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**

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M.Sc. Microbiology Semester II

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

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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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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 , Susrutha and Vaghbhata. Pioneers of Microbiology. - Anton Van Leeuwenhoek, Louis Pasteur, Robert Koch, Edward Jenner, Winogradsky, Biejerinck, Alexander Flemming, SelmanWalkmann.	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 gropus 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.

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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 Mandelstum, Mc Quillon and Dawes;
12. Bacterial Metabolism by Dwellely
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

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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. Cultivation and quantification of bacteriophages, plant and animal viruses	**3Hrs**
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, Baculovirdae	**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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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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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

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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 Leaning 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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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, Pyramidines, 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

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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 Km 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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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 Eukaryotic telomere and its replication	4Hrs
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. Detection and analysis of mutations (Replica plating, Antibiotic enrichment, Ames test, etc).	2Hrs
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

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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.

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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

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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. Haematopoeisis, 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 Histocompatability 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

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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. Chimeric Antibodies 2 Hrs
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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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 Heamocytometer 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. Test 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

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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 & $VitB_{12}$
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

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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

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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 Prescot 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

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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, F_0 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. Medicinal plants derived natural products	2 Hrs
Classification of antimicrobial agents. Drugs, Semi-synthetic drugs and Antibiotics, Topical agents. Choice of drug, dosage, route of administration, combined/mixed multi drug therapy.	2 Hrs
Selective toxicity, molecular principles of drug targeting	3 Hrs
Development of synthetic drugs: Sulphanamides, Chloramphenicol, Antitubercular compounds, Quinolinones, Metronidazole, Anti-tumor drugs.	3 Hrs
Mode of action of important drugs – Cell wall inhibitors (Betalactam – e.g. Penicillin),	4 Hrs

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.

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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 Febigor, Baltimore
2. Pharmaceutical Microbiology. Huge, W.B. and Russel, AD.Blackwell Scientific, Oxford
3. Principles and methods of sterilization in health sciences. Perkins, JK. Pub: Charles C. Thomos, 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.

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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

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