DEPARTMENT OF MICROBIOLOGY

Course Structure and Syllabus

Based on National Education Policy -2020

FOR

M.Sc. Microbiology

MK UNIVERSITY

PATAN, GUJARAT

ESTABLISHED BY THE GUJARAT GOVT. RECOGNIZED BY UGC UNDER SECTION 2(f) OF UGC ACT,1956

Sem-I										
Sr No.	Course Type	Course Code	Course Name	Lecture (hrs.)	Tutorial	Practical (hrs.)	Credits	Examination		Total Marks
								Internal	External	
1	MAJOR	MSCMB101	General Microbiology	4	0	0	4	30	70	100
2	MAJOR	MSCMB102	Mycology, Phycology and Virology	4	0	0	4	30	70	100
3	MAJOR	MSCMB103	Microbial genetics	4	0	0	4	30	70	100
4	MINOR	MSCMB104	Microbial Biochemistry	4	0	0	4	30	70	100
5	MINOR	MSCMB105	Practical on General Microbiology, Mycology, Phycology and Virology	0	0	2	2	20	30	50
6	MINOR	MSCMB106	Practical on Microbial Biochemistry and Microbial Genetics	0	0	2	2	20	30	50
TOTAL				16	0	4	20	160	340	500

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Sem-II										
Sr No.	Course Type	Course Code	Course Name	Lecture (hrs.)	Tutoril	Practical (hrs.)	Credits	Examination		Total Marks
								Internal	External	
1	MAJOR	MSCMB201	Immunology	4	0	0	4	30	70	100
2	MAJOR	MSCMB202	Molecular Biology and recombinant DNA technology	4	0	0	4	30	70	100
3	MINOR	MSCMB203	Parasitology, Medical and Veterinary Microbiology	4	0	0	4	30	70	100
4	MINOR	MSCMB204	Food Microbiology	4	0	0	4	30	70	100
5	MINOR	MSCMB205	Practical on Immunology & Molecular Biology	0	0	2	2	20	30	50
6	MINOR	MSCMB206	Practical on Medical and Food Microbiology	0	0	2	2	20	30	50
TOTAL				16	0	4	20	160	340	500

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Sem-III										
Sr No.	Course Type	Course Code	Corse Name	Lecture (hrs.)	Tutorial	Practical (hrs.)	Credits	Examination		Total Marks
								Internal	External	
1	MAJOR	MSCMB301	Microbial Genomics, Proteomics & Bioinformatics	4	0	0	4	30	70	100
2	MAJOR	MSCMB302	Applied Microbiology & Enzyme technology	4	0	0	4	30	70	100
3	MAJOR	MSCMB303	Inheritance Biology	4	0	0	4	30	70	100
4	MAJOR	MSCMB304	Microbial fermentation technology	4	0	0	4	30	70	100
5	MAJOR	MSCMB305	RESEARCH PROJECT	0	0	8	8	50	150	200
TOTAL				16	0	8	24	200	400	600

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Sem-IV										
Sr No.	Course Type	Course Code	Corse Name	Lecture (hrs.)	Tutorial	Practical (hrs.)	Credits	Examination		Total Marks
								Internal	External	
1	MAJOR	MSCMB401	Soil and Environmental Microbiology	4	0	0	4	30	70	100
2	MAJOR	MSCMB402	Bioinstrumentation and biotechniques	4	0	0	4	30	70	100
3	MAJOR	MSCMB403	Biosafety and IPR	4	0	0	4	30	70	100
4	MINOR	SCMB404	RESEARCH PROJECT	0	0	12	12	100	200	300
TOTAL				12		12	24	190	410	600

SYLLABUS (1ST SEMESTER)

Paper I: General Microbiology	**Subject code: MSCMB101**
L-T-P-C-4-0-0-4	**Credit units: 4**

Course Objective:

The course is developed with the following objectives:

- To enable the students to develop a historical perspective of the subject of microbiology
- To understand the fundamental principles of microbiology like Koch's postulates
- To explain the scientific organization of microbial organisms into taxons and introduce to the students, the major system of microbial classification
- To enable understanding of the general and ultra-structural organization of the bacterial cell
- To impart the basic skills for the culture of microbes

Course Outcomes

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** Remember the basic concepts of General Microbiology and History.	**BT 1**
CO 2	**Understand** media preparation, sterilization techniques, and cultivation of microbes.	**BT 2**
CO 3	**Apply** the knowledge of microbiology techniques and conceptsin research.	**BT 3**
CO 4	**Analyze** the problem associated with microbes in humans, animals, and plants.	**BT 4**
CO 5	**Evaluate** their understanding of expanding their future prospect forpursuing an entrepreneurial venture	**BT5**

Detailed Syllabus:

Modules	Topics / Course content
I	Introduction to the world of microbes, Scope of microbiology, major contribution of scientists in development of microbiology, Refutation of a biogenesis. Classification of Micro-organism: History of bacterial classification. Haeckel's three kingdom concept, Whittaker's five kingdom concept, three domain concept of Carl Woese; Basis of microbial classification, molecular approaches in microbial classification, concept of microbial species; Principle and classification of bacteria on the basis of*Bergey's manual of Determinative bacteriology*.
II	Overview of prokaryotes and their differences with eukaryotic organism. Morphology and fine structure of bacteria, archaea**:**cell walls of archaea, Gram negative, Gram positive eubacteria, cell membranes – structure, composition and properties.
III	Structure and function of cell appendages and inclusions: capsule, flagella, fimbrae, pili, cilia, gas vesicles, chromosomes, carboxysomes, magnetosomes, phycobillisomes, nucleoid, plasmids (types of plasmids and function); Bacterial spores: Regulation of spore formation. Reserve materials, inorganic and organic inclusions.
IV	Microbial nutrition, culture media, culture methods- pure culture techniques, Growth curve, generation time, synchronous, batch and continuous culture; Measurement of growth and factors affecting growth, Sterilization and disinfection, Microbial diversity and extremophiles: Microbial diversity, distribution ecological niche, abundance and density. Extremophiles – Psychrophiles, acidophiles, alkaliphiles, thermophiles, barophiles etc., non-culturable bacteria (Metagenomics), Methanogens, Methanotrophs and Methylotrophs.
Total	

Textbooks:

1. Pelczar MJ, Chan ECS and Krieg NR. (2010). *Microbiology*. 8th edition. McGraw Hill Book Company.
2. Sharma PD. (2005). *Microbiology.* 4th edition (reprint). Rastogi Publication, Meerut.
3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's*

Microbiology. 8th edition. McGraw Hill Higher Education.
4. Ananthanarayan R and Paniker CKJ. (2005). *Textbook of Microbiology*. 7th edition (edited by Paniker CKJ). University Press Publication.

Reference Books:

1. Atlas RM. (2005). *Principles of Microbiology*. 4th edition. WMT. Brown Publishers.
2. Cappucino J and Sherman N. (2010). *Microbiology: A Laboratory Manual*. 9th edition. Pearson Education limited.
3. Frazier WC and Westhoff DC. (2005). *Food Microbiology*. 5th edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
4. Martin A. (1977). *An Introduction to Soil Microbiology*. 2nd edition. John Wiley & Sons Inc. New York & London.

Paper II: Mycology, Phycology and Virology **Subject code: MSCMB102**

L-T-P-C-4-0-0-4 **Credit units: 4**

Course Objective:

- To provide foundational knowledge of fungi, algae and viruses, including their classification, structure, and biological significance.
- To understand the morphological and physiological characteristics of fungi, algae, and viruses.
- To explore the ecological and economic importance of fungi and algae, particularly in agriculture, industry, medicine, and environmental sustainability.
- To analyze the structural and functional diversity among viruses, including their replication mechanisms and interactions with host organisms.
- To develop laboratory and analytical skills relevant to the identification and study of fungi, algae, and viruses.
- To promote awareness of current research trends and advancements in the fields of Mycology, Phycology, and Virology.

Course Outcomes

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the basic concepts of Algae, Fungi, and viruses.	**BT 1**
CO 2	**Understand** the diversity, distribution, cell structure, life cyclesand economic importance of both algae and fungi.	**BT 2**
CO 3	**Apply** the knowledge of microbiology techniques and conceptsin phycology and mycology and virology research.	**BT 3**
CO 4	**Analyze** the problem and disease associated with fungus and virus in human, animals and plants.	**BT 4**
CO 5	**Evaluate** their future prospect for pursuing an entrepreneurial venture.	**BT5**

Detailed Syllabus:

Modules	Topics / Course content
I	**Phycology (Algae)** General Characteristics Morphology, cellular structure, pigmentation, and reproduction Classification systems (Fritsch and modern molecular approaches) Major Groups of Algae Cyanophyta (Blue-green algae), Chlorophyta (Green algae), Bacillariophyta (Diatoms), Rhodophyta (Red algae), Phaeophyta (Brown algae) Algal Physiology and Ecology Algal photosynthesis and CO_2 fixation pathways Algal blooms and eutrophication Bioindicators and ecological roles of algae Applications of Algae Algae in biotechnology: biofuels, pharmaceuticals, and nutraceuticals Algae as biofertilizers and in wastewater treatment
II	**Mycology (Fungi)** General Characteristics Morphology, cell wall composition, types of spores, and reproduction Classification of fungi (traditional and molecular) Major Fungal Groups Zygomycota, Ascomycota, Basidiomycota, Deuteromycota Fungal Physiology and Ecology Growth kinetics, nutritional requirements, secondary metabolism Mycorrhizae, fungal ecology, and fungal biodiversity Fungal Pathogenesis and Applications Human and plant pathogenic fungi: mechanisms of infection and virulence Industrial and pharmaceutical uses of fungi: enzymes, antibiotics, and organic acids Mycotoxins and food spoilage

III	**Virology** Nature and Structure of Viruses Virus morphology, symmetry, and genome organization Classification of viruses (Baltimore classification and ICTV taxonomy) Viral Replication and Genetics Lytic and lysogenic cycles Replication strategies of DNA and RNA viruses Mutation, recombination, reassortment, and evolution Bacteriophages Lytic and temperate phages Phage therapy and phage display technology Viruses and Disease Viral pathogenesis and host immune responses Emerging and re-emerging viral infections (e.g., SARS-CoV-2, Zika, Ebola)
IV	**Applied and Molecular Aspects** Diagnostic Virology and Vaccines Diagnostic techniques: PCR, ELISA, plaque assay, electron microscopy
	Antiviral strategies and vaccine development Industrial and Environmental Mycology Bioremediation and bio-control agents Fungal biomass in fermentation and food industries Algal Biotechnology Genetic engineering of algae Algal bioplastics and carbon sequestration Recent Advances CRISPR/Cas systems in virus and fungal research Metagenomics of algal and fungal communities Algae and fungi in climate change mitigation

Text Books:

1. Pelczar MJ, Chan ECS and Krieg NR. (2010). *Microbiology*. 8th edition. McGraw Hill Book Company.
2. Barasanti L and Guaaltieri P. (2006). Algae: Anatomy Biochemistry and Biotechnology. Taylor and Francis Group,New York
3. Dube HC. (1981). An Introduction to Fungi. Vikas Publishing House Pvt. Ltd.
4. Raham LE, Graham JM and Wilcox LW. (2009). Algae.2nd edition. Benjamin Cumming, New York.
5. Vashishta BR and Sinha AK. (2008). Fungi. S. Chand and Company Ltd.
6. Webster J. (1980). Introduction to Fungi.2nd edition. Cambridge University Pres

7. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology.6th edition BlackwellPublishing Ltd.
8. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
9. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology,
Molecular biology, Pathogenesis and Control.2nd edition. ASM press Washington DC.

Reference Books:

1. Wagner EK, Hewlett MJ. (2004). Basic Virology.2nd edition.Blackwell Publishing.
2. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
3. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
4. Bos L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
5. Versteeg J. (1985). A Color Atlas of Virology.Wolfe Medical Publication.
6. Levy JA, Conrat HF, Owens RA. (2000). Virology.3rd edition.Prentice Hall publication, New Jersey.

Paper III: Microbial Genetics	**Subject code: MSCMB103**
L-T-P-C-4-0-0-4	**Credit units: 4**

Course Objective:

- This course is design to make the students understand understand the basic principles of genetics as applied to microorganisms, including bacteria, viruses, fungi, and archaea.
- To study the structure and function of microbial genomes, including chromosomal and extrachromosomal elements like plasmids.
- To explore mechanisms of genetic variation in microbes, such as mutation, recombination, transformation, transduction, and conjugation.
- To examine the regulation of gene expression in prokaryotes and simple eukaryotic microorganisms.
- To analyze genetic mapping techniques and molecular tools used in microbial genetics, including PCR, electrophoresis, and DNA sequencing.
- To understand the role of horizontal gene transfer in microbial evolution and antibiotic resistance.

Course Outcomes

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the basic concepts of DNA andGenetic material.	**BT 1**
CO 2	**Understand** the DNA structure, chromosome organization in microbes.	**BT 2**
CO 3	**Apply** the knowledge of DNA and chromosome in genetic issue detection in human and plant.	**BT 3**
CO 4	**Analyze** the genetic disease associated with microbes in humans, animals, and plants.	**BT 4**
CO 5	**Evaluate** the future prospect to cure genetic disorder.	**BT5**

Detailed Syllabus:

Modules	Topics / Course content
I	**Introduction to Microbial Genetics** History and importance of microbial genetics, Genetic material in microbes, Prokaryotic vs. Eukaryotic genomes, Characteristics of microbial chromosomes and plasmids, Gene Structure and Function, Genetic elements: Chromosomes, plasmids, transposons, integron, ISCR elements.
II	**Gene Expression and Regulation in Microbes** Gene Expression Mechanisms, Transcription and translation in prokaryotes, Mechanisms of gene regulation (induction and repression) Operons and Regulons, The lac operon, trp operon, and other examples of bacterial gene regulation, Global gene regulation and regulatory networks Two-component signal transduction systems, Regulatory RNAs, Small RNAs (sRNAs) and their role in gene regulation, Riboswitches and attenuation
III	**Genetic Variation, Mutation, and Repair Mechanisms** Mutation and Genetic Variation, Types of mutations (point mutations, insertions, deletions), Causes of mutations (spontaneous, induced, environmental factors), DNA Repair Mechanisms, Repair pathways: Mismatch repair, nucleotide excision repair, base excision repair, Mechanisms of recombination: Homologous and site-specific recombination, Horizontal Gene Transfer, Transformation, conjugation, and transduction in bacteria, Antibiotic resistance and the spread of resistance genes, Role of mobile genetic elements (plasmids, transposons)
IV	**Advanced Topics in Microbial Genetics and Applications** Microbial Evolution and Phylogenetics, Microbial genome evolution, Horizontal gene transfer and its role in microbial diversity, Phylogenetic tree construction and interpretation, Genome Editing and Synthetic Biology, CRISPR-Cas systems in bacteria and their applications, Synthetic biology and microbial engineering, Applications of genetic engineering in biotechnology and medicine, Applications of Microbial Genetics in Medicine and Environment, Genetic factors influencing pathogenicity and virulence, Microbial genetics in vaccine development Microbial biotechnology in agriculture, waste management, and environmental cleanup

Text Books:

1. James D Watson *et al*. (2009). Molecular biology of the gene. 5th Edition, Pearson.
2. Karp, G. (2010);*Cell and Molecular Biology: Concepts and Experiments*, 6th edition, . John Wiley &Sons.Inc.
3. Stanley R Maloy. Microbial Genetics. 5th Edition, Narosa publishing house.
4. Daniel J Fairbanks. Genetics: The Continuity of Life, Wadsworth Publishing, ISBN-10: 0534252796

Reference Books:

1. Peter J Russel. Genetics. Pearsons Education India, ISBN-10: 9332571627.
2. William Klug, Michael Cummings, Charlotte A Spencer, Michael A Palladino. Concept of Genetics, 10th edition, Pearsons.

Paper IV: Microbial biochemistry	**Subject code: MSCMB104**
L-T-P-C-4-0-0-4	**Credit units: 4**

Course Objective:

- This course focuses on the structure and function of biomolecules such as carbohydrates, proteins, lipids, and nucleic acids in microbial systems.
- To explore microbial metabolic pathways, including catabolic and anabolic reactions, energy production, and biosynthesis.
- To analyze enzymatic mechanisms and kinetics specific to microbial enzymes and their regulation.
- To examine microbial respiration and fermentation processes, including aerobic and anaerobic energy generation.
- To understand the biochemical basis of microbial growth, adaptation, and survival under various environmental conditions.
- To stay updated on recent advancements in microbial biochemistry, including industrial and pharmaceutical applications.

Course Outcomes

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the basic information about the Chemistry of Life and biomolecules.	**BT 1**
CO 2	**Understand** the structure of biomolecules such as proteins, enzymes, lipids etc.	**BT 2**
CO 3	**Apply** the knowledge for the synthesis and application of biomolecules in industries and the agriculture sector	**BT 3**
CO 4	**Analyze** the role of the different biomolecules to maintain crucial life functions.	**BT 4**
CO 5	**Evaluate** the future prospect of synthesis of biomolecules at the commercial level.	**BT5**

Detailed Syllabus:

Modules	Topics / Course content
I	**Introduction to Biochemistry** Structure of atoms, molecules, and chemical bonds; Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.); Principle of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).
II	**Structure and Function of Biomolecules Proteins:** Amino acids: Structure, classification, and properties. Protein structure: Primary, secondary, tertiary, and quaternary structures. Protein folding and denaturation. Techniques for protein analysis: Electrophoresis, chromatography, mass spectrometry. **Carbohydrates and Lipids:** Carbohydrates: Structure, classification, and function (monosaccharides, oligosaccharides, polysaccharides). Lipids: Types, structure, and functions (phospholipids, glycolipids, sterols). Role of glycoproteins and glycolipids in cell recognition and signaling.
III	**Enzyme Biochemistry and Kinetics** Enzyme Structure and Function: Enzyme classification and nomenclature. Active site, enzyme specificity, and mechanism of catalysis. Enzyme cofactors: Coenzymes, prosthetic groups, and metal ions. **Enzyme Kinetics:** Michaelis-Menten equation, Lineweaver-Burk plot. **Enzyme inhibition:** Competitive, non-competitive, and uncompetitive inhibitors. Allosteric enzymes and regulation. Enzyme regulation in metabolic pathways. Metabolism of Biomolecules: Overview of catabolism and anabolism. Role of ATP in energy transfer and metabolism.

IV	**Metabolic Pathways and Bioenergetics** **Carbohydrate Metabolism:** Glycolysis: Pathway, regulation, and ATP yield. TCA cycle (Krebs cycle): Reactions, energy production, and regulation. Glycogen metabolism and regulation. Gluconeogenesis and pentose phosphate pathway. **Lipid Metabolism:** Fatty acid oxidation: Beta-oxidation and ATP production. Biosynthesis of fatty acids and triglycerides. Cholesterol metabolism and its regulation. Protein Metabolism: Amino acid catabolism: Deamination, urea cycle, and amino acid degradation. Protein synthesis and regulation.
	Bioenergetics: Overview of the thermodynamics of metabolism. ATP generation via oxidative phosphorylation. Electron transport chain and oxidative phosphorylation.

Text Books:

1. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
2. Nelson D L, Cox M. M. Lehningers. (2004). Principle of Biochemistry. 4th ed. Freeman and company, New York, USA.
3. Berg, J. M., Tymoczko, J. L. and Stryer.(2006). *Biochemistry*, 6th Edition, W.H Freeman and Co.

Reference Books:

1. White David (2000). Physiology and Biochemistry of Prokaryotes. 2nd ed. Oxford University Press, New York.
2. Gottschalk, Gerhard (1986). *Bacterial Metabolism*. 2nd ed. Springer-Verlag, New York.
3. Moat, Albert G., Foster, John W., and Spector, Michael P. (2002). *Microbial Physiology*. 4th ed. Wiley-Liss, New York.

Practical on General Microbiology, Mycology, Phycology & Virology

Subject code: MSCMB105

L-T-P-C-0-0-2-2 **Credit units: 2** **Scheme of evaluation: (P)**

Course Objective:

- The objective of the course is to familiarize the student with basic laboratory skills in handling microbial cultures safely and effectively.
- To learn proper techniques for sterilization, aseptic handling, microbial isolation from various sources and their identification.
- To cultivate and observe viral effects (e.g., cytopathic effects) using host systems like bacterial lawns or tissue culture, where applicable.
- To examine the structural diversity and reproductive features of fungi and algae through practical observation.

Course Outcomes

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the basic microbiological techniques and laboratory safety protocols used in handling microorganisms including fungi, algae, and	**BT 1**
CO 2	**Understand** the morphological and structural characteristics of bacteria, fungi, algae, and viruses through microscopic and staining	**BT 2**
CO 3	**Apply** standard microbiological procedures to isolate, culture, and identify microorganisms from various environments.	**BT 3**
CO 4	**Analyze** the growth patterns, physiological characteristics, and ecological significance of microbes including pathogenic and beneficial	**BT 4**
CO 5	**Evaluate** the potential uses and implications of microbes in biotechnology, agriculture, medicine, and environmental sustainability.	**BT5**

Detailed Syllabus:

Modules	Topics / Course content

I	1: Preparation of buffer, chemical solutions, stock solution. 2: Microscope principle, operation, and study of various components of the microscope. 3: Sterilization process for glassware,culture media, and preparation of culture plates. pure culture preparation and subculturing technique.
II	4: Determining of bacterial growth curve and microbial growth measurement by direct cell count method,Effect of pH, temperature, and chemicals on bacterial growth. 5: Serial dilution method and bacterial colony counting. 6: Staining technique-simple, Gram's staining, spore staining, Acid- fast staining. Staining of Fungus. 7: Determination of bacterial motility (Bacterial twitching and swimming motility test, motility observation by hanging drop method).
III	8: Isolation and identification of fungi (*Aspergillus, Penicillium, Fusarium, Alternaria,* Nostoc etc.) using selective media Potato Dextrose Agar (PDA), Sabouraud Dextrose Agar (SDA) etc. 9: Lactophenol Cotton Blue Staining **f**or fungal identification (e.g., *Aspergillus*, *Penicillium*, *Rhizopus*)
IV	10: Identification of Major Algal Groups Chlorophyta (e.g., *Spirogyra*, *Chlamydomonas*), Cyanophyta (e.g., *Oscillatoria*, *Nostoc*), Bacillariophyta (e.g., diatoms) 11. Demonstration: Bacteriophage Plaque Assay and Viral Cytopathic Effects (CPE) Using image slides

Text Books:

1. Cappuccino, J.G., & Welsh, C. (2017). *Microbiology: A Laboratory Manual* (11th Edition). Pearson Education, New York.
2. Dubey, R.C., & Maheshwari, D.K. (2016). *Practical Microbiology* (Revised Edition). S. Chand Publishing, New Delhi.
3. Aneja, K.R. (2003). *Experiments in Microbiology, Plant Pathology and Biotechnology* (4th Edition). New Age International Publishers, New Delhi.
4. Bisen, P.S., & Verma, M.K. (2008). *Handbook of Microbiology* (1st Edition). CBS Publishers & Distributors, New Delhi.
5. Talbot, P. (2001). *Laboratory Techniques in Mycology and Plant Pathology* (2nd Edition). Scientific Publishers, Jodhpur.

Reference Books:

1. Harley, J.P., & Prescott, L.M. (2002). *Laboratory Exercises in Microbiology* (5th Edition). McGraw Hill, New York.
2. Atlas, R.M. (1995). *Principles of Microbiology: Laboratory Manual* (1st Edition). Wm. C. Brown Publishers, Dubuque.
3. Benson, H.J. (2001). *Microbiological Applications: Laboratory Manual in General Microbiology* (8th Edition). McGraw Hill, Boston.

Practical on Microbial Biochemistry and Microbial Genetics		**Subject code: MSCMB106**
L-T-P-C-0-0-2-2	**Credit units: 2**	**Scheme of evaluation: (P)**

Course Objectives:

The course is developed with the following objectives:

- To impart hands-on training in the preparation and standardization of various types of laboratory solutions and buffer systems, essential for biochemical and genetic experiments.
- To develop proficiency in qualitative and quantitative biochemical analyses for detecting and estimating biomolecules.
- To provide foundational understanding and practical experience in enzyme assays and kinetics and basic microbial genetics techniques.
- To enhance understanding of protein structure and enzyme function through model-based visualization, and to connect theoretical knowledge with experimental approaches in microbial biochemistry and genetics.

Course Outcomes

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the fundamental biochemical processes in microorganisms and the molecular basis of microbial genetics.	**BT 1**
CO 2	**Understand** the structure and function of microbial enzymes, metabolic pathways, and genetic materials through practical	**BT 2**
CO 3	**Apply** experimental techniques to analyze microbial metabolism and perform genetic manipulation (e.g., plasmid isolation, transformation).	**BT 3**
CO 4	**Analyze** the biochemical reactions and genetic traits that influence microbial physiology and adaptation.	**BT 4**
CO 5	**Evaluate** the potential applications of microbial biochemistry and genetics in biotechnology, medicine, and industry.	**BT5**

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	Preparation of molar, normal, molal, percentage, and ppm solution, Preparation of buffers solution, Estimation of pH of plant juice, water, and soil sample	
II	Qualitative tests for organic acids, carbohydrates, lipids, and proteins from laboratory samples. Quantitative estimation of estimation of proteins by Lowry's method, carbohydrates by Anthrone method, Estimation of nucleic acids (DNA and RNA)	
III	Estimation of catalase activity, hydrolysis of starch, gelatin liquefaction, hydrolysis of casein, Study of protein secondary and tertiary structures with the help of models. Study of enzyme kinetics – calculation of Vmax, Km, Kcat values	
IV	Demonstration of Bacterial Transformation using plasmid DNA into *E. coli* and Selection of transformants on antibiotic-containing media. UV Mutagenesis in Bacteria (exposure of bacterial cultures to UV light and determination of mutation frequency, Replica Plating Technique for Detection of Auxotrophic Mutants. Demonstration of bacterial conjugation.	
Total		

Textbooks:

1. Cappuccino, J.G., & Welsh, C. (2017). *Microbiology: A Laboratory Manual* (11th Edition). Pearson Education, New York.

2. Aneja, K.R. (2003). *Experiments in Microbiology, Plant Pathology and Biotechnology* (4th Edition). New Age International Publishers, New Delhi.
3. Dubey, R.C., & Maheshwari, D.K. (2016). *Practical Microbiology* (Revised Edition). S. Chand Publishing, New Delhi.
4. Benson, H.J. (2001). *Microbiological Applications: Laboratory Manual in General Microbiology* (8th Edition). McGraw Hill, Boston.
5. Green, M.R., & Sambrook, J. (2012). *Molecular Cloning: A Laboratory Manual* (4th Edition). Cold Spring Harbor Laboratory Press, New York.

Reference Books:

1. Maloy, S.R., Cronan, J.E., & Freifelder, D. (1994). *Microbial Genetics* (2nd Edition). Jones and Bartlett Publishers, Boston.
2. Reece, R.J. (2004). *Analysis of Genes and Genomes* (1st Edition). John Wiley & Sons, Chichester.
3. Wilson, K., & Walker, J. (2010). *Principles and Techniques of Biochemistry and Molecular Biology* (7th Edition). Cambridge University Press, Cambridge.

SYLLABUS (2nd SEMESTER)

Paper I: Immunology		**Subject code: MSCMB201**
L-T-P-C-4-0-0-4	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Objective:

- To understand the fundamental components and functions of the immune system, including innate and adaptive immunity.
- To analyze the mechanisms of immune responses to pathogens, vaccines, and allergens.
- To examine the role of immune cells and signaling pathways in health and disease.
- To evaluate current advances in immunological research, such as immunotherapy and vaccine development.
- To identify immunological disorders, including autoimmune diseases, immunodeficiencies, and hypersensitivity reactions, and discuss their clinical implications.

Course Outcomes

CO Level	Course Outcome
CO 1	**Remember** the basic concepts about the innate and adaptive immune system.
CO 2	**Understand** the basic concepts about the innate and adaptive immune system.
CO 3	**Apply** the knowledge of antigen, antibody, RIA and other techniques
	in HLA typing and related research.
CO 4	**Analyze** autoimmune disease and other related issues.
CO 5	**Evaluate** the future prospect to solve immunity-related issues.

Detailed Syllabus:

Modules	Topics / Course content

I	History and scope of immunology: types of immunity – innate and acquired, passive and active. Physiology of immune response- Humoral and cell mediated immunity, Lymphoid organs. Immunohaematology of blood groups, ABO and RH compatibility.
II	Antigens and Antibodies: structure and properties (types, iso and allo). haptens, adjuvants; antigen specificity; Immunoglobulins (antibodies) – structure, heterogeneity – types and subtypes, properties (physico- chemical and biological). Antigen – Antibody reactions; agglutination, haemagglutination, precipitation, Complement fixation, major histocompatibility complex(MHC-I &II).
III	Immunofluorescence; enzyme linked immunosorbent assay (ELISA), radioimmunoassay.Hybridoma technology – monoclonal antibodies and its uses. Complement pathways. Hypersensitivity-anaphylaxis, cytotoxic reaction. Cytokines. Organization and expression of Ig genes and rearrangements.
IV	Hypersensitivity, Autoimmunity, Transplantation immunology and tumorimmunology.HLA tissue typing, major histocompatibility complex.Immunotoxins; vaccines and its types, toxoidsnational immunization programmes, newer generation vaccines

Text Books:

4. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
5. Nelson D L, Cox M. M. Lehningers. (2004). Principle of Biochemistry. 4th ed. Freeman and company, New York, USA.
6. Berg, J. M., Tymoczko, J. L. and Stryer.(2006). *Biochemistry*, 6th Edition, W.H Freeman and Co.
7. Janis Kuby. (2013). Immunology. 7th Edition, WH Freeman.

Reference books:

1. Kathleen parkTalaro (2017). Foundations in Microbiology. 10th Edition, McGraw Hill. Science
2. White David (2000). Physiology and Biochemistry of Prokaryotes. 2nd ed. Oxford University Press, New York.

Paper II: Molecular biology and Recombinant DNA technology		**Subject code: MSCMB202**
L-T-P-C-4-0-0-4	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Objective:

- This course provides detail information regarding the molecular structure and function of DNA, RNA, and proteins**,** and how they regulate cellular processes.
- To **e**xplain key techniques in recombinant DNA technology, including gene cloning, PCR, and gel electrophoresis.
- To **a**nalyze the applications of genetic engineering in medicine, agriculture, and biotechnology.
- To **e**valuate the ethical, legal, and social implications of recombinant DNA technology.
- To **e**xplore recent advancements and future trends in molecular biology and genetic manipulation.

Course Outcomes

CO Level	Course Outcome
CO 1	**Remember** the basic concept of genome organization and omics approaches.
CO 2	**Understand** the replication, Transcription, and translation mechanism in the cell.
CO 3	**Apply** the knowledge of genome organization in mutation and virulence gene study.
CO 4	**Analyze** the genetic material to correlate gene mutation and its impact on function.
CO 5	**Evaluate** the future prospect to solve genetic disorders.

Detailed Syllabus:

Modules	Topics / Course content

I	**O**rganization of DNA in eukaryotic cell; palindromic DNA; Types of RNA-rRNA; mRNA (the 5' cap, non-coding region, initiation codon, coding region, termination codon; Poly (A) region, post transcriptional modification,differences between prokaryotic and eukaryotic mRNA; tRNA (structure of tRNA-clover leaf model); superhelicity in
	DNA.Dispersive, conservative and semi-conservative models; Watson and Crick's model of DNA replication (experimental evidence); Enzyme involved in DNA replication (DNA polymerase I, Pol II, Pol III, DNA ligase); Mechanism of DNA replication; Models of DNA replication, inhibitors of DNA replication.Exonuclease and endonuclease.
II	Gene diversity; split genes, overlapping gene; molecular nature of mutation, spontaneous and induced mutation; DNA damage and repair – types of damage (deamination, oxidative damage, alkylation, pyrimidine dimmers); repair pathways – methylation – directed mismatch repair, nucleotide excision repair, base excision repair, recombination repair, SOS repair.
III	Gene Regulation and expression- Gene regulation – negative regulation – *E. coli lac* operon (structural, operator, promoter and repressor genes), Positive regulation – *E. coli trp*-operon.Central dogma; RNA polymerase; Site of transcription. Transcription – chain initiation, chain elongation, chain termination, RNA turnover; translation – charging of tRNA, initiation of polypeptide synthesis, elongation of the polypeptide chain, translocation, termination of the polypeptide chain;
IV	Cloning vectors – Plasmids, phages and cosmids, phagemids, Ti plasmids, other viral vectors (M13 and retroviruses); Cloning strategies, cloning and selection of individual genes; Gene libraries– cDNA and genomic libraries. Expression vectors, promoter probe vectors, vectors used for construction of library – artificial chromosomes; BAC vectors, YAC vectors. Working principle of PCR, requirements, types of PCR, application of PCR, Sequencing of DNA and protein in brief. Recombinant products – human growth hormone (insulin somatotropin), vaccines (hepatitis B virus vaccine, FMD vaccine), interferons.

Text Books:

1. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
2. James D. Watson et al. (2009). *Molecular Biology of the Gene* (4th Edition). Pearson.

3. David P. Clark & Nanette J. Pazdernik (2019). *Molecular Biology* (3rd Edition). Academic Press.
4. T.A. Brown (2016). *Gene Cloning and DNA Analysis: An Introduction* (7th Edition). Wiley-Blackwell.
5. Jeremy W. Dale & Malcolm von Schantz (2011). *From Genes to Genomes: Concepts and Applications of DNA Technology* (3rd Edition). Wiley-Blackwell.
6. Bruce Alberts et al. (2014). *Molecular Biology of the Cell* (6th Edition). Garland Science.

Reference Books:

1. Gerard J Tortora, Berdell R Funke, Christine L Case. Microbiology: An Introduction. Dorling Kindersley (india) Pvt Ltd.
2. Karp, G.(2010). *Cell and Molecular Biology: Concepts and Experiments*, 6th edition,.John Wiley &Sons.Inc.

SYLLABUS (2nd SEMESTER)

Paper: Parasitology, Medical and Veterinary Microbiology		**Subject code: MSCMB203**
L-T-P-C-4-0-0-4	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Objective:

The course is developed with the following objectives:

- To enable the students,to develop a proper understanding of different pathogenic microbes.
- To understand the mode of transmission and life cycle of human and animal pathogens.
- To enable understanding of the mode of action of anti-microbial agents.
- To impart the basic skills for the diagnosis and identification of pathogenic microbes.

Course outcome:

CO Level	Course Outcome
CO 1	**Remember** the basic concept of pathogenesis and transmission and life cycle.
CO 2	**Understand** normal microflora of human body; role of resident flora. Host-parasite relationships, Infection type.
CO 3	**Apply** the knowledge of antimicrobial agents and antibiotics as chemotherapeutic agents.
CO 4	**Analyze** the Emerging communicable diseases (Plague, Anthrax) and their control.

Detailed Syllabus:

Modules	Topics / Course content
I	Introduction to medical parasitology-classification. Pathogenesis, transmission, life cycle, lab diagnosis, treatment of Protozoa-*Entamoeba, Toxoplasma, Cryptosporidium, Leishmania,Trypanosoma, Plasmodium, Giardia, Trichomonas*and*Balantidium*. Introduction to *Mycobacteria, Brucella, Listeria, Pasturella*andErysepelas. Spirochetes, *Rickettsiae, Chlamydia, Mycoplasma* and *Ureoplasma.*

II	Discovery of pathogenic micro-organisms; normal microflora of human body; role of resident flora. Host-parasite relationships, Infection, type and source. Disease cycle (sources of diseases, reservoirs, transmission of pathogens); Intoxications (exotoxins and endotoxins and their mechanism of action). Antimicrobial agents and antibiotics: Antiseptics, chemotherapeutic agents, effect of antibiotics on protein, nucleic acid, cellwall and cytoplasmic membrane.
III	Morphology, classification, cultural characteristics, pathogenicity and laboratory diagnosis of Staphylococci, Streptococci, Pneumococci, Neisseriae (Gonococci and Meningococci), *Haemophilus, Bordetella, Corynebacterium, Clostridium.*
IV	Study of Enterobacteriaceae (*E. coli, Klebsiella, Salmonella, Shigella, Proteus*), Vibrios and Nonfermenting Gram negative bacilli. Emerging communicable diseases (Plague, Anthrax) - symptom, identification, monitoring and surveillance and quarantine administration.

Textbooks:

1. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
2. Text Book Of Medical Mycology by JagdishChander, Mehta Publishers, New Delhi
3. Sherris Medical Microbiology : An Introduction to Infectious Diseases by Kenneth Ryan, McGraw-Hill Medical.
4. Jawetz, Melnick, &Adelberg's Medical Microbiology (Lange basic), McGraw-Hill Medical
5. Medical Microbiology by Patrick R. Murray, Michael A. Pfaller, & Ken S. Rosenthal, Elsevier
6. Text book of microbiology by Ananthanarayan and Paniker. Medical Microbiology by Cedric Mims, John Playfair and Ivan roitt. Mosby-wolfe

Reference Books:

1. Jawetz, Melnick, &Adelberg's. (2013). Medical Microbiology. 26th Edition. McGraw-Hill.
2. Dey, N.C., Dey, T.K. and Sinha, D., 1999. Medical Bacteriology including Medical Mycology and AIDS. 17th edition, New Central Book agency. Kolkatta.
3. Finegold, S.M. (2000) Diagnostic Microbiology, 10th Edn. C.V. Mosby Company, St. Louis
4. Chatterjee, 1986. Medical Parasitology. Tata McGraw Hill, New Delhi.
5. Karyakarte, R.P. and Damle, A.S., 2005. Medical Parasitolog. Revised edition. Published by Books and Allied (P) Ltd., Kolkatta.
6. JeyaramPaniker, 2004. Text book of Medical Parasitology. 5th edition, JAYPEE brothers, Medical Publishers (P) Ltd, New Delhi.
7. Veterinary Microbiology and Microbial Disease" by P J Quinn and B K Markey

SYLLABUS (2nd SEMESTER)

Paper: Food Microbiology		**Subject code: MSCMB204**
L-T-P-C-4-0-0-4	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Objective:

The course is developed with the following objectives:

- To enable the students to develop a proper understanding of different food-born microbes.
- To understand the principles of food preservation.
- To enable understanding of food born infection and intoxication.
- To impart the basic skills for laboratory testing and quality control of food.

Course outcome:

CO Level	Course Outcome
CO 1	**Remember** the micro-organisms and their importance in food microbiology – molds, yeast, bacteria.
CO 2	**Understand** the organisms, and different factors those influence microbial growth in food.
CO 3	**Apply** the knowledge of microbes in Food fermentation – Bread, vinegar, fermented vegetables, fermented dairy products.
CO 4	**Analyze** the microbial potential for fermentation and product development.
CO5	**Evaluate** their understanding of expanding their future prospect for pursuing an entrepreneurial venture

Detailed Syllabus:

Modules	Topics / Course content

I	Micro-organisms and their importance in food microbiology – molds, yeast, bacteria, general features, classification; principles of food preservation; asepsis – control of micro-organisms (anaerobic conditions, high temperature, low temperature, drying); factors influencing microbial growth in food – extrinsic and intrinsic factors; chemical preservation and food additives; canning process for heat treatment. Contamination and Spoilage – Cereals, Sugar products, vegetables, fruits, meat and meat products; milk and milk products, fish and sea food,
	poultry spoilage of canned food; detection of spoilage and characterization.
II	Food-borne infections and intoxications – bacterial: *Brucella, Bacillus, Clostridium, Escherichia, Shigella, Staphylococcus, Vibrio, Yersinia*and non-bacterial intoxication (withexamples of infective and toxic types) – Protozoa, algae, fungi and viruses; food borne outbreaks– laboratory testing procedures, preventive measures, GMP and Hazard Analysis and Critical Control Point. Food control agencies and its regulations; Employee's health standards, waste treatment, disposal and quality control.
III	Food fermentation – Bread, vinegar, fermented vegetables, fermented dairy products; experimental and industrial production methods; spoilage and defects of fermented dairy products; oriental fermented foods – its quality standard and control.
IV	Microbial cells as food (Single cell protein), mushroom cultivation; fermented beverages –beer and wine; steroid conversion – industrial enzymes, production of amylases, proteinases, cellulases, amino acid production – glutamic acid and lysine; pickles, olives, soy sauce,genetically modified (GM) foods.

Textbooks:

1. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
2. Food Microbiology by William C Frazier. Tata Mgraw Hill
3. Food Microbiology by dams and Moss. Springer Verlag
4. Basic food microbiology by Banwart. Cbs Publishers & Distributors Pvt Ltd.
5. Principles of Microbiology by Ronald M. Atlas (1995), Amy Mc Cullen
6. Fundamental Principles of Bacteriology A J Salle

Reference Books:

1. Adams MR & MO Moss (2005). Food Microbiology, New Age International (P) Limited.

Publishers; 1st Edition, New Delhi.
2. James M Jay (2004). Modern Food Microbiology, CBS Publishers & Distributors; 4th Edition, New Delhi.
3. William Frazier and Dennis Westhoff (2008) - Food Microbiology McGraw Hill Education; 4 edition.

Practical on Immunology & Molecular biology		**Subject code: MSCMB205**
L-T-P-C- 0-0-4-2	**Credit units: 2**	**Scheme of evaluation: (P)**

Course Objective:

- To understand and apply basic immunological techniques, such as ELISA, for detecting antigen-antibody interactions.
- To develop hands-on skills in molecular biology methods, including DNA extraction, PCR amplification, gel electrophoresis, and restriction enzyme digestion.
- To integrate theoretical knowledge with laboratory practices by interpreting experimental data, troubleshooting procedures, and drawing scientific conclusions from results.
- To promote good laboratory practices and biosafety awareness, ensuring accurate documentation, proper handling of biological materials, and adherence to ethical standards in biotechnology research.

Course Outcomes

CO Level	Course Outcome
CO 1	**Remember** the basic principles and laboratory techniques used in immunology, molecular biology, and enzyme technology.
CO 2	**Understand** the structure and function of antibodies, nucleic acids, and enzymes through practical experiments.
CO 3	**Apply** immunological and molecular techniques such as ELISA, PCR, and DNA isolation in diagnostic and research settings.
CO 4	**Analyze** enzyme kinetics, antigen-antibody interactions, and gene expression through hands-on experimental data.
CO 5	**Evaluate** the future potential and commercial applications of molecular biology tools, immunoassays, and enzymatic processes in

Detailed Syllabus:

Modules	Topics / Course content
I	1: Determination of blood groups and Rh factor and Demonstration of agglutination reaction with reference to widal test and VDRL test.2: Demonstration of haemagglutination with reference to *Treponema pallidum* Haemagglutination test. 3: Demonstration of ODD (Ouchtlerlony Double Diffusion)-an
	immunological technique used in the detection, identification, and quantification of antibodies and antigens.
II	4: Separation and characterization of serum-by-serum electrophoresis method. 6: Separation and characterization of lymphocytes from blood, Demonstration of Antigen-antibody reaction by ELISA.
III	7: Plasmid DNA isolation from bacteria. 8: Isolation of Genomic DNA from bacteria 9: Separation of DNA by agarose gel electrophoresis.
IV	10: Primer Designing for Bacterial DNA amplification and demonstration of PCR (polymerase chain reaction). 11: Restriction digestion of bacterial DNA.

Text Books:

1. Raghavendra, P., & Rathnamma, D. (2010). *A Laboratory Manual of Immunology* (1st Edition). Dominant Publishers, New Delhi.
2. Sambrook, J., & Russell, D.W. (2001). *Molecular Cloning: A Laboratory Manual* (3rd Edition). Cold Spring Harbor Laboratory Press, New York.
3. Wilson, K., & Walker, J. (2010). *Principles and Techniques of Biochemistry and Molecular Biology* (7th Edition). Cambridge University Press, Cambridge.
4. Hames, B.D., & Hooper, N.M. (2000). *Biochemistry and Molecular Biology: Practical Approach* (2nd Edition). Oxford University Press, Oxford.
5. Segel, I.H. (1993). *Enzyme Kinetics: Behavior and Analysis of Rapid Equilibrium and Steady-State Enzyme Systems* (1st Edition). Wiley-Interscience, New York.

Reference books:

1. Roitt, I.M., Brostoff, J., & Male, D.K. (2001). *Immunology* (6th Edition). Mosby, London.
2. Brown, T.A. (2016). *Gene Cloning and DNA Analysis: An Introduction* (7th Edition). Wiley-Blackwell, Oxford.
3. Trevan, M.D. (1987). *Enzyme Biotechnology* (1st Edition). Wiley-Interscience, New York.

Practical on Medical and Food Microbiology		**Subject code: MSCMB206**
L-T-P-C-0-0-4-2	**Credit units: 2**	**Scheme of evaluation: (P)**

Course Objective:

- To impart practical knowledge of culturing, isolating, and identifying clinically and industrially significant microorganisms using standard microbiological techniques.
- To train students in performing diagnostic procedures such as antibiotic sensitivity testing, pathogen identification, and interpretation of results
- To enable students to analyze the microbiological quality of food and water, applying methods for detecting contamination, spoilage organisms, and foodborne pathogens.
- To familiarize students with microbial standards and safety practices in medical and food microbiology laboratories, promoting adherence to biosafety and hygiene protocols.

Course outcome:

CO Level	Course Outcome
CO 1	**Remember** the basic concepts and laboratory practices related to pathogenic microorganisms and food-associated microbes.
CO 2	**Understand** the morphological and biochemical characteristics of clinically and industrially important microorganisms through practical
CO 3	**Apply** microbiological methods for the detection, isolation, and identification of pathogens in clinical and food samples.
CO 4	**Analyze** microbial contamination, spoilage patterns, and their implications in food safety and human health.
CO5	**Evaluate** the potential of microbiological quality control and diagnostic techniques in medical and food industries.

Detailed Syllabus:

Modules	Topics / Course content
I	1. Collection, transport and preservation of different samples from animal sources.

	2. Isolation, identification and characterization of microorganisms from animal sources. of microorganisms. Study of antibiogram, Study of LD50 against disinfectants.
II	. 4.Collection of milk samples from infected milking cow shed areas and application of COB (Clot on boiling) Test 5:MR (Milk Ring) Test to study the level of adulteration of milk.
III	6.Identification of *Candida* by microscopical examination (Staining and germ tube formation) and cultural characteristics. 7.Rapid detection tests in Microbiology: i) Dip stick test for detection of Malarial parasite ii) Dot EIA for detection of Typhoid fever. Comb assay for detection of *Mycobacterium tuberculosis*
IV	8. Screening of antibiotics producing microbes from soil. 9.Production and enzymes assay: a). Amylase b). Protease Lipase

Textbooks:

1. Cheesbrough, M. (2006). *District Laboratory Practice in Tropical Countries, Part 2* (2nd Edition). Cambridge University Press, Cambridge.
2. Cruickshank, R., Duguid, J.P., Marmion, B.P., & Swain, R.H.A. (1975). *Medical Microbiology: A Guide to Diagnosis and Control of Infection* (12th Edition). Churchill Livingstone, Edinburgh.
3. Jay, J.M., Loessner, M.J., & Golden, D.A. (2005). *Modern Food Microbiology* (7th Edition). Springer, New York.
4. Frazier, W.C., & Westhoff, D.C. (1988). *Food Microbiology* (4th Edition). McGraw-Hill Education, New York.
5. Tortora, G.J., Funke, B.R., & Case, C.L. (2018). *Microbiology: An Introduction* (12th Edition). Pearson Education, New York.

Reference Books:

1. Adams, M.R., & Moss, M.O. (2008). *Food Microbiology* (3rd Edition). Royal Society of Chemistry, Cambridge.
2. Baron, S. (1996). *Medical Microbiology* (4th Edition). University of Texas Medical Branch, Galveston.
3. Harrigan, W.F. (1998). *Laboratory Methods in Food Microbiology* (3rd Edition). Academic Press, San Diego.

SYLLABUS (3rd SEMESTER)

Paper : Microbial Genomics, Proteomics and Bioinformatics		**Subject code: MSCMB301**
L-T-P-C-4-0-0-4	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Objective:

- The course is designed to give an idea about genome and proteome organization, sequencing technologies, and gene/protein structure and function.
- The syllabus is also designed to make students understand the concept tools and techniques such as genome annotation, protein separation, and identification methods including 2D-PAGE and mass spectrometry.
- Further the course is designed to introduce key bioinformatics tools and databases for the analysis and interpretation of genomic and proteomic data, including sequence alignment, molecular modelling etc.
- The course is also designed to enable students to apply omics approaches for solving biological problems in fields such as medicine, agriculture, and environmental science.

Course Outcomes

CO Level	Course Outcome
CO 1	**Remember** the basic principles of genomics, proteomics, and bioinformatics, including genome organization and structure.
CO 2	**Understand** the methodologies involved in gene and protein sequencing, annotation, and the use of key databases and tools.
CO 3	**Apply** computational tools and algorithms to analyze DNA, RNA, and protein sequences, and interpret biological data.
CO 4	**Analyze** and evaluate genome-wide expression patterns and protein-protein interactions to understand cellular functions and disease
CO 5	**Evaluate** problem-solving skills using bioinformatics pipelines for real-world biological questions in health, agriculture, and environment.

Detailed Syllabus:

Modules	Topics / Course content

I	Introduction to microbial genomics, sequencing genomes: first generation DNA sequencing, shotgun sequencing, second generation DNA sequencing, Next Generation Sequencing (NGS), Biological sequences as information: DNA, RNA and protein as informative molecules, general characteristics of microbial genomes, genome assembly, genome annotation, core and pangenomes of microbial species , genomic islands and their role in evolution, lateral gene transfer, phylogenetic analysis based on genome data, microbial genomes size and content, small genomes and large genomes, genomes of organelles
II	Functional genomics: microarrays and transcriptomes, gene chips and gene expression and its applications, RNA sequence analysis, comparative genomics, culture independent studies of microorganisms: metagenomic, steps in construction of metagenomes, examples of metagenomic studies, metagenomics as a tool to reveal the vast microbial diversity
III	Introduction to microbial proteomics, Proteome Analysis Techniques: Mass spectrometry for protein identification, protein-protein interaction analysis, SDS-PAGE, 2D PAGE, MALDI-TOF, ESI-MS, protein-protein interaction analysis, Edman degradation technique for protein sequencing, functional proteomics and structural proteomics, applications of proteomics in drug discovery and diagnostics
IV	Biological databases: NCBI, ENSEMBL, Uniprot, KEGG, PDB, BLAST & FASTA tool, genome annotation, tools to study genome assembly, sequence alignment algorithms, phylogenetic tree analysis, in silico prediction of secondary metabolite biosynthetic gene clusters, comparative genomic analysis, phylogenomic, protein structure prediction tool, basics of molecular simulation and docking

Textbooks:

1. Brown T. A. 2007, Genomes 3. Garland Science Publishing, New York.
2. Dunham, I., 2003. Genome Mapping and sequencing. Horizon Scientific
3. Discovering Genomics, Proteomics and Bioinformatics 2nd edition - by A. Malcolm Campbell and Laurie J. Heyer. by Cold Spring Harbor Laboratory Press 2006.
4. Bioinformatics and Functional Genomics (3rd Ed.) by Pevsner, J., John Wiley and Sons, New Jersey, USA. 2015

Reference Books:

1. Principles of Genome Analysis and Genomics by Primrose, S.B. and Twyman, R.M., Blackwell Publishing Company, Oxford, UK, 2003
2. Introduction to Proteomics-Tools for the new biology (1st edition) by Liebler, D.C., Humana Press Inc., New Jersey, USA, 2002
3. Bioinformatics: sequence and Genome Analysis by Mount, D., Cold Spring Harbor Laboratory Press, New York, 2004

Paper : Applied microbiology and Enzyme technology		**Subject code: MSCMB302**
L-T-P-C-4-0-0-4	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Objective:

- The course is designed to give an idea about the diversity of microbes and their identification.
- The syllabus is also design to understand the role of microbe in waste treatments especially degradation of xenobiotics compound. Further the course is design to give the basic idea about the microbial biotechnology and the application of different microbes in the industries.
- The course is also designed to allow students to understand about different microbial enzymes produce by microbes, their purification technique and its application in different fields. Further, students will also learn about the products (antibiotics, biofuel etc.) that can be produced from microbes.

Course Outcomes

CO Level	Course Outcome
CO 1	**Remember** the basic concept of microbiology related to the application in various fields.
CO 2	**Understand** the synthesis mechanism of Biopolymers and bioplastics, Bioprocess technology, beer,wing etc.
CO 3	**Apply** the knowledge of microbes to produce enzymes at a commercial scale.
CO 4	**Analyze** microbial potential for the benefit of society, environment, and industries.
CO 5	**Evaluate** the future prospect to solve issues related to mankind and the environment.

Detailed Syllabus:

Modules	Topics / Course content

I	Introduction to Microbial Diversity, identification of unknown microbes: Strategy and methods, newer approaches for exploring unculturable bacteria from environmental samples like sewage. Microorganism for waste treatment, treatment of wastes - Sewage disposal, compost making, methane generation. Microbiology of degradation of xenobiotics in environment: hydrocarbons, oil pollution, surfactants, pesticides.
II	General concepts of microbial biotechnology. Microorganisms as factories for the production of novel compounds, Nature of microbial polysaccharides, mechanism of synthesis; Biopolymers and bioplastics, Bioprocess technology, beer brewing, cheese manufacture, mold– modified foods, Wine, Vinegar, The fermentation process, procedure and equipments, Ideal bioreactors, Batch, fed batch, CSTR, PFR, Multiphase bioreactors, packed bed, bubble column fluidized trickle bed, immobilization. Aseptic, septic and anaerobic fermenters.
III	Enzymes from microbial sources, large scale production of enzymes, recovery of enzymes, enzyme purification methods - enzyme precipitation, separation by chromatography, enzyme immobilization. Application of enzymes (food industries and pharmaceutical). Enzymes in diagnostic assays. Enzyme electrodes, immunoenzyme techniques.
IV	Commercial products of microbes: Antibiotics, biopolymers, biosensors, biopesticides, Production of biofuels. Microbial toxins: Types, biochemical and molecular basis of toxin production, implications. Genetically engineered microbes, anti-HIV, anticancer, antifungal, antiplasmodial, anti-inflammatory compounds.

Text Books:

1. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
2. Barnett, H. L. and Hunter, B. B. (1960). Illustrated Genera of Imperfect Fungi.Burgess Publishing Co., Minnesota.
3. Breed and Buchanan ((2003). Bergey's Manual of Systematic Bacteriology. 2nd Edition, (Volumes. 1 – 5)
4. Cook T. (2002) Microbial Biodiversity: Saving Bacteria to save ourselves, Harvard Science Review, 26-28.
5. Nelson D L, Cox M. M. Lehningers. (2004). Principle of Biochemistry. 4th ed. Freeman and company, New York, USA.

Reference books:

1. Keller M. and Zengler K. (2004) Tapping in to Microbial Diversity. Nature Reviews 2, 141-150.
2. Pace N. (1997) A Molecular View of Microbial Diversity and the Biosphere, Science, 276, 734-740.
3. White David (2000). Physiology and Biochemistry of Prokaryotes. 2nd ed. Oxford University Press, New York

Paper: Inheritance Biology		**Subject code: MSCMB303**
L-T-P-C-4-0-0-4	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Objective:

- The course is developed with an objective to understand the fundamental principles of Mendelian inheritance, including multiple allelism, lethal alleles, gene interactions, and sex-linked transmission.
- The course is also designed to enable the students to apply the principles of inheritance as formulated by Mendel and understand basic aspects of the flow of genetic information from DNA to proteins.
- Further, this course will enable students to understand the structure and its functional role in encoding genetic material.

Course outcome:

CO Level	Course Outcome
CO 1	**Remember** the basic concept of genetics.
CO 2	**Understand** the transmission of character from one generation to the next generation.
CO 3	**Apply** the mendelian law and another concept to recognize the genetic disorder
CO 4	**Analyze** patterns of inheritance of character generation to generation
CO5	**Evaluate** the scope to fix the genetic disoder.

Detailed Syllabus:

Modules	Topics / Course content
I	Rules of Inheritance:Milestones in genetics, Mendelian genetics- Examples In pea plants, Drosophila and human, Patterns of inheritance, concept of gene.

II	Chromosomes as genetic material: Inheritance, Types, structure, Mitosis, Meiosis, polytene chromosome. DNA as the genetic material: - Structure, replication, gene expression- transcription, translation, and recombination.
III	Genome – Prokaryotic and Eukaryotic genome organization, Organelle genomes and Jumping genes, Genetic basis of heritable change – Mutation and its effects, chromosomal variations, Chromosomal syndromes
IV	Animal development – Embryogenesis, Genes involved in early development in Drosophila, Basic body axis formation, Evolution of body plan

Textbooks:

1. Brooker, R. J. 1999. Genetics: Analysis and Principles. Benjamin Cummings, Longman, INC.
2. Gardner E. J. M. J. Simmons and D.P. Snustad 1991 Principles of Genetics. John Wiley & Sons. INC. New York.
3. Klug, W. S. and M. R. Cummings 1994 Concepts of Genetics MacMillan Colley Publishing and Company NY.
4. Strickberger M. W. 1996. Genetics. Mac Millan Publishing Co. NewYork
5. Tamarin,. R H. 1999. Principles of Genetics. McGraw-Hill.

Reference Books:

1. Griffiths,AJF, Wessler SR, Lewontin RC, Gelbart WM and JH Miller 2005, Introduction to genetic analysis W.H. Freeman and Company, New York.
2. Simmons S 2006, Principles of genetics, 4th Edition, John Wiley & Sons (Asia) Pte Ltd. New Jersey.

Paper: Microbial fermentation technology		**Subject code: MSCMB304**
L-T-P-C-4-0-0-4	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Objective:

The course is developed with the following objectives:

- The enable the students in learning different fermentation process using microorganisms
- To understand about development of different bioproducts, bioprocess and bottle necks of fermentation industry
- The gain information about how microorganisms can contribute to product formation
- To impart the basic skills for the culture of microbes.

Course outcome:

CO Level	Course Outcome
CO 1	**Remember** the basic concepts of microbial fermentation technology and History.
CO 2	**Understand** media formulation, inoculum development and process optimization.
CO 3	**Apply** the knowledge of fermentation techniques and concepts in research.
CO 4	**Analyze** the problem associated with culture selection for fermentation.
CO5	**Evaluate** their understanding of expanding their future prospect for pursuing an entrepreneurial venture.

Detailed Syllabus:

Modules	Topics / Course content
I	Introduction and historical developments in fermentation technology: Introduction to fermentation processes, Fermentation classification, Solid state and Submerged Fermentations, Microbial culture selection for fermentation processes. Media formulation, inoculum development and process optimization.
II	Design and operation of Fermenters: Design of batch, fed batch, continuous bioreactors, Microbial growth kinetics, Basic concepts for selection of a reactor, Packed bed reactor, Fluidized bed reactor, Trickle bed reactor, Bubble column reactor, Scale up of Bioreactor. Sensors and Biosensors used in fermentation monitoring.
III	Fermentation processes for production of SCP, enzymes, amino acids, citric acid, penicillin, Bioprocess economics and Bioproduct regulation. Fermented traditional foods: Microorganisms and enzymes as key tools of fermentation. Isolation, preservation, and improvement of industrially important microorganisms. Application of microbes and microbial processes in food and healthcare industries - food Processing.
IV	Down Stream processing. Recovery of particulate matter, product isolation, distillation, centrifugation, whole broth processing, filtration, aqueous two-phase separation, solvent extraction, chromatography, and electrophoresis. Development of inoculum for industrial use. Inoculum preservation and storage. Cell banks: Working cell back and Mater cell bank. Fermented foods: nutrition and human health.

Textbooks:

1. Lee, Y. K. (2013). Microbial Biotechnology: Principles and Applications. Hackensack, NJ: World Scientific.
2. Moo-Young, M. (2011). Comprehensive Biotechnology. Amsterdam: Elsevier.
3. Nelson, K. E. (2015). Encyclopedia of Metagenomics. Genes, Genomes and Metagenomes: Basics, Methods, Databases and Tools. Boston, MA: Springer US.
4. The New Science of Metagenomics Revealing the Secrets of Our Microbial Planet. (2007). Washington, D.C.: National Academies Press.

Reference Books:

1. Biely, J.E. and Ollis, D.F. Bio Chemical Engineering Fundamentals (1986), Mcgraw Hills. Rehm, H.J. and Reed, G. (ed), Biotechnology, Vol 1-2, Verlag chemie.
2. Stanbury, P.E. and Whitaker, A., Principles of Fermentation Technology (1984), Pergamon Press.
3. Pirt, S.J., Principles of Microbial and Cell Cultivation. Blackwell Scientific Publication, London. 4. Moo-young, M., Comprehensive Biotechnology, Vol. 1-4, Pergamon Press, Oxford.

SYLLABUS (4th SEMESTER)

Paper : Soil and Environmental Microbiology		**Subject code: MSCMB401**
L-T-P-C-4-0-0-4	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Objective:

The course is developed with the following objectives:

- To enable the students to develop a proper understanding of soil and environment microbes.
- To understand the role of microbesin the environment.
- To enable understanding of the application of microbes such as a biofertilizer
- To impart the basic knowledge of environmental microbes and their application.

Course outcome:

CO Level	Course Outcome
CO 1	**Remember** the agriculturally important and environment-friendly microbe.
CO 2	**Understand** various soil types, Rhizosphere, and rhizoplane. Nitrogen fixation: A symbiotic and symbiotic nitrogen fixation system.
CO 3	**Apply** the knowledge for the Production of biofertilizers and biopesticides
CO 4	**Analyze** the role of microbes in terrestrial and aquatic ecosystems.
CO5	**Evaluate** the future prospect of different microbial consortia for agriculture and environmental issue

Detailed Syllabus:

Modules	Topics / Course content
I	Aero-microbiology - droplet nuclei, aerosol, assessment of air quality, brief account of airborne microbes – bacteria, fungi, and viruses, their diseases and preventive measures; Phylloplane and Phyllospheremicroflora. Role of microbes in environment – Organic matter decomposition, factors

	affecting litter decomposition; Biogeochemical cycling of C, N, P and S; Microbial biomass and soil fertility; Biodegradation of hydrocarbons and xenobiotics, Microbial leaching of iron and copper.
II	Soil Microbiology – Classification of soil-physical and chemical characteristics, soil as a habitat for micro-organisms, microflora of various soil types, Rhizosphere and rhizoplane. Nitrogen fixation: Asymbiotic and symbiotic nitrogen fixation systems – root nodulation symbiotic bacteria (process of root nodule formation), Leghemoglobulin. Microbial interactionssymbiosis, mutualism, commensalisms, amensalism, competition, antibiosis;Actinorrhiza; Mycorrhizal fungi and its effect on plants.
III	Production of biofertilizers and biopesticides– Quality control, BIS norms of biofertilizers; Biofertilizers (rhizobial inoculants, mass production and method of application); Biopesticides (viral, bacterial and fungal biopesticides); Biopolymers – Polyhydroxybutyrate (PHB), xantham gum.
IV	Aquatic Microbiology – Water ecosystems – types, fresh water (pond, lakes), marine habitats (estuaries, deep sea, hydrothermal vents); Eutrophication, food chain; potability of water, microbial assessment for water quality, water purification, physical, chemical, microbiological characteristics of sewage. Characterization of solid and liquid wastes, physical, chemical and biological (aerobic, anaerobic – primary, secondary, tertiary) treatment; Solid waste treatment; Liquid waste treatment – trickling, activated sludge, oxidation ponds. Formation of biofilm. Biomagnifications.

Textbooks:

1. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.
2. Microbiology: Principles and Explorations by Jacquelyn Black
3. Soil Microbiology by SubbaRao. India Book House Pvt Ltd
4. Environmental Microbiology by Raina M. Maier, Ian L. Pepper, Charles P. Gerba. Academic Press
5. Fundamental Principles Of Bacteriology A J Salle

Reference Books:

1. SubbaRao NS (2004). Soil Microbiology.Fourth edition, Oxford and IBH Publishing Co.Pvt. Ltd., New Delhi.
2. Mishra RR (2004). Soil Microbiology.First edition, CBS Publishers and distributors, New Delhi.
3. Rangaswami G and Mahadevan A (2002). Disease of Crop Plants in India.Fourth edition, PHI Learning (P) Ltd., New Delhi.
4. Robert, L Tate (1995). Soil Microbiology.First edition, John Wiley and Sons, Inc. New York.
5. R,M, Atlus and Richard Bartha (2000). Microbial Ecology, Fourth edition, An imprint of Addison Wesley Longman, Inc, New York.

SYLLABUS (4th SEMESTER)

Paper : Bioinstrumentation and biotechniques		**Subject code: MSCMB402**
L-T-P-C-4-0-0-4	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Objective:

- To understand the fundamental principles and working of various bioinstrumentation devices used in biological and biomedical research.
- To gain proficiency in key biotechnological techniques such as chromatography, electrophoresis, centrifugation, and spectroscopy.
- To develop the ability to analyze and interpret data obtained from bioinstrumentation tools.
- To apply bioinstrumentation methods in real-world biological and clinical problem-solving.

Course outcome:

CO Level	Course Outcome
CO 1	**Remember** the principles and operation of various bioinstrumentation devices used in research and diagnostics.
CO 2	**Understand** experimental data generated from bioinstrumentation and troubleshoot common technical issues.
CO 3	**Apply** biotechnological techniques such as chromatography, electrophoresis, and spectroscopy for the analysis and characterization of biological samples.
CO 4	**Analyze** experiments using appropriate bioinstrumentation tools to solve biological and biomedical problems.
CO5	**Evaluate** recent advancements in bioinstrumentation and integrate new technologies into biotechnological research and applications.

Detailed Syllabus:

Modules	Topics / Course content
I	Electrochemistry: pH and Buffers Potentiometric and Conductometric titration. Principal and application of Light, phase contrast, Fluorescence Scanning and Transmission electron microscopy, confocal microscopy, cytophotometry and flow cytometry, Preparation samples for microscopy.

II	Principle Methodology and applications of gel filtration, ion exchange and affinity chromatography, Thin layer and gas chromatography, High performance liquid chromatography, FPLC, Centrifugation: Basic principle and application, differential – density gradient and ultra centrifugation.
III	Principle of biophysical method for analyzing biopolymer structure, X ray diffraction Fluorescence, UV ORD/CD Visible IR, NMR and ESR spectroscopy, atomic absorption and plasma emission spectroscopy.
IV	MS and MALDI –TOF, Electrophoresis, Principle and application of Native, SDS Agarose and 2D gel Electrophoresis. Blotting techniques – Southern blotting, Northern blotting, Western blotting.

Textbooks:

1. Upadhyay A, Upadhyay K, Nath N (2009). *Biophysical Chemistry: Principles and Techniques.* Himalaya Publishing House, Mumbai; Third edition.
2. Khan F H (2009). *The Principles of Biotechnology and Their Applications to Agriculture.* University Press, Hyderabad; First edition.
3. Wilson K, Walker J (2010). *Principles and Techniques of Biochemistry and Molecular Biology.* Cambridge University Press, New Delhi; Seventh edition.
4. Rao B G (2006). *Bioinstrumentation.* New Age International Publishers, New Delhi; First edition.
5. Singh B D (2015). *Biotechnology: Expanding Horizons.* Kalyani Publishers, New Delhi; Fifth edition.

Reference books:

1. Khan F H (2009). *The Principles of Biotechnology and Their Applications to Agriculture.* University Press, Hyderabad; First edition.
2. Wilson K, Walker J (2010). *Principles and Techniques of Biochemistry and Molecular Biology.* Cambridge University Press, New Delhi; Seventh edition.
3. Rao B G (2006). *Bioinstrumentation.* New Age International Publishers, New Delhi; First edition.
4. Palaniraj A (2008). *Biotechniques: Theory and Practice.* Anmol Publications, New Delhi; First edition.

Paper II: Biosafety and IPR		**Subject code: MSCMB403**
L-T-P-C-4-0-0-4	**Credit units: 4**	**Scheme of evaluation: (T)**

Course Objective:

- To develop a comprehensive understanding of biosafety protocols and regulations, ensuring students can apply safety measures in biological research environments.
- To examine the intersection of biotechnology and intellectual property to enable students to identify and protect innovative biotechnological discoveries through patents and other IPR tools.
- To enhance critical thinking skills by encouraging students to assess the ethical, legal, and social implications of biosafety practices and IPR in the context of modern biotechnology.
- To foster practical application of biosafety and IPR concepts, equipping students with the ability to navigate and comply with international agreements and policies affecting biotechnology innovation.

Course outcome:

CO Level	Course Outcome
CO 1	**Remember** the fundamental concepts and importance of biosafety in biological research and biotechnology.
CO 2	**Understand** the International Agreements and Regulations with respect to Biosafety, guidelines to protect biological inventions, different treaties, rights and duties of Patent owner and the process of filing a patent
CO 3	**Apply** knowledge of biosafety and IPR to solve practical problems related to research, product development, and commercialization.
CO 4	**Analyze** and Manage the Risks involved with GMOs
CO5	**Evaluate** the role of IPR in promoting innovation, technology transfer, and commercial exploitation of biotechnological **inventions.**

Detailed Syllabus:

Modules	Topics / Course content

I	Introduction, biosafety issues; Biological Safety Cabinets & their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms. Biosafety Guidelines: Biosafety

	guidelines and regulations (National and International); GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture.
II	Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol. Use of Animals in Research and Testing, and Alternatives for Animals in Research, Animal Cloning, Human Cloning and their Ethical Aspects. Testing of Drugs on Human Volunteers Public and Non-Governmental Organizations (NGOs)Participation in Biosafety and Protection of Biodiversity
III	Introduction to Intellectual Property and History. Patents, Trademarks, Copyright, Trade secrets, Industrial Design and Rights, Traditional Knowledge, Geographical Indications importance of IPR – patentable and non-patentable – patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO), Ethics, Pros and Cons of IP protection.
IV	Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner. Agreements and Treaties: GATT, TRIPS Agreements; WIPO Treaties; Budapest Treaty on international recognition Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments. Patenting Living Organisms

Text Books:

1. Introduction to Plant Biotechnology, H S Chawla
2. M K Sateesh. Bioethics and Biosafety. Kindle Edition
3. Shomini Parashar, Deepa Goel IPR, Biosafety and Bioethics Pearson India 2013

Reference Books:

1. Private Power, Public Law: The Globalization of Intellectual Property Rights By Susan

K. Sell Cambridge University Press, 2000
2. Essentials of Intellectual Property: Law, Economics, and Strategy By Alexander I. Poltorak; Paul J. Lerner Wiley, 2011 (2nd edition)
3. Diane O. Fleming, Debra L. Hunt Biological Safety: Principles and Practices, 4th Edition. ASM 2006