

M. Sc ACADEMIC  
BATCH

2023 – 25



**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 from 2023 onwards

**M.Sc. Microbiology Semester I**

Syllabus Ref No	Subject	Credits	Teaching Hours	Marks		
				Internal Assessment	Semester Exam	Total
<b>THEORY</b>						
PMB 101	General Microbiology & Microbial Physiology (Core)	3	3	30	70	100
PMB 102	Virology (Core)	3	3	30	70	100
PMB 103	Research Methodology & Techniques (Core)	3	3	30	70	100
PMB 104	Microbial Biochemistry (Core)	3	3	30	70	100
<b>PRACTICALS</b>						
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
	<b>Total</b>	<b>20</b>	<b>28</b>	<b>120</b>	<b>480</b>	<b>600</b>

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**M.Sc. (Previous) I Semester (CBCS)**  
**Paper I PMB 101 General Microbiology and Microbial physiology (Theory)**  
**(Core) (CBCS) (3 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.

<b>Unit I</b>	<b>15 Hrs</b>
Pioneers of Microbiology. - Anton Van Leeuwenhoek, Louis Pasteur, Robert Koch, Edward Jenner, Winogradsky, Biejerinck, Alexander Flemming, Selman Walkmann.	3 Hrs
Microscopy - Principles, working and applications of bright field microscope, fluorescent microscope, phase contrast microscope, electron microscope	3 Hrs
Microbial Cell Structure: Prokaryotic cell, Eukaryotic cell, Organization and function of cellular organelles.	2 Hrs
Bacterial endospore structure, biochemistry and genetics of sporulation.	1 Hrs
Microbial identification: Staining methods and microscopic; Molecular and genetic characteristics (16srRNA)	2 Hrs
General characters of actinomycetes, fungi, protozoa and algae	4 Hrs
 <b>Unit II</b>	 <b>15 Hrs</b>
Principles of bacterial taxonomy and classification: - Numerical taxonomy, Bergey's manual and its importance, general properties of bacterial groups.	2 Hrs
Microbial nutrition and metabolism: autotrophy – Photoautotroph and bacterial photosynthesis, Chemoautotrophy and heterotrophic metabolism.	2 Hrs
Microbial growth: The concept of growth and definition, formation of protoplasm, building of macromolecules from elemental nutrients, supramolecules, organelles of cell and cellular components.	3 Hrs
Cell cycle in microbes and generation time.	1 Hrs
Growth phases of bacteria and importance of each growth phase.	1 Hrs
Synchronous cultures – Methods of synchronous culturing, Continuous culturing methods.	2 Hrs
Factors effecting growth	2Hrs
Methods of growth measurement	2Hrs

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**Unit III****15 Hrs**

Methods of sterilization and disinfection: Physical methods and chemical methods, Containment facility.	3 Hrs
Microbiological media - Autotrophic media, defined synthetic mineral media, heterotrophic media. The concept of prototrophs and auxotrophs, prototrophic (minimal media) complex media (undefined media).	3 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).	4 Hrs
Isolation of pure cultures.	2Hrs
Preservation and Maintenance of Microbial Cultures: Routine methods and Liquid nitrogen preservation, freeze-drying (Lyophilization), etc.	3Hrs

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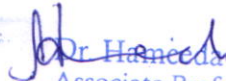
**I Semester Practical Paper I(CBCS)**  
**PMB 151 General Microbiology and Microbial Physiology (4 HPW-2 Credits)**

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)

**Recommended books**

1. Microbiology by Pelczar M.J., Ried, RD and Chan, ECS.
2. Microbiology by Gerard J. Tortora, Berdell Ra. Funke and Christine L. Case. Publ: Pearson Education Inc.
3. Text book of Microbiology by M. Burrows
4. General Microbiology by Stainier, Deudroff and Adelberg Review of medical microbiology by Jawitz, Melnick and Adelberg
5. Bacterial and Mycotic infections of man. Ed. Dubos and Hirst Lipincott
6. Principles of Microbiology and Immunology by Davis, Dulbecco, Eison, Ginsberg and Wood.
7. Microbiology by Pelczar M.J., Ried, RD and Chan, ECS.
8. Microbial Physiology by Moat, Brock's Biology of Microorganisms by Madigan, MT et al
9. Biochemistry of bacterial growth by Mandelstum, Mc Quillon and Dawes;
10. Bacterial Metabolism by Dwellely
11. Photosynthesis by Dewlin and Barker;
12. Laboratory Experiments in Microbiology by Gopal Reddy et al.
13. Microbes in Action by Seoley HW and Van-Demark, PJ
14. Biology of microorganisms by Madigan, MT et al

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**M.Sc. (Previous) I Semester Microbiology (CBCS)**  
**Paper II PMB 102 Virology (Core) (CBCS)**  
**(3 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** **15 Hours**

History of virology (latest Scientific investigations), Viral classification: Baltimore. Recent changes to virus taxonomy, ICTV-Virosphere and Hierarchical ranks	3
Viral metadata resource, viral metagenomics -Virome	1
Virus structure and morphology	1
Detection of viruses: physical, biological, serological and molecular methods.	2
Cultivation and quantification of bacteriophages, plant and animal viruses	2
Sub-viral particles: structure, replication and diseases caused by satellites virus, viroids and prions	2
Significance of emerging viruses: Ebola, Nipah, Hantavirus, Zika virus.	3
General idea about cyanophages, actinophages and mycophages	3

**Unit-2** **15 Hours**

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

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**Unit-3****15 Hours**

Recombination in phages, multiplicity reactivation and phenotypic mixing	3
General account of Tumor virus (RNA and DNA)	3
Viral Interference and Interferons. Classification of Interferons. Antiviral agents (chemical) and their mode of actions	3
Different types of viral vaccines	3
Viral vectors used for cloning and sequencing: Lambda phage, M 13, Retro viruses, CaMV 35S promoter and its application.	3

**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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**M.Sc. (Previous) I Semester (CBCS)**  
**Paper III PMB 103 Research Methodology and Techniques (Theory)**  
**(Core) (CBCS) (3 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.

<b>Unit I</b>	<b>15 Hrs</b>
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	2 Hrs
Chromatographic techniques: HPLC, FPLC, paper, thin layer, ion-exchange, gel-filtration and Affinity-chromatography. Counter current distribution.	2 Hrs
Diffusion, dialysis, cell disruption methods, cell-free protein synthesis, centrifugation techniques.	3 Hrs
Radio isotopes -Detection and Measurement of Radioactivity (Scintillation counter and Geiger-Mueller counter), autoradiography. Radiation safety. Stable isotopes and their use.	3Hrs
<b>Unit II</b>	<b>15 Hrs</b>
Population, sample and sampling procedures, types of variables, and frequency distributions.	3 Hrs
Descriptive statistics: Measures of Central Tendency and Dispersion.	3 Hrs
Elements of probability, Gaussian or Normal distribution, Binomial distribution, Poisson distribution, t-distribution, F-distribution and Chi-square distribution.	2 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.	2Hrs

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<b>Unit III</b>	<b>15Hrs</b>
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.	3 Hrs
MS-Word and MS-Excel	3 Hrs
Data presentation, Manuscript preparation, and Plagiarism	2 Hrs
QA, QC, GLP, GMP, Research ethics, Patents & IPR.	3 Hrs
Introduction to Machine Learning and Artificial Intelligence in Microbiology/Biological Sciences	2 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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**M.Sc. (Previous) Microbiology I Semester (CBCS)**  
**Paper IV PMB 104 Microbial Biochemistry (Core) (CBCS)**  
**(3HPW- 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** **15Hrs**


pH and its biological relevance. Determination of pH. Buffer Preparation and Types of Buffers	2
Concept of entropy, free-energy, free energy changes, high energy compounds. Equilibrium constants	2
Redox potentials, Biological Redox systems, Biological oxidation	2
Biological membranes, Electron transport, Oxidative phosphorylation and mechanism.	3
Lipids classification: Bacterial lipids, Prostaglandins- structure and function, Major steroids of biological importance.	3
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	3

**Unit II** **15 Hrs**

Nucleic acids: Structure and properties of Purines, Pyrimidines, nucleosides and nucleotides.	2
Metabolism of Purines and Pyrimidines - Biosynthesis and degradation	3
Proteins and amino acids: Properties of amino acids, structure, confirmation and properties of proteins	2
Metabolism of amino acids. Biosynthesis and degradation — an overview	2
Enzymes nomenclature and classification, Methods for determination of enzyme activity	2
Isolation and purification of enzymes.	2
Enzyme kinetics: Effect of pH, substrate concentration, temperature and inhibitors.	2

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**Unit III****15 Hrs**

Mechanism of enzyme action – Action of Hydrolases (RNase), Oxidases (Cytochrome Oxidase) and reductases (Ribonucleotide reductase).	3
Coenzyme catalysis (Pyridoxal phosphate and TPP).	2
Isoenzymes.	2
Competitive and non-competitive inhibition.	3
Methods for increased microbial enzymes production and activity. Enzyme engineering.	3
Control and Regulation of enzyme activity: Allosteric enzymes and feedback mechanisms	3
Metabolic compartmentalization in relation to enzyme,	1
Enzymes and secondary metabolites	1

**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)**

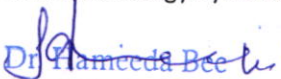
1. Safety and good lab practices, Biochemical calculations
2. Preparation of buffers and adjustment of pH
3. Qualitative tests for carbohydrates and analysis of unknowns
4. Qualitative tests for amino acids and analysis of unknowns
5. Tests for lipids (qualitative)
6. Quantitative estimation of glucose and fructose
7. Determination of Saponification value of fats
8. Partial purification of enzymes ( $\beta$ -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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**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	1
Protein Folding and unfolding	1
Protein functions: structural, storage, transport, hormonal, receptor, contractile, defensive, Catalytic functions	2
Separation techniques – 2-D gel and Polyacrylamide gel electrophoresis (PAGE)	2
Biological mass spectrometry -MALDI-MS, ESI-MS, LC-MS	3
Protein identification – Peptide mass fingerprinting (PMF),	3
Electro blotting and sequencing	3

**Unit II****15 hrs**

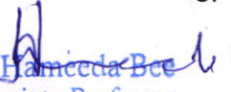
Determination of 3-D structures by X-ray crystallography	2
NMR and Homology modeling	2
Methods of to study Protein-Protein interaction, Protein-DNA interactions	3
Protein microarrays- Protein Markers, Clinical Proteomics, Small peptides	3
Personalized medicine	2
Protein engineering	2
Drug design.	1

**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.

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

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

**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.

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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

Cob 2: Understand the Patent Law, Rights and duties of patentee, Patent processing and Patent drafting.

**Unit 1** **15Hrs**

Introduction to Intellectual Property Rights	2
Types of Intellectual Property Rights - Patents, Trademarks, Copyrights and Industrial designs	3
Geographical indication and plant varieties, Genetic Resources and Traditional Knowledge	3
Trade secrets, semiconductor chip/integrated circuits	2
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	5

**Unit 2** **15Hrs**

Indian patent law- a primer (the patents act, 1970)	1
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	5
Pre-requisites in patenting process (NDA, IDF, SEARCHES)	1
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	3
Patent drafting (enablement, definiteness, clarity etc)	2
Claims (types of claims)	2

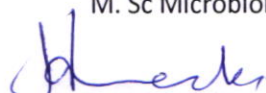
**Course Outcomes:**

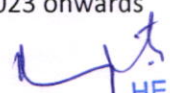
The student will be able to


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.

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## M.Sc. Microbiology Semester II

SEMESTER – II						
Syllabus Ref No	Subject	Credits	Teaching Hours	Marks		
				Internal Assessment	Semester Exam	Total
<b>THEORY</b>						
PMB 201	Molecular Biology and Microbial Genetics (Core)	3	3	30	70	100
PMB 202	Immunology (Core)	3	3	30	70	100
PMB 203	Industrial Microbiology (Core)	3	3	30	70	100
PMB 204	Pharmaceutical Microbiology (Core)	3	3	30	70	100
PMB 205	Seminar, Research paper presentation	-	2	-	-	-
<b>PRACTICALS</b>						
PMB 251	Molecular Biology and Microbial Genetics	2	4	--	100	100
PMB 252	Immunology	2	4			
PMB 253	Industrial Microbiology	2	4	--	100	100
PMB 254	Pharmaceutical Microbiology	2	4			
	<b>Total</b>	<b>20</b>	<b>30</b>	<b>120</b>	<b>480</b>	<b>600</b>

  
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**M.Sc. (Previous) Microbiology II Semester (CBCS)**  
**Paper I MB 201 Molecular Biology & Microbial Genetics (core)**  
**(3 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

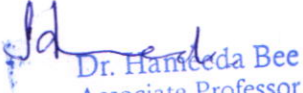
**Unit I** **15Hrs**

Detailed structure of DNA, Z-DNA, A & B DNA, Denaturation and melting curves.	2
Genome organization in prokaryotes and eukaryotes	3
DNA replication- Meselson and Stahl Experiment. Mechanism of Semi conservative replication. Rolling circle model, theta model. Etc. Enzymology of DNA replication	3
Eukaryotic telomere and its replication	
Prokaryotic and eukaryotic transcription	2
Structure and processing of m-RNA, r-RNA t-RNA	2
Ribozyme, Genetic code and Wobble hypothesis	1
Translation in Prokaryotes and eukaryotes, Post translational modifications.	2


**Unit II** **15Hrs**

Concept of gene, Benzer's fine structure of gene – muton, cistron, recon. Types of genes – structural, constitutive, regulatory	2
Gene regulation and expression – Lac operon, arabinose and tryptophan operons, Gene regulation in eukaryotic systems, repetitive DNA, gene rearrangement, promoters, enhancer elements	3
Mutation: Molecular basis of mutations, Physical, chemical and biological mutagens.	2
Detection and analysis of mutations (Replica plating, Antibiotic enrichment, Ames test, etc).	
DNA damage and repair mechanisms	2
Bacterial Recombination -Discovery, gene transfer, molecular mechanism, detection, efficiency calculation and applications.	1
Bacterial transformation- Competency and resistance.	1
Bacterial conjugation – Sex factor in bacteria, F and HFR transfer, linkage mapping	1
Bacterial transduction – transduction phenomenon, methods of transduction.	1
Transposable elements – Definition, detection of transposition in bacteria, types of bacterial transposons and applications of transposons.	2

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<b>Unit III</b>	<b>15Hrs</b>
Principles of genetic engineering: Vectors: Plasmids, phagemids / viral vectors, cosmids, Artificial chromosomes.	4
Restriction Enzymes, Polymerases, ligases, etc	1
General methods of gene cloning: Cloning Techniques: cloning in <i>E-coli</i> , Cloning in <i>Bacillus subtilis</i> , Cloning in Yeast,	3
Selection of recombinants, blue white selection, Expression and detection of cloned genes.	2
Polymerase chain reaction and Quantitative real time PCR.	2
rRNA/ Genomic/ c DNA Library construction and screening.	3

### 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 201CO 2.** 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)

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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<sub>2</sub> 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

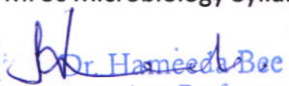


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**M.Sc. (Previous) Microbiology II Semester (CBCS)**  
**Paper II PMB 202 Immunology (Core) (CBCS)**  
**(3 HPW-3Credits)**

**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

<b>Unit 1</b>	<b>15 Hrs</b>
History of immunology. Haematopoeisis, Cell lineage, components of immune system, cells and organs of immune system	2
Antigens –Nature, properties and types. Haptens	2
Antibody - Structure, functions and classification. Isotypes, allotypes and idiotypes	2
Immunoglobulin genes. Generation of antibody diversity. Clonal nature of the immune response - Clonal selection theory.	2
Generation of T cell receptor diversity by genomic rearrangement	3
Structure of B and T cell receptors	1
Overview of Innate and adaptive immunity	1
Toll-like receptors, cell-mediated and humoral immune responses, inflammation	1
Role of inflammasome in innate immune response	1
 <b>Unit 2</b>	 <b>15 Hrs</b>
Major Histocompatibility Complex (MHC)- MHC restriction and processing and presentation of antigen by MHC	2
Transplantation immunology: MHC, types of grafts, grafts rejection, GVH reactions, mechanism of graft rejection, and prevention of graft rejection	2
Immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, Congenital and acquired immunodeficiencies	2
Immunological tolerance-central and peripheral	2
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) and its applications in Immunology. Development Of immuno diagnostic kits	4
Classical, Alternate and Lectin mediated Complement pathways	3

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<b>Unit 3</b>	<b>15 Hrs</b>
Hypersensitivity - immediate and delayed type hypersensitivity reactions	2
Autoimmunity – systemic and localized autoimmune disorders	2
Types of conventional vaccines and principles of Immunization	2
Modern vaccines; peptide, DNA, recombinant / vector, and anti-idiotypic vaccines	1
Schedules of common vaccination, Benefits and adverse consequences of vaccination	1
Production of polyclonal antibodies; Animals models for production of antibodies	1
Hybridoma techniques and monoclonal antibody production. Applications of monoclonal antibodies in biomedical research, clinical diagnosis and treatment. Chimeric Antibodies	2
Immuno suppression and its mechanism of action	1
Immune evasion by bacteria and viruses	1
Tumor immunology. Immuno diagnosis and immune therapy of cancer	2

### 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

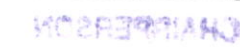
**PMB 202 CO3.** Apply the concepts of Autoimmunity, Hypersensitivity and Relate between cancer and immunology,


  
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## II Semester MB 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)

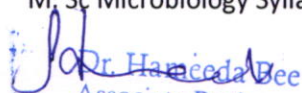
### Recommended Books

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. (Previous) Microbiology II Semester (CBCS)**  
**Paper III PMB 203 Industrial Microbiology (Core) (CBCS)**  
**(3 HPW-3Credits)**

**Objectives:**

**Cob1:** Learn Strain improvement strategies and types of fermentation

**Cob2:** Understand fermentative production of alcohol, beer and wine making

**Cob3:** Gain knowledge on large scale production and applications of penicillin, tetracycline and Immobilization methods

**Unit 1** **15 Hrs**

Introduction to industrial microbiology. Screening and selection of microorganisms for industrially important products like amylase, organic acid, antibiotic, amino acid and vitamins. 4

Strain improvement strategies. Environmental and genetic factors for strain improvement. Inoculum media, inoculum preparation 3

Upstream strategies and raw materials for fermentation process. Cost economics and use of low-cost agro-industrial wastes 3

Fermentation media and sterilization 2

Types of fermentations processes – Solid state, surface and submerged fermentations 3

**Unit 2** **15 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

Fermentative production of industrial alcohol, uses, raw materials, microorganisms, inoculum preparation, preparation of wort, fermentation and recovery 3

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

Principles of wine making – Fruit selection, picking, crushing, sulphite addition, processing, fermentation, aging and bottling 4

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**Unit 3****15 Hrs**

Microorganisms involved, Media preparation, Fermentation and recovery process of Antibiotics – Commercial production of benzyl penicillin, and semi-synthetic penicillins.	4
Fermentative production of tetracyclines – uses, chlortetracycline, oxy-tetracycline, tetracycline and semi-synthetic tetracyclines	3
Downstream strategies for product recovery. Detection and assay of fermentation products. Physico-chemical methods and biological assays	4
Immobilization methods used in industries – Absorption, covalent linkage, entrapment and cross linkage, types of carriers, advantage and disadvantages	4

**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 alcohol, beer and wine making

**PMB 203 CO3.** Discuss large scale production and applications of penicillin, tetracycline and Immobilization methods



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## II Semester MB 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. Immobilization of microbial cells by entrapment method

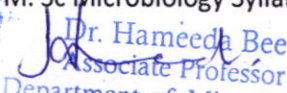
### Recommended Books

1. Industrial Microbiology by Casida, LE
2. Industrial Microbiology by Prescott and Dunn
3. Microbial Technology by Pepler, 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 II Semester (CBCS)**  
**Paper IV 204 Pharmaceutical Microbiology (Core)**  
**(3 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**

**15 Hrs**

- Pharmaceutical industry. Importance of various pharmacopeias with special reference to Indian pharmacopeia, British pharmacopeia, United States pharmacopeia and international pharmacopeia 2  
 Design and layout of sterile product manufacturing unit 1  
 Microbiological issues for inspection of pharmaceutical facilities: Sterilization (D value, z value, F value, F<sub>0</sub> value, survival curve), Depyrogenation, Environmental monitoring, Room design and Equipment, 4  
 Water purification and Delivery system, Personnel, Product sampling, Method suitability test, Sample analysis (Bioburden, Sterility test. Concept of GxP and Quality Assurance in pharmaceuticals. 2  
 Introduction to FDA's CAPA (Corrective and Preventive action) steps requirements and regulations, OOPs, SOPs. ISO, WHO and US certification 2  
 Understanding the changing dynamics of pharma ecosystem. 1  
 Digitization of equipment, instrument, air and water systems. 1  
 Adherence to guidelines like GAMP (Good automated manufacturing practice and CFR (Code of federal regulations). 21 2

**Unit II**

**15 Hrs**

- History of chemotherapy –Paul Ehrlich and his contributions. Arsenicals as therapeutics. 2  
 Medicinal plants derived natural products  
 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  
 Selective toxicity, molecular principles of drug targeting 1  
 Development of synthetic drugs: Sulphanamides, Chloramphenicol, Antitubercular compounds, Quinolones, Metronidazole, Anti-tumor drugs. 3  
 Mode of action of important drugs – Cell wall inhibitors (Betalactam – eg. Penicillin), membrane inhibitors (Polymyxins), macromolecular synthesis inhibitors (streptomycin). 3

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Macrolides and antifungal antibiotics (Nystatin).	
Drug metabolism and Response; Pharmacokinetics (ADME), Pharmacodynamics, Pharmacogenomics	2
Emerging antimicrobial resistance (AMR) and antimicrobial resistance genes (ARG) in different environments	2

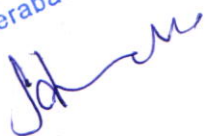
**Unit III****15Hrs**

Antimicrobial Effectiveness Testing (AET): Microbial contamination and spoilage of certain pharmaceutical products sterile injectable, non-injectable, ophthalmic preparations, implants	5
Cosmetic products and preservatives (PET), Bacterial endotoxin testing	2
Non antibiotic antimicrobial compounds: Metals and Biocides (Phenol coefficient/RWC).	3
Drug sensitivity testing methods and their importance.	2
Antibiotic potency tests / Microbial assays for antibiotics – Determination of MIC, the liquid tube assay, solid agar tube assay, agar plate assay (disc diffusion, agar well and cylinders cup method).	3

**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 MB 254 Pharmaceutical Microbiology Practicals (CBCS) - Paper II

1. Bioburden testing methods for pharmaceutical and cosmetic products
2. Sterility testing by *Bacillus stearothermophilus* or any other method
3. Sampling of pharmaceuticals for microbial contamination and load (syrups, suspensions, creams and ointments, ophthalmic preparations).
4. Determination of D value, Z value for heat sterilization in pharmaceuticals.
5. Determination of antibacterial spectrum of drugs/antibiotics
6. Testing for antibiotic/drug sensitivity/resistance
7. Determination of MIC, LD 50 of antimicrobial chemicals
8. Microbiological assays for antibiotics (Liquid tube, agar tube, agar plate assays)
9. Antimicrobial effectiveness testing
10. Bioassay with Chloramphenicol
11. Bacterial endotoxin test (Demonstration through kit or tutorial mode)
12. Bioassays with any plant / microbial secondary metabolites against Gram positive and Gram negative bacteria
13. Tests for disinfectants : Phenol coefficient/RWC
14. 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. Hüge, 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.
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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**M.Sc. Microbiology II Semester (CBCS)**  
**MB 205: Seminar: Review Paper Presentation**

All the students have to make power point presentation of the Review or Research article of area of their interest in Microbial Sciences. The focus of presentation can be towards the Project work that would be taken up during IV semester.

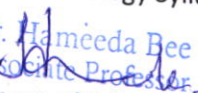
**Note:**

However, there are no credits and internal assessment can be done by the faculty members.

  
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