M.Sc Academic Year

2025-2027

Bharatiya Vidya Bhavan

BHAVAN'S VIVEKANANDA COLLEGE OF SCIENCE, HUMANITIES AND COMMERCE, SAINIKPURI, SECUNDERABAD.

Autonomous College

Affiliated to Osmania University, Hyderabad.

(*Accredited with 'A' grade by NAAC*)

Department of Microbiology

M.Sc. Microbiology CBCS Syllabus

Effective for 2025-27

M.Sc. Microbiology Semester I

Syllabus Ref No	Subject	Credits	Teaching Hours	Marks		
				Internal Assessment	Semester Exam	Total
	THEORY					
PMB 101	General Microbiology& Microbial Physiology **(Core)**	3	4	30	70	100
PMB 102	Virology **(Core)**	3	4	30	70	100
PMB 103	Research Methodology &Techniques **(Core)**	3	4	30	70	100
PMB 104	Microbial Biochemistry **(Core)**	3	4	30	70	100
	PRACTICALS					
PMB 151	General Microbiology & Microbial Physiology	2	4	-	50	50
PMB 152	Virology	2	4	-	50	50
PMB 153	Research Methodology, Techniques	2	4	-	50	50
PMB 154	Microbial Biochemistry	2	4	-	50	50
	Total	**20**	32	**120**	**480**	**600**

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

CHAIRPERSON
BOS in Microbiology
Bhavan's Vivekananda College
Sainikpuri

Bharatiya Vidya Bhavan

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M.Sc. Microbiology Semester II

SEMESTER – II						
Syllabus Ref No	**Subject**	**Credits**	**Teaching Hours**	**Marks**		
				Internal Assessment	**Semester Exam**	**Total**
THEORY						
PMB 201	Molecular Biology and Microbial Genetics (Core)	3	4	30	70	100
PMB 202	Immunology (Core)	3	4	30	70	100
PMB 203	Industrial Microbiology (Core)	3	4	30	70	100
PMB 204	Pharmaceutical Microbiology (Core)	3	4	30	70	100
PRACTICALS						
PMB 251	Molecular Biology and Microbial Genetics	2	4	--	50	50
PMB 252	Immunology	2	4	--	50	50
PMB 253	Industrial Microbiology	2	4	--	50	50
PMB 254	Pharmaceutical Microbiology	2	4	--	50	50
	Total	**20**	**32**	**120**	**480**	**600**

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Associate Professor
Department of Microbiology
Osmania University, Hyd-07

CHAIRPERSON
BOS in Microbiology
Bhavan's Vivekananda College
Sainikpuri

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M.Sc. Microbiology Semester III

Syllabus Ref No	Subject	Credits	Teaching Hours	Marks		
				Internal Assessment	Semester Exam	Total
THEORY						
PMB 301	Environmental and Agricultural Microbiology(Core)	3	4	30	70	100
PMB 302	Medical Bacteriology (Core)	3	4	30	70	100
PMB 303	Elective I A: Molecular Biotechnology & AI in Biology B: Microbial Proteomics	3	4	30	70	100
PMB 304	Elective II A: Entrepreneurship in Microbial sciences B: Applied Biotechnology	3	4	30	70	100
PMB305	MOOCS	2	4	-	50	50
PRACTICALS						
PMB 351P	Environmental and Agricultural Microbiology	2	4	-	50	50
PMB 352P	Medical Bacteriology	2	4	-	50	50
PMB 353P	A: Molecular Biotechnology & AI in Biology B: Microbial Proteomics	1	2	-	25	25
PMB 354P	Elective II A: Entrepreneurship in Microbial sciences B: Applied Biotechnology	1	2	-	25	25
	Total	**20**	**32**	**120**	**480**	**600**

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Department of Microbiology
Osmania University, Hyd-07

CHAIRPERSON
BOS in Microbiology
Bhavan's Vivekananda College
Sainikpuri

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M.Sc. Microbiology Semester IV

SEMESTER – IV						
Syllabus Ref No	**Subject**	**Credits**	**Teaching Hours**	**Marks**		
				Internal Assessment	**Semester Exam**	**Total**
THEORY						
PMB401	Food Microbial Technology (core)	3	4	30	70	100
PMB402	Medical Virology & Parasitology(core)	3	4	30	70	100
PMB403	Elective 1 A: Microbial Ecology: Host microbiome interactions B: Nanobiotechnology & Bioinformatics	3	4	30	70	100
PMB404	Project work	5	10	50	100	150
PRACTICALS						
PMB 451	Food Microbial Technology (core)	2	4	--	50	50
PMB 452	Medical Virology & Parasitology(core)	2	4	--	50	50
PMB 453	Elective 1 A: Microbial Ecology: Host microbiome interactions(HMI), B: Nanobiotechnology & Bioinformatics	2	4	--	50	50
	Total	**20**	**34**	**140**	**460**	**600**

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Associate Professor
Department of Microbiology
Osmania University, Hyd-07

CHAIRPERSON
BOS in Microbiology
Bhavan's Vivekananda College
Sainikpuri

M.Sc MICROBIOLOGY (2025-27)
M.Sc. (Final) Microbiology III Semester (CBCS)
Paper I PMB 301 Environmental and Agricultural Microbiology (core)
(4 Hrs per week = 3 credits)

Overall Course Objective: To discuss concepts of environmental microbiology (such as the role of microbes in air, water, and soil, water quality, sewage treatment, microbial decomposition, nutrient cycling, bioremediation, and waste management), and agricultural microbiology (such as production and significance of biopesticides and biofertilizers).

Objectives:

Cob 1. Describe the importance of microbes in air, water, and soil.
Cob 2. Discuss the concepts of bioremediation technologies.
Cob 3. Determine the role of microbes in decomposition.

Unit I **20 Hrs**

Microbes in air:

Air spora of indoor and outdoor environment, factors affecting air spora, Techniques of trapping air borne microorganisms. 3 Hrs

Role of microbes in climate change (IPCC). Green house gases mitigation, carbon sequestration. 2 Hrs

Microbes in water:

Distribution of microbes in Fresh and Marine ecosystems. 2 Hr

Water-borne pathogenic microbes and their transmission. 2 Hrs

Sanitary quality of water. 2 Hrs

Water pollution due to organic matter; BOD. 4 Hrs

Aerobic sewage treatment – Oxidation ponds, trickling filters, activated sludge treatment; Anaerobic sewage treatment – Septic tank. Sewage treatment plant. Reverse osmosis and ultrafiltration.

Microbes in soil:

Soil properties - (physical, chemical and biological), Soil microbes. Methods of enumeration and activity of microbes in environment/soil. Importance of soil microorganisms, nutrient transformation processes. 3 Hrs

Interactions between microbes: Mutualism, commensalism, amensalism, synergism, parasitism, predation, competition. 2 Hrs

Unit II **20 Hrs**

Degradation of carbonaceous materials in soil. Biochemistry of decomposition of cellulose, hemicelluloses and lignin. Factors governing the decomposition. Soil humus formation. 4 Hrs

Ammonification, Nitrification, and Denitrification: Microbes involved and biochemical mechanisms. Factors influencing nitrification and denitrification. 3 Hrs

Dr. Hameeda Bee
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Osmania University, Hyd-07

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Nitrate pollution.	2 Hr
Composting and sustainable agriculture, biogas production.	2 Hr
Plastic degrading microorganisms as a tool for bioremediation, challenges in waste management.	2 Hr
Microbial bioremediation of environmental pollutants - Xenobiotics. Bioremediation. Strategies for bioremediation technologies.	2 Hrs
Microbial degradation of organic pollutants with a special emphasis on pesticides like DDT and 2,4-D.	2 Hrs
Microbial enhanced oil recovery, bioleaching of copper, gold and uranium, electronic waste management.	2 Hrs
Hazardous waste management and its treatment.	1 Hr

Unit III **20 Hrs**

Agricultural Microbiology:	
Agronomy and production of important crop plants, Green revolution.	2 Hrs
Biocontrol Agents - Biocontrol agents and their scope in control of plant diseases.	2 Hrs
Integrated plant pest management (IPPM), concept and component of IPPM.	2 Hrs
Microbial pesticides – *Bacillus thuringiensis,* structure of BT toxin and their mode of action. Production technology for BT and Baculovirus based pesticide.	2 Hrs
Nitrogen fixation: Asymbiotic and symbiotic nitrogen fixation, microbes involved, biochemistry and genetics of nitrogen fixation, measurement of nitrogen fixation, ecological and economic importance of nitrogen fixation.	5 Hrs
Biofertilizers: Types of bio-fertilizers, Screening, selection, establishment.	2 Hrs
Mass-production and quality control of bio inoculants, BIS standards recommendation for biofertilizers production and its economics; methods of bio-fertilizer inoculation.	3 Hrs
Vermiculture and vermicomposting.	2 Hr

III Semester - Paper I Practicals (CBCS)
PMB 351 Environmental and Agricultural Microbiology (Core: 2 credits)

1. Isolation and observation of air, water and soil microflora.
2. Enumeration of soil microorganisms (bacteria, actinomycetes, fungi) by standard plate count.
3. Estimation of soil microbial activity by CO_2 evolution.
4. Estimation of COD and BOD.
5. Testing for microbial sanitary quality of water (coliform test).
6. Measurement of Total solids (TS), Mixed Liquor Suspended Solids (MLSS), Mixed Liquor Volatile Suspended Solids (MLVSS) of waste water.
7. Isolation of cellulose decomposing microbes and estimation of cellulase activity.
8. Isolation and culturing of Rhizobium sp. from root nodules and *Azospirillum* from grasses (Cyanodon).

Dr. Hameeda Bee
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9. Isolation and observation of phyllosphere and rhizosphere microflora.
10. Observation of beneficial fungi/algae for biofertilizer application: *Trichoderma.*
11. Observation of cyanobacteria (blue green algae).
12. Observation of VAM.

Reference Books

1. Soil Microbiology by Alexander Martin
2. Microbial ecology. Fundamentals and Applications Ed. Benjamin-Cummings
3. Environmental Biotechnology-Fundamentals and applications. By Parihar (Agrobiosindia – publishers)
4. Soil Microbiology by Singh, Purohit, Parihar published by student edition.
5. Soil Microbiology and Biochemistry by Paul E. and PE Clank
6. Soil Microorganisms and Plant Growth by N.S. Subba Rao.
7. Laboratory experiments in microbiology by Gopal Reddy et al
8. Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom production technology by K R Aneja
9. Biofertilizers for sustainable Agriculture by Arun K. Sharma
10. Brock Biology of Micro organisms by Madigan et al
11. Biodegradation and Bioremediation second edition by Martin Alexander (Academic Press 2001)
12. Bioremediation - Principles and Applications by Ronald L Crawford and Don L Crawford ,Cambridge University Press
13. Kannaiyan. S. (2002). Biotechnology of Biofertilizers, Alpha science international, 1stedition.
14. Bagyaraj D.G. and Rangaswami. G. (2005). Agricultural Microbiology, Prentice- Hall of India, 2nd edition, New Delhi.
15. Neelima Rajvaidya and Dilip Kumar Markandey. (2006). Agricultural Applications of Microbiology, Nangia S.B. and A.P.H. publishing corporation, New Delhi.
16. Soil Fertility and Fertilizers by Tisdale et.al. (2003)Prentice Hall of India Pvt. Ltd.
17. Recent Published papers on advances in relevant area to be referred

Course Outcomes:

Students will be able to

PMB 301 CO1. Construct a mind map on the role of microbes in air and water pollution.
PMB 301 CO2. Summarize the role of microbes in bioremediation technologies.
PMB 301 CO3. Interpret the role of microbes in decomposition.
PMB 301 CO4. Apply the concepts of biopesticides and biofertilizers for sustainable agriculture.

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

CHAIRPERSON
BOS in Microbiology
Bhavan's Vivekananda College
Sainikpuri

M.Sc MICROBIOLOGY (2025-27)
M.Sc. (Final) Microbiology III Semester (CBCS)
Paper II PMB 302 Medical Bacteriology
(4 Hrs per week = 3 credits)

Overall Course Objective: To summarize on clinical significance of pathogenic bacteria
Course Objectives:
The student will be able to

Cob 1 Understand medical importance and Classification of microorganisms , Normal flora of human body: Discuss basic concept on Properties of pathogenic microorganisms and infections. Introduction to Diagnostic microbiology

Cob 2 Describe Bacterial air borne infections and sexually transmitted diseases caused by bacteria

Cob 3 Understand Systematic bacteriological study on Water borne infections and Wound infections

Unit I	**20Hrs**
Principles of Medical Microbiology: Classification of medically important microorganisms	3 Hrs
Normal flora of human body – Origin of normal flora, factors that influences normal flora, role of the resident flora, effect of antimicrobial agents on normal flora, characteristics of normal flora	3 Hrs
Distribution and occurrence of normal flora (Skin, conjunctiva, nose, nasopharynx, sinuses, mouth, upper respiratory tract, intestinal tract, urogenital tract)	3 Hrs
Bacteria in the blood and tissues.	2 Hr
Properties of pathogenic microorganisms. Factors that influence pathogenicity	3 Hrs
Type of infections, source of infections, different modes/means of infections	3 Hrs
Diagnostic microbiology – Types of specimen, specimen collection, transportation of specimen, processing, laboratory investigations, specific lab. Tests, non-specific lab tests, diagnosis and report.Use of lab animals in diagnostic microbiology	3 Hrs

Unit II	**20Hrs**
Systematic bacteriology – Detailed study of morphology, cultural characteristics, antigenic structure, pathogenesis, diagnostic lab tests (conventional and molecular), epidemiology, prevention and treatment of the following bacterial pathogens	3 Hrs
Bacterial air borne infections – β-Haemolytic Streptococci	3 Hrs
Pneumococci	2 Hrs
Corynebacterium diphtheriae,	2 Hrs
Mycobacterium tuberculosis, Mycobacterium leprae	2 Hrs
Neisseria meningitides	2 Hrs
Haemophilus influenzae	2 Hrs
Sexually transmitted diseases caused by bacteria, *Treponema pallidum,*	2 Hrs
Neisseria gonorrhoeae.	2 Hrs

Unit III **20Hrs**

Dr. Hameeda Bee
Associate Professor
Department of Microbiology

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Systematic bacteriology – Detailed study of morphology, cultural characteristics, antigenic structure, pathogenesis, diagnostic lab tests (conventional and molecular), epidemiology, prevention and treatment of the following pathogenic bacteria — 3 Hrs

Water borne infections – *E.coli*	3 Hrs
Salmonella typhi	3 Hrs
Shigella dysenteriae	3 Hrs
Vibrio cholerae	2 Hrs
Wound infections – *Staphylococcus aureus*	2 Hrs
Clostridium tetani, Clostridium welchii,.	2 Hrs
Pseudomonas aeruginosa	2 Hrs

III Semester - Paper II Practicals (CBCS)
PMB 352 Medical Bacteriology (Core: 2 credits)

1. Preparation of different types of culture media/observation. Blood Agar, Chocolate Agar, Mannitol salt agar, Baird Parker medium, MacConkey agar, Lowenstein-Jenson medium, Wilson Blair Bismuth sulphite medium, Biochemical media, etc.
2. Gram's staining of bacteria
3. Acid Fast staining of *M. tuberculosis*
4. Albert Staining for *C. diptheriae*
5. Capsular staining of *K. pneumoniae*
6. Isolation and identification of various pathogenic bacteria by microscopic, macroscopic, biochemical, enzymatic and serological tests (IMViC Tests)
7. Kirby-Bauer Disc Diffusion method for testing antibiotic sensitivity of pathogens from clinical samples
8. WIDAL Test for diagnosis of typhoid
9. Coagulase test for detection of pathogenic *S. aureus*
10. Catalase test
11. Detection of syphilis by VDRL test
12. Bacteriological examination of urine from a UTI patient
13. Examination of pathogenic bacteria /permanent slides
14. Bacteriological examination of pus from wound infection and throat swab etc from patient suffering with throat infection
15. PCR based diagnosis of TB

Recommended Books

1. Review of Medical Microbiology by Jawitz, Melnick and Adelberg
2. Diagnostic Microbiology by Bailey and Scott
3. Medical Microbiology by Cruckshanak et al Vol I & II
4. Text book of Microbiology by Ananthanarayanan and JayaramPaniker
5. Microbiology by Greenwood, Slack and Peutherer

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

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Course Outcomes:

The student will be able to

PMB 302 CO1	Explain the clinically important microorganisms and Normal flora of human body. Describe the nature and basic concepts of pathogenic microorganisms, infection and process of diagnosis and perform the requisite diagnostic protocols
PMB 302 CO2	Discuss of air borne and sexually transmitted bacterial pathogens bacterial pathogens.
PMB 302 CO3	Illustrate water borne bacterial pathogens and wound infections of bacteria.

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Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

M.Sc MICROBIOLOGY (2025-27)
M.Sc. (Final) Microbiology III Semester (CBCS)
Paper III PMB 303
Molecular Biotechnology and AI in Biology
(Elective I A: 4 Hrs per week = 3 credits)

Overall Course Objective:

This paper is designed to lay foundation in principles and application of cell cycle regulation and cancer induction, r DNA technology, and modern methods used in molecular diagnosis and therapy. Introduction of Artificial Intelligence in Biology.

Course Objectives:

The student will be able to

Cob 1 Acquaint with concepts in cell cycle regulation, Programmed cell death, Cancer biologyand Insight into Signal transduction pathways.

Cob 2 Understand DNA/Protein Interactions, Principle and applications of Molecular Techniques for Gene Silencing. Gene therapy and Emerging omics techniques

Cob 3 Learn Basics of Artificial Intelligence, methods and their applications in Biology

Unit I **20Hrs**

Cell cycle: Cell division regulation and cancer.	2 Hrs
Cancer biology and genetics: role of oncogenes and tumor suppressor genes – examples, Myc, ras, src, p53, RB, BCR-Abl,	4Hrs
Role of protein Kinases in cell cycle.	2 Hrs
Programmed cell death	2 Hrs
Geno toxicity assays	2 Hrs
Signal transduction: G- Protein linked receptors	3 Hrs
Concept of second messenger cAMP and GMP.	2 Hrs
Steroid/peptide hormone regulation, tissue specific regulation.	3 Hrs

Unit II **20Hrs**

Protein folding and the roles of Molecular chaperones.	2 Hrs
Analysis of Protein-protein and protein-DNA interactions	2Hrs
Biochips (DNA chips and Protein chips)	2 Hrs
DNA fingerprinting and DNA markers: RAPD, RFLP, AFLP, Simple sequence repeat (SSR) markers	3 Hrs
Site directed mutagenesis	2 Hrs
Reverse Genetics,	2 Hrs
Gene knock out – RNAi and Gene silencing	2 Hrs
Gene therapy	2 Hrs
Emerging omics techniques: Metagenomics, Transcriptomics and proteomics;	3Hrs

Dr. Hameeda Bee
Associate Professor
Department of Microbiology

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Methodology and Applications

Unit III	**20 Hrs**
Introduction to Artificial Intelligence(AI) in Biology	2 Hrs
Biological Intelligence vs Artificial Intelligence.	2Hrs
AI Basics: Concepts, terminologies and Work flow	2 Hrs
Applications of AI - Health care	3 Hrs
Applications of AI - Pharmaceutical Industry; Drug design and Clinical trials	3 Hrs
Applications of AI - Biomarker discovery	3 Hrs
Applications of AI - Bioinformatics; Synthetic Biology; Agriculture	3 Hrs
Risks and Ethical Concerns	2Hrs

III Semester - Paper III Practicals (CBCS)
PMB 353: Molecular Biotechnology & AI in Biology (Elective I A: 1credit)

1. Isolation of Plasmid DNA from *E. coli*
2. Isolation of nucleic acids, proteins from *E. coli* through tutorial mode
3. Demonstration of mitosis in onion root bud
4. Restriction mapping. Method and problems
5. Preparation of competent cells and transformation of *E. coli* cells and PCR
6. Gene cloning in bacteria (Demonstration) and Recombinant confirmation (blue white selection).
7. Demonstration of RFLP , AFLP
8. Demonstration of workflow in AI

Recommended Books

- Molecular biology by Robert Weaver
- Molecular biology by David and Freifelder
- Microbial genetics by David and Freifelder
- Molecular biotechnology by Chanarayappa
- Methods in Molecular Cloning by Sambrook.
- Genetics of bacteria and their viruses by William Hayes
- Molecular biology of the gene by Watson et al
- Cell and Molecular Biotechology by Darnell, Lodish and Baltimore
- Genes IX by Benjamin Lewin
- The Biochemistry of nucleic acids by Davidson JN
- Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub.Primrose, S. B., Twyman, R. M., Primrose, S. B., & Primrose, S. B.
- Molecular Biotechnology by Bernard R. Glick and Jack J Pasternak
- DNA Microarrays Ed. M. Schena

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

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- Dr.Parag Suresh Mahajan (2019)Artificial intelligence in healthcare,2nd Edition
- Artificial Intelligence in Agriculture (Co-Published With CRC Press-UK) (English, Hardcover, Singh Rajesh Singh, Anita Gehlot, Mahesh Pratap Gehlot, Bhupendra)
- Mullaicharam Bhupathyraaj, K. Reeta Vijaya Rani, Musthafa Mohamed Essa (2023) Artificial intelligence in Pharmaceutical Sciences

Course Outcomes:

The students should be able to

PMB 303 CO1	Describe the mechanism of cell cycle regulation, apoptosis and Cancer induction & inheritance, Signal transduction pathways
PMB 303 CO2	Comprehend DNA/Protein Interactions, Principle and applications of Molecular Techniques for Gene Silencing, Gene therapy and Emerging omics techniques.
PMB 303 CO3	Explain the work flow of Artificial Intelligence, methods and their applications in Biology

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

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M.Sc. (Final) Microbiology III Semester (CBCS)
Paper III PMB 303 Microbial Proteomics
(Elective I B: 4 Hrs per week = 3 credits)

Overall Course Objective:

The course aims to provide students with a comprehensive understanding of proteomics, including its evolution from protein chemistry, protein structure, analysis, and functions to advanced techniques in protein separations, quantitative proteomics, functional proteomics, protein-protein interactions, post-translational modifications, structural proteomics, and applications in various fields such as personalized medicine, drug design, and diagnostics. Additionally, students will explore the role of bioinformatics in proteomics research and the challenges and future prospects of the field.

Course Objectives:

The student will be able to

Cob 1 To introduce students to the fundamental concepts of proteomics, including protein structure, function, and interaction in cellular processes.

Cob 2 To familiarize students with protein separation techniques, quantitative proteomics methods, and functional proteomics approaches

Cob 3 To delve into advanced topics in proteomics such as protein-protein interactions, post- translational modifications, and their applications in medicine and biotechnology

Unit I	**20Hrs**
An introduction to proteomics: Evolution from protein chemistry to proteomics	3 Hrs
Protein structure – Different levels of protein structure	3Hrs
Protein Folding and unfolding	3 Hrs
Active sites and effects of pH, temperature, substrate concentrations, inhibitors and activators on activity.	3 Hrs
Protein Analysis and functions For e.g. structural, storage, transport, hormonal, receptor, contractile, defensive, enzymatic.	4 Hrs
Protein interaction in cell signaling neurotransmitters and membrane channel opening and closing.	4 Hrs
	20 Hrs
Unit II	
Protein separations, protein analyses	2 Hrs
Quantitative proteomics - stable isotope labeling by amino acids in cell culture (SILAC), isotope-coded affinity tag (ICAT), isobaric tagging for relative and absolute quantitation (iTRAQ)	3 Hrs

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Identification and analysis of proteins by Two-dimensional fluorescence difference in-gel electrophoresis (DIGE), 2D gel electrophoresis, Isoelectric focusing — 3 Hrs

Spot visualization and picking, Tryptic digestion of protein and peptide fingerprinting; Mass spectrometry — 3 Hrs

Functional proteomics: Recombinational cloning, Interactomics - techniques to study protein-protein interactions, yeast two-hybrid, immunoprecipitation, protein microarrays, Nucleic Acid Programmable Protein Array (NAPPA), Label-free nanotechnologies in proteomics, Surface Plasmon Resonance (SPR). — 3 Hrs

Proteomics of *Saccharomyces cerevisiae*-cell wall & transport, differential expression in stress. — 3 Hrs

Proteomics of probiotic lactobacilli-intestinal epithelial cells interactions, Lantibiotics and Immunomodulators. Microbial pathogenesis: Studies at proteome level. Proteomic Identification of *Mycobacterium tuberculosis.* — 3 Hrs

Unit III — **20Hrs**

Strategies and studies on Protein-Protein interaction, Protein-DNA interactions. Yeast two hybrid system.) — 3 Hrs

Nucleic Acid Programmable Protein Array (NAPPA), Label-free nanotechnologies in proteomics, Surface Plasmon Resonance (SPR — 3Hrs

Modificomics: understanding post-translational modifications; — 3 Hrs

Structural proteomics ; Protein micro arrays- Protein Markers, Clinical Proteomics, Small peptides, Personalized medicine — 3 Hrs

Protein engineering. Application of machine learning in protein engineering. — 2 Hrs

Drug Design, Proteomics based plasma markers, molecular markers and cancer diagnostics — 2Hrs

Bioinformatics in proteomics, proteome databases; Challenges and future prospects of proteomics research. — 2 Hrs

Prions — 2Hrs

Semester III - Paper III Practicals (CBCS)
PMB 353 Microbial Proteomics (Elective 1B:1 credit)

1. Protein isolation from *E coli*
2. Isolation of proteins from *Bacillus*
3. Isolation of proteins from Yeast.
4. Sequence analysis of proteins (by BLAST, ClustalW and Phylip).
5. Protein structure prediction by Homology modeling.
6. Demonstration of *In silico* translation of protein
7. Overexpression of heterologous protein in *E.coli.*
8. Purification of cloned protein in *E.coli.*
9. Protein identification by immunoblotting
10. Separations of Proteins by Column chromatography

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

CHAIRPERSON
BOS In Microbiology
Bhavan's Vivekananda College
Sainikpuri

Reference Books

1. Principles of Protein structure, Schultz, G. E., and Schirmer, R. H. Dr. ShaktiSahi
2. Proteomics, Daniel C. Leibler
3. Introduction to Proteomics: Tools for the New Biology. Totowa, NJ: Humana Press. Liebler, D. C.
4. Microbial Proteomic, MarjoPoutanen
5. Proteins: Structures and Molecular Principles (2d ed.), TE Creighton
6. Organic spectroscopy, William Kemp
7. Proteome Research: Two-Dimensional Gel Electrophoresis and DetectionMethods (Principles andPractice), T. Rabilloud (Editor), 2000, Springer Verlag
8. Introduction to Protein Architecture: The Structural Biology of Proteins, M.Lesk, 2001, Oxford University Pres
9. Campbell, A. M., &Heyer, L. J. Discovering Genomics, Proteomics, and Bioinformatics. San Francisco: Benjamin Cummings

Course Outcomes:

PMB 303 CO1	Describe the different levels of protein structure, protein functions and protein interactions in cell signaling, neurotransmitters, and membrane channel opening and closing
PMB 303 CO2	Explain various protein separation techniques, and analyse proteomics studies related to microbial pathogenesis
PMB 303 CO3	Discuss strategies and techniques for studying protein-protein and protein-DNA interactions such as yeast two-hybrid, NAPPA, label-free nanotechnologies, SPR and future prospects in the field of proteomics research, including prions

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

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BOS in Microbiology
Bhavan's Vivekananda College
Sainikpuri

M.Sc MICROBIOLOGY (2025-27)
M.Sc. (Final) Microbiology III Semester (CBCS)
Paper IV PMB 304 Entrepreneurship in Microbial Sciences
(Elective II A: 4 Hrs per week = 3 credits)

Overall Course objective: To provide an overall knowledge on understanding of microbial entrepreneurship focusing on regulatory protocols and familiarize with IPR, bioethics and biosafety principles

Course Objectives:

The student will be able to

Cob1. To provide students with a comprehensive understanding of entrepreneurship, including the process, competencies, financial management, and the differences between general and biotechnology entrepreneurship

Cob2. To equip students with the necessary knowledge and skills in microbial entrepreneurship, including bio based technology, waste management, and setting up clinical diagnostic centers, focusing on practical aspects and regulatory protocols

Cob3 To familiarize students with intellectual property rights (IPR) and regulatory issues relate to microorganisms and biotechnology processes/products, along with funding procedures and commercialization aspects, emphasizing bioethics and biosafety principles

Unit I **20 Hrs**

Entrepreneurial society Entrepreneur development – activity – Institutions involved – Government contributions to entrepreneurs – risk assessment 3 Hrs

Entrepreneur, Entrepreneurship, MSMEs, Enterprise &Startups Process of Entrepreneurship Competencies & Skills/ Qualities of an Entrepreneur 4Hrs

Types of Entrepreneurs & Enterprise. Approaches to manage capital & cost of capital . Working capital & cash flow planning. 3Hrs

Financial Planning & Budgets Measuring &reporting financial performance. 3 Hrs

Entrepreneur management and case studies 3 Hrs

Biotechnology entrepreneurship versus general entrepreneurship. Biotech and Pharma industries. Indian and Global scenario and market. 4Hrs

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

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Unit II	**20 Hrs**
Microbial Entrepreneurship: Biobased technology. Use of microorganisms for different industrial products	3 Hrs
CRISPR based technologies for metabolic engineering	2Hrs
Biomass resources, renewable feed stocks, agro- lignocellulosic residual material for valorization.	2 Hrs
Circular economy and sustainable development goals.	2 Hrs
Practical aspects to set up of Labs for soil and water analysis. Management of drinking water plant. Sources of contamination	3 Hrs
Management of drinking water plant. Sources of contamination. Management strategies for wastes generated from different urban locations and industries for renewable products. Annamox process and waste water treatment.	3Hrs
Documentation, Accreditation and permission protocols to set up clinical diagnostic centre	2Hrs
Practical aspects, considerations and challenges faced to set up clinical microbiology lab. Handling of samples: Serological, Microbial, Urine and stool. PCR and other diagnostic procedures. Documentation and report analysis of hematology, serology and pathology.	3Hrs

Unit III	**20Hrs**
IPR and regulatory issues in relation to microorganisms and / or products / processes;;	3 Hrs
Architecture of a typical patent application. Regulations of National Biodiversity authority (NBA) and Features of Biological Diversity Act 2002.	3Hrs
Documentation and deposition of potential microbial strains for patent application.	3Hrs
Funding procedures for Start ups. Typical stages in commercialization aspects of biotechnology processes / products; Financial appraisal of biotechnology projects.	4Hrs
TRIPS (Trade – Related Aspects of Intellectual Property Rights) agreement; Alternative models of technology transfer and licensing; Funding mechanisms of commercial projects.	4 Hrs
Bio safety principles; Bio ethics. Regulations and Bioethical committee.	3Hrs

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

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BOS in Microbiology
Bhavan's Vivekananda College
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Semester III - Paper IV Practicals (CBCS)
PMB 354 - Entrepreneurship in Microbial Sciences (Elective IIA: 1 credit)

1. Visit to industry for making biofertilizers and report writing
2. Visit to food and dairy industry and report writing
3. Visit to pharma sector and report writing
4. Visit of drinking water plant and checking for sources of contamination and report writing
5. Visit to Medical Diagnostic lab and report writing
6. Production of bio-fertilizer in flask level.
7. Production and characterization of different microbial metabolites
8. PoC of the project idea
9. Application and project proposal writing for translation research
10. Demonstration of Sustainability and Life cycle assessment in biotech industry
11. Lab set up and diagnostic studies

Recommended Books

1. Industrial Microbiology- L.E.Casida, jr, New age International publication.
2. Entrepreneurial Development in India- By Arora
3. Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom production technology- K.R.Aneja, New age International publication.
4. Bioentrepreneurship development Ms Shreya Singh
5. Dynamics of Entrepreneurial development and management by Vasant Desai
6. Recent Research and Review Papers

Course outcomes:

PMB 304 CO1 Students will gain entrepreneurship expertise, enabling critical evaluation and pursuit of ventures, particularly in biotech and pharma, on local and global scales

PMB 304 CO2 Students will be capable in utilizing microbial resources for industrial applications, managing environmental challenges through sustainable practices, and navigating regulatory frameworks for establishing clinical diagnostic facilities, thus preparing them for careers in the field of microbial entrepreneurship

PMB 304 CO3 Students will possess a comprehensive grasp of IPR regulations, funding mechanisms, and commercialization strategies in biotechnology, facilitating effective navigation of legal and ethical challenges and responsible contribution to the industry's growth

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
University, Hyd-07

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BOS In Microbiology
Bhavan's Vivekananda College
Sainikpuri

M.Sc MICROBIOLOGY (2025-27)
M.Sc. III Semester Microbiology (CBCS)
Paper IV PMB 304 Applied Biotechnology
(Elective II B: 4 Hrs per week = 3 credits)

Overall Course Objective: To provide an overall knowledge on applications of industrial products and acquire knowledge on animal cell culture techniques and stem cell technology

Course objectives:

The student will be able to

Cob 1 Understand the principles and applications of microbial biotechnology, focusing on the production of small and macromolecules

Cob 2 Explore the utilization of plants as bioreactors, with a focus on Arabidopsis thaliana as a model plant, morphogenesis, and organogenesis

Cob 3 Acquire knowledge and skills in animal tissue culture techniques, stem cell technology, and tissue engineering principles

UNIT I	**20Hrs**
Microbial biotechnology. Microbial production of small and macromolecules	3Hrs
Qualitative and quantitative assays for detection of enzymes, amino acids, organic acids, vitamin B12, steroids.	4Hrs
Designing microbial cell factories for production of different chemicals and Biofuels.	3Hrs
Bio-transformations used in microbial process.	3Hrs
Production of monoclonal antibodies and antimicrobial peptides at industrial level.	3Hrs
Microbial nanotechnology. Bio-fabrication of nanoparticles and characterization studies.	4Hrs

UNIT II	**20Hrs**
Plants as bioreactors. Importance of *Arabidopsis thaliana* as a model plant.;	3Hrs
Morphogenesis and organogenesis in plants (*A. thaliana*). Special features and organization of plant cells; Totipotency; Regeneration of plants from leaves, roots, stem etc	3Hrs
Plant cell culture studies for natural products of industrial importance.	2Hrs
CRISPR based gene editing for agriculture.	2Hrs
Transgenic plants, Biosafety concerns of transgenic plants.	2Hrs
Manipulation of plants for —Photosynthesis, Nitrogen fixation, Nutrient uptake efficiency.Quality improvement-Protein, Lipids, carbohydrates, vitamins and minerals., Biotic Stress Tolerance- Herbicide resistance, Glyphosate, Insect Resistance, Bt toxin, Disease Resistance, Virus resistance. Abiotic Stress Tolerance-Drought, Flooding, Salt and temperature	8Hrs

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

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UNIT III **20Hrs**

Animal Tissue Culture: Primary culture, Organ culture, Embryo Culture.. 3Hrs

Established Cell lines and their propagation. Scale-up of cell culture processes; Cryopreservation, Culture Collections. 4Hrs

Stem Cell Technology- adult and embryonic stem cells., Risks and Safety, Bioethics 3Hrs

Genome editing tools CRISPR/Cas9, retroviral methods, DNA microinjection method, etc and their applications (gene therapy). 3Hrs

Transgenics and knockouts: Transgenic cattle, Transgenic birds, Transgenic fish, Transgenic mice. 3Hrs

Tissue Engineering: cells, scaffold, growth factors and mechanical environment. Types of tissue engineering 4Hrs

Semester III -Paper IV - Practicals (CBCS)

PMB 352 Applied Biotechnology (Elective IIB: 1credit)

1. Production of amino acid (Glutamic acid/lysine) by fermentation
2. Production of citric acid by fungal fermentation, recovery and estimation
3. Production of amylase, cellulose, protease by fermentation, recovery and estimation
4. Scale up of fermentation demonstration studies
5. Bio-fabrication of nanoparticles through demonstration.
6. Plant tissue culture and Hairy root culture demonstration
7. Terminology, Laboratory design of Animal tissue culture laboratory
8. Preparation of medium for cell culture and sterility checking
9. Demonstration of chick embryo fibroblast culture, viable staining.

Books Recommended

1. Industrial Microbiology by Casida, LE
2. Industrial Microbiology by Patel, AH
3. Industrial Microbiology by Miller, BM and Litsky
4. Industrial Microbiology by Prescot and Dunn
5. Microbial Technology by Peppler, JH and Perlman, D.
6. Biochemistry of Industrial Microorganisms, by Rainbow and Rose
7. Economic Microbiology by Rose Vol I – V

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

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8. Microbial Enzymes and Biotechnology by Fogarty WM and Kelly, CT
9. Comprehensive Biotechnology, All volumes Ed. Murray Moo-Yong
10. Biotechnology (A text book of industrial Microbiology) Ed. Cruger&Cruger
11. Advances in Applied Microbiology Ed. Perlman Series of volumes
12. Plant Biotechnology: The genetic manipulation of plants,2005,A.Slater ,N.Scott&
13. M.Fowler, Oxford Univ Press, Oxford.
14. Introduction to Plant Biotechnology(3rd Edtn), H.S. Chawla
15. Roberta Smith, Plant Tissue Culture: Techniques and Experiments,2ndEdtn,Academic
16. Press,2000
17. H.K.Das(ed),Textbook of Biotechnology,Wiley India,2004
18. J.H.Hammond, P.Mcgarvey, and V.Yusibov(eds), Plant Biotechnolgy,Springer
19. Verlag,Heidelberg,2000
20. Animal Cell Culture by Ian Freshney
21. Basic Cell Culture.Ed.J.M.Davis 2nd.Ed 2007. Oxford press
22. Animal Cell Culture SudhaGangal
23. Principles of biotechnology and applications-Glick and Pasternack

Course Outcomes :

PMB 304 CO1	Students will gain skills in designing microbial cell factories for chemical and biofuel production, and conducting assays for detecting various biomolecules and will also learn about bio-transformations and industrial-level production of specific bioproducts like antibodies, peptides, and nanoparticles
PMB 304 CO2	Students will acquire expertise in plant regeneration, cell culture for industrial applications, CRISPR-based gene editing, biosafety considerations, and plant manipulation for quality enhancement and stress tolerance
PMB 304 CO3	Students will gain knowledge on a range of techniques in animal tissue culture as well as propagation of established cell lines and scale-up processes while understanding the ethical considerations of stem cell technology, genome editing, transgenics, and tissue engineering principles

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Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

M.Sc. III Semester Microbiology (CBCS)
Paper V PMB-305 MOOCS on line course (2 Credits)

Students will be allowed to opt relevant online MOOC's course and follow the SWAYAM guidelines for completion of course

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BOS in Microbiology
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Sainikpuri

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

M.Sc MICROBIOLOGY (2025-27)
M.Sc. (Final) Microbiology IV Semester (CBCS)
Paper I PMB 401 Food Microbial Technology (Theory)
(Core: 4HPW-3 Credits)

Overall Course Objectives: To provide students with comprehensive knowledge and understanding of the microbiological aspects of food, including the identification, significance, and control of microorganisms in various food products, as well as the principles and methods of food preservation, safety, and quality control.

The students should be able to

Cob 1 To understand the microbial habitat, adaptations, and changes in various food materials, as well as the principles of food preservation and factors influencing microbial growth in food.

Cob 2 To explore dairy microbiology, fermented foods, and the health aspects of fermented products, as well as the production and significance of fermented foods in various cultures.

Cob 3 To understand food spoilage, food borne diseases, detection methods for food borne microorganisms, and principles of quality control and food safety standards.

Unit I	**20 Hrs**
Food associated molds, yeasts, yeast-like fungi and bacteria.	**3 Hrs**
Microbial habitat of specific food materials, adaptations and changes in microbiota of vegetables, fruits, milk, fermented and non-fermented milk products, fresh meats, poultry and non-dairy fermented foods.	**3 Hrs**
Factors influencing microbial growth in food: Extrinsic and intrinsic factors.	**3 Hrs**
Principles of food preservation. Methods of food preservation - Canning. Heat-treatment, Drying, Refrigeration, Chemical food preservatives and additives. Removal of microorganisms, modified atmosphere/vacuum packaging, etc).	**4 Hrs**
Bacteriological examination of fresh foods; Detection of specific bacterial pathogens in foods.	**4 Hrs**
Bacteriological examination of canned foods	**3 Hrs**

Unit II	**20 Hrs**
Dairy Microbiology - Types of microorganisms in milk and their significance	**1 Hrs**
Microbial products of milk -Acidophilus Milk, Bifidus Milk, Bulgarian milk, Kefir, Kumiss	**2Hrs**
Microbiology of cheese, butter, yogurt. Microbiological examination of milk, control of microbial flora of milk.	**3 Hrs**
Fermented foods - Understanding benefits of traditional and non-traditional fermented foods	**4Hr**
Health aspects of fermented foods. Production of fermented milk and milk products,	**3Hrs**

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

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plant-based products - Sauerkraut and pickles, cereal and legume based fermented products, bread, soya sauce, tempeh,, fish products, meat products etc.

Microbiology, processing and fermentation of bread and idly.	**2 Hrs**
Production and significance of Silage.	**1 Hrs**
Production of Vinegar and concept of bioactive compounds from fermented foods	**1Hr**
Microorganisms as food – single cell proteins, sea weed (algae), Mushrooms	**2Hr**
Prebiotics, Probiotics and their screening methods. Beneficial effects of prebiotics, probiotics and postbiotics as nutraceuticals.	**1Hr**

Unit III **20 Hrs**

Spoilage of raw and processed/canned foods, detection of food spoilage	**2 Hrs**
Significance of food borne diseases, Microbial food poisoning and intoxications: *Botulism, Listeriosis, Bacillus* cereus food poisoning	**2Hrs**
Food borne Gastroenteritis by *Salmonella, Shigella, Vibrio, Campylobacter* and *Yersinia, Staphylococcus*.	**3 Hrs**
Effect of different mycotoxins on human and animal health and their detoxification methods (Physical, Chemical and biological).	**2Hr**
Methods for Detection of food-borne microorganisms: Cultural, Microscopic, Biochemical (Thermostable nuclease and *Limulus* Lysate for Endotoxins), Molecular - Nucleic Acid (DNA) probes, DNA Amplification (PCR), and Immunological: Fluorescent Antibody and Serology – Salmonella 1-2, methods.	**3 Hrs**
Biosensors to detect food borne pathogens	**2 Hrs**
Principles of quality control and microbiological criteria, Indicators of product quality and microbiological safety of foods, Hazard analysis, critical control points (HACCP), Good manufacturing practices (GMP) Microbiological standards Codex Alimentarius and Food legislation with respect to FSSAI, NABL and ISO.	**3 Hrs**
Introduction to 3D printing technologies in foods, its nutritional value, microbial contamination and regulatory frameworks	**3Hr**

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

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IV Semester- Paper I Practicals (CBCS)
PMB 451 Foods Microbial Technology (Core: 4HPW-2 Credits)

1. Microbiological examination of fresh fruits, vegetables and juices
2. Microbiological examination of spoiled and canned foods
3. Bacterial examination of potable water by MPN and membrane filters technique
4. Microbiological examination of Milk by Breeds method and quality assessment by MBRT test
5. Isolation, Screening and Identification of bacterial (LAB) and yeast probiotics
6. Extraction of Mycotoxins (aflatoxin) from contaminated grains/foods and Detoxification of mycotoxins
7. Determination of TDT (Thermal death time) and TDP (Thermal death point)
8. Sterilization techniques of food products: Filtration, Pasteurization and Tyndallization
9. Food preservation methods i) Pickle preparation. ii) Squash (pulp) preparation. iii) Jam preparation.
10. Isolation and observation of mushroom fungi

Reference books:

1. Food Microbiology by W.C. Frazier, D.C. Westhoff , K.N. Vanitha. 5th edition. McGraw Hill Education. 2013.
2. Biotechnology: Food Fermentation : Microbiology, Biochemistry, and Technology by VK Joshi and Ashok Pandey
3. Food Microbiology by M. R. Adams, M. O. Moss, P. McClure. 4th edition. Royal Societyof Chemistry. 2015
4. Food Microbiology: An Introduction by T. Montville, K. Matthews, K.Kniel. 4th edition ASM press. 2017.
5. Bibek Ray and ArunBhunia (2008) Fundamental Food Microbiology 4th Ed. CRC Press.
6. Adams M R and Moss M O (2008) Food Microbiology 3rd Ed. RSC Publishing.
7. Brock's Biology of Micro organisms by Madigan et al
8. Probiotics 3 by R. Fuller, G. Perdigon (Kluwer Academic Publishers)
9. Probiotics and Prebiotics: Scientific Aspects by Gerald W. Tannock University of Otago, Dunedin, New Zealand (Caister Academic Press)
10. Laboratory experiments in microbiology by Gopal Reddy et al
11. Foodborne Pathogens and Food Safety by Md. Latiful Bari, Dike O. Ukuku (CRC Press)
12. Ahmed E.Y. and Carlstrom C. 2003 Food Microbiology: A Laboratory Manual, John Wiley and Sons, Inc. New Jeresy.
13. Sperber, William H., Doyle, Michael P. (Eds.). 2010. Compendium of the Microbiological Spoilage of Foods and Beverages. Springer.
14. Stephen J. Forsythe. 2010. The Microbiology of Safe Food, 2nd Edition. Wiley-Blackwell.
15. Fundamental Food Microbiology by B. Rayand A. Bhunia. 5th edition. CRC press. 2013.
16. Frazier W.C. and Westhoff C.D. 2008 Food Microbiology. Tata McGraw Hill Publishing Company Limited, New Delhi. IndianEdition.
17. Recent Published papers on advances in relevant area to be referred

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

CHAIRPERSON
BOS in Microbiology
Bhavan's Vivekananda College
Sainikpuri

Course Outcome:

The student will be able to

PMB 401 CO1. Identify different food-associated molds, yeasts, yeast-like fungi, and bacteria, the significance of fermented foods in daily lives

PMB 401 CO2. Identify types of microorganisms in milk, microbial products of milk, and various fermented foods.

PMB 401 CO3. Assess the microbiological standards, indicators of product quality and safety, and regulatory frameworks including Codex Alimentarius, Food legislation, and the introduction of 3D printing technologies in foods.

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

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M.Sc MICROBIOLOGY (2025-27)
M.Sc. (Final) Microbiology IV Semester (CBCS)
Paper II PMB 402 Medical Virology and Parasitology
(Core: 4HPW- 3 Credits)

Overall Course Objective: To summarize on clinically significant of viruses and parasites

Course Objectives:
The students should be able to

Cob 1 Understand diagnostic microbiology and describe study on viral air borne infections
Cob 2 Perform Systematic study on water borne, zoonotic and sexually transmitted diseases viral infections
Cob 3 Gain knowledge on Parasitic and Mycotic infections

Unit I	**20Hrs**
Diagnostic virology – Cultivation of pathogenic viruses in lab animals and tissue culture	**3Hrs**
Identification of pathogenic viruses and establishment of viral etiology	**2Hrs**
Structure, cultivation, pathogenicity, lab diagnostics, prevention and control of air borne viral infections	**2Hr**
Influenza virus	**2Hrs**
Rhinovirus,	**2Hr**
Corona virus	**2Hrs**
Rubella virus	**2Hr**
Adenovirus (type 2),	**2Hrs**
Mumps virus	**2Hr**
Measles virus	**1Hr**
Unit II	**20Hrs**
Structure, cultivation, pathogenicity, lab diagnostics, prevention and control of viruses transmitted by water - Hepatitis (HAV),	**2Hrs**
Polio mellitus	**3Hrs**
Structure, cultivation, pathogenicity, lab diagnostics, prevention and control of viruses transmitted by Zoonosis – Rabies,	**3Hrs**
Dengue	**2Hr**
Japanese encephalitis	**2Hr**
Structure, cultivation, pathogenicity, lab diagnostics, prevention and control of contact and sexually transmitted viral diseases – Small pox	**2Hr**
Herpes (Herpes simplex virus),	**2Hrs**
Hepatitis viruses - HBV	**2Hrs**
Acquired immunodeficiency syndrome (AIDS)	**2Hrs**

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

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BOS In Microbiology
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Unit III	**20Hrs**
Structure, cultivation, pathogenicity, lab diagnostics, prevention and control of Malaria	**2Hrs**
Amoebiasis	**2Hr**
Trichomoniasis	**2Hr**
Helminthic infections	**2Hr**
Round worms	**2Hr**
Hook worms	**2Hr**
Medical Mycology- Dermatomycosis, Systemic mycosis. Types, pathogenesis and diagnostics	**5Hrs**
Fungal infections associated with COVID19. Precaution and management	**3Hrs**

IV Semester- Paper II Practicals (CBCS)
PMB 452 Medical Virology and Parasitology
(Core: 4HPW-2 Credits)

1. Cell culture techniques (demonstration)
2. Virus cultivation methods using embryonated eggs and plants
3. Microscopic studies of viruses infected materials (demonstration)
4. Examination of pathogenic fungi
5. Examination of stool sample for Hookworm and Round worm
6. Examination of stool sample for *Entamoeba histolytica*
7. Examination of blood smear by Leishman stain for Malarial parasites
8. Immunodiagnostics - Tridot test for HIV
9. Immunodiagnostics – Hepatitis B test for HBV
10. ELISA for diagnosis of HIV
11. Examination of urine sample for fungal infection
12. Demonstration of laboratory animals and their handling
13. PCR based diagnosis of HIV
14. Rapid diagnosis of Covid19 (demonstration)
15. Diagnosis of Dengue by detection of IgG & IgM antibody & NS1 antigen (Demonstration)

Recommended Books

1. Review of medical microbiology by Jawetz et al
2. Medical laboratory Manual for tropical countries Vol I & II by Monica Cheesbrough
3. Text Book of Microbiology by Ananthanarayanan and JayaramPanicker
4. Viral and Ricketsial infections of Man by Horsfall and Jam
5. Text book of Virology by Rhodes and Van Royan
6. Virological Procedures by Mitchalhasking
7. Virology by Wilson and Topley

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

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BOS In Microbiology
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Sainikpuri

Course Outcomes:

The students should be able to

PMB 402 CO1	Explain the process of diagnosis and perform the requisite diagnostic procedures for identification of viruses and list out air borne viral pathogens
PMB 402 CO2	Classify and understand water borne viral pathogens, zoonotic viral pathogens and sexually transmitted viral pathogens
PMB 403 CO3	Categorize parasitic and mycotic infections

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BOS in Microbiology
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Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

M.Sc. (Final) Microbiology IV Semester (CBCS)
Paper III PMB 403 Microbial Ecology: Host Microbe Interactions
(HMI) - (ElectiveIII A: 4HPW- 3Credits)

Overall Course Objective: To create awareness on Microbial biodiversity & methods of analysis in natural environments, explore plant microbe interactions to develop microbial formulations for plant growth promotion and illustrate molecular mechanism of Quorum sensing, plant immunity and resistance

Course Objectives:
The students should be able to

Cob 1 Understand concepts of microbial distribution and diversity in natural environments and molecular methods for microbial diversity analysis and microbial ecology

Cob 2 Appreciate the Role of PGPR and PGPM in agriculture, application of Microbial formulations and detection of bioinoculants. Understand molecular interactions between plant & microbe, two-component Signalling, systemic and induced resistance, Quorum sensing Systems in Microorganisms and their role in Pathogenesis

Cob 3 Understand animal microbe interactions – Human microbiome, microbiota distribution, role of Microbiome in infections and disease, Gut Brain axis and immunity Microbiome modulation therapies and trends in Microbiome research. .

Unit I	**20 Hrs**
Microbial ecology: Concept of habitat and niche; population and community, biome.	**2Hrs**
Microbial signaling and Quorum sensing	**2Hrs**
Planktonic growth and Biofilm formation, Nature of microbial communities	**2Hr**
Microbial growth curve representing r and k reproductive strategies.	**2Hrs**
Microbial diversity	**2Hrs**
Phylogenetic based approach (16S rRNA, Internal transcribed region), Sequence based approach (NGS)., Alpha and beta diversity,	**2Hrs**
Species diversity, Richness and evenness	**2Hrs**
operational taxonomic unit (OTU) Diversity indices (Shannon, Simpson's).	**2Hrs**
Ecological succession and comparative analysis of microbial communities.	**2Hrs**
Climax community. Key stone species	**2Hrs**

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

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BOS in Microbiology
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Sainikpuri

Unit II	**20Hrs**
Host (Plant) –microbe interactions. Epiphytes and Endophytes,	**2 Hrs**
Role of Soil microbiome vs plant	**2Hrs**
Plant growth promoting rhizobacteria (PGPR): Direct and indirect mechanisms of microorganisms to promote soil and plant health	**2Hrs**
Microbiomes for plant health	**2Hrs**
Plant microbe beneficial interactions with Pseudomonas, Bacillus and Trichoderma	**2 Hrs**
Role of biotic and abiotic factors in plant- microbe interactions	**2Hrs**
Two-component regulatory system (Gac S and Gac A) in plant growth promoting bacteria	**2Hrs**
Microbial formulations(peat, lignite, talc) and mode of inoculation.Detection of microbial inoculants by staining, biochemical and molecular methods	**1Hrs**
Plant -pathogen interactions: Bacterial (*Xanthomonas*) and (Fungal) *Macrophomina* infection in plants.	**1Hrs**
Plant pest (Helicoverpa) nematode (Meloidogyne).	**1Hr**
Root exudates and their role in recruitment of beneficial microbiome.	**1Hr**
Basic concept of plant immunity (MAMPs, PAMPs). Plant defense mechanisms: induced systemic resistance (ISR); systemic acquired resistance (SAR).	**2Hrs**

Unit III	**20Hrs**
Host (Animal) microbe interactions: Introduction to Microbiome studies of insects, Zebra fish, Rumen and Human.	**3 Hrs**
Microbiota transmission in Humans: pregnancy and birth. Microbiome of oral cavity, naso-pharynx and respiratory tracts	**3Hrs**
Role of human microbiome in infectious, inflammatory non communicable diseases.	**3Hrs**
Human Gut microbiota (Gut Brain Axis): Health and immunity. Eubiosis and Dysbiosis	**3Hrs**
Microbiome modulation therapies. Transient shift of microbiome, Stabilization, Evenness of healthy microbiome	**3 Hrs**
Microbiome Engineering and Restoration	**3 Hrs**
Emerging studies on Microbiome and One Health concept.	**2Hrs**

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

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Semester IV - Paper III Practicals (CBCS)
PMB 453 -Microbial ecology: Host Microbe Interactions (HMI) –
(Elective III A: 4HPW-2 Credits)

1. Isolation of plant growth promoting bacteria (PGPB) from diversified sources
2. Isolation and characterization of PGPB for ammonia production, P, Zn-solubilization,
3. Characterization of Siderophore production on selective medium
4. Isolation of Pseudomonas on Kings B medium and microscopic identification
5. Isolation of actinomycetes on selective medium and microscopic identification
6. Isolation of trichoderma on selective medium and microscopic identification
7. Isolation of bacteria with ability to produce plant growth hormone indole acetic acid (IAA)
8. Quantification of IAA by spectrophotometric method
9. Quantification of phosphate by spectrophotometric method
10. Screening for biosurfactant activity.
11. Isolation of antagonistic microbes using dual-culture method
12. Demonstration of Plant microbiome studies with wild and cultivated varieties to explain microbiome restoration.
13. Demonstration and comparison of culturable and metagenomic studies of insects, zebra fish etc
14. Demonstration of microbiome studies using faecal sample and faecal microbiota transplant (FMT)

Recommended Books / Research articles

1. Toole 'O' George, H. B. Kaplan, R. Kolter,(2000) Biofilm formation as microbial development Annual Review of Microbiology, Vol. 54, 49-79 Melissa B. Miller and Bonnie L. Bassler (2001) Quorum sensing in bacteria. Annu. Rev. Microbiol. Vol. 55, 165–99.
2. Sonali Shinde and Aparna. 2021. Microbial Diversity and Ecology in Hotspots. Elsevier publications
3. Christopher M. Waters and Bonnie L. Bassler (2005) Quorum sensing:cell-to-cell communication in bacteria. Annu. Rev. Cell Dev. Biol. Vol. 21, 319–46.
4. Nelson D. L. and Cox M. M. (2005) Lehninger's Principles of Biochemistry, Fourth edition,
5. W. H. Freeman & Co. New York. MunehikoAsayama and Yasuo Kobayashi (1993) Signal transduction and sporulation in *Bacillus subtilis*: autophosphorylation of SpoOA, a sporulation initiation
6. PGPR: biocontrol and biofertilization by Zaki A. Siddiqui, Plant-bacteria interactions: strategies and techniques to promote plant growth by Iqbal Ahmad, John Pichtel, S. Hayat Biochemical and genetic mechanisms used by plant growth-promoting bacteria by Bernard R. Glick
7. Plant-microbe interactions, Volume 1 by Gary Stacey and Noel T. Keen
8. Sabu Thomas. 2022. Human Microbiome: Clinical Implications and Therapeutic Interventions, Springer Nature

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

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BOS in Microbiology
Bhavan's Vivekananda College
Sainikpuri

M.Sc. (Final) Microbiology IV Semester (CBCS)
Paper III –PMB 403 Nanobiotechnology and Bioinformatics
(ElectiveIII B: 4HPW: 3 Credits)

Overall Course Objective:

To provide students with a foundational understanding of bioinformatics, nanobiotechnology, and emerging nanostructures, including their applications in various fields, and to equip them with computational and experimental skills necessary for research in biological and nanotechnology-related disciplines.

Cob 1 To introduce students to basic concepts of nanobiotechnology, including nanoparticles synthesis, characterization, and applications.

Cob 2 To explore emerging nanostructures and their applications in various fields, emphasizing, biomimetics and nanotechnology's role in diverse sectors

Cob 3 To introduce students to bioinformatics basics, including computational tools, database concepts, sequence analysis, and structural bioinformatics

Unit I	**20Hrs**
Basic concepts of Nanobiotechnology	**3 Hrs**
Nanoparticles -Origin and their classification, Nanoscale systems	**3Hrs**
Nano particles: Synthesis, Bottom up and Top down approach. Synthesis of nanoparticles – physical, chemical and biological methods and their characterization	**3Hrs**
Methods of biological synthesis- Use of plants, bacteria, algae, fungi, fermented metabolites	**3Hr**
Characterization techniques for nano materials. Optical- UV–Visible spectroscopy, zeta potential, X-ray diffraction, FTIR.	**4 Hrs**
Imaging and Size- Scanning Electron Microscope (SEM), Transmission. Electron Microscopy (TEM), Atomic Fluorescence Microscopy (AFM)	**4 Hrs**

Unit II	**20Hrs**
Emerging Nano structures and their applications -Carbon nanotubes, quantum dots, Semiconductor nanoparticles, metal based nanostructures, nanowires- polymer based nanostructures, gold nanostructures.	**4 Hrs**
Nano – Biomimetics. Biomimicry in nanotechnology	**3Hrs**
Use of nanotechnology in multiple platforms: Agriculture and food sector,	**3Hrs**
Health care and drug delivery	**4 Hrs**
Textiles and fabrics	**3Hrs**
Sports Equipment, Material Science, Environment conservation etc	**3Hrs**

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

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Unit III **20Hrs**

Bioinformatics Basics: Use of computational tools in biology and diagnostic studies.	**2Hrs**
DNA sequence studies. Database concepts; Protein and nucleic acid databases; Structural databases; Biological XML DTD's; pattern matching algorithm basics; databases and search tools. NCBI, EMBL, DDBJ, EBI.	**3Hrs**
Identification of protein sequence from DNA sequence; database mining tools.	**2Hrs**
Multiple sequence analysis: use of CLUSTALW and CLUSTALX. Submitting DNA and protein sequence to databases	**3 Hrs**
Primer Designing	**2Hrs**
Phylogenetics analysis and Tree construction (Distance Matrix, UPGMA based tree construction, Neighbor Joining Method); Structure Based Drug Design and Ligand Based drug Design	**2Hrs**
Docking studies (AutoDock, GOLD);	**4Hrs**
In silico ADME	**2Hrs**

Semester IV - Paper III Practicals (CBCS)
PMB 453 Nanobiotechnology and Bioinformatics
(Elective IIIB: 4HPW: 2 Credits)

1. Chemical Synthesis of Nano Biomaterials
2. Microbiological Synthesis of Nano Biomaterials
3. Green synthesis of metal nanoparticles - Copper, Zinc and Silver using plants extracts
4. Characterization of Nanoparticles by UV spectrometry
5. Demonstration of characterization of nanoparticles by zeta potential and SEM studies
6. Database searching
7. BLAST and MSA
8. Primer Design
9. Protein Modeling
10. Submission of DNA and protein sequences
11. Phylogenetic tree construction
12. Protein Ligand Docking

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Sainikpuri

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

Recommended Books

1. Lesk M.A. (2008) Introduction to Bioinformatics. Oxford Publication, 3rd International Student Edition
2. Rastogi S.C., Mendiratta N. and Rastogi P. (2007) Bioinformatics: methods and applications, genomics, proteomics and drug discovery, 2nd ed. Prentice Hall India Publication
3. Primrose and Twyman (2003) Principles of Genome Analysis & Genomics. Blackwell
4. Ghosh, Z. and Mallick, V. (2008) Bioinformatics- Principles and Applications. Oxford University Press.
5. Bionanotechnology: Lessons from Nature by David S. Goodsell
6. Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology-Hari Singh Nalwa
7. Nanomaterials for Biosensors, Cs. Kumar, Wiley – VCH, 2007
8. Nanostructures and Nanomaterials: Synthesis, properties and applications. GhuzangG.Cao .Imperical College Press, 2004
9. Biosensors: A Practical Approach, J. Cooper & C. Tass, Oxford University Press, 2004
10. Nanotoxicology: Characterization, Dosing and Health Effects, Informa Healthcare. Nancy A. Monteiro – Riviere and C. Lang Tran, 2007.
11. Nanomedicine, Vol. IIA: Biocompatibilityby Robert A. Freitas

The student will be able to

PMB 303 CO1	Identify and classify nanoparticles, understand their synthesis methods, and describe characterization techniques for nanomaterials
PMB 403 CO2	Explain the concept of Biomimicry in nanotechnology and the use of nanotechnology in different sectors such as agriculture, healthcare, and environmental conservation
PMB 403 CO3	Describe computational tools used in biology and diagnostic studies, database concepts, and sequence analysis algorithms.

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

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BOS in Microbiology
Bhavan's Vivekananda College
Sainikpuri

M.Sc. (Final) Microbiology IV Semester (CBCS)
PMB 404 PROJECT WORK (5 Credits)

It's Mandate to have project work and the credits to be given are 5

Project work Assessment: 5 Credits (150 Marks)

1. Basic concepts of Project planning
   a) Selection of Project topic and defining objectives
   b) Planning of methods/approaches

2. Guidelines for Project writing
   - Title of the Project, Name of the Student & Supervisor
   - Declaration by the Student &Supervisor
   - Objectives of the project
   - Introduction & Review of Literature
   - Methodology
   - Results and Discussion
   - Conclusion
   - References

Course Objectives:

COb 1: To select a research topic and execute the planned work using correct methodology.

COb 2: To organize the completed work in the form of project dessertation and submit.

1. Project work will involve experimental work/data collection and it has to be completed in the stipulated time by the student.
2. Students will be asked their choice for Project work at the beginning of Semester IV and all formalities of topic and mentor selection will be completed. Project work will be offered as per the expertise and infrastructural facilities available in the department.
3. Project work may be allotted to students as individual or as group project (not exceeding 5 students per group).
4. The completed work and compiled data would be presented in the form of results and submitted in the form of a dissertation/project report.
5. Final evaluation of the project work will be through a panel consisting of internal and external examiners.
6. Guidelines provided for execution and evaluation of project work would be strictly adhered.
7. The grading would be based on evaluation of punctuality, experimental work, record keeping, academic inputs, data presentation, interpretation etc.

Dr. Hameeda Bee
Associate Professor
Department of Microbiology

CHAIRPERSON
BOS in Microbiology
Bhavan's Vivekananda College
Sainikpuri

Course Outcome

At the end of the course, students will be able to

CO1: Plan and execute a project effectively in the stipulated time

CO2: Develop analytical skills, statistical data handling skills, paper writing and oral Presentation skills.

PROJECT WORK EVALUATION SCHEME

Internal Assessment: 2 credits =50 Marks*

*Internal assessment based on project design presentation and project work. (50 Marks)

Semester End Assessment: 3 credits =100 Marks#

#Dissertation work and Final Presentation

#Thesis writing and viva voce

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

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M.Sc. Microbiology (CBCS)
Value added course
Proteomics

Course Objective:

The student will be able to

Cob1. Acquaint with basic knowledge on Proteomics and Update with current separation techniques practiced by the industry.

Cob2. Understand the clinical importance of proteins in drug designing and Correlate the importance of protein sequence in bioinformatics.

Unit I	**15 hrs**
Protein structure and conformations	1Hr
Protein Folding and unfolding	1Hr
Protein functions: structural, storage, transport, hormonal, receptor, contractile, defensive, Catalytic functions	2Hrs
Separation techniques – 2-D gel and Polyacrylamide gel electrophoresis (PAGE)	2Hrs
Biological mass spectrometry -MALDI-MS, ESI-MS, LC-MS	3Hrs
Protein identification – Peptide mass fingerprinting (PMF),	3Hrs
Electro blotting and sequencing	3Hrs

Unit II	**15 hrs**
Determination of 3-D structures by X-ray crystallography	2Hrs
NMR and Homology modeling	2Hrs
Methods of to study Protein-Protein interaction, Protein-DNA interactions	3Hrs
Protein microarrays- Protein Markers, Clinical Proteomics, Small peptides	3Hrs
Personalized medicine	2Hrs
Protein engineering	2Hrs
Drug design.	1Hr

Course Outcomes:

The student will be able to

1. Explain the fundamentals of Protein structure and Function and Describe the protein separation techniques and identification methods
2. Understand significance of Protein-Protein, Protein-DNA interactions and Understand significance of Clinical Proteomics, Protein engineering, Drug design

Dr. Hameeda Bee
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Department of Microbiology
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Value added course
Artificial Intelligence in Biology

Course Objectives:

The student will be able to

Cob1: Understand the overview on basics in AI, ML, DL and Applications of AI in Medicine.
Cob 2: Understand the role of AI in Pharmaceutical Industry, Agriculture and Bioinformatics.

Unit 1	**15 Hours**
Introduction to AI in Biology	2Hrs
Biological Intelligence vs Artificial Intelligence	2hrs
AI Basics: Concepts, terminologies and Work flow	2Hrs
Basics of Machine Learning (ML) and Deep Learning (DL)	3Hrs
AI in Medicine	2Hrs
Recent advancements in Health care through AI	2Hrs
AI and medical Imaging	2Hrs

Unit 2	**15 Hours**
Applications of AI in Pharmaceutical Industry	2Hrs
AI in drug design and Clinical trials	3Hrs
AI for Biomarker discovery	2Hrs
AI in Future of Bioinformatics	3Hrs
AI and Synthetic Biology	2Hrs
Applications of AI in Agriculture	2Hrs
Risks and Ethical Concerns involved	1Hr

Course Outcomes:

The student will be able to

CO1: Apply the knowledge of AI, ML, DL in analyzing the data in Medicine and Health care.
CO2: Analyze and visualize the data in Bioinformatics, Agriculture and Pharmaceutical Industry.

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07

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BOS in Microbiology
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Sainikpuri

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Value added course

Basics in Patent Drafting

Course Objectives:

The student will be able to

Cob1: Understand the overview on basics in IPR, types and its origin
Cob2: Understand the Patent Law, Rights and duties of patentee, Patent processing and Patent drafting.

Unit 1	**15Hrs**
Introduction to Intellectual Property Rights	2Hrs
Types of Intellectual Property Rights - Patents, Trademarks, Copyrights and Industrial designs	3Hrs
Geographical indication and plant varieties, Genetic Resources and Traditional Knowledge	3Hrs
Trade secrets, semiconductor chip/integrated circuits	2Hrs
IPR in India: Genesis and development – IPR in abroad - Major International Instruments concerning Intellectual Property Rights: Paris Convention, 1883, the Berne Convention, 1886, the Universal Copyright Convention, 1952, the WIPO Convention, 1967, the Patent Co-operation Treaty, 1970, the TRIPS Agreement, 1994	5Hrs

Unit 2	**15Hrs**
Indian patent law- a primer (the patents act, 1970)	1Hr
Patents - Elements of Patentability: Novelty, Non-Obviousness (Inventive Steps),	1Hr
Industrial Application - Non - Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentee, Assignment and license, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties - Patent office and Appellate Board	5Hrs
Pre-requisites in patenting process (NDA, IDF, SEARCHES)	1Hr
Parts of patent specification (provisional v/s non-provisional)including Field of invention, Background, Objectives, Summary, Detailed description, Experimental details, Independent and Dependent claims, Drawings, etc	3Hrs
Patent drafting (enablement, definiteness, clarity etc)	2Hrs
Claims (types of claims)	2Hrs

Course Outcomes:

The student will be able to

CO1: Apply the basic knowledge of IPR and identify the type of patent for filing.
CO2: Understand the procedure of patent drafting and processing of Patent application.

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
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