

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

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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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

Hameeda

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

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BOS in Microbiology
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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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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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 Osmania University, Hyd-07

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M.Sc MICROBIOLOGY (2025-27)
M.Sc. (Previous) I Semester (CBCS)
Paper I PMB 101 General Microbiology and Microbial physiology (Theory)
(Core) (CBCS) (4 HPW-3 Credits)

Overall Course Objectives: This paper provides overview on history, taxonomy and fundamental concepts in microbial techniques.

Objectives:

- Cob1.** Describe the history of microbiology; learn principles of microscopy and microbial identification.
- Cob2.** Outlines of bacterial taxonomy & concept of microbial growth and factor effecting growth.
- Cob3.** Discuss microbiological culturing and preservation methods.

Unit I

20 Hrs

- Concept of Vedic Microbiology, Pioneers of Vedic Microbiology- Acharya Charaka , Susruta and Vagbhata. Pioneers of Microbiology. - Anton Van Leeuwenhoek, Louis Pasteur, Robert Koch, Edward Jenner, Winogradsky, Biejerinck, Alexander Flemming, Selman Walkmann. 4 Hrs
- Microscopy - Principles, working and applications of bright field microscope, fluorescent microscope, phase contrast microscope, electron microscope 4 Hrs
- Microbial Cell Structure: Prokaryotic cell, Eukaryotic cell, Organization and function of cellular organelles. 3 Hrs
- Bacterial endospore structure, biochemistry and genetics of sporulation. 2 Hrs
- Microbial identification: Staining methods and microscopic; Molecular and genetic characteristics (16srRNA) 3 Hrs
- General characters of actinomycetes, fungi, protozoa and algae 4 Hrs

Unit II

20 Hrs

- Name and classification of Krimis (germs)- Name of krimis in Veda , names and colour of krimis, major groups of krimis in veda. Principles of bacterial taxonomy and classification: - Numerical taxonomy, Bergey's manual and its importance-general properties of bacterial groups. 3 Hrs
- Microbial nutrition and metabolism: autotrophy – Photoautotroph and bacterial photosynthesis, Chemoautotrophy and heterotrophic metabolism. 2 Hrs
- Microbial growth: The concept of growth and definition 2 Hr
- Cell cycle in microbes and generation time. 2 Hrs
- Growth phases of bacteria and importance of each growth phase. 2 Hrs
- Synchronous cultures – Methods of synchronous culturing, Continuous culturing methods. 2 Hrs
- Factors effecting growth 3Hrs
- Methods of growth measurement 2Hrs



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Microbial Stress Response – Oxidative Stress, Thermal stress, Starvation Stress, Aerobic to Anaerobic Transition. 2 Hrs

UNIT III

20Hrs

Methods of sterilization and disinfection: Physical methods and chemical methods, Containment facility. 4 Hrs

Microbiological media - Autotrophic media, defined synthetic mineral media, heterotrophic media. The concept of prototrophs and auxotrophs, prototrophic (minimal media) complex media (undefined media). 4 Hrs

Cultivation of Bacteria, Fungi and Algae: Routine and special culture methods (agar slant, agar stab, agar plate, roll tube, shake flask, aerobic and anaerobic culturing). 5 Hrs

Isolation of pure cultures. 3Hrs

Preservation and Maintenance of Microbial Cultures: Routine methods and Liquid nitrogen preservation, freeze-drying (Lyophilization), etc. 4Hrs

Course Outcomes:

Students will be able to

PMB 101 CO1. Apply concepts of microscopy and identifying various microbes.

PMB 101 CO2. Distinguish bacteria based on taxonomy & summarize bacterial growth.

PMB 101 CO3. Adapt various microbiological techniques & microbial culturing techniques.



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



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BOS in Microbiology
Shri. V. V. Vivekananda College
Sainikpuri

I Semester Practical Paper I(CBCS)
PMB 151 General Microbiology and Microbial Physiology (4 HPW-2 Credits)

1. General instructions, Microbiology laboratory and its discipline
2. Handling of microscopes, Calibration and measurement of microscopic objects
3. Staining techniques for bacteria – simple, differential and special staining
4. Sterilization procedures/methods
5. Preparation of microbiological media. Autotrophic media, minimal media, basic media, Enriched media, enrichment media, and differential media.
6. Isolation and cultivation of pure cultures
7. Identification methods of bacteria: Biochemical & Molecular (demonstration)
8. Isolation and culturing of fungi (yeasts and molds) and algae
9. Culturing methods of microbes – slant and stab cultures, tube culture, flask cultures, shake flask cultures
10. Anaerobic culturing methods – anaerobic jar and its use, pyrogallol method, thioglycolate media culturing, anaerobic glove box and its application
11. Microbial growth experiments – Viable count of growing cultures and generation time determination
12. Study of bacterial growth curve
13. Factors effecting the microbial growth (pH and temperature)
14. Microbial stress response in salinity conditions

Recommended books

1. Microbiology by Pelczar M.J., Ried, RD and Chan, ECS.
2. Vedic Microbiology (2020) Dubey, R.C., Motilal Banarsidass international publication.
3. Vedic Microbiology- A Scientific approach; chakradhar f. 'Anjista' and shriji kurup, ravi prakash arya; Publishers: Indian foundation for vedic science, rohtak
4. Microbiology by Gerard J. Tortora, Berdell Ra. Funke and Christine L. Case. Publ: Pearson Education Inc.
5. Text book of Microbiology by M. Burrows
6. General Microbiology by Stainier, Deudroff and Adelberg Review of medical microbiology by Jawitz, Melnick and Adelberg
7. Bacterial and Mycotic infections of man. Ed. Dubos and Hirst Lipincott
8. Principles of Microbiology and Immunology by Davis, Dulbecco, Eison, Ginsberg and Wood.
9. Microbiology by Pelczar M.J., Ried, RD and Chan, ECS.
10. Microbial Physiology by Moat, Brock's Biology of Microorganisms by Madigan, MT et al
11. Biochemistry of bacterial growth by Mandelstam, Mc Quillon and Dawes;
12. Bacterial Metabolism by Dwellley
13. Photosynthesis by Dewlin and Barker;
14. Laboratory Experiments in Microbiology by Gopal Reddy et al.
15. Microbes in Action by Seoley HW and Van-Demark, PJ
16. Biology of microorganisms by Madigan, MT et al

MSc MICROBIOLOGY (2025-27)
M.Sc. (Previous) I Semester Microbiology (CBCS)
Paper II PMB 102 Virology (Core) (CBCS)
(4 HPW-3 Credits)

Overall Course Objectives: This course provides knowledge on structure, replication, and recombination in viruses and summarizes the applications of viruses in various fields.

Objectives:

Cob1. Describe virus classification, structure, detection methods and replication

Cob2. Comparison of lytic and lysogenic viruses and various replication strategies of viruses

Cob3. Outline the concepts of recombination in phages and discuss applications of viruses in various areas.

Unit-1

20 Hours

History of virology (latest Scientific investigations), Viral classification: Baltimore. Recent changes to virus taxonomy, ICTV-Virosphere and Hierarchical ranks	3Hrs
Viral metadata resource, viral metagenomics -Virome	2Hrs
Virus structure and morphology	2Hrs
Detection of viruses: physical, biological, serological and molecular methods.	3Hrs
Cultivation and quantification of bacteriophages, plant and animal viruses	
Sub-viral particles: structure, replication and diseases caused by satellites virus, viroids and prions	3Hrs
Significance of emerging viruses: Ebola, Nipah, Hantavirus, Zika virus.	4Hrs
General idea about cyanophages, actinophages and mycophages	3Hrs

Unit-2

20 Hours

Viral replication Strategies: Cellular interactions---Clatherin coated pits, lipid rafts, endocytosis and virus uncoating mechanisms	3Hrs
Host response to viral infection-apoptosis, necrosis, stress response. Cellular basis of transformation, types of cytopathic effects.	3Hrs
Structure, characteristics and replication strategies of Bacteriophages: T2 and Lambda	3Hrs
Structure, characteristics and replication strategies of ds DNA viruses-Adenoviridae, Baculoviridae	3Hrs
SS DNA virus Geminiviridae, Nanoviridae-BBTV	3Hrs
SS DNA/ds DNA virus-Pleolipoviridae, Reverse transcribing DNA/RNA virus-Hepadnaviridae-HBV, Retroviridae-HIV	3Hrs
ds RNA viruses Reovirales; positive sense RNA virus-Virgaviridae-TMV, Coronaviridae- SARS-CoV-2; negative sense RNA virus-paramyxoviridae	2Hrs


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 Department of Microbiology
 Osmania University, Hyd-07


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Unit-3**20 Hours**

Recombination in phages, multiplicity reactivation and phenotypic mixing	4Hrs
General account of Tumor virus (RNA and DNA)	4Hrs
Viral Interference and Interferons. Classification of Interferons. Antiviral agents (chemical) and their mode of actions	4Hrs
Different types of viral vaccines	4Hrs
Viral vectors used for cloning and sequencing: Lambda phage, M 13, Retro viruses, CaMV 35S promoter and its application.	4Hrs

Course Outcomes:**Students will be able to****PMB 102 CO1.** Classify the virus based on structure, and replication**PMB 102 CO2.** Distinguish lytic and lysogenic viruses and interpret replication strategies.**PMB 102 CO3.** Interpret concepts of recombination in phages and Summarize applications of viruses in various areas


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Associate Professor
Department of Microbiology
Osmania University, Hyd-07



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BOS in Microbiology
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**I Semester Practical Paper II
(CBCS) PMB 152 Virology (4 HPW-2 Credits)**

1. Isolation of E.coli phage from soil
2. Isolation of E.coli phage from sewage
3. Isolation of phages from contaminated food samples
4. Application of bacteriophages as food preservatives
5. Quantification of phages
6. Cultivation and preservation of phages
7. Growth phages of phage and burst size (Demonstration)
8. Phage induction demonstration
9. Cultivation of animal viruses in egg allantoic, amniotic and CAM
10. Symptomatic observations of plant viral infections
11. Demonstration of cytopathological changes of animal virus
12. Study of pathogenic lesions of animal virus diseases through slides.
13. Application of NPV and its role as biopesticide.
14. Visit to lab for NPV production
15. Awareness and participation in vaccination programs (extension activity).

Recommended Books

1. Recent publications: Research papers and review articles from Google search engine
2. General Virology by Luria and Damel .
3. Basic Virology. E.K. Wagner .
4. Virology and Immunology by Jokli .
5. Laboratory manual of Microbiology and Biotechnology by Aneja, I(R . Text book of Virology by Rhodes and Van Royen
6. Plant Virology by Smith
7. Genetics of bacteria and their viruses by W. Hayes
8. Molecular Biology of the gene by Watson, Roberts, Staitz and Weiner . A laboratory guide in virology by Chjarles H. Lunningham
9. Basic lab procedures in diagnostic virology by Marty Christensen
10. Review of medical microbiology by Jawitz et al
11. Medical laboratory manual for tropical countries Vol I & II by Monica Cheesbrough .
12. Text Book of Microbiology by Ananthanarayanan and Jayaram Paniker
13. Text book of Virology by Rhodes and Van Royan
14. Principles of Virology: Molecular Biology, pathogenesis and control of animal viruses


Dr. Hameeda Bee
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 Osmania University, Hyd-07


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MSc MICROBIOLOGY (2025-27)
M.Sc. (Previous) I Semester (CBCS)
Paper III PMB 103 Research Methodology and Techniques (Theory)
(Core) (CBCS) (4 HPW- 3 Credits)

Overall Course Objectives: This paper provides knowledge about some of the important bioanalytical techniques and their instruments, biostatistics, and computer-based tools that are required for the preparation of manuscripts.

Objectives:

- Cob1.** Present principles of various optical methods and separation techniques such as electrophoresis, centrifugation, and chromatography, and techniques that involve radioisotopes and stable isotopes.
- Cob2.** Teach descriptive as well as inferential statistics for biological data.
- Cob3.** Outline computer-based tools that are useful in writing scientific manuscripts.

Unit I **20 Hrs**

Optical methods: colourimetry and spectrophotometry, fluorimetry, polarimetry (optical rotation), circular dichroism, NMR, ESR spectroscopy, X-ray diffraction, types of mass spectrometry. 5 Hrs

Electrophoretic techniques and application 3 Hrs

Chromatographic techniques: HPLC, FPLC, paper, thin layer, ion-exchange, gel-filtration and Affinity-chromatography. Counter current distribution. 4 Hrs

Diffusion, dialysis, cell disruption methods, cell-free protein synthesis, centrifugation techniques. 4 Hrs

Radio isotopes -Detection and Measurement of Radioactivity (Scintillation counter and Geiger-Mueller counter), autoradiography. Radiation safety. Stable isotopes and their use. 4Hrs

Unit II **20 Hrs**

Population, sample and sampling procedures, types of variables, and frequency distributions. 4 Hrs

Descriptive statistics: Measures of Central Tendency and Dispersion. 4 Hrs

Elements of probability, Gaussian or Normal distribution, Binomial distribution, Poisson distribution, t-distribution, F-distribution and Chi-square distribution. 4 Hrs

Inferential statistics: Types of t-tests, ANOVA, and Chi-square tests. Post-hoc tests (e.g. DMRT). Correlation and linear regression. 5 Hrs

Design of Experiments (DoE) using statistical tools. 3 Hrs



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Unit III**20 Hrs**

Introduction to Computers and Windows	2 Hrs
Introduction to disk operating systems (DOS); Sample commands, DIR-CD-RD-DEL-COPYMOVE-REN-TYPE-EDIT (Editor) CE-DATE and TIME.	4 Hrs
MS-Word and MS-Excel	3 Hrs
Data presentation, Manuscript preparation, and Plagiarism	4 Hrs
QA, QC, GLP, GMP, Research ethics, Patents & IPR.	4 Hrs
Introduction to Machine Learning and Artificial Intelligence in Microbiology/Biological Sciences	3 Hrs

Course Outcomes:**Students will be able to...**

- CO1.** Select the right bioanalytical technique for studying the biochemical sample and for separating the desired molecules from a mixture.
- CO2.** Describe and statistically analyze biological data.
- CO3.** Write organized scientific manuscripts including a master's thesis.



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BOS in Microbiology
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I Semester Practical Paper III (CBCS)
PMB 153 Research Methodology and Techniques (4 HPW- 2Credits)

1. Creating documents using MS-Word.
2. Usage of spreadsheet (MS-Excel) for biological applications.
3. Biostatistics (problems).
4. Absorption maxima of proteins, nucleic acids, tyrosine, and riboflavin (determination of molar extinction coefficient, calculations based on Beer Lambert's Law).
5. Estimation of DNA and protein concentration by UV-Vis spectrophotometry.
6. Estimation of protein concentration by Folin's-Lowry method.
7. Demonstration of differential centrifugation.
8. Paper chromatography of amino acids.
9. Dialysis for desalting of proteins.
10. Demonstration of Gel-filtration technique.
11. Demonstration of electrophoresis of DNA and proteins.
12. Estimation of phosphorous by Fiske-Subba Rao method

Recommended Books

1. Biochemistry by Lehninger.
2. Outlines of Biochemistry by Cohn and Stumph.
3. Biological Chemistry by Mullar and Cards.
4. Biochemistry by White, Handler and Smith.
5. Methods in Enzymology series.
6. The Cell - BratchamdMirsky series.
7. Laboratory experiments in Microbiology by Gopal Reddy et al.
8. Biochemistry lab manual by Jayararnan.
9. Introduction to the theory of statistics by Alexander, M Mood and Franklin.
10. Fundamentals of Biometry by L.N.Balam.
11. Statistical methods by Snedecor and Cochran.
12. Introduction to computer and its application by ChaeC.Chien.
13. Basic Programming language by Bajaraman.
14. Biostatistics - A manual of statistical methods for use in Health, Nutrition and Anthropology by K. Vishveshwar Rao.

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MSc MICROBIOLOGY (2025-27)
M.Sc. (Previous) Microbiology I Semester (CBCS)
Paper IV PMB 104 Microbial Biochemistry (Core) (CBCS)
(4HPW- 3Credits)

Overall Course Objectives:

This paper provides knowledge in Bioenergetics, Classification and metabolism Biomolecules and basic concepts in Enzymology.

Objectives:

- Cob1.** Discuss biological significance of pH and fundamental concepts of Bioenergetics and understand Classification, Structure, and Properties of Carbohydrates and Lipids
- Cob2.** Understand the Classification, Structure, and Properties of Purines, Pyrimidines, Proteins, Amino acids and Enzymes, Isolation & purification and Kinetic properties of enzymes
- Cob3.** Gain knowledge on Catalytic mechanism, types of enzyme regulation, inhibition and methods of enhancing enzyme activity, Enzyme engineering.

Unit I

20Hrs

pH and its biological relevance. Determination of pH. Buffer Preparation and Types of Buffers	3Hrs
Concept of entropy, free-energy, free energy changes, high energy compounds. Equilibrium constants	3Hrs
Redox potentials, Biological Redox systems, Biological oxidation	3Hrs
Biological membranes, Electron transport, Oxidative phosphorylation and mechanism.	3Hrs
Lipids classification: Bacterial lipids, Prostaglandins- structure and function, Major steroids of biological importance.	4Hrs
Carbohydrates: Classification, basic chemical structure, monosaccharides, aldoses, and ketoses. Cyclic structure of monosaccharides, stereoisomerism, anomers and epimers. Sugar derivatives, deoxy sugars, amino sugars, and sugar acids	4Hrs

Unit II

20 Hrs

Nucleic acids: Structure and properties of Purines, Pyrimidines, nucleosides and nucleotides.	3Hrs
Metabolism of Purines and Pyrimidines - Biosynthesis and degradation	3Hrs
Proteins and amino acids: Properties of amino acids, structure, confirmation and properties of proteins	3Hrs
Metabolism of amino acids. Biosynthesis and degradation — an overview	3Hrs
Enzymes nomenclature and classification, Methods for determination of enzyme activity	3Hrs
Isolation and purification of enzymes.	3Hrs

Enzyme kinetics: Effect of pH, substrate concentration, temperature and inhibitors. 2Hrs

Unit III

20 Hrs

Mechanism of enzyme action – Action of Hydrolases (RNase), Oxidases (Cytochrome Oxidase) and reductases (Ribonucleotide reductase). 3Hrs
 Coenzyme catalysis (Pyridoxal phosphate and TPP). 3Hrs
 Isoenzymes. 3Hrs
 Competitive and non-competitive inhibition. 3Hrs
 Methods for increased microbial enzymes production and activity. Enzyme engineering. 3Hrs
 Control and Regulation of enzyme activity: Allosteric enzymes and feedback mechanisms 3Hrs
 Metabolic compartmentalization in relation to enzyme, 2Hrs
 Enzymes and secondary metabolites 3Hrs

Course Outcomes:

Students will be able to

- PMB 104 CO1.** Determine pH of solutions and prepare Buffers for laboratory work
PMB 104 CO2. Analyze the biomolecules by carrying out qualitative analysis.
PMB 104 CO3. Perform enzyme assay and calculate enzyme activity and Identify enzymes from various sources and purify them.



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**I Semester Practical Paper III
(CBCS) PMB 154 Microbial Biochemistry
(4 HPW- 2Credits)**

1. Safety and good lab practices, Biochemical calculations
2. Preparation of buffers and adjustment of pH
3. Qualitative tests for carbohydrates and analysis of unknowns
4. Qualitative tests for amino acids and analysis of unknowns
5. Tests for lipids (qualitative)
6. Quantitative estimation of glucose and fructose
7. Determination of Saponification value of fats
8. Partial purification of enzymes (β -amylase, urease and Catalase)
9. Effect of substrate concentration, pH, time and temperature on enzyme activity
10. Calculation of K_m for partially purified enzyme
11. Study for inhibition of enzyme activity

Recommended Books

1. Biochemistry by Lehninger
2. Outlines of Biochemistry by Cohn and Stumph
3. Biochemistry of Nucleic acids by Davidson
4. Biological Chemistry by Mullar and Cards
5. Biochemistry by White, Handler and Smith
6. Methods in Enzymology series
7. The Cell – Bratch and Mirsky series
8. Biochemistry lab manual by Jayaraman

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CHAIRPERSON
BOS In Microbiology
Phavan's Vivekananda College
Sainikpuri

M.Sc MICROBIOLOGY (2025-27)
M.Sc. (Previous) Microbiology II Semester (CBCS)
Paper I PMB 201 Molecular Biology & Microbial Genetics (core)
(4 Hrs per week = 3 credits)

Overall Course Objectives: This paper provides knowledge in Structure of Nucleic Acids, Gene expression and regulation, Mutational biology and Bacterial genetic recombination.

Objectives:

- Cob1.** Describe DNA structure and genome organization and Illustrate DNA replication, transcription, translation and gene regulation
- Cob2.** Outline mutations types, DNA damage and repair mechanisms.
- Cob3.** Present Bacterial Recombination and Genetic mapping and Gene cloning in *E.coli* and Yeast

Unit I **20Hrs**

Detailed structure of DNA, Z-DNA, A & B DNA, Denaturation and melting curves.	3Hrs
Genome organization in prokaryotes and eukaryotes	4Hrs
DNA replication- Meselson and Stahl Experiment. Mechanism of Semi conservative replication. Rolling circle model, theta model. Etc. Enzymology of DNA replication	4Hrs
Eukaryotic telomere and its replication	
Prokaryotic and eukaryotic transcription	3Hrs
Structure and processing of m-RNA, r-RNA t-RNA	2Hrs
Ribozyme, Genetic code and Wobble hypothesis	2Hrs
Translation in Prokaryotes and eukaryotes, Post translational modifications.	2Hrs

Unit II **20Hrs**

Concept of gene, Benzer's fine structure of gene – muton, cistron, recon. Types of genes – structural, constitutive, regulatory	2Hrs
Gene regulation and expression – Lac operon, arabinose and tryptophan operons, Gene regulation in eukaryotic systems, repetitive DNA, gene rearrangement, promoters, enhancer elements	3Hrs
Mutation: Molecular basis of mutations, Physical, chemical and biological mutagens.	2Hrs
Detection and analysis of mutations (Replica plating, Antibiotic enrichment, Ames test, etc).	
DNA damage and repair mechanisms	2Hrs
Bacterial Recombination -Discovery, gene transfer, molecular mechanism, detection, efficiency calculation and applications.	2Hrs
Bacterial transformation- Competency and resistance.	2Hrs
Bacterial conjugation – Sex factor in bacteria, F and HFR transfer, linkage mapping	2Hrs
Bacterial transduction – transduction phenomenon, methods of transduction.	2Hrs
Transposable elements – Definition, detection of transposition in bacteria, types of bacterial transposons and applications of transposons.	3Hrs


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


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Unit III

20Hrs

Principles of genetic engineering: Vectors: Plasmids, phagemids / viral vectors, cosmids, Artificial chromosomes. 4Hrs

Restriction Enzymes, Polymerases, ligases, etc 3Hrs

General methods of gene cloning: Cloning Techniques: cloning in *E-coli*, Cloning in *Bacillus subtilis*, Cloning in Yeast, 3Hrs

Selection of recombinants, blue white selection, Expression and detection of cloned genes. 4Hrs

Polymerase chain reaction and Quantitative real time PCR. 3Hrs

rRNA/ Genomic/ c DNA Library construction and screening. 3Hrs

Course Outcomes:

Students will be able to

PMB 201 CO1. Compare the structural variations of DNA and genome organization and Illustrate Replication, Transcription, translation and gene regulation

PMB 201 CO2. Differentiate the types of mutations, DNA damage and repair mechanisms.

PMB 201 CO3. Solve problems in genetic mapping, apply the methods of gene Cloning, PCR and molecular library constructions.



Dr. Hameeda Bee

Associate Professor

Department of Microbiology
Osmania University, Hyd-07



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BOS in Microbiology
Phavan's Vivekananda College
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Phavan's Vivekananda College
Sainikpuri

II Semester Practical Paper I (CBCS)
PMB 251 Molecular Biology and Microbial Genetics (CBCS) - Paper I (4HPW-2Credits)

1. Isolation of genomic DNA from E.coli
2. Isolation of genomic DNA from Yeast.
3. Estimation of DNA (Colorimetry)
4. Estimation of RNA
5. Estimation of protein by Folin's method
6. Induction of mutations by physical mutagens (UV) and chemical mutagens (EMS, etc.)
7. Screening and isolation of mutants by Replica plating technique
8. Digestion of DNA by restriction endonucleases
9. Determination of molecular weight of DNA resolved on Agarose gel electrophoresis
10. Induction of Lac operon (Demonstration by kit or tutorial mode)
11. Demonstration of Transformation in bacteria using CaCl_2 heat shock method

Recommended books

1. Molecular Biology by Upadhyay and Upadhyay
2. Molecular biology by David Freifelder
3. Microbial genetics by David Freifelder
4. Cell and Molecular Biotechnology by Darnell, Lodish and Baltimore
5. Molecular biology of the gene by Watson et al
6. Principles of Biochemistry by Lehninger
7. Molecular biotechnology by Primrose
8. Genes IX by Benjamin Lewin
9. Molecular Biotechnology by Bernard R. Glick and Jack J Pasternak
10. Molecular Genetics of Bacteria by Larry Snyder and Wendy Champness
11. Cell Biology by Geoffrey Cooper and Robert Hausman



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



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Sainikpuri

M.Sc MICROBIOLOGY (2025-27)
M.Sc. (Previous) Microbiology II Semester (CBCS)
Paper II PMB 202 Immunology (Core) (CBCS)
(4 HPW-3Credits)

Overall Course Objectives:

This paper provides knowledge on components of immune system, mechanisms involved in inducing immune response, immunological techniques, concept of vaccines and immune diagnosis and therapy of Cancer.

Objectives:

- Cob1.** Describe the Antibody structure and diversity and types of immunity
Cob2. Outline immunological techniques, Hypersensitivity and autoimmunity
Cob3. Review on relationship between Hypersensitivity, Autoimmunity, Cancer and immunology

Unit 1 **20 Hrs**

History of immunology. Haematopoiesis, Cell lineage, components of immune system, cells and organs of immune system	2 Hrs
Antigens –Nature, properties and types. Haptens	2 Hrs
Antibody - Structure, functions and classification. Isotypes, allotypes and idiotypes	2 Hrs
Immunoglobulin genes. Generation of antibody diversity. Clonal nature of the immune response - Clonal selection theory.	3 Hrs
Generation of T cell receptor diversity by genomic rearrangement	3 Hrs
Structure of B and T cell receptors	2 Hrs
Overview of Innate and adaptive immunity	2 Hrs
Toll-like receptors, cell-mediated and humoral immune responses, inflammation	2 Hrs
Role of inflammasome in innate immune response	2 Hrs

Unit 2 **20 Hrs**

Major Histocompatibility Complex (MHC)- MHC restriction and processing and presentation of antigen by MHC	3 Hrs
Transplantation immunology: MHC, types of grafts, grafts rejection, GVH reactions, mechanism of graft rejection, and prevention of graft rejection	3 Hrs
Immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, Congenital and acquired immunodeficiencies	3 Hrs
Immunological tolerance-central and peripheral	3 Hrs
Antigen and antibody reactions–Agglutination, Precipitation, neutralization, and function. Labeled antigen-antibody reactions- ELISA, RIA, immune blotting, CFT, immunofluorescence. Flow cytometry (Fluorescence activated cell sorter)	5 Hrs


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


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and its applications in Immunology. Development Of immuno diagnostic kits
Classical, Alternate and Lectin mediated Complement pathways 3 Hrs

Unit 3 20 Hrs

Hypersensitivity - immediate and delayed type hypersensitivity reactions 2 Hrs
Autoimmunity – systemic and localized autoimmune disorders 2 Hrs
Types of conventional vaccines and principles of Immunization 2 Hrs
Modern vaccines; peptide, DNA, recombinant / vector, and anti-idiotypic vaccines 2 Hrs
Schedules of common vaccination, Benefits and adverse consequences of vaccination 2 Hrs
Production of polyclonal antibodies; Animals models for production of antibodies 2 Hrs
Hybridoma techniques and monoclonal antibody production. Applications of monoclonal antibodies in biomedical research, clinical diagnosis and treatment. 2 Hrs
Chimeric Antibodies
Immuno suppression and its mechanism of action 2 Hrs
Immune evasion by bacteria and viruses 2 Hrs
Tumor immunology. Immuno diagnosis and immune therapy of cancer 2 Hrs

Outcomes:

Students will be able to

PMB 202 CO1. Illustrate the Antibody structure and diversity and Summarize the types of immunity

PMB 202 CO2. Apply immunological techniques practically and complement pathways

PMB 202 CO3. Apply the concepts of Autoimmunity, Hypersensitivity and Relate between cancer and immunology,

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

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II Semester PMB 252 Immunology Practicals (CBCS) - Paper II

1. Demonstrating identification of Blood groups
2. Agglutination reactions – WIDAL test- slide and tube agglutination method
3. Diagnosis of syphilis by VDRL (Flocculation test)
4. Single Radial Immunodiffusion and Ouchterlony double diffusion test
5. Rocket Immunoelectrophoresis
6. WBC count and RBC count
7. Differential Leukocyte Count
8. Separation of serum and plasma proteins
9. Blot transfer and detection of protein on blot by staining (Demonstration by kit or tutorial mode)
10. Demonstration of ELISA technique
11. Lymphocyte culture, staining and Hemacytometer count.
12. Indirect agglutination (Pregnancy hCG Ag)

Recommended Books

1. Immunology by Janice Kuby
2. Cellular and molecular immunology by Abul K. Abbas et al
3. Text book of Immunology by Barrett
4. Immunology – The science of self-non self-discrimination by Jan Klein
5. Essential Immunology by Roitt, IM
6. Immunology by Tizard
7. Medical Microbiology by Ananthanarayan and Jayaram Panicker
8. The elements of Immunology by Fahim Halim Khan

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

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Rhavan's Vivekananda College
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M.Sc MICROBIOLOGY (2025-27)
M.Sc. (Previous) Microbiology II Semester (CBCS)
Paper III PMB 203 Industrial Microbiology (Core) (CBCS)
(4 HPW-3Credits)

Objectives:

- Cob1:** Learn Strain improvement strategies and types of fermentation
Cob2: Understand fermentative production of alcohol, beer, wine making, citric acid, amylase & VitB₁₂
Cob3: Gain knowledge on large scale production and applications of antibiotics, bioproducts and Immobilization methods

Unit 1 **20 Hrs**

- Introduction to industrial microbiology. Screening and selection of microorganisms for industrially important products like amylase, organic acid, antibiotic, amino acid and vitamins. 5 Hrs
- Strain improvement strategies. Environmental and genetic factors for strain improvement. 4 Hrs
- Upstream strategies and raw materials for fermentation process. Cost economics and use of low-cost agro-industrial wastes 4 Hrs
- Fermentation media and sterilization 3 Hrs
- Types of fermentations processes – Solid state, surface and submerged fermentations 4 Hrs

Unit 2 **20 Hrs**

- Design of fermentor, types of fermentor, agitation, aeration, antifoam, pH and temperature control. Inoculum media and seed culture preparation and frozen stocks. Batch, fed batch and continuous fermentations. Direct, dual or multiple fermentations. 4 Hrs
- Fermentative production of industrial alcohol, uses, raw materials, microorganisms, inoculum preparation, preparation of wort, fermentation and recovery 4 Hrs
- Fermentative production of beer – Medium components, malt, malt adjuncts, hops, water. Preparation of wort, mashing, wort boiling, microorganism, inoculum preparation, fermentation, cold storage maturation, carbonation, packing and preservation. 4 Hrs
- Principles of wine making – Fruit selection, picking, crushing, sulphite addition, processing, fermentation, aging and bottling 4 Hrs
- Industrial Production of Citric acid, Amylase, Vit – B12 and Biotransformation of Steroids. 4 Hrs



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



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Unit 3

20 Hrs

Microorganisms involved, Media preparation, Fermentation and recovery process of Antibiotics – Commercial production of benzyl penicillin, and semi-synthetic penicillins.	5 Hrs
Fermentative production of tetracyclines – uses, chlortetracycline, oxy-tetracycline, tetracycline and semi-synthetic tetracyclines	3 Hrs
Microbial productions of Bioplastic (PHB & PHA). Bioinsecticides (Thuricides) and Biopolymer- An Emerging technological approach.	4 Hrs
Downstream strategies for product recovery. Detection and assay of fermentation products. Physico-chemical methods and biological assays	4 Hrs
Immobilization methods used in industries – Absorption, covalent linkage, entrapment and cross linkage, types of carriers, advantage and disadvantages	4 Hrs

Course Outcomes:

The student will be able to

PMB 203 CO1. Explain different types of fermentation and strain improvement strategies

PMB 203 CO2. Describe the fermentative production of fermentative production of industrial products.

PMB 203 CO3. Discuss large scale production and applications of antibiotics, bioproducts and Immobilization methods

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

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II Semester PMB 253 Industrial Microbiology Practicals (CBCS) - Paper II

1. Isolation and screening for amylase producing microorganisms
2. Isolation and screening for lipolytic microorganisms
3. Isolation of antibiotic producing microorganisms by crowded plate technique
4. Estimation of glucose
5. Estimation of maltose
6. Estimation of ethanol by dichromate method
7. Production of ethanol by flask fermentation, recovery of ethanol by distillation and calculation of fermentation efficiency.
8. Preparation of wine from grapes/fruits by fermentation
9. Isolation of *Penicillium* spp. from different source samples
10. Production of Penicillin by fermentation process
11. Characterization of antibiotic produced by *Penicillium* spp.
12. Production and estimation of Citric Acid by fermentation process.
13. Immobilization of microbial cells by entrapment method

Recommended Books

1. Industrial Microbiology by Casida, LE
2. Industrial Microbiology by Prescott and Dunn
3. Microbial Technology by Peppler, JH and Perlman, D.
4. Biochemistry of Industrial Microorganisms, by Rainbow and Rose
5. Economic Microbiology by Rose Vol I – V
6. Microbial Enzymes and Biotechnology by Fogarty WM and Kelly, CT
7. Comprehensive Biotechnology, All volumes Ed. Murray Moo-Yong
8. Biotechnology (A text book of industrial Microbiology) Ed. Cruger & Cruger
9. Advances in Applied Microbiology Ed. Perlman Series of volumes
10. Recent Published papers on advances in relevant area to be referred



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



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M. Sc MICROBIOLOGY (2025-27)
M.Sc. Microbiology II Semester (CBCS)
Paper IV PMB204 Pharmaceutical Microbiology (Core)
(4 HPW-3 credits)

Overall Course Objectives: This paper provides knowledge on microbial spoilage, preservation, GMP, principles of chemotherapy, drug resistance and cosmetic microbiology.

Objectives:

- Cob1.** Present concepts in microbial spoilage, prevention and preservation of pharmaceutical products, GMP and Discuss concepts of chemotherapy and anti-microbial agents.
Cob2. Relate the principles of Chemotherapy and important antibiotic drugs in therapy.
Cob3. Review the methods of microbiological assays in Cosmetic microbiology and pharmaceutical industry.

Unit I

20 Hrs

- Pharmaceutical industry. Importance of various pharmacopeias with special reference to Indian pharmacopeia, British pharmacopeia, United States pharmacopeia and international pharmacopeia 2 Hrs
 Design and layout of sterile product manufacturing unit 2 Hrs
 Microbiological issues for inspection of pharmaceutical facilities: Sterilization (D value, z value, F value, F₀ value, survival curve), Depyrogenation, Environmental monitoring, Room design and Equipment, 3 Hrs
 Water purification and Delivery system, Personnel, Product sampling, Method suitability test, Sample analysis (Bioburden analysis, Sterility testing, Bacterial endotoxin testing). Concept of GxP and Quality Assurance in pharmaceuticals. 4 Hrs
 Introduction to FDA's CAPA (Corrective and Preventive action) steps requirements and regulations, OOPs, SOPs. ISO, WHO and US certification 2 Hrs
 Understanding the changing dynamics of pharma ecosystem. 2 Hrs
 Digitization of equipment, instrument, air and water systems. 2 Hrs
 Adherence to guidelines like GAMP (Good automated manufacturing practice and 21 CFR (Code of federal regulations). 3 Hrs

Unit II

20 Hrs

- History of chemotherapy –Paul Ehrlich and his contributions. Arsenicals as therapeutics. 2 Hrs
 Medicinal plants derived natural products
 Classification of antimicrobial agents. Drugs, Semi-synthetic drugs and Antibiotics, 2 Hrs
 Topical agents. Choice of drug, dosage, route of administration, combined/mixed multi drug therapy.
 Selective toxicity, molecular principles of drug targeting 3 Hrs
 Development of synthetic drugs: Sulphanamides, Chloramphenicol, Antitubercular compounds, Quinolones, Metronidazole, Anti-tumor drugs. 3 Hrs
 Mode of action of important drugs – Cell wall inhibitors (Betalactam – e.g. Penicillin), 4 Hrs


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


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membrane inhibitors (Polymyxins), protein synthesis inhibitors (streptomycin). Macrolides and antifungal antibiotics (Nystatin).	
Drug metabolism and Response; Pharmacokinetics (ADME), Pharmacodynamics, Pharmacogenomics	3 Hrs
Emergence and mechanisms of antimicrobial resistance (AMR) and antimicrobial resistance genes (ARG) in different environments	3 Hrs

Unit III 20 Hrs

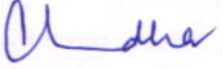
Antimicrobial Effectiveness Testing (AET) or Preservative Effectiveness Testing (PET) of cosmetics and pharmaceutical products	4 Hrs
Microbial contamination and spoilage of cosmetic and pharmaceutical products - sterile injectables, non-injectables, ophthalmic preparations, and implants	4 Hrs
Non antibiotic antimicrobial compounds: Metals and Biocides (Phenol coefficient/RWC).	4 Hrs
Antimicrobial/Drug sensitivity testing (AST) methods and their importance – Disc Diffusion, and Determination of MIC using Broth/Agar Dilution method, and Epsilometer test.	4 Hrs
Microbial assays for antibiotics/Antibiotic potency tests (APT) – Cylinder/cup plate method and Turbidometric/tube method.	4 Hrs

Course Outcomes:

Students will be able to

- PMB 204 CO1.** Analyze microbial spoilage, prevention and preservation of pharmaceutical products, GMP and Discriminate the mode of actions of various anti-microbial agents.
- PMB 204 CO2.** Use Practical skills in preservation and testing of various industrial products.
- PMB 204 CO3.** Perform microbiological assays in pharmaceutical industry.


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


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BOS in Microbiology
Shavan's Vivekananda College
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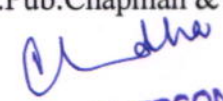
II Semester PMB 254 Pharmaceutical Microbiology Practicals (CBCS) - Paper II

1. Bioburden testing and tests for specific microorganisms of non-sterile pharmaceutical products (such as syrups, suspensions, creams and ointments, ophthalmic preparations).
2. Bioburden testing and tests for specific microorganisms of cosmetic products.
3. Sterility testing of sterile-pharmaceutical products.
4. Bacterial endotoxin test [BET] (Demonstration through kit or tutorial mode)
5. Validation of autoclave using *Bacillus stearothermophilus* or any other biological/chemical indicator method.
6. Determination of sterilizing values (such as D value and z value) for heat treatment in pharmaceuticals.
7. Determination of antimicrobial (drug/antibiotic) susceptibility/resistance. Specifically, Antimicrobial Susceptibility Testing [AST] using Disc Diffusion,
8. Determination of antimicrobial (drug/antibiotic) susceptibility/resistance. Specifically, Antimicrobial Susceptibility Testing [AST] - Determination of MIC using Broth/Agar Dilution method and Epsilometer test.
9. Determination of antibiotic spectrum using disc diffusion.
10. Determination of LD 50 of antimicrobial chemicals.
11. Microbiological assays for antibiotics such as chloramphenicol, specifically, Antibiotic Potency Testing [APT] (using Agar plate or cylinder/cup plate method and Liquid tube or turbidometric method)
12. Antimicrobial effectiveness testing [AET] of pharmaceutical products.
13. Bioassays with any plant / microbial secondary metabolites against Gram positive and Gram negative bacteria.
14. Tests for disinfectants: Phenol coefficient/Rideal-Walker Method.
15. Treatment of bacterial cells with Cetrimide, phenol and detection of Leaky substances. (Demonstration or tutorial mode).

Recommended Books

1. Disinfection, sterilization and preservation. Block, S.S. (ed). Lea and Febiger, Baltimore
2. Pharmaceutical Microbiology. Hume, W.B. and Russel, AD. Blackwell Scientific, Oxford
3. Principles and methods of sterilization in health sciences. Perkins, JK. Pub: Charles C. Thomas, Springfield.
4. Compendium of methods for the microbiological examination of foods. Vanderzant, C. and Splittstoesser, D. Pub: American Public Health Association, Washington, D.C.
5. Disinfectants: Their use and evaluation of effectiveness. Collins, CH., Allwood, MC., Bloomfield, SF. And Fox, A. (eds). Pub: Academic Press, New York
6. Inhibition and destruction of microbial cell by Hugo, WB. (ed). Pub: Academic Press, NY
7. Manual of Clinical Microbiology. Lennette, EH. (ed). Pub: American Society for Microbiology, Washington.
8. Principles and Practices of disinfection. Russell, AP., Hugo, WB., and Ayliffe, GAJ. (eds). Publ. Blackwell Sci.
9. Biochemistry of antimicrobial action. Franklin, DJ and Snow, GA. Pub: Chapman & Hall.


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


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BOS in Microbiology
Rhavan's Vivekananda College
Sainikpuri

10. Antibiotics and Chemotherapy. Garrod, L.P., Lambert, HP. And C'Grady, F. (eds).
Publ: Churchill Livingstone.
11. Antibiotics. Lancini, G. and Parenti, F. publ: Springer-Verlag.
12. The Molecular Basis of antibiotic action. Gae, EF. Et al. Publ: Wiley, New York.
13. Antimicrobial Drug action. Williams, RAD., Lambart, PA. & Singleton, P. Pub:Bios Sci.
14. Microbiological Assays. Hewitt.
15. Indian Pharmacopea; United States Pharmacopea; British Pharmacopea



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 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
Associate Professor
Department of Microbiology
Osmania University, Hyd-07


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BOS in Microbiology
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Sainikpuri

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.	2 Hrs
Bioremediation. Strategies for bioremediation technologies.	
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

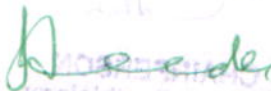
Agricultural Microbiology:

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 – <i>Bacillus thuringiensis</i> , 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 CO₂ 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
 Associate Professor
 Department of Microbiology
 Osmania University, Hyd-07


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 Sainikpuri

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, 1st edition.
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 meningitidis 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

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 – <i>E.coli</i>	3 Hrs
<i>Salmonella typhi</i>	3 Hrs
<i>Shigella dysenteriae</i>	3 Hrs
<i>Vibrio cholerae</i>	2 Hrs
Wound infections – <i>Staphylococcus aureus</i>	2 Hrs
<i>Clostridium tetani</i> , <i>Clostridium welchii</i> ,.	2 Hrs
<i>Pseudomonas aeruginosa</i>	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. diphtheriae*
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 Cruickshank 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.



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 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 biology and 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

20Hrs

Unit I

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

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 Biotechnology 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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Sainikpuri

- 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 Bhupathyaaj, 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



CHAIRPERSON
BOS in Microbiology
Rhavan's Vivekananda College
Sainikpuri

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M.Sc MICROBIOLOGY (2025-27)
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


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


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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 <i>Saccharomyces cerevisiae</i> -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 <i>Mycobacterium tuberculosis</i> .	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


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Reference Books

1. Principles of Protein structure, Schultz, G. E., and Schirmer, R. H. Dr. ShaktiSahi
2. Proteomics, Daniel C. Liebler
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
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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

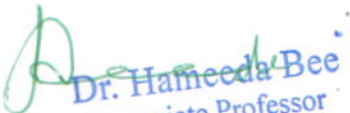
Entrepreneurial society Entrepreneur development – activity – Institutions involved – 3 Hrs
Government contributions to entrepreneurs – risk assessment
Entrepreneur, Entrepreneurship, MSMEs, Enterprise & Startups Process of 4Hrs
Entrepreneurship Competencies & Skills/ Qualities of an Entrepreneur
Types of Entrepreneurs & Enterprise. Approaches to manage capital & cost of capital . 3Hrs
Working capital & cash flow planning.
Financial Planning & Budgets Measuring & reporting financial performance. 3 Hrs
Entrepreneur management and case studies 3 Hrs
Biotechnology entrepreneurship versus general entrepreneurship. Biotech and Pharma 4Hrs
industries. Indian and Global scenario and market.


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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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

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 <i>Arabidopsis thaliana</i> as a model plant.;	3Hrs
Morphogenesis and organogenesis in plants (<i>A. thaliana</i>). 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

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, cellulase, 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 Prescott 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 |

Deeds

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

Usha
CHAIRPERSON
BOS in Microbiology
Bhavan's Vivekananda College
Sainikpuri

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


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


CHAIRPERSON
BOS in Microbiology
Phavan's Vivekananda College
Sainikpuri

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

Food associated molds, yeasts, yeast-like fungi and bacteria.	20 Hrs
	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

Dairy Microbiology - Types of microorganisms in milk and their significance	20 Hrs
	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


CHAIRPERSON
BOS in Microbiology
Bhavan's Vivekananda College
Sainikpuri

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: **2Hrs**

Botulism, Listeriosis, Bacillus cereus food poisoning

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

CHAIRPERSON
BOS in Microbiology
Bhavan's Vivekananda College
Sainikpuri

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 Society of Chemistry. 2015
4. Food Microbiology: An Introduction by T. Montville, K. Matthews, K. Kniel. 4th edition ASM press. 2017.
5. Bibek Ray and Arun Bhunia (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 Jersey.
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. Ray and 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. Indian Edition.
17. Recent Published papers on advances in relevant area to be referred


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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.



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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

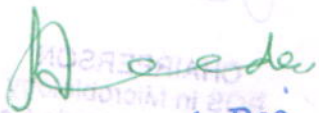
Course Objectives:

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


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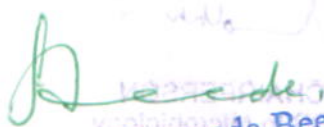
Unit III	20Hrs
Structure, cultivation, pathogenicity, lab diagnostics, prevention and control of Malaria	2Hrs
Amoebiasis	2Hr
Trichomoniasis	2Hr
Helminthic infections	2Hr
Round worms	2Hr
Hook worms	2Hr
Medical Mycology- Dermatomycosis, Systemic mycosis. Types, pathogenesis and diagnostics	5Hrs
Fungal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

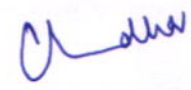
IV Semester- Paper II Practicals (CBCS)
PMB 452 Medical Virology and Parasitology
(Core: 4HPW-2 Credits)

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. Immunodiagnosics - Tridot test for HIV
9. Immunodiagnosics – 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 Rickettsial 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


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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

Usha

**CHAIRPERSON
BOS in Microbiology
Bhavan's Vivekananda College
Sainikpuri**

Hameeda

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

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M.Sc. (Final) Microbiology IV Semester (CBCS)
Paper III PMB 403 Microbial Ecology: Host Microbe Interactions
(HMI) - (Elective III 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

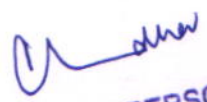
Course Objectives:

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. .

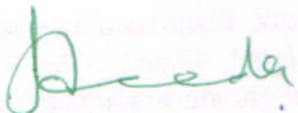
Unit I	20 Hrs
Microbial ecology: Concept of habitat and niche; population and community, biome.	2Hrs
Microbial signaling and Quorum sensing	2Hrs
Planktonic growth and Biofilm formation, Nature of microbial communities	2Hr
Microbial growth curve representing r and k reproductive strategies.	2Hrs
Microbial diversity	2Hrs
Phylogenetic based approach (16S rRNA, Internal transcribed region), Sequence based approach (NGS)., Alpha and beta diversity, 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

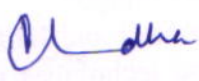

Dr. Hameeda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07


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BOS in Microbiology
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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 <i>Pseudomonas</i> , <i>Bacillus</i> and <i>Trichoderma</i>	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 (<i>Xanthomonas</i>) and (Fungal) <i>Macrophomina</i> infection in plants.	1Hrs
Plant pest (<i>Helicoverpa</i>) nematode (<i>Meloidogyne</i>).	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.	3Hrs
Microbiome of oral cavity, naso-pharynx and respiratory tracts	
Role of human microbiome in infectious, inflammatory non communicable diseases.	3Hrs
Human Gut microbiota (Gut Brain Axis): Health and immunity.	3Hrs
Eubiosis and Dysbiosis	
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


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 Associate Professor
 Department of Microbiology
 Osmania University, Hyd-07


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 BOS in Microbiology
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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. Munehiko Asayama 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


CHAIRPERSON
BOS in Microbiology
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Sainikpuri

M.Sc. (Final) Microbiology IV Semester (CBCS)
Paper III –PMB 403 Nanobiotechnology and Bioinformatics
(Elective III 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
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 Department of Microbiology
 Osmania University, Hyd-07


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BOS in Microbiology
Bhavan's Vivekananda College
Sainikpuri

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.	3 Hrs
Submitting DNA and protein sequence to databases	
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
<i>In silico</i> 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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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. Ghuzang G. Cao. Imperial 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: Biocompatibility by 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. |



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Osmania University, Hyd-07



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BOS in Microbiology
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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 dissertation 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
Hyd-07


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


CHAIRPERSON
BOS in Microbiology
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Sainikpuri

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


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M.Sc. Microbiology (CBCS)
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. Hamceda Bee
Associate Professor
Department of Microbiology
Osmania University, Hyd-07


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BOS in Microbiology
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M.Sc. Microbiology (CBCS)

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), 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	1Hr
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
Osmania University, Hyd-07



CHAIRPERSON
BOS in Microbiology
Phavan's Vivekananda College
Sainikpuri