoptosis factors.

Text Books:

- 1 Tortora, Funke and Chase (2006). *Microbiology An Introduction* (9th ed.). Benjamin Cummings. I SBN 13: 9780321733603
- 2 Stanier, Ingraham, Wheelis. (1987) *General Microbiology* (5th ed.). MacMillan. ISBN-13: 978-0333417683

Reference Books:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. *Molecular biology of the cell*. Garland Science, New York.
2. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Scott, M.P., Bretscher, A., Ploegh, H. and Matsudaira, P. *Molecular cell biology*. W.H. Freeman and Company, New York.
3. Cooper, G.M. and Hausman, R.E. *Cell: Molecular approach*. ASM Press, Washington, D.C.
4. Robertis, E. D. P. and de Robertis, E.M.F. *Cellular and molecular biology*. Saunders, Philadelphia.
5. Pollard, T.D., Earnshaw, W.C. and Schwartz, J.L. *Cell biology*. Saunders, Philadelphia.
6. Karp, G. *Cell and molecular biology - Concepts and experiments*. John Wiley and Sons, New York.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Define Intracellular Compartmentalization of Cell, cell signaling, replication, protein synthesis and cell cycle, and cell death.
CO2	Understanding the types of cell organelles and cell signaling, mode of replication, transcription and Translation process in cell, Gene regulation, Mitosis and meiosis, the mechanisms and pathways leading to programmed cell death.
CO3	Explain the various cell organelles and function, various methods of signaling, Evidence and mechanism of Replication, protein synthesis in Prokaryotes and Eukaryotes, Types of cell division and cell death.
CO4	Analyze and explain Structure, organization and functions of cell organelles, process of cell signaling, Protein synthesis process in Prokaryotes and Eukaryotes, Types of Gene Regulation,
CO5	Summarize the function of cell organelles, role of signal molecule in cell, Protein synthesis in Pro- and Eukaryotes with post transcriptional and translational modification. Control of gene expression. Phases of cell cycle and mechanism of cell death.
CO6	Justify the role of cell organelles, various pathways of signalling, cell cycle, protein synthesis and gene regulation and role of apoptosis in development and disease, cell death.

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	3	3	2	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	1	1	2	2	2	2	2	2	2	2	3	2
CO3	2	2	1	2	2	2	2	2	2	2	2	2	3	3	2	2
CO4	2	3	2	2	2	2	2	2	2	1	2	2	2	2	3	2
CO5	2	2	1	2	1	1	2	2	2	2	2	2	2	2	2	2
CO6	2	2	2	2	1	1	2	2	2	2	2	2	2	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MMBC-104			
Course Name	: MICROBIAL GENETICS			
Semester /Year	: I			
	L	T	P	C
	3	0	0	3

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To understand the structure and function of microbial genomes.
2. To explore mechanisms of genetic variation in microbes
3. Analyse gene expression and regulation in prokaryotes
4. Apply molecular techniques to study microbial genetics

Course Content

Unit I: Essentials of Genetics

Genetic notations: prototrophs, auxotrophs, diploid, and electroporation. Gene as unit of mutation and recombination, molecular nature of mutation, origin of resistance due to spontaneous mutation. Model organisms and genetic analysis of bacteria and yeast. Locating a gene on a ‘small DNA molecule’ and a ‘large DNA molecule

Unit II: Recombination and Transposition

Recombination: Types, Models for homologous recombination (The Holliday model and Double-strand break repair model), Proteins involved in recombination; Transposition: Insertion sequences and transposable elements in prokaryotes and eukaryotes, Mechanism of transposition;

Unit III: Mutation and Repair Mechanism

Mutations: Types of mutations, Mutagens, screening chemicals for mutagenicity; DNA repair: Photoreactivation, methyl-directed mismatch repair, very short-patch mismatch repair, Nucleotide excision repair, Base excision repair, SOS system.

Unit IV: Gene transfer mechanisms

Bacterial plasmids: Types of plasmids, Fertility or (F) plasmid, resistance or R plasmid, colplasmid, degradative plasmid and virulence plasmids (Ti and Ri) and their uses in genetic analysis, Col plasmid and colicins; cryptic plasmids, penicillinase plasmid, resistance (R) plasmid- heavy metal resistance plasmids, degradative plasmids, Ti-plasmids and Ri-plasmids Compatibility and incompatibility, Mobilizable plasmids, Copy number of plasmids, Fertility inhibition, Donation and conduction; Transformation (Competence factor, natural and artificial transformation), Conjugation (F+ X F- mating, Hfr, Hfr X F-, and F’, mechanism of conjugation and sexduction)

Unit V: Phage genetics

Bacteriophage Cultivation, Replication, One step growth curve, Life cycle of lytic phages (T4, T7), lysogenic phages (phage, ΦX 174, M13), Regulation of lytic and lysogeny in lambda phage.

Transduction (Mechanism of generalized and specialized transduction, LFT and HFTlysate)

Text Books:

1. Tortora, Funke and Chase (2006). *Microbiology An Introduction* (9th ed.). Benjamin Cummings. ISBN 13: 9780321733603
2. Stanier, Ingraham, Wheelis. (1987) *General Microbiology* (5th ed.). MacMillan. ISBN-13: 978-0333417683
3. Weaver, R. F. (2012). *Molecular biology*. New York: McGraw-Hill. ISBN 0072345179.
4. P.S. Verma and V.K. Agarwal (2008). *Cell biology, Genetics, Molecular Biology, Evolution and Ecology*. S. Chand & Company Ltd, ISBN: 81-219-2442-1.
5. H Lodish et al, (2016). *Molecular Cell Biology*. 8/e, Freeman, ISBN 9781464183393.
6. Lehninger (2009). *Principles of Biochemistry*. W.H. Freeman; (6th ed). ISBN: 071677108X
7. Lewin, B. (2004). *Genes VIII*. International Edition, Pearson Education International, ISBN 0131238264

Reference Books:

1. GM Cooper & RE Hausman. (2016). *The Cell- Molecular Approach* 7/e. ISBN 978-1-60535-290-9.
2. JD Watson. (2013). *Molecular Biology of the Gene*, 7/e. Pearson. ISBN 978-0321762436.
3. Benjamin Lewin, *Genes IX*. (2008). Publisher: J&B ISBN: 0763752223

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Memorize the terms used in genetics.
CO2	Discuss the molecular mechanism underlying mutation, recombination, transposition, DNA damage, and repair.
CO3	Identify the role of plasmids and bacteriophages in transformation, conjugation and transduction
CO4	Correlate the knowledge of genes with the development of resistance, gene location, and the model organism.
CO5	Summarize different types of plasmids, and life cycles of bacteriophages, and the gene transfer mechanism
CO6	Write about different models of recombination, types of mutation, transposable elements, and DNA repair.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PS O1	P S O 2	PS O3	PS O4
CO1	3	2	3	2	3	2	2	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	1	1	2	2	2	1	2	2	2	2	3	2
CO3	2	2	1	2	2	2	2	2	2	1	2	2	3	3	2	2
CO4	2	2	2	2	2	2	2	2	2	1	2	2	2	2	3	2
CO5	2	2	1	2	1	1	2	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	1	1	2	2	2	1	2	2	2	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MMBL-105			
Course Name	: Laboratory Course-I (Based on paper 1 & 2)			
Semester /Year	: I			
	L	T	P	C
	0	0	3	3

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To develop proficiency in basic microbiological techniques
2. To observe and analyze microbial growth patterns
3. To perform qualitative and quantitative biochemical tests
4. To understand and apply biochemical principles

Course Content

CREDITS: 03

1. Safety rule so f working in microbiology lab, disposal of cultures, calibration, validation and maintenance of instruments.
2. Principles and working of instruments used in microbiology lab.
3. Media preparation and it's a sterilization.
4. Isolation and enumeration of bacteria and fungi from the given sample.
5. Isolation and maintenance of pure culture of bacteria and fungi.
6. Staining of bacterial cells (Simple staining, Gram staining, and negative staining).
7. Staining of fungal cell.
8. Staining of endospore and capsule.
9. Study of the morphology of algae.
10. Symptomatology of, infection of plant pathogens.
11. Measurement of bacterial cell size using a micro meter.

- 12.** Safety rules of working in the lab, hazards from chemicals, handling of chemicals, disposal of chemicals, recording of scientific experiments, calibration, validation, and maintenance of instruments.
- 13.** Calculation of moles, molarity, molality, and normality of a given solution.
- 14.** Calculation of pH of given solution.
- 15.** Preparation of solutions and buffers of different concentrations and pH.
- 16.** Qualitative tests for sugars, amino acids, proteins, and lipids in the given sample.
- 17.** Quantitative estimation of sugar in a given sample.
- 18.** Quantitative estimation of protein in the given sample.
- 19.** Estimation of lipid concentration in a given sample.

Course outcomes (COs):**Upon successful completion of the course, a student will be able to**

CO1	Define safety rules of working in the lab, sterilization techniques, and state the principles and working of instruments. Enumeration of bacteria and fungi from the given sample.
CO2	Estimate quantitatively and qualitatively the sugar, protein, and lipid in a given sample and identify different types of bacteria and fungi based on different staining techniques.
CO3	Preparation of media, solution, and buffers.
CO4	Calculation of moles, molarity, molality, and normality, and pH of a given solution.
CO5	Assess characteristic features of algae and symptoms of infection by plant pathogens.
CO6	Prepare and maintain a pure culture of bacteria.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	1	1	3	2	3	2	2	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	1	1	2	2	2	1	2	2	2	2	3	2
CO3	1	2	1	2	2	2	2	2	2	1	2	2	3	3	2	2
CO4	2	1	2	2	2	2	2	2	2	1	2	2	2	2	3	2
CO5	2	2	1	2	1	1	2	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	1	1	2	2	2	1	2	2	2	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MMBL-106			
Course Name	: Laboratory Course-II(Based on paper 3 & 4)			
Semester /Year	: I			
	L	T	P	C
	0	0	3	3

L - Lecture T – Tutorial P – Practical C – Credit

- 1.To learn to perform genomic DNA isolation from bacterial culture.
2. To learn to perform the preparation of competent cells.
- 3.Determination of the quality of DNA by the spectrophotometric method.

Course Contents

CREDITS: 03

1. Study of different stages of mitosis.
2. Study of different stages of meiosis.
3. To prepare a temporary slide of mitosis.
4. To prepare a temporary slide of meiosis.
5. Demonstration of transformation in bacteria.
6. Quantitative estimation of DNA by diphenylamine (DPA) and the spectrophotometric method.
7. Isolation of RNA.
8. Determination of the quality of DNA by the spectrophotometric method.
9. Isolation of genomic DNA from bacterial culture.
10. Visualization of DNA by agarose gel electrophoresis.
11. Determination of T_m of the given DNA sample.
12. Study of the effect of different concentrations of urea on the denaturation of DNA.
13. Demonstration of dark repair mechanism in bacteria.
14. Study of the effect of temperature and pH on the denaturation of DNA.
15. Mutagenesis in the given bacterial culture by UV radiation.
16. Demonstration of the photo reactivation mechanism in bacteria.
17. Preparation of competent cells.
18. Demonstration of conjugation in bacteria.
19. Isolation of antibiotic-resistant bacteria by the gradient plate method.
20. Isolation of antibiotic-resistant mutants by the replica plating technique.

Course outcomes (COs):**Upon successful completion of the course, a student will be able to**

CO1	Identify different stages of the cell cycle.
CO2	Isolate the genomic DNA of bacteria and antibiotic-resistant bacteria.
CO3	Demonstrate the process of mutagenesis, photoreactivation, transformation, and conjugation.
CO4	Analyze the effect of environmental stress on the denaturation of DNA
CO5	Estimate the quantity of DNA
CO6	Prepare slides of mitosis and meiosis, and a competent cell

CO- PSO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PS O1	P S O 2	PS O3	PS O4
CO1	3	2	3	2	3	2	2	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	1	1	2	2	2	1	2	2	2	2	3	2
CO3	2	2	1	2	2	2	2	2	2	1	2	2	3	3	2	2
CO4	2	2	2	2	2	2	2	2	2	1	2	2	2	2	3	2
CO5	2	2	1	2	1	1	2	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	1	1	2	2	2	1	2	2	2	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MMBC-201			
Course Name	: MICROBIAL PHYSIOLOGY AND METABOLISM			
Semester /Year:	II			
	L	T	P	C
	3	0	0	3

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To provide an in-depth understanding of microbial energy generation mechanisms through photosynthesis and chemolithotrophy .
2. To explain the principles of microbial respiration and fermentation .
3. To explore bacterial membrane dynamics, stress responses and adaptive strategies.
4. To examine the regulation of microbial metabolism

Course Content

Unit I: Microbial Photosynthesis and Chemolithotrophy

Photosynthetic microorganisms: General characteristics of photosynthetic bacteria, Photosynthetic and accessory pigments, Oxygenic and anoxygenic photosynthesis, Photosynthetic electron transport system, cyclic and non-cyclic photophosphorylation, Dark reaction, Physiological groups of chemolithotrophs, Characteristic features of chemo lithotrophs, Mechanism of energy generation in methylotrophs and methanogens.

Unit II: Nitrogen and Sulphur Metabolism

Nitrogen metabolism: Nitrogen fixation (Characteristics of nitrogen fixing bacteria, biochemistry of nitrogenase complex, nitrogenase types, functions of nif genes, symbiotic nitrogen fixation and regulation of nitrogenase), Inorganic nitrogen metabolism, Assimilation of inorganic nitrogen, Sulphur metabolism: Free and bound pathways of assimilation of sulphate into cysteine, Glutathione and its role in sulphur metabolism.

Unit III: Microbial Respiration and Fermentation

Respiration: Aerobic respiration, Components of the electron transport chain, and electron transport, oxidative phosphorylation, and theories of ATP formation, inhibition electron transport chain. Anaerobic respiration, Mechanism of oxygen toxicity; Fermentation: Glucose, acetic acid, lactic acid, butyric acid, propionic acid, and mixed acid fermentation.

Unit IV: Bacterial Permeation

Structure and organization of membrane, fluid-mosaic model of the membrane. Methods to study diffusion of solutes in bacteria, passive diffusion, facilitated diffusion, different mechanisms of active diffusion (Proton Motive Force, PTS, role of permeases in transport, different permeases in E. coli., Various Protein secretion pathways in bacteria

Unit V: Microbial Stress Response

Osmotic stress and osmoregulation, Mechanism of transition from aerobic to anaerobic, Oxidative stress and its regulation, pH stress and acid tolerance response, Thermal stress and heat shock response, Nutrition stress and starvation-stress response, Stringent response, Sporulation and morphogenesis (Endospores: Physiological and genetic aspects of sporulation, Activation, germination and outgrowth). Quorum sensing; Bioluminescence in microorganisms.

Text Books:

1. Foster, J.W. and Spector, M.P. Microbial physiology. John Wiley and Sons, New York
2. Pelczar, M.J., Chan, E.C.S., and Kreig, N.R. Microbiology. McGraw-Hill, New York
3. Wiley, J.M., Sherwood, L.M., and Woolverton, C.J. Prescott, Harley, Microbiology. McGraw-Hill, New York.

Reference Books:

1. Foster, J.W. and Spector, M.P. Microbial physiology. John Wiley and Sons, New York.
2. Madigan, M.T., Martinko, J.M., and Parker, J. Brock Biology of Microorganisms. Prentice Hall, New Jersey.
3. Brun, Y.V. and Shimkets, L.J. Prokaryotic development. ASM Press, Washington, D.C.
4. Rose, A.H. Advances in microbial physiology. Academic Press, New York.
5. David, W., Drummond, J.T. and Fuqua, C. Physiology and biochemistry of prokaryotes. Oxford University Press, New York.

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Define microbial photosynthesis and chemolithotrophy, nitrogen and sulphur metabolism in bacteria, microbial respiration and fermentation, bacterial permeation, and Microbial stress.
CO2	Summarize the photosynthetic microorganism and its function, chemolithotrophs, Nitrogen fixation and Sulphur metabolism in bacteria, mechanism of Microbial Respiration. Structure and organization of membrane, Osmotic stress and osmoregulation in microorganisms.
CO3	Explain Aerobic respiration and Anaerobic respiration in bacteria, the fermentation pathway in microorganisms. Structure and organization of the membrane, Response of bacteria in stress conditions.
CO4	Explain the Photosynthetic electron transport system, Characteristic features of chemolithotrophs, Characteristics, biochemistry, and mechanism of nitrogen fixing bacteria, various sulphur metabolism pathways in Microorganism, Mechanism of microbial stress response in microorganism.
CO5	Summarize the Microbial Photosynthesis, Mechanism of photosynthesis in microorganisms, Respiration and Fermentation pathway in microorganisms, Cell membrane pathway in bacteria, and Different types of stress in bacteria.

CO6	Justify Phototrophs and chemotrophs, role of nitrogen fixing bacteria in the nitrogen fixation process, sulphur metabolism process, Aerobic and anaerobic respiration in bacteria, Role of bacteria in fermentation pathway, Transport system in bacteria, Regulation of Microbial stress and mechanism in bacteria.
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CO-PSO-PO Mapping;

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PS O1	P S O 2	PS O3	PS O4
CO1	2	2	2	2	3	2	2	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	1	1	2	2	2	1	2	2	2	2	3	2
CO3	2	2	2	2	2	2	2	2	2	1	2	2	3	3	2	2
CO4	2	2	2	2	2	2	2	2	2	1	2	2	2	2	3	2
CO5	2	2	2	2	1	1	2	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	1	1	2	2	2	1	2	2	2	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MMBC—202			
Course Name	: IMMUNOLOGY			
Semester /Year	: II			
	L	T	P	C
	3	0	0	3

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:The objectives of this course are

- 1.To gain knowledge of the immune system.
- 2.To gain knowledge of Antigen structure and properties.
- 3.To make the student aware of Tumour immunology.

Course Content

Unit I: Overview and elements of the immune system

Cells and Organs of the Immune; Innate Immunity/Inflammation Immune response – naturally acquired immunity; artificially acquired immunity. Humoral and cell-mediated immunity; Immunization: Active and passive Cytokines

Unit II: Antigens and Antibodies

Antigens: Structure and properties; Antigen-specificity; Haptens; Adjuvants; Immunogenicity; Factors affecting immunogenicity; Immunoglobulin: Structures, Heterogeneity, Types and subtypes, Properties(Physicochemical and biological), Monoclonal antibodies (General properties and applications), Hybridoma technology; Antigen–antibody reactions: Precipitation and agglutination reactions. Immunodiagnostic techniques: Immuno electrophoresis, RIA, ELISA, Chemiluminescence immunoassay, Western blotting, Complement fixation test, Immunofluorescence, Flow cytometry.

Unit III: Complement System and Major Histocompatibility Complex

Complement activation pathways (Classical, alternate, and lectin pathways), Biological consequences of complement activation, Complement assay. Structure and function of MHC and HL-A system; Role of MHC in the Immune Response: Antigen processing and presentation; Transplantation: Graft vs. host reaction and rejection

Unit IV: Humoral and Cell-Mediated Immune Response and Regulation

B-cell receptor; Development and differentiation of B cells, T–cell receptor complex; Development and differentiation of T cells. Immune Response: T-Cell -Cell mechanisms, T-Cell dependent defense mechanisms; Cell-mediated cytotoxicity: T cytotoxic cells, Natural Killer (NK)Cells, Antibody-dependent cell cytotoxicity (ADCC), Macrophage-mediated cytotoxicity.

Unit V: Medical Application of Immunology (Immunopathology)

Hypersensitivity reactions (antibody-mediated type I, anaphylaxis, type II- antibody dependent cell

cytotoxicity, type III-immune complex-mediated reactions, and type IV-delayed hypersensitivity reactions). Autoimmunity; Immunodeficiency; Tumor immunology-tumour specific antigens, immune response to tumor, Tumor escape mechanisms, Immunotherapy of cancer; Vaccines

Text Books:

1. Delves, P.J., Martin, S.J., Burton, D.R., and Roitt, I.M. Roitt's essential immunology. Wiley-Blackwell, New Jersey.
2. Abbas A.K., Lichtman A.H.H., and Pillai, S. Cellular and molecular immunology. Saunders, Philadelphia.

Reference Books

1. Kindt, T.J., Goldsby, R.A., Osborne, B.A., and Kuby, J. Kuby immunology. W.H. Freeman and Company, New York.
2. Male, D.K. Immunology: An illustrated outline. Elsevier Health Sciences, Philadelphia.
3. Tizard, I.R. Immunology: An introduction. Saunders, Philadelphia.

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Define the terms used in the immune system, Antigen and antibody, complement system and MHC, immune response, and medical applications of immunology.
CO2	Discuss and differentiate between cells of the immune system, types of immunity and immune response, antigens, and antibodies. Explain the role of the complement system in immune response, MHC, and medical applications of immunology.
CO3	Write about the basic concept of immunity and the immune system. Explain with diagrams the antigen –its properties, types, and functions, and antibodies, their types and functions, complement component, pathways, etc. MHC, Transplantation, immune response and regulation, and immunopathology.
CO4	Illustrate and diagrammatically explain cells of the immune system. Explain types of immunity and immune response, concept of antigen and antibodies, MHC, complement system and its activation pathways, transplantation, immune response and regulation, and medical applications of immunology.
CO5	Summarize along with diagrams the concept of the immune system, antigens, antibodies, complement system and MHC, transplantation, immune response and regulation, and medical applications of immunology.
CO6	Generalize the concept of Immunology

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PS O1	P S O 2	PS O3	PS O4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	1	1	1	2	2	1	2	2	2	2	3	2
CO3	2	2	2	2	2	1	1	2	2	1	2	2	3	3	2	2
CO4	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MMBC—203			
Course Name	: BIOLOGICAL TECHNIQUES			
Semester /Year	: II			
	L	T	P	C
	3	0	0	3

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To aware the student to principle of the pH meter.
2. To learn about the principles and applications of various electrophoretic techniques.
3. To learn about spectroscopy and radio isotopic techniques.

Course Content

Unit I: Basic Laboratory Instruments No. Of Hours: 12

Principle and working of a pH meter, Laminar-airflow. Centrifugation: Common centrifuges used in laboratory (Clinical, micro, high speed, ultra, and industrial centrifuges); Types of rotors (Fixed, angle, swinging bucket, and continuous tubular); Types of centrifugation (Principle and applications): Preparative (Differential and density gradient centrifugation) and analytical centrifugation.

Unit II: Microscopy and Biosensors

Microscopy (Principles and Applications): Light, phase contrast, fluorescence, Scanning and transmission electron microscopy; Biosensors: Introduction and principles, First, second, and third generation instruments, Cell-based biosensors, Enzyme immunosensors, DNA biosensor

Unit III: Chromatographic Techniques

Theory, principle, and applications of chromatography; Types of chromatography (Principles and applications): Adsorption chromatography, Ion exchange chromatography, Affinity chromatography, Size exclusion chromatography, Thin-layer chromatography, Gas chromatography, High-pressure liquid chromatography (HPLC), Supercritical fluid chromatography.

Unit IV: Electrophoretic Techniques

Basic principles and applications of electrophoresis; Types of electrophoresis (Principles and applications): Paper electrophoresis, moving boundary electrophoresis, Isotachopheresis, Agarose gel electrophoresis,

Polyacrylamide gel electrophoresis (SDS-PAGE, Native-PAGE, Denaturing-PAGE, and Reducing-PAGE), Isoelectric focusing (IEF).

Unit V: Spectroscopy and Radio isotopic Techniques

An elementary idea of spectroscopy. Radiotracer techniques: Applications of radioisotopes in biology, Properties and units of radioactivity, Radioactive isotopes and half-life, Safety rules in handling of radioisotopes
Autoradiography: Principle and its applications.

Text Books:

1. Cappuccino, J. and Sherman, N. Microbiology: A laboratory manual. Benjamin/Cummings Publishing Company, San Francisco.
2. Prescott, L.M. and Harley, J.P. Laboratory exercises in microbiology. William C. Brown, Dubuque.
3. Aneja, K.R. Experiments in microbiology, Plant Pathology and Biotechnology. New Age International(P) Limited, New Delhi

Reference Books

1. Atlas, R.M., Brown, A.E., and Parks, L.C. Laboratory manual of experimental microbiology. Mosby College Publishing Company, St. Louis. Kannan, K. Laboratory manual in general microbiology. Panima, New Delhi.
2. Holt, J.G. and Krieg, N.R. Bergey's manual of determinative bacteriology. Lippincott Williams and Wilkins, Philadelphia. Jayaraman, J. Laboratory manual in biochemistry. New Age International (P) Limited, New Delhi
3. Sawhney, S.K. and Singh, R. Introductory practical biochemistry. Narosa Publishing House, New Delhi.
4. Segel, I.H. Biochemical calculations. John Wiley and Sons, New York.
5. Plummer, D.T. Introduction to practical biochemistry. McGraw-Hill, New York.
6. Boyer, R.F. Modern experimental biochemistry. Prentice Hall, New Jersey.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Define basic principle of laboratory Instruments, Microscopy and Biosensors, Chromatography, electrophoresis, Spectroscopy and Radioisotope.
CO2	Summarize the principals and function of laboratory Instruments , Microscopy and Biosensors , Theory, principle and applications of chromatography, Basic principles and applications of electrophoresis and spectroscopy. Applications of radioisotopes in biology
CO3	Explain application and principle of laboratory instruments, Introduction and principles of Microscopy and biosensors, Theory, principle and applications of chromatography, Basic principles and applications of electrophoresis, Elementary idea of spectroscopy. Radiotracer techniques.
CO4	Explain principles of Instruments, Types of biosensor and Microscopy, principle and applications of electrophoresis, principle and applications of radioisotopes.
CO5	Summarize the principles and types of Ph meter, Laminar air flow and centrifugation., Applications of radioisotopes in biology
CO6	Justify basic laboratory Instruments, function of microscopy and biosensor, principle and applications of chromatography, Applications of radioisotopes in biology.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PS O1	P S O 2	PS O3	PS O4
CO1	2	2	3	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	3	2	2	2	1	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	2	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	2
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MMBC—204			
Course Name	: RECOMBINANT DNA TECHNOLOGY			
Semester /Year	: II			
	L	T	P	C
	3	0	0	3

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To understand the basic principles and tools of recombinant DNA technology.
2. To learn various techniques for gene cloning
3. To explore applications of recombinant DNA in medicine, agriculture, and industry
4. To develop practical skills in molecular biology methods

Course Content

Unit I: Principles and Tools of Gene Cloning

Isolation of nucleic acids; Enzymes used in genetic engineering; Restriction endonucleases; Cloning vectors: Characteristic features and applications of vectors based on plasmids (*E. coli* and yeast), phages (λ and M13 bacteriophage), Cosmids, phasmids, artificial chromosome vectors (BAC, PAC and YAC), vectors for plants and animal cells and shuttle vectors.

Unit II: Strategies of Gene Cloning

Gene cloning: Steps of cloning, Formation of DNA fragments using linkers, adaptors and homopolymer tails, Introduction of DNA into host cells (Bacteria and animal cells); Construction of cDNA and genomic library; Obtaining clone of a specific gene: Problem of selection, Direct selection, Selection strategies for recombinants produced by different vectors, Methods of identification of a clone from a gene library.

Unit III: Expression of Cloned Gene in Heterologous System

Expression vectors: structure, components, and advantages; Characteristic features of pEt, and cytomegalovirus expression systems; Model host systems: *E. coli*, Fungi, Mammalian cell lines, Insect cells, Transgenic plants and animals; Screening strategies; Identification and study of translation product of a cloned gene: HRT and HART techniques.

Unit IV: Sequence Detection, Amplification, and Modification Techniques

Blotting techniques (Methodologies and applications): Southern, Northern, and Western blotting; Probe labelling and hybridization; DNA sequencing (Chemical, enzymatic, and automated methods); Sequence assembly for whole genome analysis; PCR: Principle and applications; Types of PCR; Site-directed mutagenesis.

Unit V: Genome Analysis and Applications of RDT

Principles and applications of techniques used in genome analysis: Exon trapping, R analysis, S1– mapping, Chromosome walking, Ribonuclease protection assay, Gel retardation assay, DNA foot printing, DNA fingerprinting, Antisense technology, Ribozyme technology; Applications of recombinant DNA technology in forensic science, therapeutics, and agriculture.

Text Books:

1. Brown, T.A. Gene cloning and DNA analysis: An introduction. Wiley-Blackwell, New Jersey.
2. Primrose, S.B. and Twyman, R. Principles of gene manipulation and genomics. Wiley-Blackwell, New Jersey.
3. Brown, T.A. Genomes. Wiley-Liss, Oxford
4. Sambrook, J. and Russell, D.W. Molecular Cloning: A laboratory manual. Cold Spring Harbor Lab Press, New York.

Reference Books

1. Nicholl, D.S.T. An introduction to genetic engineering. Cambridge University Press, Cambridge.
2. Glick, B.R., Pasternak, J.J., and Patten, C.L. Molecular biotechnology: Principles and applications of recombinant DNA. ASM Press, Washington, D.C. Hartwell, L. Genetics: From genes to genome. McGraw-Hill, New York.
3. Old, R.W. and Primrose, S.B. Principles of gene manipulation. Blackwell Science, Oxford.
4. Winnacker, E.L. From genes to clones: Introduction to gene technology. Wiley-VCH, Germany.
5. Reece R.J. Analysis of genes and genomes. John Wiley and Sons, New York.
6. Recombinant DNA safety guidelines. Department of Biotechnology, Ministry of Science and Technology, Government of India, New Delhi.

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Describe principles, tools, techniques, and strategies used in gene cloning and genome analysis.
CO2	Elucidate the molecular techniques involved in gene manipulation and rDNA technology.
CO3	Explain the concept of vectors and gene transfer methods for the production of transgenic plants and animals.
CO4	Appreciate the techniques used in genome analysis and their applications.
CO5	Summarize the role of vectors in gene cloning and expression.
CO6	Develop understanding of sequence detection, gene amplification, modification, and genome analysis techniques, and also applications of RDT.

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	1	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	2	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	2
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MMBL-205			
Course Name	: Laboratory Course-I(Based on paper 1 & 2)			
Semester /Year	: I			
	L	T	P	C
	0	0	3	3

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To learn to perform the effect of temperature, pH, and salt Concentration on the growth of bacteria.
2. To study of different stages of sporulation in *Bacillus*.
3. To study the separation and preservation of serum and plasma.

Course Content

CREDITS: 03

1. Study of the effect of temperature, pH, and salt concentration on the growth of bacteria.
2. Determination of the ability of bacteria to reduce nitrate.
3. Determination of the ability of bacteria to produce H₂S.
4. Determination of the presence of cytochrome oxidase in bacteria.
5. Determination of the presence of catalase in bacteria.
6. Determination of the ability of bacteria to produce acidic or neutral end products from glucose.
7. Determination of the ability of bacteria to utilize sugars by oxidative or fermentative mode.
8. Study of different stages of sporulation in *Bacillus*.
9. Effect of pH, sugars, amino acids, and inorganic compounds on spore germination.
10. Study of the mechanism of diffusion.
11. Study of the mechanism of exosmosis and endosmosis.
12. Effect of isotonic, hypotonic, and hypertonic solutions on the cell.
13. Separation and preservation of serum and plasma.
14. Determination of blood group and Rh factor.
15. Demonstration of agglutination reaction of bacterial cultures by the slide agglutination test.

Course outcomes (Cos):**Upon successful completion of the course, a student will be able to**

CO1	Observe the biochemical characterization of bacteria
CO2	Observe the effect of pH, sugars, amino acids, and inorganic ions on spore germination
CO3	Determine the effect mechanism of diffusion and osmosis on the cell.
CO4	Separation of blood components.
CO5	Perform a test for the presence of a specific antibody for its antigen by the Dot-ELISA method.
CO6	Serological test for the given blood/serum sample.

CO- PSO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	3	2	3	2	3	2	2	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	1	1	2	2	2	1	2	2	2	2	3	2
CO3	2	2	1	2	2	2	2	2	2	1	2	2	3	3	2	2
CO4	2	2	2	2	2	2	2	2	2	1	2	2	2	2	3	2
CO5	2	2	1	2	1	1	2	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	1	1	2	2	2	1	2	2	2	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MMBL-206			
Course Name	: Laboratory Course-II(Based on paper 3 & 4)			
Semester /Year	: I			
	L	T	P	C
	0	0	3	3

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To make the student to aware separation of sugars by paper chromatography.
2. To make student to aware principle of Lambert Beers law.
3. To learn perform preparation of competent cells.

Course Content

CREDITS: 03

1. Separation and identification of amino acids by ascending and descending paper chromatography.
2. Separation and identification of sugars by paper chromatography.
3. Separation and identification of sugars by thin layer chromatography.
4. Verification of Lambert Beer's law.
5. Determination of molecular weight of DNA by agarose gel electrophoresis.
6. Separation and determination of molecular weight of proteins by SDS-PAGE.
7. Visualization of enzyme activity by NATIVE-PAGE.
8. Isolation of genomic DNA from plant sample.
9. Isolation of genomic DNA from animal cell
10. Isolation of plasmid DNA from bacterial cell.
11. Isolation of genomic DNA from bacterial cell
12. PCR amplification of DNA.
13. Restriction digestion of vector and DNA.
14. Preparation of competent cells.
15. Determination of similarity between different bacterial isolates using RFLP.

Course outcomes (Cos):

Upon successful completion of the course a student will be able to

CO1	Identify and separate amino acid and sugars by chromatographic techniques.
CO2	Interpret molecular weight of DNA by gel electrophoresis techniques.

CO3	Demonstrate isolation of genomic and plasmid DNA and visualize by electrophoresis
CO4	Verify Lambert Beer's law.
CO5	Perform restriction digestion and amplification of DNA.
CO6	Prepare competent cells.

CO- PSO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PS O1	PS O 2	PS O3	PS O4
CO1	3	2	3	2	3	2	2	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	1	1	2	2	2	1	2	2	2	2	3	2
CO3	2	2	1	2	2	2	2	2	2	1	2	2	3	3	2	2
CO4	2	2	2	2	2	2	2	2	2	1	2	2	2	2	3	2
CO5	2	2	1	2	1	1	2	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	1	1	2	2	2	1	2	2	2	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MMBC—301			
Course Name	: Medical Microbiology			
Semester /Year	: III			
	L	T	P	C
	3	0	0	3

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To understand the fundamentals of Medical Microbiology.
2. To gain knowledge about mechanism of microbial pathogenesis.
3. To gain knowledge of major bacterial, viral and fungal disease.

Course Content

TOTAL HOURS: 60

CREDITS: 03

Unit I: Basics of Medical Microbiology

Normal microbiota of human body; Role of resident flora and human host; Routes of transmission of pathogens; Nosocomial infections; Collection, transportation and processing of clinical samples; Isolation and identification of pathogenic organisms; Quality control in medical microbiology laboratory.

Unit II: Pathogenesis

Pathogenicity islands; Mechanism of pathogenesis: Mechanism of bacterial adhesion, colonization and invasion, mechanism of survival, Bacterial toxins (Classification and mode of action), Cytoskeletal modulation of host cell.

Unit III: Antimicrobial Chemotherapy

Methods of drug susceptibility testing: Kirby-Bauer’s disc diffusion method, Stokes method, Agar dilution method, Broth dilution method, E-strip method; Mechanism of action of antimicrobial agents; Emergence of drug resistance in bacteria (MRSA, ESBL and MDR TB); Resistance mechanism; Various types of vaccines for prevention of infectious diseases; COVID Vaccine, National immunization program and immunization schedule.

Unit IV: Bacterial Diseases

Clinical features, transmission, characteristics of causative organism, pathogenesis, laboratory diagnosis, prevention and control of bacterial diseases and clinical syndromes: Cholera, Leprosy, Diphtheria, Tetanus, Meningitis, Conjunctivitis, Pneumonia and Gastroenteritis.

Unit V: Viral and Fungal Diseases

Clinical features, transmission, characteristics of causative organism, pathogenesis, laboratory diagnosis, prevention and control of viral diseases: Herpes, Chikungunya, Influenza, Measles, Mumps, Hepatitis, HIV, Coronavirus. clinical features, transmission, pathogenesis, laboratory diagnosis, prevention and control of fungal diseases: Aspergillosis, Cryptococcosis, Candidiasis, Blastomycosis.

Text Books:

1. ArtiKapil.
(2013). *Ananthnarayan & Paniker's Textbook of Microbiology*, (9th ed). Universities press (India) Private Limited, ISBN: 9788173718892.
2. Ananthnarayanan, R. and Panicker, C.K.J. *Textbook of microbiology*. Orient Longman, Hyderabad
3. Chakraborty, P. *A textbook of microbiology*. New Central Book Agency Private Limited, Calcutta.
4. Paniker, J. *Textbook of medical parasitology*. Jaypee Brothers Medical Private Limited, New Delhi

Reference Books

1. Koneman, E. W. *Koneman's color atlas and textbook of diagnostic microbiology*. Lippincott Williams and Wilkins, Philadelphia.
2. Topley, W. W. C., Wilson, S. G. and Parker, M. T. *Topley and Wilson's principles of bacteriology, virology and immunity*. Edward Arnold, London.
3. Greenwood, D., Slack, R. B. and Peutherer, J. F. *Medical microbiology*. Churchill Livingstone, London.
4. Mahon, C. R. and Manuselis, G. *Textbook of diagnostic microbiology*. Saunders, Philadelphia.

Course outcomes (Cos):

Upon successful completion of the course a student will be able to

CO1	Define Normal microbiota of human body, pathogenesis, Antimicrobial Chemotherapy, Bacterial Diseases, Viral and Fungal Diseases.
CO2	Summarize the role of resident flora and human host, Pathogenicity islands, drug susceptibility testing, bacterial diseases and clinical syndromes, control of viral diseases.
CO3	Explain the normal microflora in human, mechanism of pathogenesis, methods of drug susceptibility testing, transmission, characteristics of causative organism, pathogenesis, laboratory diagnosis, prevention and control of bacterial, viral and fungal disease.
CO4	Explain infection and pathogenicity, role of microorganism in human flora, various method of drug susceptibility testing, different bacterial diseases, prevention and control, transmission, pathogenesis, laboratory diagnosis, prevention and control of fungal diseases.
CO5	Summarize the role of resident flora and human host, Pathogenicity islands, methodology of drug susceptibility testing, various bacterial, viral and fungal disease

CO6

Justify the routes of transmission of pathogens, how to bacteria enter the host, Methods of drug susceptibility testing, pathogenesis , treatment and control of bacterial ,viral and fungal diseases.

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	1	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	2	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	2
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MMBC—302				
Course Name : INDUSTRIAL AND PHARMACEUTICAL MICROBIOLOGY				
Semester /Year : III				
	L	T	P	C
	3	0	0	3

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To make student aware to fermenter design and function.
2. To gain knowledge about media formulation and Inoculum development
3. To make student aware Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry

Course Content

Unit I: Introduction to Industrial Microbiology

Primary and secondary metabolites; Structure of fermenter/bioreactor; Types of fermenter /bioreactors; Scale up and scale down processes; Types of fermentation (Solid state, surface and submerged fermentation). Batch and continuous culture.

Unit II: Basic Aspects of Fermentation

Media formulation; Sterilization; Inoculum development; Effect of temperature, pH and high nutrient concentration on fermentation; Operational modes of fermentation (Batch, fed-batch and continuous); Downstream processing.

Unit III: Microbial Strain Improvement

Strategies for isolation and cultivation of desired microorganisms; Screening for the desired product; Strategies for strain improvement: Mutation, Protoplast fusion, Recombinant DNA technology, idea of Novel strategies. Preservation of cultures after strain improvement programme.

Unit IV: Industrial Production Aspects Production of antibiotics

(streptomycin, Griseofulvin), amino acid (Glutamic acid and lysine), Production of enzymes (Pectinase, amylase, lipase, protease, cellulase and xylanase), organic acids (Citric acid, acetic acid and lactic acid), ergot alkaloids and bioplastics (PHB and PHA). Antifoam agent.

Unit V: Introduction to Quality Assurance and Validation

Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry; Basic principles of quality control (QC) and quality assurance (QA); Guidelines for QA and QC (Raw materials, sterilization, media, stock cultures and products), ISO, WHO and US certification; Sterilization control and sterility testing; Validation on study; LAL test; Sterility testing and bioassay; Application of Biosensors in pharmaceuticals.

Text Books:

1. Crueger, W. and Crueger, A. Biotechnology: A textbook of industrial microbiology. Sinauer Associates, Sunderland.
2. Reed, G. Prescott and Dunn's industrial microbiology. Globe Book services, London.
3. Demain, A. Land Davies, J.E. Manual of industrial microbiology and biotechnology. ASM Press, Washington, D.C.
4. Casida, J.E. Industrial microbiology. Wiley Eastern, New Delhi.
5. Patel, A.H. Industrial microbiology. MacMillan India Limited, New Delhi.

Reference Books

1. Hershberger, C.L., Queener, S.W. and Headmen, Q. Genetics and biotechnology of industrial microorganisms. ASM Press, Washington, D.C
2. Adams, M.R., and Moss, M.O. Food microbiology. Royal Society of Chemistry Publication, Cambridge.
3. Stanbury, P. F. and Hall, S.J. Principles of fermentation technology. Pergamon Press, Oxford.
4. Robinson, R.K. Dairy microbiology. Elsevier Applied Sciences, London

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Define Basic Aspects of Fermentation, Introduction to Industrial Microbiology, Antibiotic production and Quality Assurance and Validation
CO2	Summarize basic structure and function of fermenter, fermentation, strain improvement and QA and QC
CO3	Write about fermentation, concept of strain improvement, antibiotic production and Guidelines for QA and QC, (GMP) and (GLP) in pharmaceutical industry.
CO4	Explain the basic concept of fermenter, Strategies for strain improvement, Production of antibiotic and Quality Assurance and Validation.
CO5	Summarize the concept of Industrial and Pharmaceutical Microbiology.
CO6	Compile and write about the study of Industrial and Pharmaceutical Microbiology.

CO- PSO-PO Mapping:

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PS O1	P S O 2	PS O3	PS O4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	2	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Course code	: MMBE--303a			
Course Name	: Elective – IA Food and Dairy Microbiology			
Semester /Year	: III			
	L	T	P	C
	0	0	3	3

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To aware the student principles of food preservation.
2. To make student to aware spoilage of fermented foods
3. To aware the student Food Safety and Quality Assurance

Course Content

Unit I: Principles of Food Preservation

Factors influencing microbial growth in food; Asepsis; Food preservation: Principles, Physical methods (Dehydration, freeze drying, heat and irradiation), Chemical methods (Chemical preservatives and food additives); Canning; Processing for heat treatment (D, Z and F values) and working out treatment parameters; Microbiological quality standards of food.

Unit II: Contamination and Spoilage

Characterization of contamination and spoilage of cereals, vegetables, fruits, meat and meat products, milk and milk products, fish and sea foods, beer and wines; Spoilage of fermented foods and canned foods. Difference between contamination and spoilage.

Unit III: Food borne Infections and Intoxications

Bacteria and non bacterial infections and intoxications of *Brucella*, *Bacillus*, *Clostridium*, *Escherichia*, *Salmonella*, *Shigella*, *Staphylococcus*, *Vibrio*, *Yersinia*, *Listeria*, nematodes, protozoa, algae, fungi and viruses; Structure and functions of aflatoxins; Laboratory testing procedures.

Unit IV: Food Safety and Quality Assurance

Microbiological quality standards of food; Food control agencies and their regulations: FDA, EPA, CDC and ISI; Good Manufacturing Practice; Plant sanitation (Employee health standards, waste treatment and disposal); Hazard Analysis and Critical Control Point (HACCP) system; Food Safety Act and Trade Regulations.

Unit V: Production of Fermented Foods

Industrial production methods of bread, cheese, fermented vegetables (Olives and cucumber), fermented dairy products (Acidophilus milk, cheese and yoghurt), single cell proteins, sauerkraut, meat and fishery products (Sausages and fish sauces); Production of oriental foods (Mycoprotein, tempeh, soya sauce, idli, natto and poi) and beverages (Vinegar, cider, sake and palmwines); Alcoholic beverages of Himalayan region; Genetically modified foods; Probiotics and its application.

Text Books:

1. Adams, M.R., and Moss, M.O. Food microbiology. Royal Society of Chemistry Publication, Cambridge
2. Frazier, W.C. and Westhoff, D.C. Food microbiology. Tata McGraw Hill, New Delhi.
3. Stanbuty, P.F. and Hall, S.J. Principles of fermentation technology. Pergamon Press, Oxford.

Reference Books

1. Banwart, G.J. Basic food microbiology. CBS Publishers and Distributors, New Delhi.
2. Robinson, R.K. Dairy microbiology. Elsevier Applied Sciences, London.
3. James M.J. Modern food microbiology. CBS Publishers and Distributors, New Delhi.
4. Wood, B.J. Microbiology of fermented foods. Elsevier Applied Sciences, London
5. . Ayres, J.C., Mundt, O., and Sandinee, W.E. Microbiology of foods. W.H. Freeman and Company, New York

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Define the principles of food preservation, canning, contamination and spoilage, foodborne infections and intoxications, food safety and quality assurance, and the production of fermented foods, alcoholic beverages, probiotics, and genetically modified foods.
CO2	Describe the principles and methods of food preservation, factors influencing microbial growth, and the characterization of contamination and spoilage in various food products.
CO3	Write about the principles of food preservation, canning, contamination and spoilage, foodborne infections and intoxications, food safety and quality assurance, and the production of fermented foods, alcoholic beverages, probiotics, and genetically modified foods.
CO4	Explain in detail the principles of food preservation, canning, contamination and spoilage, foodborne infections and intoxications, food safety and quality assurance, and the industrial production of fermented foods, alcoholic beverages, probiotics, and genetically modified foods.
CO5	Summarize the key concepts of food and dairy microbiology, including microbial roles in food processing, spoilage, and safety.
CO6	Compile and present a comprehensive overview of food and dairy microbiology, integrating theoretical knowledge with practical applications in food safety and biotechnology.

CO- PSO-PO Mapping:

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PS O1	P S O 2	PS O3	PS O4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Course code	: MMBE--303b			
Course Name	: Elective-I DRUG DESIGNING AND NANO-BIOTECHNOLOGY			
Semester /Year	: III			
	L	T	P	C
	3	0	0	3

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To gain a comprehensive understanding of molecular modeling and its applications in drug design.
2. To learn the principles, techniques, and applications of nanobiotechnology in biomedical research.
3. To acquire knowledge of various drug delivery systems, including targeted and controlled release mechanisms.

Course Content

Unit I: Drug Receptor Interactions

Introduction to receptors, their classification, subtypes, and structural organization. Study of blood cell receptors, neurotransmitter-receptor interactions, and receptor modulation mechanisms. Exploration of receptor sites, cross-talk between receptors, organ-specific receptors, and constitutive activation. Application of recombinant DNA (r-DNA) technologies in receptor bioassays and receptor desensitization. Overview of drug classes based on target interactions with receptors, enzymes, DNA, and carbohydrates, including signal transduction pathways.

Unit II: Drug Targeting and Drug Delivery Systems

Introduction to receptors, their classification, subtypes, and structural organization., Study of blood cell receptors, neurotransmitter-receptor interactions, and receptor modulation mechanisms., Exploration of receptor sites, cross-talk between receptors, organ-specific receptors, and constitutive activation. Application of recombinant DNA (r-DNA) technologies in receptor bioassays and receptor desensitization. Drug-receptor interactions, including active transport, affinity, efficacy, allosteric binding, and chirality effects. Overview of drug classes based on target interactions with receptors, enzymes, DNA, and carbohydrates, including signal transduction pathways.

Unit III: Structure Activity Relationship

Overview of SAR and its significance in drug design and development, SAR illustrated with examples from sulphonamides, β -lactams, quinolones, nucleosides, and alkaloids. Introduction to QSAR and its role in predicting biological activity.

Unit IV: Molecular Modelling

Overview of molecular modelling techniques used in drug design and structural analysis. Quantum mechanical and molecular orbital methods for understanding molecular behaviour. Introduction to semi-empirical, molecular mechanics, and ab initio computational techniques. Study of potential energy surfaces and their role in molecular conformations. Docking and modelling of substrate–receptor interactions for drug discovery. Introduction to software tools used in Computer-Aided Drug Design (CADD).

Unit V: Nanobiotechnology

Introduction, principles, and scope of Nanobiotechnology, integrating biology with nanoscale technologies. , Fundamentals of microfabrication techniques and atomic force microscopy in biological applications. Biological synthesis of metal nanoparticles, macromolecular assemblies, and bacterial structures relevant to nano biotech. Study of nanostructures including cabooses, dendrimers, DNA conjugates, DNA octahedrons, fullerenes, nano shells, and carbon nanotubes. Applications of DNA-based nanostructures, drug delivery systems, protein/peptide delivery, and tumour targeting. Use of quantum dots, immuno-nanotechnology, biosensors, and nanoparticle-based immobilization assays in diagnostics.

Text Books:

1. Nanobiotechnology: Concepts, Applications, and Perspectives” by Niemeyer CM and Mirkin A.

Reference Books

2. Silverman, R. Organic chemistry of drug design and drug action. Elsevier, London.
3. Bio-nanotechnology” by Goodsell D S

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Learn about the basics of drug designing and nanotechnology
CO2	Discuss the methods of drug receptor interaction, drug targeting, and drug delivery systems.
CO3	Appreciate the use of nanoparticles in the field of drug design and biotechnology.
CO4	Apply molecular modelling and structure-activity relationship in drug designing
CO5	Summarize the role of drug receptors in neurotransmission, vaccine development, and drug delivery systems.
CO6	Compile information on drug designing based on molecular modelling and structure analysis.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PS O1	P S O 2	PS O3	PS O4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	3	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MMBE—303c			
Course Name	: Elective – IMOLECULAR VIROLOGY AND INFECTION			
Semester /Year	: III			
	L	T	P	C
	3	0	0	3

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To learn about the morphology of plant and animal viruses.
2. To gain knowledge of PCR techniques and their applications in molecular biology.
3. To understand the structure, function, and role of interferons in the immune response.

Course Content

UNIT – I

Overview of the history and fundamental principles of virology, Virus taxonomy and classification systems, Structural features and morphology of animal and plant viruses, Principles of biosafety in virology research, Containment facilities and biosafety levels, Maintenance and handling of laboratory animals, Requirements and safety protocols for virology laboratories

UNIT – II

Structure and replication strategies of bacteriophages: T7, λ (lambda), and Φ X174, Structure and replication strategies of plant viruses: single-stranded RNA virus (TMV) and double-stranded DNA virus (CaMV), Structure and replication strategies of animal viruses: Influenza virus, Adenovirus, Retrovirus, and Coronavirus

UNIT – III

Viral interference and the role of interferons, Nature and sources of interferons, Classification of interferons, Mechanisms of interferon induction, Antiviral agents (chemical and biological) and their modes of action

UNIT – IV

Methods of virus cultivation: embryonated eggs, tissue culture, and laboratory animals. Conventional vaccines: killed (inactivated) and attenuated (live) vaccines, Modern vaccine technologies: recombinant proteins, subunit vaccines, DNA vaccines, synthetic peptides, and immunomodulators (e.g., cytokines), vaccine delivery systems and the role of adjuvants, Large-scale vaccine manufacturing processes, Overview of COVID-19 vaccines and their development strategies

UNIT – V

Virus purification techniques with emphasis on ultracentrifugation, Quantitative diagnostic methods: haemagglutination, complement fixation, neutralization assays, Western blotting, and flow cytometry, Nucleic acid-based diagnostic techniques: PCR, microarray analysis, and nucleotide sequencing, Application of microscopic techniques: fluorescence microscopy, confocal microscopy, and electron microscopy, Diagnostic approaches for Coronavirus (COVID-19), including molecular and serological methods

Text Books:

1. Rothman, K.J. and Greenland, S. Modern epidemiology. Lippincott-Raven, Philadelphia.
2. Dockrell, H., Zuckerman, M., Roitt, I.M. and Chiodini, P.L. Mim's Medical Microbiology. Elsevier, London
3. Gordis, L. Epidemiology. Saunders, Philadelphia.
4. Anderson, R.M. and May, R.M. Infectious diseases of humans: Dynamics and control. Oxford University Press, Oxford

Reference Books

1. Giesecke, J. Modern infectious disease epidemiology. Edward Arnold, London
2. Clayton, D., and Hills, M. Statistical models in epidemiology. Oxford University Press, Oxford.
3. Rothman K.J., Greenland, S., and Lash, T.L. Modern Epidemiology. Lippincott Williams and Wilkins, Philadelphia

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Learn about the molecular basis of viral infection.
CO2	Discuss history, cultivation, replication, and virological methods of viruses.
CO3	Write about viruses structure, replication, cultivation, and antiviral agents.
CO4	Explain the viral infection, cultivation, antiviral agent, and Virological Methods.
CO5	Summarize the steps of the viral life cycle with reference to an antiviral agent.
CO6	Compile the infection of viruses and Molecular diagnostic tools used in detection of viral infection.

Unit II: Air and Aquatic Microbiology

Concepts of droplet nuclei and aerosols. Methods for assessing air quality, including solid and liquid impingement techniques, Overview of airborne transmission of microbes, Zonation and microbiota of freshwater habitats (ponds, lakes, and rivers), and marine environments (estuaries and deep sea), Processes such as upwelling, downwelling, and eutrophication; role of algae in eutrophication and algal blooms Aquatic food chains and mechanisms of dissolved organic matter production Microbial assessment of water quality and methods of water purification

Unit III: Microbial Interactions

Positive and negative interactions amongst microbial populations: Cooperation, Neutralism, Commensalism, Synergism, Mutualism, Competition, Amensalism, Parasitism, Predation; Interactions between microorganisms and plants: Rhizobacteria, Mycorrhiza, Epiphytic and endophytic microorganisms; Interactions between microorganisms and animals: Predation on microorganisms by animals, Cultivation of microorganisms by animals for food and food processing.

Unit IV: Pollution and its Control

Air pollution and its control: Sources, Major pollutants, Adverse effect on living organisms (Acid rain and its impact on ecosystem, greenhouse effect, global warming, ozone layer depletion and its effect, smog), Control through biotechnology (Deodorization, reduction in CO₂ emission, bioscrubbers, biobeds and biofilters); Water pollution and its control: Sources, Groundwater contamination, Wastes: Characterization of solid and liquid wastes, Solid waste treatment (Landfills, incineration, composting, anaerobic digestion and pyrolysis), Waste water treatment (Pretreatment, primary, secondary and tertiary treatment, Application of biofilm in waste water treatment); Environment impact assessment. Soil pollution: source and causes, soil salinity.

Unit V: Impact of Microbes on the Environment

Biodegradation of recalcitrant compounds: Pesticides and Petroleum; Bioremediation: *In situ* and Ex-situ mediation, Bioremediation of oil spills; Bioaugmentation; Biomagnification; Biomineralization; Metal corrosion: Mode of deterioration, Microorganisms involved, Mode of prevention; Bioleaching of ore;

Text Books:

1. Atlas, R.M. and Bartha, R. Microbial Ecology: Fundamentals and Applications. Benjamin/Cummings Science Publishing, USA.
2. Evans, G.M. and John, J.C.F. Environmental biotechnology: Theory and applications. John Wiley and Sons, New York.

Reference Books

1. Alexander, M. Microbial ecology. John Wiley and Sons, New York
2. Eldowney, S., and Waites, S. Pollution: Ecology and biotreatment. Longman, Harlow.
3. Baker, K.H. and Herson, D.S. Bioremediation. McGraw-Hill, New York.
4. Marshal, K.C. Advances of microbial ecology. Plenum Press, New York.

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Define terminology used in Microbial Ecology, Air and Aquatic Microbiology, Microbial Interactions, Pollution and its Control, and Impact of Microbes on the Environment.
CO2	Explain and give examples where applicable related to ecosystem, ecosystem organization, and microbial community, air-borne transmission of microbes, aquatic microbiology, Positive and negative interactions amongst microbial populations, Interactions between microorganisms and plants, Interactions between microorganisms and animals, various pollution and its control, and Impact of Microbes on the Environment.
CO3	Write about the concept of ecosystem, ecosystem organization, and microbial community, airborne transmission of microbes, aquatic microbiology, Positive and negative interactions amongst microbial populations, Interactions between microorganisms and plants, Interactions between microorganisms and animals, various pollution and its control, and the Impact of Microbes on the Environment
CO4	Explain Microbial Ecology, Air and Aquatic Microbiology, Microbial Interactions, Pollution and its Control, Impact of Microbes on the Environment
CO5	Summarize the study of Microbial Ecology, Air and Aquatic Microbiology, Microbial Interactions, Pollution and its Control, Impact of Microbes on the Environment
CO6	Generalize the concept of Environmental Microbiology

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	3	3	2
CO3	2	3	2	2	2	1	1	2	2	2	2	2	3	3	2	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	2	3
CO5	2	2	2	2	1	1	1	2	2	2	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MMBE- 304b														
Course Name	: Elective–IIAGRICULTURALMICROBIOLOGY														
Semester /Year	: III														
							L	T	P	C					
							3	0	0	3					

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To learn about and understand the physico-chemical characteristics of soil.
2. To gain knowledge about biocontrol Agents for Agriculturally Important Crop Plants
3. To gain knowledge about isolation, purification, and mass multiplication of Biofertilizer.

Course Content

Unit I: Abiotic and Biotic Components of Soil

Soil as a habitat for microorganisms; Soil enzymes and significance; Soil microbes; Influence of microbial metabolism on soil chemistry and humus formation; Organic matter dynamics in soil: Microbial decomposition of cellulose, hemicellulose, and lignin, Factors affecting organic matter decomposition.

Unit II: Rhizosphere and Rhizoplane Microorganisms

Rhizosphere; Rhizoplane; Composition of root exudates; Factors affecting exudation; Plant

growth growth-promoting rhizobacteria; Mycorrhiza; Rhizosphere effect; Factors affecting microbial community in soil; Mechanism of plant growth promotion: Mechanism of nitrogen fixation, Mechanism of phosphate solubilization and phosphate mobilization, Mechanism of iron chelation, Production of plant growth promoting hormones from bacteria and fungi, Production of antibiotics by plant growth promoting microorganisms.

Unit III: Plant Pathogens

General symptoms of plant diseases, Symptoms, causative organisms, disease cycle, and control measures of plant diseases: Blight of rice, Citrus canker, Wilt of potato, *Pythium* seed rot, Grapes downy mildew, Potato early and late blights, Fusarial wilt, Wheat-smut and rust, Tikka leaf spot in groundnut, Common viral diseases of plants (Paddy, cotton, potato, tobacco, cauliflower, tomato and sugarcane); Biochemical and genetic basis of virulence in plant pathogens.

Unit IV: Biocontrol Agents for Agriculturally Important Crop Plants

Biopesticides: Source organisms (*Bacillus thuringiensis*, *Beauveria bassiana*, *Metarhizium anisopliae*, *Trichoderma*, Baculoviruses); Mechanism of biocontrol; Other means of pathogen control: Application of viral proteins in controlling viral diseases, Antisense RNA technology in disease control, and RNAi in controlling plant pathogens.

Unit V: Biofertilizers

Isolation, purification, mass multiplication, inoculum production, and the method of application of biofertilizers. Bacterial biofertilizers: *Azospirillum*, *Azotobacter*, Phosphobacteria, *Rhizobium*, *Bradyrhizobium*, *Azorhizobium*. Mycorrhizal fertilizers, Algal biofertilizers; Storage, shelf life, quality control, and marketing of biofertilizers.

Text Books:

1. Gupta, S.K., Biofertilizers, KedarNath Ram Nath, Meerut.
2. Subba Rao, N.S. (1995). Soil microorganism and growth co. Pvt. Ltd., New Delhi.

Reference Books

1. Kannaiyan, S. (2003). Bioethnology of biofertilizers, CHIPS, Texas.
2. Rai, M.K. (2005). Handbook of Microbial Biofertilizers, The Haworth Press, Inc., New York.
3. Reddy, S.M. et al. (2002). Bioinoculants for sustainable agriculture and forestry. Scientific Publishers.
4. Saleem, F. and Shakoori, A. R. (2012). Development of bioinsecticide. Lap Lambert Academic Publishing GmbH and Company.
5. Aggarwal, S.K. (2005). Advanced environmental biotechnology. APH publication

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Describe the role and effect of microorganisms in agriculture.
CO2	Identify phytopathogens and apply the knowledge of their life cycle in the prevention of plant diseases.
CO3	Apply the knowledge of rhizosphere bacteria in the development of biofertilizers.
CO4	Summarize the mechanism of biocontrol utilized by biopesticides
CO5	Appreciate the diversity of microorganisms and microbial communities inhabiting soil and affecting soil composition, and causing plant diseases.
CO6	Compile information on plant microbes interactions like rhizosphere and mycorrhizae and their applications, especially the biopesticides, biofertilizers and their production techniques.

CO- PSO-PO Mapping:

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	3	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	2	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	2	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MMBE- 304c			
Course Name	: Elective-II ECOSYSTEM ANALYSIS AND REMOTE SENSING			
Semester /Year	: III			
	L	T	P	C
	0	0	3	3

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To gain the knowledge about the basic principles and fundamentals of Aerial photo interpretation
2. To learn about principles of Aerial Photos
3. To make student aware role of remote sensing in ecological research.

Course Content

UNIT I

Aerial Photography and Photogrammetry (AP&P): Fundamentals of Aerial Photography, History, Aerial film processing, Procurement, and Security of Aerial photographs, Energy source and atmospheric effects in aerial photography. Principles of Aerial Photos (flight planning). Introduction to Photogrammetry, Geometry of Aerial Photos, Stereoscopic Photography, Measurement of Height, Aerial Triangulation. Principles and fundamentals of Aerial photo interpretation. Basics of Cartography.

UNIT II

Remote Sensing (RS): Introduction to Remote Sensing. The electromagnetic spectrum, Energy instruction with atmosphere and earth surface, satellite and sensors, Remote sensing data acquisition. Principles and basic concepts of Multispectral, Thermal, and Hyperspectral Scanning: Across-track and Along Track multispectral Scanning. History of Space Imaging.

UNIT III

Image Interpretation: Type of Imagery, elements of Interpretation, Techniques of Visual Interpretation, Role of remote sensing in ecological research. Fundamentals of digital image processing, Image rectification, Restoration, and Enhancement.

UNIT IV

Digital Image Processing (DIP): Image classification: Supervised classification, unsupervised classification, Hybrid classification, Post- Post-classification, smoothing, and classification accuracy assessment. Principles of microwave sensing, Geometric characteristics, Spatial resolution. Spaceborne Radar System, Application of passive microwave sensing.

UNIT V

Geo informatics (GIS): Basics of Computer, Hardware, and Software, Principles and Basics of Geographic Information Systems: Raster and Vector GIS, Database Creation and Management. Network Analysis, Spatial data integration, and Modeling.

Text Books:

1. Sadhasivam, S.K. and Mohammed Jaabir, M.S. (2008). IPR, biosafety, and biotechnology management. Jasen Publications, Tiruchirappalli, India.
2. Remote Sensing Principles and Interpretation” by Sabin's F.
3. “ Remote Sensing and Image Interpretation” by Lillesand, T M and Kieffer, R W.
4. “ Introduction to the Physics and Techniques of Remote Sensing” by Elachi C.

Reference Books

1. Kankanala,C.(2007).Genetic Patent Law and Strategy.ManupatraInformationSolutionPvt. Ltd., New Delhi, 1st.
2. Mittal, D.P. (1999). Indian Patents Law, Taxmann. Allied Services (p) Ltd.
3. Singh, K.K. (2015). Biotechnology and intellectual property rights: Legal and social implications. Springer India.

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Define Aerial Photography and Photogrammetry, Remote Sensing, Image Interpretation, Digital Image Processing, and Geoinformatics.
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CO2	Identify Fundamentals of Aerial Photography, Introduction of Remote Sensing and Image Interpretation, Image classification, and Principles and basics of Geographic Information Systems.
CO3	Apply the knowledge of Photogrammetry Geoinformatics, Remote Sensing, Image Interpretation, and Digital Image Processing.
CO4	Illustrate the method of Aerial Photography, Remote Sensing, Image Interpretation, Digital Image Processing, and Geoinformatics.
CO5	Summarize the Principles of Aerial Photos and Remote Sensing, Digital Image Processing, and Geoinformatics.
CO6	Justify the concept of Photogrammetry, Geoinformatics, Image Interpretation, and Digital Image Processing.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	3	3	2
CO3	2	3	2	2	2	1	1	2	2	2	2	2	3	3	2	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	2	3
CO5	2	2	2	2	1	1	1	2	2	2	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MMBE-304				
Course Name : Elective – II Mushroom Culture Technology				
Semester /Year : III				
	L	T	P	C
	3	0	0	3

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

- 1.To make students aware of the introduction, history, and cultivation of mushrooms.
2. To gain knowledge about Poisonous and Non-poisonous mushrooms.

3. To learn about the Marketing of mushrooms in India and the world.

Course Content

UNIT-1

Introduction, history of mushroom cultivation; biology of mushrooms; Nutritional value:(Proteins, amino acids, mineral elements, carbohydrates, fibers, vitamins)Medicinal value of mushrooms; Poisonous and Nonpoisonous mushrooms, edible and non-edible Mycorrhizal mushrooms and their role in plant growth, mushrooms cultivation in India and world.

UNIT-2

Cultivation of button Mushroom, morphology, raising a pure culture & spawn preparation. Preparation of compost & cultivation of *Agaricus biosporus*, *Pleurotus flabellatus*, harvest.

Unit-3

Cultivation Technology: Infrastructure, equipment, and substrates in mushroom cultivation: Polythene bags, vessels, inoculation hook, inoculation loop, low cost stove, sieves, culture racks, mushroom unit or mushroom house, water sprayer, tray, boilers, driers, pure culture, Spawn: types of spawn, preparation no spawn, mushroom bed preparation and factors affecting mushroom bed preparation; Compost: materials used for compost preparation, compost technology in mushroom production.

Unit-4

Pests and diseases of edible mushrooms, Environmental, Fungal, Bacterial, Viral, and insect diseases. Storage and food preparation from mushrooms: Methods of storage of mushroom cultivation, Long-term and short-term storage of mushrooms. Foods/recipes from mushrooms; Mushroom research centers/farms: National level and regional level, Marketing of mushrooms in India and the world.

Text Books:

1. Arora, David (1991). All That the Rain Promises and More...: A Hip Pocket Guide to Western Mushrooms. Berkeley: Ten Speed Press. ISBN 978-0-89815-388-0.
2. Marrone, Teresa (2016). Mushrooms of the Northeast: A Simple Guide to Common Mushrooms. Cambridge, MN: Adventure Publications. ISBN 978-1591935919.
3. Marrone, Teresa(2014). Mushrooms of the Upper Midwest: A Simple Guide to Common Mushrooms. Cambridge, Minnesota: Adventure Publications, Inc. ISBN 978-1591934172.

REFERENCES

1. Gogoi, R., Rathaiah, Y., & Borah, T. R. (2019). *Mushroom Cultivation Technology*. Scientific Publishers.
2. Besette, A. (2019). *Mushrooms of the Gulf Coast States*. Austin, TX: University of Texas Press. ISBN: 978-1-471815-7
3. Besette, A. (2007). *Mushrooms of the Southeastern United States*. Syracuse, NY: Syracuse University Press. ISBN: 978-0815631125
4. Kimbrough, J. (2000). *Common Florida Mushrooms*. Gainesville, FL: University of Florida, Extension Institute of Food and Agricultural Sciences. ISBN: 978-0916287306
5. Metzler, S. (1992). *Texas Mushrooms: A Field Guide*. Austin, TX: University of Texas Press. ISBN: 978-0292751262

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Define the biology of mushrooms, Pests and diseases of edible mushrooms, and Methods of storage of mushrooms.		
CO2	Identify the Methods of storage of mushrooms. Nutritional value, diseases, and Marketing of mushrooms in India and the world.		
CO3	Apply the knowledge of Nutritional value and Marketing of mushrooms in India and the world, and knowledge about Pests and diseases of edible mushrooms.		
CO4	Illustrate the method of storage of mushrooms, and also knowledge about of Nutritional value of diseases.		
CO5	Summarize the Principles of Mushroom culture technology and Mushroom research centers/farms at the national and regional levels.		
CO6	Justify the concept of Photogrammetry, Geoinformatics, Image Interpretation, and Digital Image Processing.		

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PS O1	P S O 2	PS O3	PS O4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	3	3	2
CO3	2	3	2	2	2	1	1	2	2	2	2	2	3	3	2	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	2	3
CO5	2	2	2	2	1	1	1	2	2	2	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MMBL305			
Course Name	: Lab Course I (Based on paper 1 & 2)			
Semester /Year	: III			
	L	T	P	C
	3	0	0	3

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To help students learn biosafety guidelines and understand biosafety levels.
2. To train students in the isolation and biochemical characterization of pathogenic bacteria.
3. To teach students how to determine the MIC and MBC concentrations of antibiotics using the broth dilution method.

Course Content

CREDITS: 03

1. Biosafety guidelines and biosafety levels.
2. Collection and handling of specimens for microbiological examination.
3. Isolation of microorganisms from skin.
4. Demonstration of catalase activity of bacterial flora from skin.
5. To check the effectiveness of handwash.
6. Isolation of microorganisms from teeth crevices.
7. Isolation of microorganisms from mouth- saliva.
8. Isolation of microorganisms from upper respiratory tract .
9. Determination of dental caries susceptibility.
10. Determination of antimicrobial susceptibility of pathogens by disc diffusion test.
11. Isolation and screening of bacterial and fungal cultures for enzyme production.
12. Estimation of enzyme production by microbial culture *via* liquid state fermentation.
13. Estimation of enzyme production by microbial culture *via* solid state fermentation.
14. Media formulation for enhanced enzyme production by microbial culture *via* liquid and solid state fermentation.
15. Optimization of culture conditions for enhanced enzyme production by microbial culture *via* liquid and solid state fermentation.
16. Production of wine from fruit juice.
17. Monitoring of sugar reduction during wine production.
18. Estimation of alcohol concentration in wine.
19. Estimation of vicinal diketone in beer.
20. Improvement of strain for increased yield by U.V. mutagenesis.

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Identify and memorize Biosafety guidelines and biosafety levels.
CO2	Production, monitoring, and Estimation of wine.
CO3	Determination of the Isolation, biochemical characterization, and antimicrobial susceptibility of pathogenic bacteria/fungi /clinical specimens.
CO4	Experiment to determine MIC and MBC concentration of antibiotics by the broth dilution test.
CO5	Estimate enzyme production by bacterial and fungal cultures.
CO6	Formulation of media for enzyme production by microbial cultures.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PS O1	P S O 2	PS O3	PS O4
CO1	3	2	3	2	3	2	2	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	1	1	2	2	2	1	2	2	2	2	3	2
CO3	2	2	1	2	2	2	2	2	2	1	2	2	3	3	2	2
CO4	2	2	2	2	2	2	2	2	2	1	2	2	2	2	3	2
CO5	2	2	1	2	1	1	2	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	1	1	2	2	2	1	2	2	2	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MMBL306			
Course Name	: Lab Course II (Based on paper 3& 4)			
Semester /Year	: III			
	L	T	P	C
	3	0	0	3

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To learn about Microbiological examination of food.
2. To learn to perform Production of sauerkraut.
3. To learn to perform Microbial production of curd.

Course Content CREDITS: 03

1. Microbiological examination of food.
2. Assay of quality of milk sample using MBRT test.
3. Adulteration tests for milk.
4. Microbial production of curd.
5. Isolation and identification of *Lactobacillus* from fermented dairy products.
6. Isolation and biochemical identification of microorganisms from contaminated food and dairy samples.
7. Production of sauerkraut.
8. Estimation of lactic acid production in sauerkraut.
9. Effect of salt concentration on lactic acid production in sauerkraut.
10. Estimation of acidity of vinegar.
11. Preparation of nanoparticles.
12. Microbiological testing of drug sample.
13. Detection of viral antigens by RTPCR.
14. Determination of TLC, DLC and CRP of blood sample.
15. Isolation and characterization of microorganism from air, water and soil.
16. Detection of BOD and COD of water sample.
17. Isolation and characterization of PGPR.
18. Detection of nitrogen fixing ability of bacteria.
19. Detection of siderophore production.
20. Preparation of spawn for mushroom cultivation.
21. Production and storage of button mushroom.
22. Interpretation, rectification, restoration and enhancement of aerial photographs.
23. Acquisition of data for remote sensing.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Identification of food borne, environmental and soil borne diseases.
CO2	Determine D value in heat treatment of foods
CO3	Assess quality of food, drugs and environmental samples.
CO4	Characterize bacteria isolated from soil, food and environment.
CO5	Evaluate production of lactic acid in sauerkraut
CO6	Prepare and apply biofertilizers.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PS O1	P S O 2	PS O3	PS O4
CO1	3	2	3	2	3	2	2	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	1	1	2	2	2	1	2	2	2	2	3	2
CO3	2	2	1	2	2	2	2	2	2	1	2	2	3	3	2	2
CO4	2	2	2	2	2	2	2	2	2	1	2	2	2	2	3	2
CO5	2	2	1	2	1	1	2	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	1	1	2	2	2	1	2	2	2	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MMBS307a
Course Name	: Self Study- BIOINFORMATICS & BIOLOGICAL DATA BASE
Semester /Year	: III

	L	T	P	C
	3	0	0	3

Course Objectives: The objectives of this course are

1. To make students aware of the basic principles of computing in bioinformatics.
2. To familiarize students with data retrieval using Entrez, DBGET/LinkDB, and SRS.
3. To help students understand the impact of protein families and pattern databases.

Course Content

UNIT I

Concepts, overview, and scope of bioinformatics, Bioinformatics and the Internet, Basic principles of computing in bioinformatics, Use of databases in Biology: primary databases: Gene Bank, SWISSPROT, PDB; specialized databases: PFAM, SCOP, PROSITE; database querying using keywords and search engines.

UNITII

Annotated sequence databases, Genome and organism-specific databases, miscellaneous databases, Sequencing DNA, RNA, and proteins, determination of protein structure, Gene and protein extraction *data*. Data retrieval with Entrez, DBGET/Link DB and SRS (sequence retrieval system), Sequence similarity searches, Amino acid substitution matrices, database searches with FASTA and BLAST, Multiple sequences alignment and family relationships, protein families and pattern databases.

UNIT III

Principles of genome annotation, Annotation tools and resources, Conceptual models of protein structure, protein structure and function, Obtaining, viewing, and analyzing structural data, Classification of proteins of known three-dimensional structure: CATH and SCOP, Protein structure prediction, Secondary structure prediction.

UNIT IV

Microarray data analysis, tools and resources, Sequences sampling and SAGE, Analysing data from 2D-PAGE gels, Analysing protein mass spectrometry data, modeling and restructuring molecular pathways, Protein interaction informatics, Higher-order models.

UNIT V

Phylogenetics, cladistics, and ontology; Building phylogenetic trees; Evolution of macromolecular sequences. Chemoinformatic resources, Conventions in representing molecules, Pharma informatics, Protein modeling.

Text Books:

1. Goel, D. and Prashar, S. (2013). IPR, biosafety, and bioethics. Pearson Publishers.
2. Sadhasivam, S.K. and Mohammed Jaabir, M.S. (2008). IPR, biosafety, and biotechnology management. Jasen Publications, Tiruchirappalli, India.

Reference Books

1. Bare Act, 2007. Indian Patent Act 1970 Acts and Rules. Universal Law Publishing Co. Pvt. Ltd., New Delhi.
2. Kankanala, C. (2007). Genetic Patent Law and Strategy. Manupatra Information Solution Pvt. Ltd., New Delhi, 1st.
3. Mittal, D.P. (1999). Indian Patents Law, Taxmann. Allied Services (p) Ltd.
4. Singh, K.K. (2015). Biotechnology and Intellectual Property Rights: Legal and Social Implications. Springer India.

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Define Concepts, and the scope of bioinformatics, data database of bioinformatics,
CO2	Identify the Methods of the Principles of genome annotation and Phylogenetics.
CO3	Apply the knowledge of bioinformatics, determination of protein structure, Microarray data analysis, and Phylogenetics,
CO4	Illustrate the Bioinformatics database, genome annotation, and Phylogenetics.
CO5	Summarize the Principles of computing in bioinformatics and the Methods of Principles of genome annotation, and Phylogenetics.
CO6	Justify the concept of Microarray data analysis and Phylogenetics.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PS O1	P S O 2	PS O3	PS O4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	3	3	2
CO3	2	3	2	2	2	1	1	2	2	2	2	2	3	3	2	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	2	3
CO5	2	2	2	2	2	1	1	2	2	2	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MMBS307b			
Course Name	: Self-study –BIOMEDICAL TECHNOLOGY			
Semester /Year	: IV			
	L	T	P	C
	3	0	0	3

Course Objectives: The objectives of this course are

1. To learn about Autoimmune diseases.
2. To gain the knowledge about molecular diagnosis of cancer.
3. To knowledge about Mutations and genetic disorders

Course Content

UNIT I

Cellular Pathology: causes of cell injury, necrosis, biochemical mechanisms, Ischemic and hypoxic injury. Apoptosis (Biochemical features, mechanisms), Immunological basis of diseases: Hypersensitivity(I–IV), Autoimmune diseases Preparation of polyclonal antisera: characterization of antisera, Immuno diagnostic – RIA, ELISA.

UNIT II

Mutations and genetic disorders. Single-gene disorders, Receptor proteins (hypercholesterolemia). Cytogenic disorders (Trisomy, Klinefelter's). Mutations in mitochondrial genes (LHDN), Fragile X Syndrome.

UNIT III

Types and grading of cancer. Introduction to molecular diagnosis of cancer. (Southern & Northern blot analysis, PCR-based diagnosis). Gene therapy, immunotherapy, and chemotherapy of cancer cells.

UNIT IV

Chemical mutagens. Carcinogenic agents and their cellular interactions. Radiation as a health hazard. (Types, measurements, effects, and protective measures) Introduction to DNA damage and Types of DNA repair mechanisms.

UNIT V

Molecular diagnosis (genetic disease, gene diagnosis, gene tracking & other diagnostic applications of RDT) Molecular diagnostic- direct gene diagnosis, Linkage analysis.

Nucleic acid sequences as diagnostic tools, SNPs, VNTRs, Non-invasive methodology. MRI, CT-SCAN. Reproductive Health Technologies – ICSI, IVE.

Text Books:

1. Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. Lewin's genes. Jones and Bartlett, Learning Publishers, Sudbury
2. Chaitanya, K.V. Cell and molecular biology: A lab manual. PHI Learning, New Delhi.

Reference book

1. Snustad, D.P. and Simmons, M.J. Principles of genetics. John Wiley and Sons, New York.
2. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Scott, M.P., Bretscher, A., Ploegh, H. and Matsudaira, P. Molecular cell biology. W.H. Freeman and Company, New York.
3. Synder, L.J., Peters, E., Henkins, T.M. and Champness, W. Molecular genetics of bacteria. ASM Press, Washington, D.C.
4. Maloy, S.R., Cronan, J.E. and Freifelder, D.M. Microbial genetics. Jones and Bartlett Learning, Sudbury.
5. Sambrook, J. and Russell, D.W. Molecular cloning: A laboratory manual. Cold Spring Harbor Lab Press, New York.

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Define Cellular Pathology, Mutations and genetic disorders, and Molecular diagnosis of infection.
CO2	Identify the Cellular Pathology, Types and grading of cancer, Chemical mutagens, and Molecular diagnosis of infection.
CO3	Apply the immunodiagnostics tools in the infection, immunotherapy, and chemotherapy of cancer cells. Single-gene disorders, mutation, and repair mechanisms.
CO4	Illustrate the. Immunotherapy and chemotherapy of cancer cells, Cellular Pathology, mutation, and repair mechanisms.
CO5	Summarize the Immunological basis of diseases, Gene therapy, immunotherapy, and chemotherapy of cancer cells.
CO6	Justify the autoimmune disease, genetic disorders, and Cellular Pathology.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PS O1	P S O 2	PS O3	PS O4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	3	3	2
CO3	2	3	2	2	2	1	1	2	2	2	2	2	3	3	2	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	2	3
CO5	2	2	2	2	2	1	1	2	2	2	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	: MMBI308
Course Name	:-Industrial Training Report/Presentation
Semester/Year:III	Sem

	L	T	P	C
	3	0	0	3

L- Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

- 1. To learn innovative research to solve the problems faced in the current scenario.**
- 2. To understand independent and collaborative research projects.**
- 3. To learn original research of significance and quality, for publications, presentations, and original research proposals.**

Course outcomes (Cos):

Upon successful completion of the course, a student will be able to

CO1	Observe innovative research to solve the problems faced in the current scenario.
CO2	Observe and recognize the basic concept of reading of review literature/research paper.
CO3	Apply of adequate scientific understanding of the basic concepts in instrumentation used in research for both qualitative and quantitative analysis.
CO4	Analyse and carry out independent and collaborative research projects.
CO5	Choose original research of significance and quality for publications, presentations, and original research proposals.
CO6	Formulate a small research proposal and publish in a research article.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	3	2	3	2	3	2	2	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	1	1	2	2	2	1	2	2	2	2	3	2
CO3	2	2	1	2	2	2	2	2	2	1	2	2	3	3	2	2
CO4	2	2	2	2	2	2	2	2	2	1	2	2	2	2	3	2
CO5	2	2	1	2	1	1	2	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	1	1	2	2	2	1	2	2	2	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code: MMBE401
Course Name: DISSERTATION
Semester/Year :IV Sem

	L	T	P	C
	0	0	9	9

L- Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. Understand the fundamental framework of the research process, design methodologies.
2. To learn the student to Structure the methodology to accomplish organized conduct of interdisciplinary research.
3. To gain knowledge to publish the research outcome in scientific peer reviewed journal.

Course Content

Topics for Dissertation

1. Drug Discovery
2. Drug Resistance
3. Infection and Immunity
4. Plant- Microbes Interaction
5. Microbial Diversity

6. Bioremediation
7. Prevalence and Characterization of Pathogenic Microorganisms
8. Food Adulteration and Food borne Pathogens
9. Fermented Foods
10. Strain Improvement
11. Enzyme Production
12. Microbial Biotechnology
13. Biomass and Bioenergy Production

Any other topic suggested by departmental committee may also be considered for the dissertation

CO1	Observe a small research work to accomplish organized conduct of in various fields.
CO2	Select and identify the methodology of the project
CO3	Apply and impart the outcome of their project in various seminars and conferences.
CO4	Apply and Present project work to a panel of experts.
CO5	Choose a publish the research outcome in a scientific peer-reviewed journal.
CO6	Solve a research work by research methodology.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PS O1	P S O 2	PS O3	PS O4
CO1	3	2	3	2	3	2	2	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	1	1	2	2	2	1	2	2	2	2	3	2
CO3	2	2	1	2	2	2	2	2	2	1	2	2	3	3	2	2
CO4	2	2	2	2	2	2	2	2	2	1	2	2	2	2	3	2
CO5	2	2	1	2	1	1	2	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	1	1	2	2	2	1	2	2	2	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code: MMBC402
Course Name : EPIDEMIOLOY
Semester/Year :IV Sem

	L	T	P	C
	4	0	0	4

L- Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To learn the scope and applications of epidemiology in health care.
2. To gain knowledge about modes of disease transmission.
3. To learn about the Guidelines issued by the CDC and WHO.

Course Content**Unit I: Basics of Epidemiology**

Introduction; Scope and applications of epidemiology in health care; Role, ethics, and responsibilities of an epidemiologist; Relation between virulence and spread; Reservoirs of infection (Human, animal, and non-living reservoirs); Types of carriers; Portals of entry and exit.

Unit II: Transmission of Disease

Sources of infection; Modes of disease transmission; Disease cycle; Role of remote sensing

and geographical information in recognition of an epidemic; Serological surveys; Influence of behavioral or spatial factors on transmission; Role of genetic and environmental factors in disease causation, History of outbreaks: SARS, Chikungunya, Hantavirus infection, Swine flu, Haiti cholera, COVID 19.

Unit III: Mathematical Modelling

Transmission dynamics: Incidence, Prevalence, Morbidity, Mortality; Natality; Public health surveillance: Purpose and characteristics, identifying health problems for surveillance, Collection of data for surveillance, Analysis and interpretation of data, Disseminating data and interpretation, Evaluating and improving surveillance.

Unit IV: National Health Programmes and Health Economics

Nutritional Disorders Related National Health Programs, MCH and Demographic related National Health Programs, Monitoring and evaluation of health programs
Principles of Health Economics-cost benefit, cost-effectiveness, and cost-utility, Efficacy, effectiveness, and efficiency, Evaluation needs and methods.

Unit V: Control of Epidemics

Cycle of epidemics; Emerging and re-emerging infectious diseases and pathogens; Control of transmission: Isolation, Quarantine, Threat of bioterrorism, Global travel and health considerations; Community-based control by vaccination, mass vaccination and herd immunity; Public health organizations for control: Centers for Disease Control (CDC), Guidelines issued by CDC and WHO, Health standards for international epidemics

Text Books:

1. Fundamentals of Epidemiology and Biostatistics. Deepti, S.
2. Basic and Clinical Epidemiology, Vikas Dhikav.

Reference Books

1. Methods of Clinical Epidemiology, Suhail, A.R. Dai.
2. A dictionary of epidemiology, 2014 Miquel.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Describe the basic concept of epidemiology, disease transmission and control of epidemics.
CO2	Comprehend the scope and applications of epidemiology in study of disease transmission.
CO3	Analyze and interpret data on health surveillance
CO4	Analyze the pattern of disease spread and their control.
CO5	Recommend methods to prevent disease outbreaks by studying disease transmission dynamics and health surveillance according guidelines of public health organizations

CO6

Hypothesize the cause and pattern of disease spread.

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	1	2	1	1	1.	1	1	1	3	2	1	2.	1	2	1	3
CO2	1	1	1	1	2	1	2	1	2	1	2	3	2	3	2	2
CO3	1	1	1	1	2	1	2	1	2	1.	2	3.	2	2	3	1
CO4	1	3	1	2	1	1	1	1	2	3	2	2	3	3	2	2
CO5	2	2	1	2	3	2	1	2	3	3	1	2	3	2	3	2
CO6	2	3	1	2	2	2	2	3	1	3	2	2	2	1	1	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	:MMBE403a
Course Name:	– BEVERAGE BIOTECHNOLOGY
Semester/Year	:IVSem

	L	T	P	C
	3	0	0	3

L- Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To raise awareness of the student Microorganism in the food & beverage industry.
2. To make students aware of the principles of food preservation
3. To learn about food additives.

Course Content

UNIT I

Food and Microorganism: Microorganisms in the food & beverage industry, contamination of food. General principles underlying spoilage and chemical changes

UNIT II

Contamination and spoilage of different kinds of food & beverages: Cereals & cereal products, sugar and sugar products, vegetables and fruits, meat, fish, poultry & eggs, seafood, milk & milk products, canned foods, Alcohol & alcoholic beverages, fruit juices & soft drinks, etc.

UNIT III

Biotechnology of food and feed; cultures & fermentation, Beverage production: Alcohol & alcoholic beverages, fruit juices, soft drinks, feed production, SCP, fats, amino acids, food additives.

UNIT IV

Food and Disease: Foodborne and intoxication. Food-borne disease outbreaks, disease investigation, Materials & equipment, laboratory testing, field analysis, interpretation of data, and preventive measures. QA & QC of food product.

UNIT V

Food hygiene: Food sanitation, Bacteriology of water and food products, and food

manufacturing practice. Hazard Analysis Critical Points.

Food control: International agencies, Federal Agency, and the law of state agencies, the Processing Industry, and Microbial criteria of food. Principles of food preservation, Preservation by high temperature, low temperatures, Drying, Food additives, and radiation.

Text Books:

1. Frazier, W.C. and Westhoff, D.C. Food microbiology. Tata McGraw-Hill, New Delhi.
2. Casida, J.E. Industrial microbiology. Wiley Eastern, New Delhi.

Reference Books:

1. Crueger, W. and Crueger, A. Biotechnology: A Textbook of Industrial Microbiology. Sinauer Associates, Sunderland.
2. McL and Sborough, L. Food microbiology laboratory. CRC Press, Boca Raton.
3. Harrigan, W.F. Laboratory methods in food microbiology. Gulf Professional Publishing, Houston.
4. Cappucino, J. and Sherman, N. Microbiology: A Laboratory Manual. Benjamin Cummings Publishing Company, San Francisco.
5. Frazier, W.C. and Westhoff, D.C. Food microbiology. Tata McGraw-Hill, New Delhi.
6. Casida, J.E. Industrial microbiology. Wiley Eastern, New Delhi

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Identify and describe the microorganisms in the food & beverage industry, contamination and spoilage of different kinds of food and beverages, Biotechnology of food and feed, Food, Beverages & Disease, and food hygiene.
CO2	Discuss microorganisms, contamination, and spoilage of the food and beverage industry, Biotechnology of food and feed, Bacterial food-borne infection and intoxication, disease outbreak, disease analysis, and food hygiene and food control agencies.
CO3	Explain Microorganism in the food & beverage industry, contamination and spoilage of different kinds of food and beverages, Biotechnology of food and feed, Food, Beverages Disease and food hygiene
CO4	Explain and compare the role of Microorganisms in the food & beverage industry, contamination and spoilage, Bacterial food-borne infection and intoxication, and explain disease outbreak, disease analysis, and food hygiene and food control agencies.
CO5	Summarize the Microorganisms, contamination, and spoilage in the food & beverage industry, Bacterial food-borne infection and intoxication, disease outbreak, disease analysis, and food hygiene and food control agencies
CO6	Generalize the concept of beverage biotechnology.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	1	2	1	1	1.	1	1	1	3	2	1	2.	1	2	1	3
CO2	1	1	1	1	2	1	2	1	2	1.	2	3	2	3	2	2
CO3	1	1	1	1	2	1	2	1	2	1.	2	3.	2	2	3	1
CO4	1	3	1	2	1	1	1	1	2	3	2	2	3	3	2	2
CO5	2	2	1	2	3	2	1	2	3	3	1	2	3	2	3	2
CO6	2	3	1	2	2	2	2	3	1	3	2	2	2	1	1	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	:MMBE403b
Course Name	: –BIO-ENTREPRENEURSHIP
Semester/Year	:IVSem

	L	T	P	C
	3	0	0	3

L- Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. Learn about the basics of accounting practices.
2. Learn about the source of financial assistance.
3. To make students aware balance sheet, P&L account, and double-entry bookkeeping

Course Content

Unit I

Starting a venture; Assessment of feasibility of a given venture/ new venture; Approach a bank for a loan; Sources of financial assistance; Making a business proposal/ Plan for seeking loans from financial institution & Banks; Funds from banks for capital expenditure and for working; Statutory and legal requirements for starting a company/venture; Budget planning and cashflow management.

Unit II

Introduction to accounting practices: concepts of the balance sheet, P&L account, and double-entry bookkeeping. Estimation of income, expenditure, and profit. Assessment of market demand or potential product (s)of interest; Market conditions, segments; Prediction of market changes; Identifying needs of customers, including gaps in the market, packaging the product; Market linkages, branding issues; Developing

distribution channels; Pricing/Policies/Competition; Promotion/Advertising.

Unit III

Services Marketing Negotiations/Strategy with financiers, bankers, Government law enforcement authorities; with companies/Institutions for technology transfer; Dispute resolution skills; External environment/changes; Crisis/Avoiding/Managing. Information Technology: How to use IT for business administration; Use of IT in Improving business performance; Available software for better financial management; E-business setup, management.

Unit IV

Human Resource Development (HRD): Leadership skills; Managerial skills; Organization structure, pros & cons of different structures; Team building, teamwork; Appraisal; Rewards in a small-scale set up. Fundamentals of Entrepreneurship, Support Mechanism for Entrepreneurship in India. Role of Entrepreneurship in the Microbiology Field.

Unit V

Role of knowledge center and R&D. Knowledge centers like universities and research institutions; Role of technology and upgradation; Assessment of scale of development of Technology; Managing Technology Transfer; Regulations for transfer of foreign technologies; Technology transfer agencies. Case Study

Text Books:

1. Crueger, W, and Crueger, A. (2000), *Biotechnology: A Textbook of Industrial Microbiology*, 2nd Edition, Sinauer Associates: Sunderland. Mass
2. .Stockholm,K.T.H.,Sven-OlofEnfors,andLenaHaggstrom.(2000),*BioprocessTechnology:FundamentalsandApplications*,*RoyalInstituteofTechnology*: Sweden.
3. Ashton Acton, Q. (2012). *Biological Pigments– Advances in Research and Application*. Scholarly Editions: Atlanta, Georgia.

REFERENCE BOOKS:

1. Hugo, W.B. and Russel, A.D. (2003), *Pharmaceutical Microbiology*, 6th Edition.
2. Blackwell Scientific Publications: U K.
3. Stanbury,P.F,andWhitekar.A.(1999),*PrinciplesofFermentationTechnology*,2ndEdition. Butterworth-Heinemann: Oxford.

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Define Starting a venture, accounting practices, Services Marketing, Human Resource Development, and the Role of the knowledge centre and R&D.
CO2	Explain Sources of financial assistance, accounting practices, Strategy with financiers, Entrepreneurship, and Support mechanism for Entrepreneurship in India.
CO3	Illustrate accounting practices, source of financial assistance
CO4	Explain Human Resource Development, accounting practices, and Support mechanisms for Entrepreneurship.
CO5	Summarize the Support mechanism for Entrepreneurship in India. Role of Entrepreneurship in the Microbiology Field.
CO6	Justify the knowledge about Services Marketing, Human Resource Development.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	1	2	1	1	1.	1	1	1	3	2	1	2.	1	2	1	3
CO2	1	1	1	1	2	1	2	1	2	1.	2	3	2	3	2	2
CO3	1	1	1	1	2	1	2	1	2	1.	2	3.	2	2	3	1
CO4	1	3	1	2	1	1	1	1	2	3	2	2	3	3	2	2
CO5	2	2	1	2	3	2	1	2	3	3	1	2	3	2	3	2
CO6	2	3	1	2	2	2	2	3	1	3	2	2	2	1	1	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	:MMBE403c
Course Name	: –INTELLECTUAL PROPERTY RIGHTS
Semester/Year	:IV Sem

	L	T	P	C
	3	0	0	3

L- Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To make students aware of Intellectual property.
2. To learn about the procedure for the grant of a patent in India
- 3 To aware the student about Patenting of genetically modified plants

Course Content

Unit I: Basic Aspects of Intellectual Property Rights

Introduction to IPR; Intellectual Property; WIPO; Types of Intellectual Property Rights: Copyrights, Trademarks (Collective marks, certification marks and well-known marks), Industrial designs, Geographical indications, Patents, Plant breeder’s rights; Importance and business interest of IPR for industry and academia; Relationship of IPR with biotechnology; Trade secrets; Non-disclosure agreements.

Unit II: International Treaties for Protection of Intellectual Property

Brief background of different treaties: WIPO copyright treaty, Berne convention, Rome convention, TRIPS agreement, WIPO Performances and Phonograms Treaty, Madrid agreement, Madrid protocol, Paris convention, Lisbon agreement, Hague agreement, Patent Cooperation Treaty; Relationship between IPR and trade: WTO, TRIPS agreement, GATT, Enforcement and dispute settlement under the TRIPS agreement, Implication of TRIPS for developing countries in the overall WTO system.

Unit III: Patents

Patent terminology; Patent claims; Patent life and geographical boundaries; Utilization of intellectual patents; Licensing of patents; Elements of patentability; Procedure for grant of patent in India, USA and Europe; PCT application; Patent search invention in context of “prior art”; Patent search methods; Patent databases and libraries; Country-wise patent searches (USPTO, EPO, ARIPO and India); Patent mapping; Patent harmonization; Case studies of patents in biotechnology. Ethics in Research Design.

Unit IV: Patent Acts, Issues in Pharmaceuticals, and Patent Infringement

Patent acts and latest amendments of Indian, European, and US patent systems; Patent issues in drugs and pharmaceuticals: Generics, Compulsory licensing, Exclusive marketing rights, Bolar provision, Bayh-Dole Act, Second medical use; Patent infringement (Case studies, defenses to infringement including experimental use, patent misuse, legal considerations, enforcement measures, patent valuations, competition and confidentiality issues); Assignment of Intellectual Property Rights; Technology Transfer Agreements. Plagiarism in research and publication.

Unit V: Protection of Plant Varieties and Traditional Knowledge

Protection of plant varieties: Interface between technology and IPRs in the context of plants, Key features of UPOV 1978, UPOV 1991 and TRIPS concerning IPRs on plants, Indian law on protection of plant varieties, DUS criteria, *Sui generis* system for protection, Patenting of genetically modified plants, Significance of IPRs in agricultural biotechnology, Case studies; Traditional knowledge: Importance and relevance of traditional knowledge for developing nations, Various approaches for protecting traditional knowledge, Case studies of patenting of health foods.

Text Books:

1. Goel, D. and Prashar, S. (2013). IPR, biosafety, and bioethics. Pearson Publishers.
2. Sadhasivam, S.K. and Mohammed Jaabir, M.S. (2008). IPR and biotechnology management. Jasen Publications, Tiruchirappalli, India.

Reference Books:

1. . Bare Act, 2007. Indian Patent Act 1970, Acts and Rules. Universal Law Publishing Co. Pvt. Ltd., New Delhi.
2. Kankanala, C. (2007). Genetic Patent Law and Strategy. Manupatra Information Solution Pvt. Ltd., New Delhi, 1st.
3. Mittal, D.P. (1999). Indian Patents Law, Taxmann. Allied Services (p) Ltd.
4. Singh, K.K. (2015). Biotechnology and intellectual property rights: Legal and social implications. Springer India

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Describe the basic aspects of IPR, patents, and learn about various patent acts.
CO2	Comprehend the methods to protect intellectual ideas, designs, plant varieties, etc.
CO3	Determine the role of various agencies in the protection of intellectual property.
CO4	Analyze the applicability of various treaties in the protection of intellectual property.
CO5	Appreciate the importance of patents, copyrights, geographical indications, and the protection of plant varieties.
CO6	Justify the importance of IPR in the current scenario.

CO- PSO-PO Mapping:

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	1	2	1	1	1.	1	1	1	3	2	1	2.	1	2	1	3
CO2	1	1	1	1	2	1	2	1	2	1	2	3	2	3	2	2
CO3	1	1	1	1	2	1	2	1	2	1.	2	3.	2	2	3	1
CO4	1	3	1	2	1	1	1	1	2	3	2	2	3	3	2	2
CO5	2	2	1	2	3	2	1	2	3	3	1	2	3	2	3	2
CO6	2	3	1	2	2	2	2	3	1	3	2	2	2	1	1	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code: MMBL404

Course Name: Lab Course based on paper(C402)

Semester/Year: IV Sem

	L	T	P	C
	0	0	3	3

L- Lecture T – Tutorial P – Practical C – Credit

Course Content

1. Epidemiological survey of diseases.
2. Isolation and characterization of pathogens from samples of an infected person.
3. Microbiological analysis of the water of a particular area.
4. Measurement of frequency analysis and interpretation of communication-based data.
5. Study of disease outbreak patterns.
6. Calculation of morbidity, mortality, and natality.

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Observe the pattern of spread of the disease
CO2	Associate the disease pattern with the transmission of the causal organism.
CO3	Interpret the pattern of disease spread by
CO4	Analyze the pattern of disease outbreak.
CO5	Measurement of frequency and interpretation of combination-based data
CO6	Calculation of morbidity, mortality, and natality

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	1	2	1	1	1.	1	1	1	3	2	1	2.	1	2	1	3
CO2	1	1	1	1	2	1	2	1	2	1.	2	3	2	3	2	2
CO3	1	1	1	1	2	1	2	1	2	1.	2	3.	2	2	3	1
CO4	1	3	1	2	1	1	1	1	2	3	2	2	3	3	2	2
CO5	2	2	1	2	3	2	1	2	3	3	1	2	3	2	3	2
CO6	2	3	1	2	2	2	2	2	3	1	3	2	2	1	1	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

	L	T	P	C
	0	0	1	0

Course code	:MMBJ405
Course Name	: Journal Club*
Semester/Year	:IVSem

L- Lecture T – Tutorial P – Practical C – Credit

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Read and be aware of the student's recent research work related to the Microbiology field.
CO2	Select a research paper to prepare assignment
CO3	Choose a research paper presentation as well as a research project.
CO4	Analyze and Knowledge about publication rules and regulations.
CO5	Choose and Knowledge about the screening of UGC Care Journals.
CO6	Formulate a protocol to carry on research work.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	1	2	1	1	1.	1	1	1	3	2	1	2.	1	2	1	3
CO2	1	1	1	1	2	1	2	1	2	1.	2	3	2	3	2	2
CO3	1	1	1	1	2	1	2	1	2	1.	2	3.	2	2	3	1
CO4	1	3	1	2	1	1	1	1	2	3	2	2	3	3	2	2
CO5	2	2	1	2	3	2	1	2	3	3	1	2	3	2	3	2
CO6	2	3	1	2	2	2	2	3	1	3	2	2	2	1	1	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	:MMBS406a
Course Name	: INFECTION AND IMMUNITY
Semester/Year	:IV Sem

	L	T	P	C
	3	0	0	3

L- Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To learn about infection and infectious agents.
2. To learn about the role of cells and molecules of the immune system in infections.
3. To gain knowledge about

Course Content

Unit I: Infectious Agents

Infection and its types; Infectious agents: Viruses, Bacteria, Fungi, Protozoa, Helminthes(worms), Parasites, Prions; Pathogens and immunity; Immunogenicity of pathogens; Virulence and susceptibility; Pathogen-associated molecular patterns.

Unit II: Immune Regulation of Infection

Barriers preventing establishment of infection; Mechanism of establishment of infection: Invasion, Survival in intracellular and cytoplasmic space, Role of molecular factors in establishment of infection, Role of cells and molecules of the immune system in infection, Adoptive immunity to infection, Immune elimination of infection, Mechanisms of escape from immune-mediated destruction, Infection in immunocompromised host.

Unit III: Immune Responses to Infection

Immune alteration during early and late phases of infection; Immunological basis of infection; Infection and antigen presentation; Recognition of molecular pattern of pathogen; Phagocytosis and killing of infectious agents; Humoral and cell-mediated immunity against infection; Infection-associated immunosuppression; Immunodeficiency and infection; Acquired immunodeficiencies; Nosocomial and community-acquired infections; Co-infections; Immunity in local and systemic infection (Bacteremia and viremia); Septic infection and immunity; Immunological memory against infection and secondary responses; Immunization: Active and passive;

Vaccination.

Unit IV: Immunity against Bacterial, Viral, and Prions Infections

Immune responses and immunological control of bacterial infection (*Staphylococcus* and *Mycobacterium*), viral diseases (Influenza and hepatitis), and prion infections.

Unit V: Immunity against Fungal and Parasite Infections

Immune responses and immunological control of fungal infection (*Candida* and *Aspergillus*) and parasitic diseases (Malaria, leishmaniasis, schistosomiasis, and filariasis).

Text Books:

1. Ananth Narayan, R., and Paniker, C.K.J.(2005).Textbook of Microbiology. University Press Publication, 7th ed.
2. Willey, J.M., Sherwood, L.M., and Woolverton, C.J. (2013).Prescott's microbiology.

Reference Books:

1. Brooks GF, Carroll KC, Butel JS, and Morse SA. (2013). Jawetz and Adelberg's Medical Microbiology. McGraw-Hill Publication, 26th.
2. Goering, R., Dockrell, H., Zuckerman, M.and Wakelin, D.(2007).Mims' medical microbiology. Elsevier, London, 4thed.
3. Madigan, M.T., Martinko, J.M., Dunlap, P.V.andClark, D.P.(2014).Brock Biology of Microorganisms. Pearson International Edition, 14th ed.

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Define and memorize Infectious Agents, Immune Regulation of Infection, Immune Responses to Infection, Immunity against Bacterial, Viral, and Prions Infections, Immunity against Fungal and Parasite Infections.
CO2	Discuss infection and its types, Infectious agents, pathogenicity, etc., immunological basis of infection; Immunity against Bacterial, Viral, and prion infections, Immunity against Fungal and Parasite Infections.
CO3	Write and explain about the basic concepts of infection and immunity such as infection, immunological basis of infection, immunity against various infections, etc.
CO4	Explain about infection, types, infectious agents, immunogenicity of pathogens, immunological basis of infection; Immunity against Bacterial, Viral, and Prions Infections, Immunity against Fungal and Parasite

	Infections.
CO5	Summarize the idea of infection, infectious agents, Immune Responses to Infection, Immunity against Bacterial, Viral, and Prions Infections, Immunity against Fungal and Parasite Infections.
CO6	Express the concept of infection and immunity.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	1	2	1	1	1.	1	...1	1	3	2	...1	2.	1	2	1	3
CO2	1	1	1	1	2	1	2	1	2	...1.	2	3	2	3	2	2
CO3	1	1	1	1	2	1	2	1	2	1.	2	3.	2	2	3	1
CO4	1	3	1	2	1	1	1	1	2	3	2	2	3	3	2	2
CO5	2	2	1	2	3	2	1	2	3	3	1	2	3	2	3	2
CO6	2	3	1	2	2	2	2	3	1	3	2	2	2	1	1	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code :MMBS406b	L	T	P	C
Course Name : Research Methology	3	0	0	3
Semester/Year :IV Sem				

L- Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To learn about Qualitative and quantitative data.
2. To make students aware of applications of data mining and genome mining
3. To gain knowledge about multiple sequence alignment and applications

Course Content**Unit I: Formulating Research Problem and Experimental Planning**

Selection of an area for research; Importance and need of research in that field; Literature survey; Planning of experimental work: Importance and designing of the problem to be under taken, Defining the aim and objectives of the research work planned, Importance of prior collection of protocols, Time bound frame of work plan, Designing of experimental protocol; Description of strategies to meet the objectives using state-of-the-art techniques and proper citation of standard procedures.

Unit II: Data Collection and Analysis

Types of data: Qualitative and quantitative data, Primary and secondary data; Site selection for sample collection; Source selection for data acquisition; Sampling techniques: Simple and random sampling, Systematic sampling, Stratified sampling, Multistage sampling, Cluster sampling, Multiphase sampling; Sample size; Recording of data and data summarization; Significance of triplicate readings; Measures of dispersion: Range, Quartile deviation, Mean deviation, Standard deviation, Coefficient of variation; Probability: Random experiment, Events, Sample space, Mutually exclusive events, Independent and dependent events, Statement of addition and multiplication theorems of probability.

Unit III: Statistical Basis of Biological Assay

Response-Dose Meta meter; Direct and indirect assays; Quantal responses; LD50, ED50, and PD50; Standard line interpolation assay; Parallel line assay (4-point and 6-point assays); Slope ratio assay; Count data: Examples of count data (Bacterial cell count, radioactivity count, colony counts, and plaque counts); Statistical treatment of count data: Poisson distribution, Skewness and kurtosis, Standard error; Statistical treatment to proportion data (MPN, sterility testing of medicines, therapeutic trial of drugs and vaccines); Properties and uses of tests of significance (t-test, z-test and chi-square test of heterogeneity and independence of attributes-test).

Unit IV: Analysis of Variance

Principles of experimental designs; Randomized block and Latin square designs; One-way and two-way classifications with single observation per cell; Standard curves: Correlation, Linear regression (Fitting of best line through a series of points), MLR, Multiple collinearity, Standard curves and interpolation of unknown Y-values.

Unit V: Basics of Bioinformatics and Technical Writing

Bioinformatics: Introduction to various biological databases (Primary, secondary and composite databases); Introduction to biological information system: SRS, ENTREZ; Sequence comparison and alignment: Sequence similarity searching tools (FASTA and BLAST), Multiple sequence alignment and applications; Introduction of data mining: Classification, Clustering, Data collection, Data warehousing, Data preprocessing, Applications of data mining and genome mining; Databases: Nucleotide sequence information sources (GenBank, EMBL, EBI, DBJ and UCSC), Protein sequence information sources (PIR, Ex PASY, Uni Prot KB, Swiss Prot and Tr EMBL); Technical writing: Selection of appropriate title, Abstract, Introduction, Aims and objectives, Review of literature, Methodology, Results, Discussion, Summary and Conclusions, Bibliography.

Text Books:

1. Gurumani N (2006), Research methodology for biological sciences. 1st Edition, MJ Publishers, A unit of Tamil Nādu Book House, ISBN:9783527295890.
2. Des Higgins & Willie Taylor (2000), Bioinformatics: Sequence, structure and databases. Oxford University Press, ISBN10:0199637903 ISBN13:9780199637904.
3. Arora PN & Malhon PK, (1996), Biostatistics. Imalaya Publishing House, Mumbai. ISBN Number: 978-93-5142-823-7.

Reference Books

1. John Webster (2004). Bioinstrumentation. Student edition, John Wiley & Sons, Ltd., ISBN 978-0-471-67600-3.
2. Palanivelu P(2001), Analytical Biochemistry and Separation Techniques: A Laboratory Manual. 2nd edition, Published by Tulsi Book Centre, Madurai, Tamil Nadu, ISBN:4567142233.
3. JogdandSN(2004), Gene Biotechnology, Published by Himalaya Publishing House, Mumbai, ISBN Number: 978-93-5262-087-6.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Define research problem, review and assess the quality of literature from various sources.
CO2	Understand meaning, nature and scope of research in organizational behavior context.
CO3	Collect the data by various methods: observation, interview, questionnaires.
CO4	Analyze the link between quantitative research questions and data collection and how research questions are operationalized in educational practice.
CO5	Summarize the types of descriptive statistics typically reported in educational research studies
CO6	Structure the writing style used for quantitative and qualitative study.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	...1	2	1...	2	1	1	...1	2	3	2	1	2	3	2	...	1...

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

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	:MMBS406c
Course Name	:TISSUE BIOTECHNOLOGY
Semester/Year	:IV Sem

	L	T	P	C
	3	0	0	3

L- Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To learn about Qualitative and quantitative data.
2. To make students aware of applications of data mining and genome mining.
3. To gain knowledge about multiple sequence alignment and applications.

Course Content

Unit-I

Basic concepts in cell culture; *In vitro* culture: Approaches & methodologies - preparatory steps for tissue culture - surface sterilization of plant tissue material – basic procedure for aseptic tissue transfer - incubation of culture.

Unit-II

Growth Hormones - Plant cells (Composition of culture media, Growth Hormones, Vitamins, Unidentified supplements, selection of media); Animal cells (substrate on which cells grow, Feeder layer on substrate, gas phase for tissue culture, media and supplements).

Unit-III

Plant cells (Callus Culture, Cell Suspension Culture, and Organ Micro-Culture, Plant micropropagation. Somatic Embryogenesis); Problems in Plant Tissue Culture: Contamination, Phenolic, Recalcitrance, Seasonal Variations in Response;

Animal cells (Source of tissue, Primary culture, and differentiation of cells - growth kinetics - animal cell lines and their origin and Characterization by morphology, chromosome analysis, DNA content, enzyme activity and antigenic markers, differentiation; applications of animal tissue culture.

Unit-IV

Cloning and selection of specific cell types –cloning, somatic cell fusion, and HAT selection –Medium suspension fusion - selection of Hybrid clone - production of monoclonal antibodies.

Unit-V

Primary cultures and cell lines with examples–Stemcellcultures-Therapeuticcloning-Carcinomastemcells–Germcellculture–Uses; Organculture Culture of embryonic organs-whole embryo culture-culture of adult organs; Application of Tissue Biotechnology in animals, plants – medicines.

Text Book:

1. Das, H.K. (2007). *Textbook of Biotechnology*, (3rd Ed). Wiley India Pvt Ltd: New Delhi, ISBN: 9788126564040.
2. Gangal and Sudhda. (2010). *Principles and practice of animal tissue culture*, (2nd Ed). Universities Press Pvt, Ltd: India, ISBN: 9788173717192.
3. Yadav, P.R. and Rajiv Tyagi. (2006). *Biotechnology of Animal Tissues*. Discovery Publishing Company: New Delhi, ISBN10:8183560849/ISBN:9788183560849.

Reference book:

1. Colin Ratledge and Bjorn Kristiansen. (2001). *Basic Biotechnology*. Cambridge University Press: U K, ISBN: 0-521-77074-2 (hc); 0-521-77917-0.
2. John Anthony Sharp. (1979). *An Introduction to Animal Tissue Culture*. Edward Arnold publications: London, ISBN: 978-0-470-85094-7.
3. Primrose, S.B. (2001). *Molecular Biotechnology*, (2nd Ed). Panima Publishing Corporation: India, ISBN: 0-632-03053-4.

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Define Basic concepts in cell culture, Growth Hormones, plant cells, Cloning, and selection of specific cell and primary cultures and cell lines.
CO2	Explain Primary cultures and cell lines, Growth Hormones, and Application of Tissue Biotechnology in animals, plants, and medicines.
CO3	Illustrate the Growth Hormones, Plant cells, Application of Tissue Biotechnology in animals, plants, and medicines
CO4	Explain. Growth Hormones, Plant Cells, Cloning and selection of specific cells and Primary cultures, and cell lines.

CO5	Summarize the Cloning and selection of specific cells and primary cultures, and cell lines.
CO6	Justify the knowledge about. Growth Hormones, Application of Tissue Biotechnology in Animals, plants – medicines

CO- PSO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	3	2	2	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	1	1	2	2	2	1	2	2	2	2	3	2
CO3	2	2	1	2	2	2	2	2	2	1	2	2	3	3	2	2
CO4	2	2	2	2	2	2	2	2	2	1	2	2	2	2	3	2
CO5	2	2	1	2	1	1	2	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	1	1	2	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated