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 Science

((W.E.F 2021-2022)

SHRI GURU RAM RAI UNIVERSITY, PATEL NAGAR, DEHRADUN-248001, UTTARAKHAND

Master of Microbiology

OUTCOME BASED MICROBIOLOGY

Programme outcome (POs)

Students 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 takenbased 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 establish a hypothesis for various interdisciplinary research problems.
PO5	Create a new conceptual, theoretical and operational approach to address various problems of interdisciplinary 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 lifelong 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.

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 incorporating 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 sociotechnological changes.

Eligibility for admission:

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

Duration of the Programme:

STUDY & EVALUATION SCHEME

Choice Based Credit System /ECS*

Master of Microbiology

First Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	MMBC-101	INTRODUCTORY MICROBIOLOGY	4	0	0	4	40	60	100
2	Core	MMBC-102	PRINCIPLES OF BIOCHEMISTRY	4	0	0	4	40	60	100
3	Core	MMBC-103	CELL AND MOLECULAR BIOLOGY	4	0	0	4	40	60	100
4	Core	MMBC-104	MICROBIAL GENETICS	4	0	0	4	40	60	100
Practical										
1	Lab	MMBL105	Lab Course I (Based on paper 1 & 2)	0	0	3	3	40	60	100

2	Lab	MMBL-106	Lab Course II (Based on paper 3 & 4)	0	0	3	3	40	60	100
Total								22	360	600

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

Second Semester

S. No.	Course Category	Couse 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	4	0	0	4	40	60	100
2	Core	MMBC -202	IMMUNOLOGY	4	0	0	4	40	60	100
3	Core	MMBC -203	BIOLOGICAL TECHNIQUES	4	0	0	4	40	60	100
4	Core	MMBC -204	RECOMBINANT DNA TECHNOLOGY	4	0	0	4	40	60	100
Practical										
1	Lab	MMBL 205	Lab Course I (Based on paper 1 & 2)	0	0	3	3	40	60	100
2	Lab	MMBL 206	Lab Course II (Based on paper 3 & 4)	0	0	3	3	40	60	100
Total								240		600

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

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

Third Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	MMBC 301	MEDICAL MICROBIOLOGY	4	0	0	4	40	60	100
2	Core	MMBC-302	INDUSTRIAL AND PHARMACEUTICAL MICROBIOLOGY	4	0	0	4	40	60	100
3	Elective	MMBE-303	Elective – I a)FOOD AND DAIRY MICROBIOLOGY b)DRUG DESIGNING ANDNANO-BIOTECHNOLOGY c)MOLECULAR VIROLOGY AND INFECTION	4	0	0	4	40	60	100

4	Elective	MMBE-304	Elective – II a)ENVIRONMENTALMICROBIOLOGY b)AGRICULTURALMICROBIOLOGY c)ECOSYSTEM ANALYSIS AND REMOTE SENSING d)MUSHROOM CULTURE TECHNOLOGY	4	0	0	4	40	60	100
Practical										
1	Lab	MMBL305	Lab Course I (Based on paper 1 & 2)	0	0	3	3	40	60	100
2	Lab	MMBL-306	Lab Course II (Based on Elective I & II)	0	0	3	3	40	60	100
	Self Study	MMBS307	a) BIOINFORMATICS & BIOLOGICAL b) BIOMEDICAL TECHNOLOGY	3	0	0	3	40	60	100
		MMBI308	Industrial Training Report/Presentation	3	0	0	3			

Core Credit = 11 + Elective Credit = 11 Total Credit = 22 with additional 3 credits of self-study & 3 credits of Industrial Training.

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

Fourth Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	MMBE401	DISSERTATION	0	0	9	9		180+60+60	300
2	Core	MMBC402	EPIDEMIOLOGY	4	0	0	4	40	60	100
3	Elective	MMBE403	a. Beverages Biotechnology b. Bio – Entrepreneurship c. Intellectual Property Rights	4	0	0	4	40	60	100
4	Lab	MMBL404	Lab Course based on paper(C402)	0	0	3	3	40	60	100

5	Lab	MMBJ405	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

Core Credit = 7 + Elective Credit = 13 Total Credit = 20 with additional 3 credits 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 60 marks for academic performance and 60 for presentation/viva.

Examination Scheme:

Components	**Ist internal Assignment/ Presentation**	**IInd Internal/Written Exam Presentation**	**External (ESE)**
Weightage (%) (Theory +Practical)	**20**	**20**	60
Dissertation			240

Programme Name

Course code	**: MMBC-101**
Course Name	**: INTRODUCTORY MICROBIOLOGY**
Semester /Year	**: ISem**

	L	T	P	C
	4	0	4	4

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

Course Objectives: The objectives of this course are

1. To gain knowledge about history of Microorganism.
2.To make student aware about the Bacterial morphology.
3. To learn about viruses.

Course Content

TOTAL HOURS: 60 **CREDITS: 04**

Unit I: History and Classification **No. of Hours: 13**

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: Basic of Microbiology **No. of Hours: 12**

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 chemicalagents.

Unit III: General Bacteriology **No. of Hours: 10**

Bergey's system of bacterial classification; Brief account of Gracilicutes, Fermicutes, Mendosicutes and Tenericutes; Ultrastructure 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 functions of flagella, cilia, pili, s-layer, cytoplasmic inclusions, ribosomes and nucleoid; Bacterial
Reproduction

Unit IV: General Virology and mycology **No. of Hours: 15**

Discovery of viruses; Characteristic feature 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 end point 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, ZygomycetesandDeuteromycetes.

Unit V: Extremophiles **No. of Hours: 10**

General introduction to Archae bacteria and applications Tools used for studying extremophiles, culturable and non culturable microbial diversity, Characteristic features, physiology, applications of acidophiles, alkalophiles, psychrophiles, thermophiles, barophiles, halophiles, oligotrophs, osmophiles, radiophiles, metallophiles and xerophiles.

Text Books:

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

Reference Books:

1. Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. Prescott, Harley and Klein'smicrobiology. McGraw-Hill, NewYork.
2. Black, J.G. Microbiology: Principles and exploration. John Wiley and Sons, NewJersey.
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	Gain knowledge about discoveries in the field of microbiology, scope and relevance of microbiology.
CO2	Discuss microbial taxonomy and systematic.
CO3	Learn about techniques used in cultivation of microorganism
CO4	Understand the growth kinetics of bacteria and know its control.
CO5	Explain the ultrastructure of bacterial 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	PS O1	PS O2	PSO 3	PSO4

CO1	1	2	-	1	1	2	2	2	2	2	2	2	1	1
CO2	1	1	1	-	-	1	1	1	-	-	1	-	-	-
CO3	2	2	-	1	-	-		1	1	1	1	-	-	1
CO4	1	1	-	-	1	-	1	1	-	1	1	-	1	-
CO5	1	1	1	1	1	-	1	1	-	1	2	1	-	-

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

Course code	**: MMBC-102**
Course Name	**: PRINCIPLES OF BIOCHEMISTRY**
Semester /Year	**: I 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 gain knowledge about Structure of carbohydrate.
2. To make student aware protein structure and function.
3. To learn about enzyme properties.

Course Content

TOTAL HOURS: 60 CREDITS: 04

Unit I: BioenergeticsNo. of Hours: 12

Bioenergetics: Concept of free energy, Standard free energy, Enthalpy, Entropy, High energy phosphate compounds, Phosphate group transfer, Free energy of hydrolysis of ATP, Oxidation-reduction, Redox potential; Energy generation in biological systems: Phosphorylation and electron transport chain, Electron carriers, Artificial electron donors, Inhibitors and uncouplers of oxidative phosphorylation, Chemiosmotic theory of ATPsynthesis.

Unit II: CarbohydratesNo. of Hours: 10

Classification, nomenclature, structure, general properties and functions of simple carbohydrates; Complex carbohydrates: Mucopolysaccharides, Amino sugars, Bacterial cell wall sugars, Sugar alcohols, Glycoconjugates.

Unit III: LipidsNo. of Hours: 14

General properties, nomenclature and classification of lipids; Lipid functions: Fatty acids; Saponification, acid value and iodine value of fats; Rancidity of fats; Storage and structural lipids; Metabolism: Biosynthesis of fatty acids, triacylglycerols, membrane phospholipids, cholesterol, steroids and isoprenoids, Beta oxidation and its regulation, Regulation of cholesterol biosynthesis.

Unit IV: Proteins and NucleotidesNo. of Hours: 12

Proteins: Structural features and classification of amino acids, General reactions of amino acid metabolism (Transamination, decarboxylation, oxidative and non-oxidative deamination of amino acids), Peptide bond, Properties and functions of primary, secondary, tertiary and quaternary

structure of proteins, Ramachandran plot,. Nucleotides: Structure of purines and pyrimidines and their function, overview of nitrogen fixation.

Unit V: EnzymesNo. of Hours: 12

General characteristics of enzymes; Co-enzymes; Holoenzymes; Prosthetic groups; Enzyme nomenclature; Classification of enzymes; Active site; Transition state; Activation energy; Enzyme activity; Specific activity and turn over number; Isozymes; Mechanism of enzyme catalysis and Enzyme kinetics; Reaction mechanisms of enzymes (Acid base and covalent catalysis); Reversible and irreversible inhibition of enzymes; Effect of pH and temperature on enzyme activity; Allosteric enzymes; Determination of active site and turn overnumber.

Text Books:

1. Voet, D. and Voet, J.G. Biochemistry. John Wiley and Sons, NewYork.
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, NewYork.

Reference Books:

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

Course outcomes (COs):

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

CO1	Understand basic principles of biochemistry, concept of energy and energy generation processes in cell.
CO2	Get knowledge about various molecules (carbohydrates, lipids and proteins): their structure, biological functions and metabolism**.**
CO3	Understand about enzymes; their activity and mechanism of action.
CO4	Understand the reactions of amino acids
CO5	Know about structure and functions of nucleotides; physiology of nitrogen fixation

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	PSO 1	PSO 2	PSO 3	PSO 4
CO1	1	1	-	-	-	1	1	1	1	1	2	-	-	-
CO2	1	1	-	1	1	1	1	1	1	1	1	-	-	-
CO3	1	1	-	1	-	1	1	1	1	1	1	-	-	-
CO4	1	1	-	-	-	1	1	1	1	1	1	-	-	-
CO5	1	1	-	-	-	-	1	1	1	1	1	-	-	-

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

Course code	**: MMBC-103**
Course Name	**: CELL AND MOLECULAR BIOLOGY**
Semester /Year	**: I 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 make student aware cell organelles.
2. To gain knowledge about replication.
3. To make student aware cell cycle.

Course Content

TOTAL HOURS: 60 **CREDITS: 04**

Unit I: Intracellular Compartmentalization of Cell **No. of Hours: 10**

Structure, organization and functions of nucleus, mitochondria, chloroplast, endoplasmic reticulum, golgi body, peroxisome, lysosome and endosomes; Molecular mechanism of vesicular trafficking. Fluid mosaic model, Membrane fluidity, Membranedynamics

Unit II: Cell Signalling **No. of Hours: 13**

Basic signaling mechanisms (Paracrine, endocrine and autocrinesignaling); 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, Signal amplification.

Unit III: Replication and Transcription **No. of Hours: 13**

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, Post transcriptional modifications of mRNA, rRNA and tRNA, Inhibitors of transcription; Structural features and functions of mRNA, t-RNA and r-RNA.

Unit IV: Translation and Regulation of Gene Expression **No. of Hours: 12**

Basic features of 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*, *trp*and *arb*operon, DNA binding motifs in regulatory proteins, Role of activators, enhancers, insulators, RNA interference and antisense RNA.

Unit V: Cell Cycle and Cell Death **No. of Hours: 12**

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 inducingfactors.

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

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.de Robertis, E. D. P. and de Robertis, E.M.F. Cellular and molecular biology. Saunders, Philadelphia.
4. Pollard, T.D., Earnshaw, W.C. and Schwartz, J.L. Cell biology. Saunders, Philadelphia.
5. 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	Know about structural and functional integrity of cell; vesicular trafficking
CO2	Learn about unitmembrane concept, fluid mosaic model of plasma membrane; membrane fluidity, membrane dynaics
CO3	Understand central cellular processes and their regulation (replication, transcription, translation and protein expression)
CO4	Understand the concept of cell signaling and signal transduction pathway; second messengers, cell surface receptors.

CO5	Discuss molecular mechanism of cell cycle and cell death; mitosis and meiosis

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	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	-	-	-	1	1	1	1	1	1	1	-	-
CO2	2	1	-	-	-	1	1	1	1	1	1	1	-	1
CO3	1	1	-	-	-	1	1	1	1	1	1	1	-	1
CO4	1	1	-	-	-	1	1	1	1	1	1	-	1	1
CO5	2	1	-	-	-	1	1	1	1	1	1	1	1	1

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

Course code	**: MMBC-104**
Course Name	**: MICROBIAL GENETICS**
Semester /Year	**: I 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 gain knowledge about Transposition.
2. To make student aware mutation and repair system of bacterial cell.
3. To gain knowledge about Mutation.

Course Content

TOTAL HOURS: 60 **CREDITS: 04**

Unit I: Essentials of Genetics **No. of Hours: 12**

Genetic notations- prototrophs, auxotrophs, diploid, and electroporation. Gene as unit of mutation a 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 **No. of Hours: 10**

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 **No. of Hours: 10**

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 **No. of Hours: 15**

Bacterial plasmids: Types of plasmids, Fertility or (F) plasmid, resistance or R plasmid, col

plasmid, 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-palsmids 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 **No. of Hours: 13**

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 HFT lysate)

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, ISBN0131238264

Reference Books:

1. G M Cooper & R E Hausman. (2016). *The Cell - A Molecular Approach.* 7/e. ISBN 978-1-60535-290-9.
2. J D 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	Gain knowledge on units of gene, genetic notations and model organism used for genetic studies in microbes
CO2	Understand the molecular nature ofmechanism like recombination and mutation
CO3	Understand the importance and role of DNA repair mechanism..

CO4	Understand the mechanism of gene transfer in bacteria.
CO5	Learn about life cycle and genetic structure of bacteriophages.

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	PSO 1	PSO 2	PSO 3	PSO 4
CO1	1	2	-	1	2	1	1	1	1	1	2	2	2	1
CO2	2	2	-	1	1	1	1	1	1	1	1	1	1	1
CO3	2	2	-	-	1	1	1	1	1	1	1	1	1	-
CO4	2	2	-	1	1	1	1	1	1	1	1	1	1	-
CO5	2	2	-	1	1	1	-	1	1	1	1	1	1	1

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

Course code	**: MMBL-105**
Course Name	**: Lab Course I (Based on paper 1 & 2)**
Semester /Year	**: I Sem**

	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 sterilization method.
2.To learn to perform media preparation
3. To learn to perform buffer preparation.

Course Content

CREDITS: 03

1. Safety rules of working in microbiology lab, disposal of cultures, calibration, validation and maintenance of instruments.
2. Principles and working of instruments used in microbiologylab.
3. Media preparation and itssterilization.
4. Isolation and enumeration of bacteria and fungi from givensample.
5. Isolation and maintenance of pure culture of bacteria andfungi.
6. Isolation and enumeration of bacteriophage from sewagewater.
7. Staining of bacterial cell (Simple staining, gram staining and negativestaining).
8. Staining of fungalcell.
9. Staining of endospore andcapsule.
10. Study of morphology ofalgae.
11. Symptomatology of infection of plantpathogens.
12. Measurement of bacterial cell size usingmicrometer.
13. Safety rules of working in lab, hazard from chemicals, handling of chemicals, disposal of chemicals, recording of scientific experiments, calibration, validation and maintenance ofinstruments.
14. Calculation of moles, molarity, molality and normality of givensolution.
15. Calculation of pH of givensolution.
16. Preparation of solutions and buffers of different concentrations and pH.

17. Qualitative tests for sugars, amino acids, proteins and lipids in givensample.

18. Quantitative estimation of sugar in givensample.

19. Quantitative estimation of protein in givensample.

20. Estimation of lipid concentration in givensample.

Course outcomes (COs):

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

CO1	Learn about rules and working of instruments used in microbiology lab.
CO2	Know general microbial techniques for isolation, enumeration and staining of microbial cells and their structures.
CO3	Learn to prepare buffers and calculate strength of solutions.
CO4	Learn various tests for quantification of biochemical molecules.
CO5	Know how to measure bacterial cell size

Course code	**: MMBL-106**
Course Name	**: Lab Course II (Based on paper 3 & 4)**
Semester /Year	**: I Sem**

	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 performgenomic DNA isolation from bacterial culture.
2. To learn to perform preparation of competentcells.
3.To Determination of quality of DNA by spectrophotometricmethod.

Course Contents **CREDITS: 03**

1. Study of different stages ofmitosis.
2. Study of different stages ofmeiosis.
3. To prepare temporary slide ofmitosis.
4. To prepare temporary slide ofmeiosis.
5. Demonstration of transformation inbacteria.
6. Quantitative estimation of DNA by diphenyl amine (DPA) and spectrophotometricmethod.
7. Quantitative estimation of RNA by orcinol and spectrophotometricmethod.
8. Determination of quality of DNA by spectrophotometricmethod.
9. Isolation of genomic DNA from bacterial culture.
10. Visualization of DNA by agarose gelelectrophoresis.
11. Determination of Tm of given DNAsample.
12. Study of effect of different concentrations of urea on denaturation ofDNA.
13. Demonstration of dark repair mechanism inbacteria.
14. Study of effect of temperature and pH on denaturation ofDNA.
15. Mutagenesis in given bacterial culture by U.V.radiation.
16. Demonstration of photo reactivation mechanism inbacteria.
17. Preparation of competentcells.
18. Demonstration of conjugation inbacteria.
19. Isolation of antibiotic resistant bacteria by gradient platemethod.

20. Isolation of antibiotic resistant mutants by replica platingtechnique.

Course outcomes (COs):

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

CO1	Learn and Identify different stages of mitosis and meiosis
CO2	Isolate, quantify and visualize genomic DNA.
CO3	Understand the effect of temperature and chemical on DNA denaturation.
CO4	Understand transformation and conjugation in bacteria.
CO5	Get knowledge about the repair mechanism in bacterial cell.

Course code : MMBC-201
Course Name: MICROBIAL PHYSIOLOGY ANDMETABOLISM
Semester /Year : II 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 Gain knowledge of various transport systems and protein secretion pathways in bacteria
2. To make student aware the concept osmoregulation.
3. To Gain knowledge of Quorum sensing.

Course Content

TOTAL HOURS: 60 **CREDITS: 04**

Unit I: Microbial Photosynthesis and Chemolithotrophy No. of Hours: 12

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 chemolithotrophs, Mechanism of energy generation in methylotrophs and methanogens.

Unit II: Nitrogen and Sulphur Metabolism No. of Hours: 12

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, Regulation of nitrate assimilation; 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 No. of Hours: 12

Respiration: Aerobic respiration, Components of electron transport chain, free energy changes and electron transport, oxidative phosphorylation and theories of ATP formation, inhibition of

electron transport chain Anaerobic respiration, Mechanism of oxygen toxicity; Fermentation: Glucose, acetic acid, lactic acid, butyric acid, propionic acid and mixed acidfermentation.

Unit IV: Bacterial Permeation **No. of Hours: 14**

Structure and organization of membrane(Glyco-conjugants and proteins in membrane systems), fluid mosaic model of 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,differentpermeases in E. coli. Transport of aminoacids and inorganic ions in microorganisms andtheirmechanisms. Donnan equilibrium, Thermodynamics of various transport systems, Osmotic pressure of electrolyte and non-electrolyte transport protein, Protein secretion pathways in bacteria;

Unit V: Microbial Stress Response **No. of Hours: 10**

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, NewYork
3. Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. Prescott, Harley and Klein'smicrobiology. McGraw-Hill, NewYork.

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, NewJersey.
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. OxfordUniversity Press, New York.

Course outcomes (COs):

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

CO1	Differentiate between different types of bacteria on the basis of modes and mechanism of energy conservation- Autotrophy and Heterotrophy
CO2	Understand the microbiology, physiology, genetics and biochemistry of nitrogen metabolism and nitrogen fixation.
CO3	Gain knowledge of various transport systems and protein secretion pathways in bacteria.

CO4	Discuss different types of stress in bacteria and understand their mechanism.
CO5	Explain the concept of quorum sensing and bioluminescence in 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	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	-	-	1	-	1	1	-	1	1	1	-	1
CO2	2	2	1	1	-	1	1	1	1	1	1	1	-	1
CO3	2	2	-	-	-	1	1	1	-	1	1	1	-	1
CO4	2	2	-	1	-	1	1	1	-	1	1	1	1	1
CO5	2	2	-	-	-		1	1	1	1	1	1	1	1

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

Course code	**: MMBC--202**
Course Name	**: IMMUNOLOGY**
Semester /Year	**: II 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 gain knowledge of immune system.
2. To gain knowledge of Antigen structure and properties.
3. To make the student aware Tumour immunology.

Course Content

TOTAL HOURS: 60 **CREDITS: 04**

Unit I: Overview and elements of the immune systemNo. of Hours: 10

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 **No. of Hours: 15**

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

Unit III: Complement System and Major Histo-compatibility Complex No. of Hours: 10

Complement activation pathways (Classical, alternate and lectin pathways), Biological consequences of complement activation, Complement assay. Structure and functions 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 No. of Hours: 12

B- cellreceptor;Development and differentiation of B cells, T – cell receptor complex;Developmentand differentiation of T cells. Immune Response: T -Cell independent defense 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) No. of Hours: 13

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;Tumour immunology- tumour specific antigens, immuneresponse to tumour,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 andCompany, 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	Gain knowledge of immune system and immunity.
CO2	Discuss about antigens, antibodies and their interactions and applications in diagnostic techniques.
CO3	Learn the structure and types of antibodies and their role; production of monoclonal antibodies
CO4	Explain the mechanism of immune responses and their regulation.and the role of MHC in transplantation

CO5	Understand development and differentiation of B cells and T cells and their role in humoral and cell mediated immunity respectively.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	1	1	-	1	1	1	1	1	1	1	1	1
CO2	2	2	1	1	-	-	1	1	1	1	1	1	1	1
CO3	2	2	1	1	-	1	1	1	1	1	1	-	-	-
CO4	1	2	-	1	-	-	1	1	1	1	1	-	-	1
CO5	2	2	-	1	-	-	1	1	1	1	1	-	-	1

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

Course code	**: MMBC--203**
Course Name	**: BIOLOGICAL TECHNIQUES**
Semester /Year	**: II 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 aware the student to principle of pH meter.
2.To learn about principle and applications of various electrophoretic techniques.
3. To learn about spectroscopy and radioisotopic technique.

Course Content

TOTAL HOURS: 60 **CREDITS: 04**

Unit I: Basic laboratory InstrumentsNo. of Hours: 12

Principle and working of pH meter, Laminar-air flow.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 BiosensorsNo. of Hours: 12

Microscopy (Principles and applications): Light, phase contrast, fluorescence and confocal microscopy, 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 TechniquesNo. of Hours: 12

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 fluidchromatography.

Unit IV: Electrophoretic TechniquesNo. of Hours: 12

Basic principles and applications of electrophoresis; Types of electrophoresis (Principles and applications): Paper electrophoresis, Moving boundary electrophoresis, Isotachophoresis, Agarose gel electrophoresis, Polyacrylamide gel electrophoresis (SDS-PAGE, Native-PAGE, Denaturing-PAGE and Reducing-PAGE), Isoelectric focusing (IEF).

Unit V: Spectroscopy and Radioisotopic TechniquesNo. of Hours: 12

Elementry 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, Measurement of radioactivity (GM counter, gamma counter, and liquid scintillation counter), Autoradiography: Principle and its applications.

Text Books:

1. Cappucino, J. and Sherman, N. Microbiology: A laboratory manual. Benjamin/Cummings PublishingCompany, 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 Wilkin, 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, NewDelhi.
4. Segel, I.H. Biochemical calculations. John Wiley and Sons, New York.
5. Plummer, D.T. Introduction to practical biochemistry. Mc-Graw 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	Learn working and applications of instruments used in microbiology; pH meter, Laminar Air Flow
CO2	Gain knowledge of microscopy.
CO3	Understand the concept of biosensors

CO4	Learn about principle and applications of various electrophoretic techniques
CO5	Gain knowledge about spectroscopy and radioactivity; principle and applications

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	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	-	-	1	1	1	1	1	1	2	2	-	1
CO2	2	2	2	1	-	1	1	1	1	1	2	2	-	1
CO3	2	2	1	1	-	1	1	1	1	1	2	1	-	1
CO4	2	2	1	1	-	1	1	1	1	1	2	1	-	1
CO5	2	2	1	-	-	1	1	1	1	1	2	1	-	1

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

Course code	**: MMBC--204**
Course Name	**: RECOMBINANT DNA TECHNOLOGY**
Semester /Year	**: II 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 about principle and tools of gene cloning.
2.To aware the student to types of vectors.
3. To learn about application of Recombinant DNA Technology.

Course Content

TOTAL HOURS: 60 **CREDITS: 04**

Unit I: Principles and Tools of Gene CloningNo. of Hours: 10

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 No. of Hours: 14

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

Unit III: Expression of Cloned Gene in Heterologous SystemNo. of Hours: 12

Expression vectors: structure, components and advantages ; Characteristic features of pEt, pcDNA3 and cytomegalovirus expression system; 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 TechniquesNo. of Hours: 12

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 RDTNo. of Hours: 12

Principles and applications of techniques used in genome analysis: Exon trapping, R loop 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 andagriculture.

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, NewJersey.
3. Brown, T.A. Genomes. Wiley-Liss, Oxford
4. Sambrook, J. and Russell, D.W. Molecular Cloning: A laboratory manual. Cold Spring Harbor LabPress, 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 ofrecombinant 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 manipulations. 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 andTechnology, Government of India, New Delhi.

Course outcomes (COs):

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

CO1	Learn about the enzymes and tools used in Recombinant DNA technology.
CO2	Get knowledge about different types of vectors, cloning strategies, transformation and selection (determine the selection parameters of r-DNA) of recombinant DNA.
CO3	Discuss about high capacity vectors; artificial chromosomes

CO4	Understand construction of genomic and cDNA library and their applications.
CO5	Understand the use of genetic engineering for various processes like protein interaction studies, hybridization techniques, gene tagging, mutagenesis, gene silencing, anamplification of DNA and DNA Sequencing

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	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	-	1	1	1	1	1	2	1	2	2	-	1
CO2	2	2	1	1	1	1	1	1	2	1	1	1	-	1
CO3	2	2	1	1	-	1	1	1	1	1	2	1	1	1
CO4	2	2	-	1	-	1	1	1	1	1	2	1	1	1
CO5	2	2	2	1	-	1	1	1	1	1	2	1	1	1

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

Course code	**: MMBL-205**
Course Name	**: Lab Course I (Based on paper 1 & 2)**
Semester /Year	**: II Sem**

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

Course Content

CREDITS: 03

1. Study of effect of temperature, Ph and salt concentration on growth ofbacteria.
2. Determination of ability of bacteria to reducenitrate.
3. Determination of ability of bacteria to produceH2S.
4. Determination of presence of cytochrome oxidase inbacteria.
5. Determination of presence of catalase inbacteria.
6. Determination of ability of bacteria to produce acidic or neutral end product fromglucose.
7. Determination of ability of bacteria to utilize sugars by oxidative or fermentativemode.
8. Study of different stages of sporulation in*Bacillus*.
9. Effect of pH, sugars, amino acids and inorganic ions on spore germination. 10Study of mechanism ofdiffusion.
10. Study of mechanism of exosmosis andendosmosis.
11. Effect of isotonic, hypotonic and hypertonic solutions oncell.
12. Separation and preservation of serum andplasma.
13. Determination of blood group and Rhfactor.
14. Demonstration of agglutination reaction of bacterial cultures by slide agglutinationtest.

15. Quantitative estimation of antigen by radialimmunodiffusion.
16. Detection and quantification of either antibody or antigen by ouchterlony double diffusionmethod.
17. Determination of concentration of antigen by rocketimmunoelectrophoresis.
18. Determination of the presence of specific antibody for its antigen by Dot-ELISAmethod.
19. Separation of components of antigen mixture and study the pattern byimmunoelectrophoresis.

Course outcomes (Cos):

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

CO1	Know the effect of different environmental parameters like Ph, temperature on the growth of bacteria.
CO2	Understand transport mechanism like diffusion, osmosis.
CO3	Determine the ability of bacteria to produce sugar, catalase, cytochrome oxidase etc.
CO4	Learn to perform blood group test, blood cell count and separation of serum.
CO5	Detect agglutination and apply it in disease diagnosis

Course code	**: MMBL-206**
Course Name	**: Lab Course II (Based on paper 3 & 4)**
Semester /Year	**: II Sem**

	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 paperchromatography.
2. To make student to aware principle of Lambert Beer'slaw.
3.To learn perform preparation of competentcells.

Course Content**CREDITS: 03**

1. Separation and identification of amino acids by ascending and descending paperchromatography.
2. Separation and identification of sugars by paperchromatography.
3. Separation and identification of sugars by thin layerchromatography.
4. Verification of Lambert Beer'slaw.
5. Determination of molecular weight of DNA by agarose gelelectrophoresis.
6. Separation and determination of molecular weight of proteins bySDS-PAGE.
7. Visualization of enzyme activity byNATIVE-PAGE.
8. Interpretation of UVspectra.
9. Interpretation of IRspectra.
10. Interpretation of NMRspectra.
11. Interpretation of Massspectra.
12. Isolation of genomic DNA from plantsample.
13. Isolation of plasmid DNA from bacterial cellculture.
14. PCR amplification ofDNA.
15. Restriction digestion of vector andDNA.

16. Ligation of DNA construct andvector.

17. Preparation of competentcells.

18. Introduction of recombinant DNA into bacterial cells and selection of recombinantclones.

19. Demonstration of inducible enzyme β-galactosidase in *E.coli*.

20. Expression of gene in *E. coli*.

21. Determination of similarity between different bacterial isolates usingRFLP.

Course outcomes (Cos):

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

CO1	Know separation and identification of amino acids and sugars by different chromatographic techniques.
CO2	Understand the techniques for introduction of DNA into host cells and study its expression.
CO3	Gain knowledge of amplification of DNA by PCR
CO4	Learn to perform restriction digestion of DNA; RFLP
CO5	Learn to isolate genomic and plasmid DNA

Course code	**: MMBC—301**
Course Name	**: Medical Microbiology**
Semester /Year	**: III 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 make student aware to Normal microbiota of human body.
2. To gain knowledge about mechanism of pathogenesis.
3. To gain knowledge of bacterial, viral and fungal disease.

Course Content

TOTAL HOURS: 60 **CREDITS: 04**

Unit I: Basics of Medical Microbiology **No. of Hours: 12**

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 microbiologylaboratory.

Unit II: PathogenesisNo. of Hours: 10

Pathogenicity islands; Mechanism of pathogenesis: Mechanism of bacterial adhesion, colonization and invasion, Protein toxins (Classification and mode of action), Cytoskeletal modulation of host cell; Mechanism of action of antimicrobial agents;

Unit III: Antimicrobial Chemotherapy **No. of Hours: 14**

Methods of drug susceptibility testing: Kirby-Bauer's disc diffusion method, Stokes method, Agar dilution method, Broth dilution method, E-strip method; 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 DiseasesNo. of Hours: 10

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 DiseasesNo. of Hours: 14

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

Text Books:

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

Reference Books

1. Koneman, E.W. Koneman'scolor atlas and textbook of diagnostic microbiology. Lippincott Williamsand Wilkins, Philadelphia.
2. Topley, W.W.C., Wilson, S.G.S 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	Understand the concept Normal microbiota of human body.
CO2	Understand the concepts of Pathogencity islands, protein toxin, and action of antimicrobial agent.

CO3	Discuss the different diagnostic tests in microbial diseases.
CO4	Understand the fundamentals and advanced aspects of microbiological assay of antibiotics using tube dilution, well diffusion and agar dilution method.
CO5	Discuss about the bacterial, fungal and viral disease their transmission, pathogenesis, diagnosis, prevention and control.

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	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	-	1	1	1	1	1	1	1	2	-	-	-
CO2	2	2	-	1	1	1	1	1	1	1	2	1	-	1
CO3	2	2	-	-	-	1	1	1	1	1	1	1	-	1
CO4	2	2	1	1	-	1	1	1	1	1	2	1	-	1
CO5	2	2	-	1	-	1	1	1	1	1	2	1	-	1

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

Course code	**: MMBC--302**
Course Name	**: INDUSTRIAL AND PHARMACEUTICALMICROBIOLOGY**
Semester /Year	**: III 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 make student aware to fermentor 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

TOTAL HOURS: 60 **CREDITS: 04**

Unit I: Introduction to Industrial Microbiology **No. of Hours: 12**

Primary and secondary metabolites; Structure of fermentor/bioreactor; Types of fermentor/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 FermentationNo. of Hours: 12

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 ImprovementNo. of Hours: 12

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 antibioticsNo. of Hours: 12

(streptomycin, grieseofulvin), 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 ValidationNo. of Hours: 12

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 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. SinauerAssociates, Sunderland.
2. Reed, G. Prescott and Dunn's industrial microbiology. Globe Bookservices, London.
3. Demain, A.L and 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. Hershnergev, C.L., Queener, S.W. and Hedemen, Q. Genetics and biotechnology of industrialmicroorganisms. ASM Press, Washington, D.C
2. Adams, M.R., and Moss, M.O. Food microbiology.Royal Society of Chemistry Publication, Cambridg.
3. Stanbuty, 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	Understand the Scale up and scale down processes of Industrial products. Understand the fundamentals, and applications of basic principles of quality control (QC) and quality assurance (QA); .

CO2	Describe the types of fermentation, Media formulation; Sterilization; Inoculum development.
CO3	Understand the ISO, WHO and US certification; Sterilization control and sterility testing: Validation study; LAL test; Sterility testing and bioassay.
CO4	Understand the Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry
CO5	Discuss the Screening for the desired product; Strategies for strain improvement: Mutation, Protoplast fusion, Recombinant DNA technology.

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	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	2	-	-	1	1	1	1	1	2	1	1	1
CO2	2	2	1	-	-	1	1	1	1	1	2	2	1	1
CO3	2	2	1	-	-	1	1	1	1	1	2	2	-	1
CO4	2	2	1	-	-	1	1	1	1	1	2	1	1	1
CO5	2	2	1	-	-	1	1	1	1	1	2	-	1	1

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

Course code	**: MMBE--303a**
Course Name	**: Elective – I A Food and Dairy Microbiology**
Semester /Year	**: III 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 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

TOTAL HOURS: 60 **CREDITS: 04**

Unit I: Principles of Food Preservation **No.of hours: 12**

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 **No. of hours: 12**

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: Foodborne Infections and Intoxications **No. of hours: 14**

Bacterial and nonbacterial 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 **No. of hours: 10**

Microbiological quality standards of food; Food control agencies and their regulations: FDA, EPA, CDC and ISI; Good Manufacturing Practice; Plant sanitation (Employees 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 **No. of hours: 12**

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 palm wines); 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

Course outcomes (COs):

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

CO1	Gain knowledge about the principles of food preservation.
CO2	Discuss about the Microbiological quality standards of food. .

CO3	Understand the Hazard Analysis and Critical Control Point (HACCP) system; Food Safety Act and Trade Regulations.
CO4	Understand the Spoilage of fermented foods and canned foods and Bacterial and nonbacterial infections and intoxications
CO5	Understand the Structure and functions of aflatoxins;

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	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	1	1	-	1	1	1	2	2	2	2	1	1
CO2	2	2	-	1	-	-	1	1	1	1	1	1	1	1
CO3	1	1	1	-	-	-	1	1	1	1	-	-	1	1
CO4	2	2	1	-	-	-	1	1	1	1	1	-	1	1
CO5	2	2	1	-	1.0	-	1	1	1	1	1	1	1	1

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

Course code	**: MMBE--303b**
Course Name	**: Elective – I DRUG DESIGNING ANDNANO-BIOTECHNOLOGY**
Semester /Year	**: III 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 gain knowledge about molecular modelling.
2. To learn about Nanobiotechnology.
3. To gain knowledge about drug delivery systems

Course Content

TOTAL HOURS: 60 **CREDITS: 04**

Unit I: Drug Receptor Interactions **No. Of Hours: 15**

Introduction and Classification of receptors and receptor subtypes, Structure of receptors, Blood cell receptors for endogenous compounds, Neurotransmitters and their receptors, Receptor modulation and mimics, Receptor sites, Receptor cross-talk, Organ receptors, Non-liganded and constitutive receptor activation, r- DNA receptor bioassays, Desensitization of receptors, Receptors as targets for vaccines and newer drug development; Drug-receptor interactions: Active transport, Affinity and efficacy, Allosteric binding sites, Chirality and receptor binding, Signal transduction and second messenger system, Introduction of various classes of drugs based on their interaction with target site, Interaction of drugs with receptors, enzymes, DNA and carbohydrates.

Unit II: Drug Targeting and Drug Delivery Systems **No. Of Hours: 12**

Introduction and historical perspectives of drug delivery systems; Controlled, targeted and delayed drug delivery systems; Oral dosage forms: Diffusion, Dissolution system, Osmotic pumps, Ion exchange resin; Soluble delivery systems: Micro and nano systems; Injections; Routes of drug delivery systems; Stability profile; Barriers to proteins and peptide delivery; Lymphatic transportation of proteins; Site specific protein modification; Toxicology profile characterization; Cellular level events in targeting; Carrier systems for targeting; Specialized liposomes for drug targeting.

Unit III: Structure Activity Relationship **No. Of Hours: 10**

Introduction and scope of Structure activity relationship (SAR): Structure activity relationship illustrated with examples from sulphonamides, β-lactams, quinolones, nucleosides and alkaloids; Quantitative structure activity relationship (QSAR): Role of physicochemical, electronic (Hammett equation), lipophilicity (Hansch equation) and steric parameter (Taft equation).

Unit IV: Molecular Modelling **No. Of Hours: 10**

Introduction to molecular modeling.Quantum mechanical and molecular orbital methods; Introduction to semiempirical, molecular mechanics and *ab initio* techniques; Potential energy surface; Docking and modelling substrate-receptor interactions; Introduction to software tools for CADD.

Unit V: Nanobiotechnology **No. Of Hours: 13**

Introduction principle and scope of Nanobiotechnology. Basic biology principles and practice of micro fabrication techniques; Atomic force microscopy; Biological production of metal nanoparticles and macromolecular assemblies; Bacterial structure relevant to nanobiotechnology; Cubosomes; Dendrimers; DNA nanoparticle conjugates; DNA octahedron; Fullerenes; Nanoshells; Carbon nanotubes; Nanopores; Nanostructured silicon; Viruses as nanoparticles; DNA based nanostructures: DNA-protein nanostructures, Self-assembled DNA nanotubes, Drug delivery tools *via* nanobiotechnology; Protein and peptide delivery; Tumor targeting and other diagnostic applications; Nanoparticle based immobilization assays; Quantum dots technology and its application; Immuno- nanotechnology; Biosensors and nanobiotechnology.

Text Books:

1. Nanobiotechnology: Concepts, Applications and Perspectives" by Niemeyer C M and Mirkin C A.

Reference Books

2. Silverman, R. Organic chemistry of drug design and drug action. Elsevier, London.
3. Bionanotechnology" by Goodsell D S

Course outcomes (COs):

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

CO1	Understand the Classification of receptors and subtypes of receptor.
CO2	Gain a knowledge about the Routes of drug delivery systems;; Lymphatic transportation of proteins; Site specific protein modification;
CO3	Discuss about the Quantum mechanical and molecular orbital methods
CO4	Understand the concept of molecular mechanics and *ab initio* techniques;
CO5	Discuss about Bacterial structure relevant to nanobiotechnology

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	-	-	-	1	-	1	1	1	2	-	-	1
CO2	2	2	1	-	-	-	-	1	1	1	2	1	1	1
CO3	2	2	-	-	-	1	1	1	1	1	1	-	-	1
CO4	2	2	-	-	-	1	1	1	1	1	1	-	-	1
CO5	2	2	1	1	1	1	2	2	2	2	1	-	-	1

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

Course code	**: MMBE—303c**
Course Name	**Elective – I MOLECULAR VIROLOGY AND INFECTION**
Semester /Year	**: III 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 about morphology Plant and animal viruses.
2. To gain knowledge about PCR Techniques.
3. To learn about Interferon.

Course Content

TOTAL HOURS: 60 **CREDITS: 04**

UNIT – I **No. of Hours: 12**

History of Virology and Biosafety: History and principles of virology, virus taxonomy. Structures
of animal and plant viruses and their morphology. Principles of biosafety, containment facilities, maintenance and handling of laboratory animals, and requirements of virology laboratory.

UNIT – II **No. of Hours: 14**

Virus Replication: Structure and replication strategies of bacteriophages - T7, λ, ΦX174, and

plant viruses - ss RNA virus (TMV) and ds DNA virus (CaMV). Structure and replication strategies of animal viruses - Influenza virus, Adeno virus and Retrovirus ,Corona Virus.

UNIT – III **No. of Hours: 10**

Interferon and Antiviral Agents: Viral Interference and Interferons. Nature and source of interferons, Classification of interferons. Induction of interferon. Antiviral agents (chemical and biological) and their mode of actions.

UNIT – IV **No. of Hours: 12**

Cultivation of Viruses and Viral Vaccines : Cultivation of viruses in embryonated egg, tissue culture and laboratory animals. Conventional vaccines - Killed and attenuated. Modern vaccines - Recombinant proteins, subunits, DNA vaccines, peptides, immunomodulators (cytokines). Vaccine delivery and adjuvants, large-scale manufacturing.COVID Vaccine.

UNIT – V **No. of Hours : 12**

Virological Methods: Methods for purification of viruses with special emphasis on ultracentrifugation methods. Quantitative diagnostic methods - Haemagglutination, complement fixation, neutralization, Western blot, flowcytometry. Nucleic acid based diagnosis - PCR, microarray and nucleotide sequencing. Application of Microscopic techniques - Fluorescence, confocal and electron microscopic techniques.Diagnosis method of corona virus.

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. OxfordUniversity Press, Oxford

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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	Understand the History and principles of virology.

CO2	Understand the principles of biosafety, containment facilities, maintenance and handling of laboratory animals, and requirements of virology laboratory.
CO3	Discuss about the types of animal virus and plant virus.
CO4	Discuss the Antiviral agents (chemical and biological) and their mode of actions.
CO5	Understand the Cultivation of viruses in embryonated egg, tissue culture and laboratory animals

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	-	-	-	1	1	1	1	1	2	1	1	1
CO2	2	1	-	-	-	-	2	1	1	1	2	2	1	1
CO3	2	1	-	-	-	-	1	1	1	1	2	1	-	1
CO4	2	2	1	-	1	-	1	1	1	1	2	1	-	1
CO5	2	2	-	-	-	-	1	1	1	1	2	1	-	1

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

Course code	**: MMBE-304a**
Course Name	**:Elective–II ENVIRONMENTALMICROBIOLOGY**
Semester /Year	**: III 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 gain knowledge about abiotic and biotic Ecosystem.
2.To make student to aware pollution and its types.
3. To learn about microbial interaction.

Course Content

TOTAL HOURS: 60 **CREDITS: 04**

Unit I: Fundamentals of Microbial Ecology **No. of hours: 15**

Ecosystem; Biotic and abiotic components; Habitat and Niche; Population and guilds; Concept of community; Stability hypothesis; Intermediate-disturbance hypothesis; Concept of ecologicalniche; Ecosystem organization: Structure and functions, Primary production, Energy dynamics (Trophic organization and energy flow pathways); Microbial community dynamics: r and k strategies of population selection withincommunities.

Unit II: Air and AquaticMicrobiology **No. of hours: 12**

Aerobiology: Droplet nuclei, Aerosol, Assessment of air quality, Solid and liquid impingement methods, Brief account of air born transmission of microbes; Aquatic microbiology: Zonation and microbiota of fresh water (Ponds, lake and rivers) and marine habitats (Estuaries and deep sea), Upwelling and downwelling, Eutrophication,algae in eutrophication, algal blooms, Food chain, Mechanism of dissolved organic matter production, Microbial assessment of water quality, Water purification.

Unit III: Microbial Interactions **No. of hours: 10**

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 **No. of hours: 13**

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, Ground water 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 EnvironmentNo. of hours: 10

Biodegradation of recalcitrant compounds: Pesticides and Petroleum; Bioremediation: *In situ* and *Ex situ* remediation, 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	Understand the Biotic and abiotic components of Ecosystem.
CO2	Discuss the Ecosystem organization: Structure and functions, Primary production, Energy dynamics.
CO3	Know about microbial community dynamics: & r and k strategies of population selection withincommunities.
CO4	Describe the various aspects Aerobiology, Solid and liquid impingement methods, the air born transmission of microbes
CO5	Learn about Aquatic Microbiology and and marine habitats.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	-	-	-	1	1	2	2	2	2	1	-	1
CO2	2	2	-	-	-	-	1	2	2	1	2	1	1	1
CO3	2	2	-	-	-	-	1	2	1	2	2	1	-	1
CO4	2	2	1	1	1	1	1	2	2	1	2	1	-	1
CO5	2	2	-	-	-	1	1	1	1	1	2	1	-	1

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

Course code	**: MMBE- 304b**
Course Name	**Elective– IIAGRICULTURALMICROBIOLOGY**
Semester /Year	**: III 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 about 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, mass multiplication of Biofertilizer.

Course Content

TOTAL HOURS: 60 **CREDITS: 04**

Unit I: Abiotic and Biotic Components of Soil **No. of Hours: 12**

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 **No. of Hours: 14**

Rhizosphere; Rhizoplane; Composition of root exudates; Factors affecting exudation; Plant 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 **No. of Hours: 12**

General symptoms of plant diseases, Symptoms, casuative 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 PlantsNo. of Hours: 12

Biopesticides: Source organisms (*Bacillus thuringiensis*, *Beauveriabassiana*, *Metarhiziumanisopliae*, *Trichoderma*and 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 **No. of Hours: 12**

Isolation, purification, mass multiplication, inoculum production and 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. SubbaRao, N.S (1995). Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd., New Delhi.

Reference Books

1. Kannaiyan, S. (2003).Bioetchnology of biofertilizers, CHIPS, Texas.
2. Rai, M.K. (2005). Hand book 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	Understand the Physico-chemical characteristics of soil and Soil microbes
CO2	Describe the Abiotic and Biotic Components of Soil.
CO3	Discuss about nitrogen fixation, Rhizosphere and Rhizoplane Microorganisms.
CO4	Learn about Mechanism of production of antibiotics by plant growth promoting microorganisms.
CO5	Gain knowledge about production & marketing of biofertilizer.

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	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	1	-	-	1	1	1	1	1	2	-	-	1
CO2	2	2	1	-	-	1	1	1	1	1	2	-	-	1
CO3	2	2	-	-	-	1	1	1	1	1	2	-	-	1
CO4	2	2	1	1	-	1	1	1	1	1	2	1	1	1
CO5	2	2	2	2	2	1	1	2	2	1	2	2	2	2

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

Course code : MMBE- 304c
Course Name: Elective – II ECOSYSTEM ANALYSIS AND REMOTE SENSING
Semester /Year : III 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 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 ecologicalresearch.

Course Content

TOTAL HOURS: 60 **CREDITS: 04**

UNIT I **No. of Hours: 15**

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

(flightplanningon).Introduction to Photogrammetry, Geometry of Aerial photos, Stereoscopic photography, Measurement of Height, AerialTriangulation.Principles and fundamentals of Aerial photo interpretation. Basics ofCartography.

UNIT II **No. of Hours: 12**

Remote Sensing (RS):Introduction to Remote Sensing. The electromagnetic spectrum, Energy instruction with atmosphere and earth surface, satellite and sensors, Remote sensing dataacquisition.Principles and basic concepts of Multi spectral, Thermal and hyperspectral Scanning: Across-track and Along Track multispectral Scanning. History of SpaceImaging.

UNIT III **No. of Hours: 10**

Image Interpretation: Type of Imagery, elements of Interpretation, Techniques of Visual Interpretation, Role of remote sensing in ecologicalresearch.Fundamentals of digital image processing, Image rectification, Restoration andEnhancement.

UNIT IV **No. of Hours: 13**

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

UNIT V **No. of Hours: 10**

Geoinformatics (GIS):Basics of Computer, Hardware andsoftware,Principles and basics of Geographic Information System: Raster and Vector GIS,Database creation and management. Network Analysis, Spatial data integration andModelling.

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 Sabins F 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.Manupatra Information Solution Pvt. Ltd., New Delhi, 1st ed.
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.

1.

Course outcomes (COs):

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

CO1	Understand the basic principles and fundamentals of Aerial photo interpretation.
CO2	Explain the concepts of Principles of Aerial Photos (flightplanningon).
CO3	Discuss the Remote Sensing with reference to Remote sensing dataacquisition.
CO4	Understand the Principles and basic concepts of Multi spectral, Thermal and hyper spectral Scanning.
CO5	Discuss the Image Interpretation. Type and Role of remote sensing in ecologicalresearch.

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	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	1	1	1	1	1	1	1	1	2	2	1	1
CO2	2	2	1	1	1	1	1	1	1	1	2	1	1	1
CO3	2	2	1	1	1	-	1	1	1	1	2	1	1	1
CO4	2	2	1	1	1	1	1	1	1	1	2	`1	1	1
CO5	2	2	1	1	2	1	1	2	2	1	2	`1	1	1

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

Course code	**: MMBE- 304d**
Course Name	**: Elective – II Mushroom Culture Technology**
Semester /Year	**: III 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 make student aware about introduction, history and cultivation of mushrooms.
2. To gain knowledge about Poisonous and Non-poisonous Mushroom.
3. To learn about Marketing of mushrooms in India and world.

Course Content

TOTAL HOURS: 60 **CREDITS: 04**

UNIT-1 **No of Hours: 14**

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 **No of Hours: 08**

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

Unit-3 **No of Hours: 15**

Cultivation Technology: Infrastructure, equipments and substrates in mushroom cultivation: Polythene bags, vessels, inoculation hook, inoculation loop, love cost stove, sieves, culture racks, mushroom unit or mushroom house, water sprayer, tray, boilers, driers, pure culture, Spawn: types of spawn, preparation of spawn, mushroom bed preparation and factors affecting mushroom bed preparation; Compost: materials used for compost preparation, compost technology in mushroom production.

Unit-4 **No of Hours: 10**

Pests and disease of edible Mushroom, Environmental, Fungal, Bacterial, Viral insect pest and Nematodes disease.

Unit -5 **No of Hours: 13**

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 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.

Reference Books

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

Course outcomes (COs):

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

CO1	Gain the knowledge about Mushroom Introduction ,history, cultivation and nutrition value.
CO2	Learn about Poisonous and Non-poisonous Mushroom.
CO3	Understand the methods of storage of mushroom cultivation
CO4	Gain the knowledge about Cultivation of button Mushroom, morphology raising a pure culture & spawn preparation.
CO5	Understand the Marketing of mushrooms in India and world.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	1	1	1	1	1	2	3	1	2	2	2	2
CO2	2	2	1	1	1	2	2	2	2	1	2	1	2	2
CO3	2	2	-	1	1	1	2	2	3	1	2	1	2	2
CO4	2	2	1	1	1	1	1	2	3	1	2	1	2	2
CO5	2	2	1	1	1	1	1	2	3	1	2	2	2	2

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

Course code	**: MMBL305**
Course Name	**: Lab Course I (Based on paper 1 & 2)**
Semester /Year	**: III Sem**

	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 the student Biosafety guidelines and biosafetylevels.**
2. **To learn to perform about Isolation and biochemical characterization of pathogenicbacteria.**
3. **To learn to perform Determination of MIC and MBC concentration of antibiotics by broth dilutiontest.**

Course ContentCREDITS: 03

1. Biosafety guidelines and biosafetylevels.
2. Prevalence of pathogenic microorganisms in clinicalsample.
3. Isolation and biochemical characterization of pathogenicbacteria.

4. Isolation and identification of fungal pathogens from clinicalspecimens.
5. Determination of antimicrobial susceptibility of pathogens by disc diffusiontest.
6. Determination of MIC and MBC concentration of antibiotics by broth dilutiontest.
7. Isolation and screening of bacterial and fungal cultures for enzymeproduction.
8. Estimation of enzyme production by microbial culture *via* liquid statefermentation.
9. Estimation of enzyme production by microbial culture *via* solid statefermentation.
10. Media formulation for enhanced enzyme production by microbial culture *via* liquid and solidstate fermentation.
11. Optimization of culture conditions for enhanced enzyme production by microbial culture *via* liquid and solid statefermentation.
12. Production of wine from fruitjuice.
13. Monitoring of sugar reduction during wineproduction.
14. Estimation of alcohol concentration inwine.
15. Estimation of vicinal diketone inbeer.
16. 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	Gain the Biosafety guidelines and biosafetylevels.
CO2	Determination of antimicrobial susceptibility of pathogens by disc diffusiontest.
CO3	Determine the Isolation and biochemical characterization of pathogenicbacteria.
CO4	Determine the Isolation and identification of fungal pathogens from clinicalspecimens.
CO5	Determination of MIC and MBC concentration of antibiotics by broth dilutiontest.

Course code	**: MMBL306**
Course Name	**: Lab Course II (Based on paper 3& 4)**
Semester /Year	**: III Sem**

	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 about Microbiological examination offood.**
2. **To learn to perform Production ofsauerkraut.**
3. **To learn to perform Microbial production ofcurd.**

Course ContentCREDITS: 03

1. Microbiological examination offood.
2. Assay of quality of milk sample using MBRTtest.
3. Adulteration tests formilk.
4. Microbial production ofcurd.
5. Isolation and identification of *Lactobacillus* from fermented dairyproducts.
6. Isolation and biochemical identification of microorganisms from contaminated food and

dairysamples.

7. Determination of D value in heat treatment offoods.

8. Effect of freezing temperatures on microorganisms infood

9. Production ofsauerkraut.

10. Estimation of lactic acid production insauerkraut.

11. Effect of salt concentration on lactic acid production insauerkraut.

12. Estimation of acidity ofvinegar.

Course outcomes (COs):

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

CO1	Determine the Microbiological examination offood.
CO2	Understand the Assay of quality of milk sample using MBRTtest.
CO3	Learn about the Adulteration tests formilk.
CO4	Understand the Microbial production ofcurd.
CO5	Learn about the Isolation and identification of *Lactobacillus* from fermented dairyproducts.

Course code : MMBS307a
Course Name :Self-study–BIOINFORMATICS& BIOLOGICAL DATA BASE
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 make student aware about basic principles of computing in bioinformatics**
2. **To aware the student to knowledge about Data retrieval with Entrez, DBGET/Link DB and SRS.**
3. **To learn about the impact of Protein families and pattern databases.**

Course Content

TOTAL HOURS: 48 **CREDITS: 03**

UNIT I **No of Hours:12**

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 No of Hours-10

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), Sequences similarity searches, Amino acid substitution matrices, databases searches with FASTA and BLAST, Multiple sequences alignment and family relationships, Protein families and pattern databases.

UNIT III No of Hours-08

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

UNIT IV No of Hours-09

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 No of Hours-09

Phylogenetics, cladistics and ontology; Building phylogenetic trees; Evolution of macromolecular sequences. Chemoinformatic resources, Conventions in representing molecules, Pharmainformatics, 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 ed.
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	Understanding the Basic principles of computing in bioinformatics,
CO2	Understanding the basics of databases in Biology: primary databases: Gene Bank, SWISSPROT, PDB; specialized databases: PFAM, SCOP, PROSITE.
CO3	Knowledge about Annotated sequence databases, Genome and organism-specific databases, miscellaneous databases,
CO4	Knowledge about Data retrieval with Entrez, DBGET/Link DB and SRS.
CO5	Understanding the impact of Protein families and pattern databases

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	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	1	1	1	1	2	2	2	1	2	2	2	2
CO2	2	2	1	1	1	1	2	2	2	2	2	2	2	2
CO3	2	2	`1	1	2	2	2	2	2	2	2	1	1	1
CO4	2	2	1	1	2	2	2	2	2	2	2	1	1	1
CO5	2	2	1	2	2	1	1	2	2	1	1	1	1	1

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

Course code	**: MMBS307b**
Course Name: Self-study –BIOMEDICAL TECHNOLOGY	
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 about Autoimmune diseases.**
2. **To gain the knowledge about molecular diagnosis of cancer.**
3. **To knowledge about Mutations and genetic disorders**

Course Content

TOTAL HOURS: 48 **CREDITS: 03**

UNIT I **No of Hours:12**

Cellular Pathology: causes of cell injury, necrosis, biochemical mechanism, 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 No of Hours-10

Mutations and genetic disorders. Single gene disorders, Receptor proteins (hypercholesterolemia). Cytogenic disorders (Trisomy, Klienfelters). Mutation in mitochondrial genes (LHDN),Fragile X Syndrome.

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UNIT III No of Hours-08

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 No of Hours-09

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

UNIT V No of Hours-09

Molecular diagnosis (genetic disease, gene diagnosis, gene tracking & other diagnostic application 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. **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	Discuss about causes of cell injury, necrosis, biochemical mechanism
CO2	Understand the Autoimmune diseases.
CO3	Describe the Immuno diagnostic – RIA, ELISA.
CO4	Knowledge about Mutations and genetic disorders
CO5	Describe the molecular diagnosis of cancer

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	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	-	-	-	1	1	1	1	1	2	1	-	1
CO2	2	2	-	-	-	-	1	1	1	1	1	1	-	1
CO3	2	2	-	-	-	-	1	1	1	1	2	2	1	1
CO4	2	2	-	-	-	-	-	1	1	1	2	-	-	1
CO5	2	2	-	-	-	1	1	1	1	1	2	1	-	1

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 an innovative research to solve the problems faced in 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	Perform **i**nnovative research to solve the problems faced in current scenario.
CO3	Adequate scientific understanding of the basic concepts in instrumentation used in research for both qualitative and quantitative analysis.
CO4	Conceive and carry out independent and collaborative research projects.
CO5	Accomplish in original research of significance and quality, for publications, presentations and original research proposals.

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 research process, designs and Methodologies.**
2. **To learn the student to Structure the methodologies to accomplish organized conduct of interdisciplinaryresearch.**
3. **To gain knowledge to ppublish the research outcome in scientific peer reviewed journal.**

CO1	Structure the methodologies to accomplish organized conduct of interdisciplinaryresearch.
CO3	Impart the outcome of their project in various seminars and conferences.
CO4	Present and defend their project work to a panel of experts.
CO5	Publish the research outcome in scientific peer reviewed journal.

Course Content

Topics forDissertation

1. DrugDiscovery
2. DrugResistance
3. Infection andImmunity
4. Plant- MicrobesInteraction
5. MicrobialDiversity
6. Bioremediation
7. Prevalence and Characterization of PathogenicMicroorganisms
8. Food Adulteration and Food bornePathogens
9. FermentedFoods
10. StrainImprovement
11. EnzymeProduction
12. MicrobialBiotechnology
13. Biomass and BioenergyProduction

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

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 Guidelines issued by CDC and WHO .**

Course Content

TOTAL HOURS: 60 **CREDITS: 04**

Unit I: Basics of Epidemiology No of Hours-14

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 No of Hours-08

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 No of Hours-15

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 No of Hours-10

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

Unit V: Control of Epidemics No of Hours-13

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: Centre of Disease Control (CDC), Guidelines issued by CDC and WHO, Health standards for international epidemics

Text Books:

1. Fundemental of Epidemology and Biostatics.Deepti,S.
2. Basic and clinical Epidemology,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 Scope and applications of epidemiology in health care
CO2	Discuss about types of carriers, Portals of entry and exit.
CO3	Describe the Sources of infection; Modes of disease transmission and Disease cycle
CO4	Discuss about collection of frequency data, Descriptive, analytical with reference to experimental studies.
CO5	Discuss about Transmission dynamics, Incidence, Prevalence, Morbidity, Mortality; Public health surveillance: Purpose

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	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	-	-	-	1	1	2	2	1	2	1	-	1
CO2	2	2	-	-	-	1	1	1	1	1	1	1	-	1
CO3	2	2	-	-	-	-	1	1	1	1	1	1	1	1
CO4	2	2	-	-	-	-	1	1	1	1	1	1	-	1
CO5	1	1	-	-	-	-	1	1	1	1	1	1	1	1

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

Course code : MMBE403a				
Course Name: – BEVERAGE BIOTECHNOLOGY				
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 aware the student Microorganism in food & beverage industry.**
2. **To make student aware about principles of food preservation**
3. **To learn about food additives.**

Course Content

TOTAL HOURS: 60 **CREDITS: 04**

UNIT I No of Hours-14

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

UNIT II No of Hours-08

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

UNIT III No of Hours-15

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

UNIT IV No of Hours-10

Food, Beverages & Disease Food borne illness due to bacterial food poisoning, infection and intoxication. Food-borne disease outbreaks, Disease-investigation, Materials &Equipments, laboratory testing, field analysis, interpretation of data and preventive measures.QA &QC of food product.

UNIT V No of Hours-13

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

manufacturing practice. Hazard Analysis Critical Points.
Food control: International agencies, Federal Agency and law of state agencies, 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. McLandsborough, 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	Describe the Microorganism in food & beverage industry.
CO2	Discuss about Contamination and spoilage of different kinds of food & beverages.
CO3	Describe the Biotechnology of food and feed.
CO4	Describe the Food borne illness due to bacterial food poisoning
CO5	Discuss about infection andintoxication.

CO- PSO-PO Mapping:

Course	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PSO	PSO	PSO	PSO

	1	2	3	4	5	6	7	8	9	10	1	2	3	4
CO1	2	2	-	-	-	1	1	2	2	1	2	1	-	1
CO2	2	2	-	-	-	1	1	1	1	1	1	1	-	1
CO3	2	2	-	-	-	-	1	1	1	1	1	1	1	1
CO4	2	2	-	-	-	-	1	1	1	1	1	1	-	1
CO5	1	1	-	-	-	-	1	1	1	1	1	1	1	1

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

Course code : MMBE403b

Course Name	**: –BIO-ENTREPRENEURSHIP**
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. **Learn about basics in accounting practices.**
2. **Learn about source of financial assistance.**
3. **To make student aware balance sheet, P&L account, and double entry bookkeeping**

Course Content

TOTAL HOURS: 60 **CREDITS: 04**

Unit I No of Hours-14

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 bank for capital expenditure and for working; Statutory and legal requirements for starting a company/venture; Budget planning and cashflowmanagement.

Unit II No of Hours-08

Introduction to accounting practices: concepts of balance sheet, P&L account, and double entry bookkeeping. Estimation of income, expenditure, profit. Assessment of market demand for 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 No of Hours-15

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 No of Hours-10

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

Unit V No of Hours-13

Role of knowledge centre and R&D. Knowledge centres 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 Text Book of Industrial microbiology*, 2nd Edition, SinauerAssociates :Sunderland.Mass
2. .Stockholm, K.T.H., Sven-OlofEnfors, and Lena Haggstrom. (2000), *BioprocessTechnology: Fundamentals and Applications, Royal Institute of Technology*: Sweden.
3. Ashton Acton, Q., (2012). *Biological Pigments– Advances in Research and Application.*Scholorly 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, and Whitekar. A. (1999), *Principles of Fermentation Technology*, 2ndEdition. Butterworth-Heinemann: Oxford

Course outcomes (COs):

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

CO1	Discuss about Assessment of feasibility of a given venture/ new venture.
CO2	Discuss about how to approach a bank for a loan.
CO3	Describe the source of financial assistance.

CO4	Discuss about for making a business proposal/ Plan for seeking loans from financial institution & Banks
CO5	Discuss about concepts of balance sheet, P&L account, and double entry bookkeeping.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	P O4	PO 5	P O6	PO 7	PO 8	P O9	PO 10	PSO 1	PSO 2	PSO 3	PS O4
CO1	2	2	1	1	1	1	2	2	2	1	2	2	2	2
CO2	2	2	1	1	1	1	2	2	2	1	1	-	-	1
CO3	2	2	1	-	-	-	2	2	1	1	1	1	-	1
CO4	2	2	`1	`1	1	1	1	2	1	1	2	2	2	2
CO5	2	2	2	1	1	1	-	1	1	1	2	2	2	2

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

Course code	**: MMBE403c**
Course Name	**: –INTELLECTUAL PROPERTY RIGHTS**
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 make student aware about Intellectual property.**
2. **To learn about procedure for grant of patent in India**
3. **To aware the student about Patenting of genetically modified plants**

Course Content

TOTAL HOURS: 60 **CREDITS: 04**

Unit I: Basic Aspects of Intellectual Property Rights No of Hours-14

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 IPRs with biotechnology; Trade secrets; Non-disclosure agreements.

Unit II: International Treaties for Protection of Intellectual Property No of Hours-08

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 No of Hours-15

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 No of Hours-10

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. Palagiarism in research and publication.

Unit V: Protection of Plant Varieties and Traditional Knowledge No of Hours-13

Protection of plant varieties: Interface between technology and IPRs in the context of plants, Key features of UPOV 1978, UPOV 1991 and TRIPS with respect to 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, 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 ed.
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	Understand the basic concepts and principles of bioinformatics.
CO2	Understand the importance and uses of various databases.
CO3	Discuss the annotation tools and resources
CO4	Discuss about the conceptual models of protein structure and functioning
CO5	Discuss about the Role of knowledge centre and R&D. centres like universities and research institutions.

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	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	1	1	1	-	1	2	2	2	1	2	2	2	2
CO2	2	2	1	1	-	1	2	2	1	2	2	2	2	2
CO3	2	2	1	1	1	1	2	2	2	1	1	1	1	1
CO4	2	2	1	1	-	1	1	1	1	1	2	1	1	2
CO5	2	2	1	1	2	2	2	2	2	1	2	2	2	2

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. Study of symptoms of bacterial diseases of plants.
2. Study of symptoms of fungal diseases of plants.
3. Study of symptoms of viral diseases of plants.
4. Isolation and identification of pathogenic microorganisms from diseased plant sample.

Course outcomes (COs):

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

CO1	Discuss about Plant disease and its harmful effects .
CO2	Carrying out characterization of infectious microorganisms from plants.
CO3	Carrying out characterization of infectious microorganisms from skin, hair, blood sample.
CO4	Carrying out morphological identification of isolated microorganism.
CO5	Studying the various plant microbes and their infections.

Course code	**: MMBJ405**
Course Name	**: Journal Club***
Semester /Year	**: IV Sem**

	L	**T**	**P**	**C**
	0	**0**	**1**	**0**

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

Course outcomes (COs):

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

CO1	Awarense the student to recent research work related to Microbiology field.
CO2	Understand the Student to prepare assignment
CO3	Knowledge about preparation of presentation related to research area.
CO4	Knowledge about publication rules and regulations.
CO5	Knowledge about screening of UGC Care Journals.

Course code	**: MMBS406a**
Course Name	**: INFECTION ANDIMMUNITY**
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 role of cells and molecules of immune system in infections.

3 To gain knowledge about

Course Content

TOTAL HOURS: 48 **CREDITS: 03**

Unit I: Infectious Agents **No. of Hours: 12**

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 **No. of Hours: 10**

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 immune system in infection, Adoptive immunity to infection, Immune elimination of infection, Mechanisms of escape from immune-mediated destruction, Infection in immuno-compromised host.

Unit III: Immune Responses to Infection **No. of Hours: 08**

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 immuno-deficiencies; Nosocomial and community acquired infections; Co-infections; Immunity in local and systemic infection (Bacterimia 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 **No. of Hours: 09**

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 **No. of Hours: 09**

Immune responses and immunological control of fungal infection (Candidiosis and aspergillosis) and parasitic diseases (Malaria, leishmaniasis, schistisomasis and filarisas).

Text Books:

1. Ananthanarayan, 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, Melnick and Adelberg's medical microbiology. McGraw Hill Publication, 26th ed.
2. Goering, R., Dockrell, H., Zuckerman, M. and Wakelin, D. (2007).Mims' medical microbiology. Elsevier, London, 4th ed.
3. Madigan, M.T., Martinko, J.M., Dunlap, P.V. and Clark, 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	Demonstration of Infection and its types.
CO2	Understand the Infectious agents, Pathogen associated molecular patterns
CO3	Describe the Mechanism of establishment of infection.
CO4	Discuss about the role of molecular factors in establishment of infections.
CO5	Knowledge of Immunization and its role in society.

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	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	-	-	-	-	1	2	2	1	2	-	-	1
CO2	2	2	-	-	-	-	1	2	2	1	2	-	-	1
CO3	2	2	-	-	-	-	1	2	2	1	1	-	-	1
CO4	1	1	-	-		-	1	1	1	1	1	-	-	1
CO5	2	2	-	-	-	-	1	1	1	1	1	-	-	1

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

Course code	**: MMBS406b**
Course Name	**: ResearchMethology**
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 student aware applications of data mining and genome mining**
3. **To gain knowledge about multiple sequence alignment and applications**

Course Content

TOTAL HOURS: 48 **CREDITS: 03**

Unit I: Formulating Research Problem and Experimental Planning **No of Hours: 12**

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 undertaken, 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 **No of Hours: 10**

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 **No of Hours: 08**

Response-Dose metameter; 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 to 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 tests of heterogeneity and independence of attributes,F-test).

Unit IV: Analysis of Variance **No of Hours: 10**

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 **No of Hours: 09**

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, ExPASY, UniProt KB, SwissProt and TrEMBL); 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,

MJPPublishers, A unit of Tamilnadu Book House, ISBN:9783527295890 .
2. Des Higgins & Willie Taylor (2000), Bioinformatics: Sequence, structure and databanks.Oxford University Press, ISBN 10: 0199637903 ISBN 13: 9780199637904.
3. Arora PN & Malhon PK, (1996), Biostatistics. Imalaya Publishing House, Mumbai. ISBN Number : 978-93-5142-823-7.

Reference Books

1. John G Webster(2004).Bioinstrumentation .Student edition, John Wiley &sons, Ltd.,ISBN 978-0-471-67600-3.
2. Palanivelu P (2001), Analitical biochemistry and separation Techniques A Laboratorymanual. 2nd edition, Published by Tulsi Book Centre, Madurai, Tamilnadu, ISBN :4567142233.
3. Jogdand SN (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	Understand the Selection of an area for research.
CO2	Describe the Importance and need of research and Literature survey.
CO3	Understand the Planning of experimental work: Importance and designing of the problem.
CO4	Carry out the sequences similarity searches, amino acid substitution matrices, databases searches with FASTA and BLAST,
CO5	Learn about the multiple sequences alignment and family relationships.

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	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	1	2	2	1	2	2	2	2	2	1	2	2
CO2	2	2	1	1	1	1	2	2	2	2	2	1	2	2
CO3	2	2	1	1	1	1	2	2	1	2	2	2	2	2
CO4	2	2	1	1	1	1	2	2	1	2	1	2	2	2

CO5	2	2	-	-	1	1	2	2	1	2	1	2	2	2

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 student aware applications of data mining and genome mining.**
3. **To gain knowledge about multiple sequence alignment and applications.**

Course Content

TOTAL HOURS: 48 **CREDITS: 03**

Unit-I **No. of Hours: 12**

Basic concepts in cell culture; *Invitro*culture: Approaches & methodologies - preparatory steps fortissue culture - surface sterilization of plant tissue material – basicprocedure for aseptic tissue transfer - incubation of culture.

Unit-II **No. of Hours: 10**

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

Unit-III **No. of Hours: 08**

Plant cells (Callus Culture, CellSuspension Culture, and Organ Micro-Culture, Plant micro propagation. Somatic Embryogenesis); Problems in Plant TissueCulture: Contamination, Phenolic, Recalcitrance, SeasonalVariations 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 **No. of Hours: 09**

Cloning and selection of specific cell types –cloning, somatic cell fusion and HAT selection – Mediumsuspension fusion - selection of Hybrid clone - production ofmonoclonal antibodies.

Unit-V **No. of Hours: 09**

Primary cultures and cell lines with examples – Stemcell cultures - Therapeutic cloning - Carcinoma stem cells – Germcell culture – Uses; Organ culture -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). *Text book 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, ISBN 10: 8183560849 / ISBN: 9788183560849.

Reference book:

1. Colin Ratledge and Bjorn Kristiansen. (2001). *Basic Biotechnology*. Cambridge UniversityPress: U K, ISBN: 0–521–77074–2 (hc); 0–521–77917–0.
2. John Anthony Sharp.(1979). *An Introduction to Animal Tissue Culture*. Edward Arnoldpublications: 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	Gain fundamental knowledge in principles, practices and application of animal andplant tissue biotechnology.
CO2	Acquire the knowledge about the techniques, laboratory organization and measuresadopted for maintenance of aseptic condition.
CO3	Explain the fundamental scientific principles that underlie cell culture and itsnutritional requirements.
CO4	Aware on isolation and maintenance of animal cells culture developed from embryonicorgans, whole embryo and adult organs

CO5	Explore the various applications of tissue biotechnology pertaining to Drug Designingand Drug Therapy.

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	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	2	1	2	2	1	2	2	2	2	2	1	2	2
CO2	2	2	1	1	1	1	2	2	2	2	2	1	2	2
CO3	2	2	1	1	1	1	2	2	1	2	2	2	2	2
CO4	2	2	1	1	1	1	2	2	1	2	1	2	2	2
CO5	2	2	-	-	1	1	2	2	1	2	1	2	2	2

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