# M. Sc ACADEMIC BATCH 2022 – 24

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 from 2022 onwards

## 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)** | 4 | 4 | 30 | 70 | 100 |
| PMB 102 | Virology **(Core)** | 4 | 4 | 30 | 70 | 100 |
| PMB 103 | Research Methodology &Techniques **(Core)** | 4 | 4 | 30 | 70 | 100 |
| PMB 104 | Microbial Biochemistry **(Core)** | 4 | 4 | 30 | 70 | 100 |
| | **PRACTICALS** | | | | | |
| PMB 151 | General Microbiology | 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** | **24** | 32 | **120** | **480** | **600** |

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# SEMESTER I

## M.Sc. (Previous) I Semester (CBCS)
## Paper I PMB 101 General Microbiology and Microbial physiology (Core) (CBCS) (4 HPW-4 Credits)

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

**Objectives:**

**Cob1.** Describe the history of Microbiology and to learn principles of microscopy.
**Cob 2.** Discuss Microbiological culturing methods
**Cob 3.** Outlines of bacterial taxonomy
**Cob 4.** Explain microbial growth and factor effecting growth

**Unit I**

Pioneers of Microbiology. - Anton Van Leewenhoek, Louis Pastuer, Robert Koch, Edward Jenner, Winogradsky, Biejerinck, Alexander Flemming, SelmanWalkmann.

Microscopy - Principles, working and applications of bright field microscope, fluorescent microscope, Phase contrast microscope, electron microscope.

Microbial Cell Structure: Prokaryotic cell, Eukaryotic cell, Organization and function of cellular organelles. Bacterial endospore structure, biochemistry and genetics of sporulation

**Unit II**

Methods of sterilization and disinfection: Physical methods and chemical methods, Containment facility. Microbiological media - Autotrophic media, defined synthetic mineral media, heterotrophic media. The concept of prototrophs and auxotrophs, prototrophic (minimal media) complex media (undefined media).

Cultivation of Bacteria, Fungi and Algae: Routine and special culture methods Agar slant, Agar stab, Agar plate, Rolled tube, Test tube, Flask, Aerobic and Anaerobic.

Isolation of pure cultures.

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

**Unit III**

Identification methods and classification of bacteria: -

Microscopic identification characteristics, staining methods. Ecological identification methods, Nutritional (cultural) identification characters, biochemical identification methods, immunological characteristics, Molecular and genetic characteristics identification (16s rRNA).

Principles of bacterial taxonomy and classification: - Numerical taxonomy, Bergey's manual and its importance, general properties of bacterial groups.

Microbial nutrition and metabolism: autotrophy – Photoautotroph and bacterial photosynthesis Chemoautotrophy and heterotrophic metabolism.

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**Unit IV**

Microbial growth: The concept of growth and definition, formation of protoplasm, building of macromolecules from elemental nutrients, supramolecules, organelles of cell and cellular components. Cell cycle in microbes and generation time.

Growth phases of bacteria – Lag phase, exponential (logarithmic) phase, stationary (ideo) phase, decline and survival of microbial cells. Importance of each growth phase.

Synchronous cultures – Methods of synchronous culturing, Continuous culturing methods, factors effecting growth.

Methods of growth measurement

**Recommended books**


Microbiology by Pelczar M.J., Ried, RD and Chan, ECS.

Microbiology by Gerard J. Tortora, Berdell Ra. Funke and Christine L. Case. Publ: Pearson Education Inc.

Text book of Microbiology by M. Burrows

General Microbiology by Stainier, Deudroff and Adelberg Review of medical microbiology by Jawitz, Melnick and Adelberg

Bacterial and Mycotic infections of man. Ed. Dubos and Hirst Lipincott

Principles of Microbiology and Immunology by Davis, Dulbecco , Eison, Ginsberg and Wood.

Microbiology by Pelczar M.J., Ried, RD and Chan, ECS.

Microbial Physiology by Moat, Brock's Biology of Microorganisms by Madigan, MT et al

Biochemistry of bacterial growth by Mandelstum, Mc Quillon and Dawes;

Bacterial Metabolism by Dwellely

Photosynthesis by Dewlin and Barker;

Laboratory Experiments in Microbiology by Gopal Reddy et al.

Microbes in Action by Seoley HW and Van-Demark, PJ

Biology of microorganisms by Madigan, MT et al


**Course Outcomes:**

**Students will be able to**

**PMB 101 CO1.** Apply concepts of microscopy for identifying various microbes

**PMB 101 CO2.** Experiment different microbial culturing techniques

**PMB 101 CO3.** Distinguish bacteria based on taxonomy

**PMB 101 CO4.** Summarize factors on microbial growth

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## I Semester Practical Paper I(CBCS)
## PMB 151 General Microbiology (6 HPW-3Credits)

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, differential media.
6. Isolation and cultivation of pure cultures
7. Identification methods of bacteria
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)

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## M.Sc. (Previous) I Semester Microbiology (CBCS)
## Paper II PMB 102Virology (Core) (CBCS)
## (4 HPW-4 Credits)

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

**Objectives:**

**Cob 1.** Describe virus classification, structure, detection methods and replication
**Cob 2.** Comparison of lytic and lysogenic viruses.
**Cob 3.** Outline the concepts of recombination in phages.
**Cob 4.** Discuss the applications of viruses in various areas

**Unit I**

History of virology (latest Scientific investigations), Viral classification and nomenclature (ICTV system of classification).

Virus structure and morphology. Detection of viruses: physical, biological, immunological, serological and molecular methods. isolation, purification, identification and quantification of bacteriophages, plant viruses and animal viruses.

Sub-viral particles: Discovery, structure, replication and diseases caused by satellites virus, viroids and prions. General idea about cyanophages, actinophages and mycophages.

**Unit II**

Virus replication Strategies: Principal events involved in replication: Adsorption, penetration, uncoating nucleic acid and protein synthesis, intracellular trafficking, assembly, maturation and release, viral-host interaction, Host response to viral infection. An Overview of Cellular interactions—clatharin coated pits, lipid rafts, endocytosis and virus uncoating mechanisms. Comparison of Lytic cycle and lysogenic cycle (T4 Bacteriophage, Lambda). Morphology, Ultrastructure, Genome organization and replication strategies of Adeno Virus., TMV. Influenza virus – HIV, HBV.

**Unit –III**

Recombination in phages, multiplicity reactivation and phenotypic mixing

General account of Tumor virus (RNA and DNA).

Viral Interference and Interferons. Nature and source of interferons, Classification of interferons. Induction of interferons. Antiviral agents (chemical and biological) and their mode of actions.

**Unit –IV**

Introduction to viral vaccines, preparation of vaccines. Viruses as cloning vectors. Vectors used for cloning and sequencing: λ phage, M 13, retro viruses. CaMV 35S promoter and its application. Baculovirus System for insect cell lines and its importance, Viruses as therapeutic agents, viruses for gene delivery, viruses to destroy other viruses.



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**Recommended Books**

Recent publications: Research papers and review articles General Virology
by Luria and Darnel
Virology and Immunology by Jokli
Text book of Virology by Rhodes and Van Royen
Plant Virology by Smith
Genetics of bacteria and their viruses by W. Hayes
Molecular Biology of the gene by Watson, Roberts, Staitz and Weiner
A laboratory guide in virology by Chjarles H. Lunningham
Basic lab procedures in diagnostic virology by Marty Cristensen
Review of medical microbiology by Jawitz et al
Medical laboratory manual for tropical countries Vol I & II by Monica Cheesbrough
Text Book of Microbiology by Ananthanarayanan and Jayaram Paniker
Viral and Ricketsial infections of Man by Horsfall and Jam
Text book of Virology by Rhodes and Van Royan
Virological Procedures by Mitchal hasking
Virology by Wilson and Topley

**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.
**PMB 102 CO3.** Interpret concepts of recombination in phages.
**PMB 102 CO4.** Summarize applications of viruses in various areas

## I Semester Practical Paper II
## (CBCS) PMB 152 Virology (6 HPW-3Credits)

1. Isolation of phage from different soil samples & sewage samples
2. Cultivation and preservation of phages.
3. Quantification of phages
4. Growth phages of phage and burst size (Demonstration)
5. Phage induction
6. Cultivation of animal viruses in egg allantoic, amniotic and CAM
7. Symptomatic observations / slides plant viral infections
8. Demonstration of cytopathological changes of animal virus (slides/pictures)

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## M.Sc. (Previous) Microbiology I Semester (CBCS)
## Paper III PMB 103 Research Methodology & Techniques (Core) (CBCS)
## (4 HPW-4 Credits)

**Overall Course Objectives:** This course provides knowledge in principles of biochemical techniques, Statistical concepts and basics in computers.

**Objectives:**

**Cob 1.** Present principles of Optical and Electrophoretic techniques.
**Cob 2.** Outline various Separation and radioactive methods.
**Cob 3.** Illustrate the techniques in descriptive statistics to study samples.
**Cob 4.** Demonstrate tests of inference, confidence intervals and scientific writing

**Unit I**
Optical methods: colorimetry and spectrophotometry, fluorimetry, optical rotation Circular dichroism, NMR, ESR spectroscopy, x-ray diffraction, types of mass spectrometry. Electrophoretic techniques and application, counter current distribution.

**Unit II**
Separation methods: Chromatographic techniques – HPLC, FPLC paper, thin layer, ion exchange, gel filtration and affinity chromatography.
Diffusion, dialysis, cell disruption methods, centrifugation techniques, cell free extracts and their use in metabolic studies.
Radio isotopes – detection and measurement of radioactivity – scintillation counters, autoradiography, stable isotopes and their use. Safety precautions. General method of study of intermediary metabolism in microbes. Uses of mutants in study of metabolism.

**Unit III**
Population, samples and sampling procedures, variables, variations and frequency distributions, measures of central tendency and dispersion, element of probability, gaussian or normal distribution, binomial distribution, Poisson distribution, 't' distribution, 'F' distribution and Chi-square distribution, correlation and linear regression.
Normal curve test, 't' test, 'F' test, ANOVA, analysis of covariance, Chi-square test, and confidence intervals. DMRT and its use in biological experiments. Experimental designs using statistical tools.

**Unit IV**
Introduction to Computers
Introduction to disk operating systems (DOS): Sample commands, DIR-CD-RD-DEL-COPY-MOVE-REN-TYPE-EDIT (Editor) CE-DATE and TIME.
Introduction to Windows: Word Processing: Electronic Spread Sheet
Data collection, Data representation, Manuscript preparation, Plagiarism, Research ethics, QA, QC, GLP, GMP, Patents & IPR

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**Recommended books**

Biochemistry by Lehninger
Outlines of Biochemistry by Cohn and Stumph
Biological Chemistry by Mullar and Cards
Biochemistry by White, Handler and Smith
Methods in Enzymology series
The Cell – Bratch amd Mirsky series
Laboratory experiments in Microbiology by Gopal Reddy etal
Biochemistry lab manual by Jayaraman
Introduction to the theory of statistics by Alexander, M Mood and Franklin
Fundamentals of Biometry by L.N.Balam
Statistical methods by Snedecor and Cochran
Introduction to computer and its application by Chae C.Chien
Basic Programming language by Bajaraman
Biostatistics – A manual of statistical methods for use in Health, Nutrition and Anthropology by K. Vishveshwar Rao

**Outcomes:**

Students will be able to

**PMB 103 CO1.** Select the right method for probing a given property of a sample molecule
**PMB 103 CO2.** Apply the most appropriate method for separation of molecules in a given mixture.
**PMB 103 CO3.** Use Excel and apply appropriate statistical analysis.
**PMB 103 CO4.** Write an organized scientific manuscript for a project.

**I Semester Practical Paper II**
**(CBCS) PMB 153 Research Methodology and Techniques)**
**(4 HPW-2Credits)**

1. Creating documents using MS word processor
2. Usage of spreadsheet to biological applications
3. Biostatistics- Problems
4. Absorption maxima of proteins, NA, tyrosine and riboflavin (Determination of molar extinction coefficient, calculations based on Beer Lambert's Law)
5. Estimation of protein concentration by UV-Vis spectrophotometry and Folin Lowry method
6. Estimation of inorganic and organic phosphate by Fiske-Subbarao method
7. 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 proteins and DNA



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## M.Sc. (Previous) Microbiology I Semester (CBCS)
## Paper IV PMB 104 Microbial Biochemistry (Core) (CBCS)
## (4 HPW-4Credits)

**Overall Course Objectives:** This paper provides knowledge in Bioenergetics, Classification and metabolism Biomolecules and basic concepts in Enzymology.

**Objectives:**

**Cob 1.** Discuss biological significance of pH and fundamental concepts of Bioenergetics
**Cob 2.** Classify the Structure, and Properties Lipids, Carbohydrates, Nitrogen Bases, Proteins, Amino acids
**Cob 3.** Differentiate mechanism of aerobic and anaerobic respiration
**Cob 4.** Describe the classification, mechanism, Isolation & purification enzymes

**Unit I**

pH and its biological relevance
Concept of entropy, free-energy, free energy changes, high energy compounds. Equilibrium constants, Redox potentials, Biological redox systems, biological oxidation, biological membranes, electron transport, oxidative phosphorylation and mechanism. Lipids classification: Bacterial lipids, prostaglandins, structure, function, Major steroids of biological importance.

**Unit II**

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.
Respiration (Aerobic and anaerobic) and fermentation. Glycolysis (EMP, HMP and ED) pathways. TCA Cycle and its integration
Nucleic acids: Structure and properties of purines, pyrimidines, nucleosides and nucleotides. Metabolism of purines and pyrimidines - Biosynthesis and degradation

**Unit III**

Proteins and amino acids: Properties of amino acids, structure, confirmation and properties of proteins, metabolism of amino acids, biosynthesis and degradation – an overview.
Enzymes nomenclature, classification methods for determination of enzyme activity. Isolation and purification of enzymes. Enzyme kinetics: Effect of pH, substrate concentration, temperature and inhibitors.

**Unit IV**

Mechanism of enzyme action – Action of Hydrolases, Oxidases and reductases. Coenzyme catalysis (pyridoxal phosphate and TPP). Isoenzymes. Competitive and non-competitive inhibition. Methods for increased microbial enzymes production and activity. Enzyme engineering. Control of enzymes. Regulation of enzyme activity: allosteric enzymes and feedback mechanisms. Metabolic compartmentalization in relation to enzyme, enzymes and secondary metabolites



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metabolites

**Recommended Books**

Biochemistry by Lehninger
Outlines of Biochemistry by Cohn and Stumph
Biochemistry of Nucleic acids by Davidson
Biological Chemistry by Mullar and Cards
Biochemistry by White, Handler and Smith
Methods in Enzymology series
The Cell – Bratch and Mirsky series
Biochemistry lab manual by Jayaraman

**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 qualitative analysis
**PMB 104 CO3.** Perform enzyme assay and calculate enzyme activity
**PMB 104 CO4.** Identify enzymes from various sources and purify them.

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

1. Safety and good lab practices
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

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## M.Sc. Microbiology Semester II

| Syllabus Ref No | Subject | Credits | Teaching Hours | Marks | | |
|---|---|---|---|---|---|---|
| | | | | Internal Assessment | Semester Exam | Total |
| | **THEORY** | | | | | |
| PMB 201 | Molecularbiology& Microbial Genetics **(Core)** | 4 | 4 | 30 | 70 | 100 |
| PMB 202 | Environmental &Agricultural Microbiology **(Core)** | 4 | 4 | 30 | 70 | 100 |
| PMB 203 | Immunology **(Core)** | 4 | 4 | 30 | 70 | 100 |
| PMB 204 | Pharmaceutical Microbiology **(Core)** | 4 | 4 | 30 | 70 | 100 |
| | **PRACTICALS** | | | | | |
| PMB 251 | Molecularbiology, Microbial Genetics, | 2 | 4 | | 50 | 50 |
| PMB 252 | Environmental &Agricultural Microbiology | 2 | 4 | | 50 | 50 |
| PMB 253 | Immunology | 2 | 4 | | 50 | 50 |
| PMB 254 | Pharmaceutical Microbiology | 2 | 4 | | 50 | 50 |
| | **Total** | **24** | 32 | **120** | **480** | **600** |

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# SEMESTER II

## M.Sc. (Previous) Microbiology II Semester (CBCS)
## Paper I PMB 201 Molecular Biology & Microbial Genetics (Core) (CBCS)
## (4 HPW-4 Credits)

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

**Objectives:**
**Cob 1.** Describe DNA structure and genome organization
**Cob 2.** Illustrate DNA replication, transcription, translation and gene regulation
**Cob 3.** Outline mutations types, DNA damage and repair mechanisms.
**Cob 4.** Present Bacterial Recombination and Genetic mapping

**Unit I**

Detailed structure of DNA, Z-DNA, A & B DNA, Denaturation and melting curves. Genome organization in prokaryotes and eukaryotes, Enzymes involved in DNA replication, Modes of DNA replication- Detailed mechanism of Semiconservative replication. Plasmids: nature, classification, properties and replication.
Eukaryotic telomere and its replication.

**Unit II**

Prokaryotic and eukaryotic transcription. Structure and processing of m-RNA, r-RNA t-RNA. Ribozyme, Genetic code and Wobble hypothesis, Translation in Prokaryotes and eukaryotes, Post translational modifications, Gene regulation and expression – Lac operon, arabinose and tryptophane operons, Gene regulation in eukaryotic systems, repetitive DNA, gene rearrangement, promoters, enhancer elements.

**Unit III**

Types of mutagens, Molecular basis of mutations. Physical and chemical mutagenic agents: UV, Ethidium Bromide and Nitrous oxide. Detection and analysis of mutations (Replica plating, Antibiotic enrichment, Ames test etc.). DNA damage and repair mechanisms. Global response to DNA damage. Transposable elements – Types of bacterial transposons and their applications

**Unit IV**

Bacterial Recombination-Discovery, gene transfer, molecular mechanism, detection, efficiency calculation and applications. Bacterial transformation- Competency and resistance.
Bacterial conjugation – Sex factor in bacteria, F and HFR transfer, linkage mapping.
Bacterial transduction – transduction phenomenon, methods of transduction, co-transduction, generalized, specialized and abortive transduction, sex-ductions.

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**commended books**

olecular biology by Robert Weaver
olecular Biology By Upadhyay and Upadhyay
Iolecular biology by David and Freifelder
Microbial genetics by David and Freifelder
Molecular biology Mc Linsky
Molecular biology of the Gene by Watson et al
Principles of Biochemistry by Nelson and Cox, Lehninger
Molecular biotechnology by Primrose
Molecular Biotechnology by Bernard R. Glick and Jack J Pasternak
Molecular Genetics of Bacteria by Larry Snyder and Wendy Champness

**Course Outcomes:**

Students will be able to

**PMB 201 CO1.** Compare the structural variations of DNA and genome organization
**PMB 201CO2.** Illustrate Replication, Transcription, translation and gene regulation
**PMB 201CO3.** Differentiate the types of mutations, DNA damage and repair mechanisms.
**PMB 201 CO4.** Solve problems in genetic recombination for genetic mapping

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

1. Isolation of genomic DNA from E. coli and Yeast.
2. Estimation of DNA and RNA (colorimetry)
3. Determination of molecular weight of DNA, resolved on agarose gel electrophoresis
4. Induction of Lac operon
5. Induction of mutations by physical/chemical mutagens, screening and isolation of mutants, Replica plating technique.
6. Transformation in bacteria
7. Conjugation in bacteria
8. Protoplast preparation, Fusion and regeneration counting

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## M.Sc. (Previous) Microbiology II Semester (CBCS)
## PMB 202 Paper II Environmental and Agricultural Microbiology (Core) (CBCS)
## (4 HPW-4Credits)

**Overall Course Objectives:** This paper provides concepts on environmental microbiology, bioremediation, microbial decomposition, production and significance of biofertilizers.

**Objectives:**

**Cob 1.** Describe the importance of air and water flora.
**Cob 2.** Discuss the concepts of bioremediation technologies.
**Cob 3.** Determine the role of microbes in decomposition.
**Cob 4.** Outlines of Biofertilizers and PGPR.

**Unit I**
Microorganisms in air and their importance (brief account); Microorganisms and water pollution Water-borne pathogenic microorganisms and their transmission; Sanitary quality of water; Water pollution due to degradation of organic matter; Aerobic sewage treatment – Oxidation ponds, trickling filters, activated sludge treatment; Anaerobic sewage treatment – Septic tank.

**Unit II**
Strategies for bioremediation technologies. Bioaugmentation; Methods of enumeration and activity of microbes in environment; Microbial biodegradation of organic pollutants; A brief account of biodegradable plastics and super bug. Microorganisms and their roles in fundamental biogeochemical cycles.

**Unit III**
Degradation of carbonaceous materials in soil – cellulose, hemicellulose and lignin decomposition, factors governing the decomposition and biochemistry of decomposition, Soil humus formation, Nitrification –Microbes involved, factors influencing nitrification, nitrifying bacteria and biochemical mechanism. Denitrification – microbes involved, factors influencing and the mechanism of denitrification. Nitrate and phosphate pollution

**Unit IV**
Nitrogen fixation – Asymbiotic and symbiotic nitrogen fixation, microorganisms involved, biochemistry and genetics of nitrogen fixation, measurement of nitrogen fixation, ecological and economic importance of nitrogen fixation. Biofertilizers – bacterial fertilizers and production of rhizobial inoculants and blue-green algae, quality control tests, Microbes and plant interactions – Rhizosphere, Phyllosphere and Mycorrhizae.

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**Recommended Books**

Recent Published papers on advances in relevant area to be referred
Soil Microbiology by Alexander Martin
Microbial ecology, Fundamentals and Applications Ed. Benjamin-Cummings
Environmental Biotechnology-Fundamentals and applications. By Parihar (Agrobios india – publishers)
Soil Microbiology by Singh, Purohit,Parihar published by student edition.
Soil Biotechnology by JM Iynch
Microbial Ecology: Organisms, Habitats, and Activities by Stolp, H.
Soil Microbiology and Biochemistry by Paul E. and PE Clank
Microbial Ecology: Principles, Methods and Applications by Lavin, Seidler, Rogul
Biological Nitrogen Fixation by Quispel
Soil Microorganisms and Plant Growth by N.S,. Subba Rao.
Laboratory experiments in microbiology by Gopal Reddy et al
Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom production technology by K R Aneja
Biofertilizers for sustainable Agriculture by Arun K. Sharma
Environmental Microbiology by K. Vijaya Ramesh (MJP Publishers) Brock Biology of Micro organisms by Madigan et al
Waste water microbiology by Bitton, G.
Waste water treatment – Biological and chemical process by Henze, M.
Biodegradation and Bioremediation second edition by Martin Alexander (Academic press 2001)
Bioremediation - Principles and Applications by Ronald L Crawford and Don L Crawford , Cambridge University Press
Biological indicators of freshwater pollution and environmental management. Elsevier Applied Science Publishers, London. (1986). J.M. Helawell
Biology of freshwater pollution. Third edit. Longman Group (1996).C. F. Mason

**Course Outcomes:**

Students will be able to

**PMB 202 CO1.** Construct a mind map on role of microbes in air and water pollution
**PMB 202 CO2.** Summarize the role of microbes in bioremediation technologies
**PMB 202 CO3.** Interpret the role of microbes in decomposition
**PMB 202 CO4.** Apply the concepts of biofertilizers for better and sustainable agricultural practice.

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## II Semester Practical II

## PMB 252 Environmental and Agricultural Microbiology -CBCS

## (4 HPW-2Credits)

1. Isolation and observation of air microflora
2. Enumeration of soil microorganisms (bacteria, actinomycetes, fungi) by standard plate count
3. Estimation of soil microbial activity by $CO_2$ evolution
4. Estimation of BOD
5. Testing for microbial sanitary quality of water (coliform test)
6. Bioremediation of organic pollutants and their effect on soil microbial activity
7. Isolation of cellulose decomposing microbes and estimation of cellulose activity
8. Estimation of ammonifiers, nitrifiers and denitrifiers in soil by MPN method
9. Isolation and culturing of Rhizobium sps from root nodules
10. Biological enrichment isolation of Rhizobium from soil by Leonard Jar experiment
11. Observation and assessment of soil algae/algal biofertilizers
12. Isolation and observation for phyllosphere microflora
13. Isolation and observation for rhizosphere microflora
14. Observation for Mycorrhizae

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## M.Sc. (Previous) Microbiology II Semester (CBCS)
## Paper III PMB 203 Immunology (Core) (CBCS)
## (4 HPW-4Credits)

**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:**

**Cob 1.** Describe the Antibody structure and diversity
**Cob 2.** Discuss the types of immunity and immunological responses to various antigens
**Cob 3.** Outline immunological techniques, Hypersensitivity and autoimmunity
**Cob 4.** Review on relationship between cancer and immunology

**Unit I**

History of immunology. Hematopoiesis, Cell lineage, components of immune system, cells and organs of immune system.

Antigens –Nature, properties and types. Haptens

Antibody -Structure, functions and classification. Isotypes, allotypes and idiotypes. Immunoglobulin genes. Generation of antibody diversity. Clonal nature of the immune response - clonal selection theory.

Generation of T cell receptor diversity by genomic rearrangement

Structure of B and T cell receptors

**Unit II**

Overview of Innate and adaptive immunity

Toll-like receptors, cell-mediated and humoral immune responses,

Major Histocompatibility Complex (MHC). Human leucocyte antigen (HLA) restriction Processing and presentation of antigen by MHC. Transplantation immunity, Immunosuppression and its mechanism of action.

Immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, Immune evasion by bacteria and viruses.

Congenital and acquired immunodeficiencies.

Immunological tolerance-central and peripheral.

**Unit III**

Auto immunity and Hypersensitivity - immediate and delayed type hypersensitivity reactions. Classical and alternate Complement pathways

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), ChIP, Surface Plasma Resonance and its applications in Immunology. Development Of immuno diagnostic kits.

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NIT –IV

/pes of conventional vaccines and principles of Immunization.

Modern vaccines; peptide, DNA, recombinant / vector, and anti-idiotypic vaccines Schedules of common vaccination, Benefits and adverse consequences of vaccination. Production of polyclonal antibodies; Animals models for production of antibodies

Hybridoma techniques and monoclonal antibody production. Applications of monoclonals in biomedical research, clinical diagnosis and treatment. Chimeric Antibodies.

Tumor immunology. Immuno diagnosis and immune therapy of cancer

**Recommended Books**

Kuby Immunology

Cellular and molecular immunology by Abul K. Abbas et al

Test book of Immunology by Barret

Immunology – The science of self-non self-discrimination by Jan Klein

Essential Immunology by Roitt, IM

Immunology by Tizard

The elements of Immunology by Fahim Halim Khan

Immunology and immunopathology by Stewart Sell

**Outcomes:**

**Students will be able to**

**PMB 203 CO1.** Illustrate the Antibody structure and diversity

**PMB 203 CO2.** Summarize the types of immunity and immunological responses to various antigens

**PMB 203 CO3.** Apply immunological techniques practically

**PMB 203 CO4.** Relate between cancer and immunology

**II Semester Practical Paper III**
**PMB 253 Immunology (CBCS)**
**(4 HPW-3Credits)**

1. Agglutination reactions – Widal, VDRL, HA, Blood typing
2. Precipitation test- single radial diffusion, Ouchterlony double diffusion. Immunoelectrophoretic.
3. Neutralization test – Plaque neutralization, Haeme adsorption test.
4. WBC and RBC count and differential blood picture.
5. Separation of serum proteins.
6. Blot transfer and detection of protein on blot by staining.
7. ELISA
8. Purification of IgG from serum
9. Indirect agglutination (Pregnancy hCG Ag)



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## M.Sc. (Previous) Microbiology II Semester (CBCS)
## Paper IV PMB 204 Pharmaceutical Microbiology (Core) (CBCS)
## (4 HPW-4Credits)

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

**Objectives:**

**Cob 1.** Present concepts in microbial spoilage, prevention and preservation of pharmaceutical products, GMP

**Cob 2.** Discuss concepts of chemotherapy and anti-microbial agents.
**Cob 3.** Relate the principles of Chemotherapy and important antibiotic drugs in therapy
**Cob 4.** Review the methods of microbiological assays in Cosmetic microbiology and pharmaceutical industry

**Unit I**

Microorganisms affecting pharmaceutical industry – The atmosphere, water, skin & respiratory flora of personnel, raw-materials, packing, equipment, building, utensils etc. Types of microorganisms occurring in pharmaceutical products.
Microbiological spoilage prevention of pharmaceutical products.
Preservation of pharmaceutical products; antimicrobial agents used as preservatives, evaluation of the microbial stability of formulation
The sterilization in pharmaceutical industry
Good manufacturing practices in pharmaceutical industry

**Unit II**

History of chemotherapy – plants and arsenicals as therapeutics, Paul Ehrlich and his contributions, selective toxicity and target sites of drug action in microbes. Development of synthetic drugs – Sulphanamides, antitubercular compounds, nitrofurans, nalidixic acid, metronidazole group of drugs.
Antibiotics - The origin, development and definition of antibiotics as drugs, types of antibiotics and their classification. Non-medical uses of antibiotics.
Cosmetics microbiology- testing methods and preservation
Antimicrobial preservation efficacy and microbial content testing

**Unit III**

Principles of chemotherapy – Clinical and lab diagnosis, sensitivity testing, choice of drug, dosage, route of administration, combined/mixed multi drug therapy, control of antibiotic/drug usage.
Mode of action of important drugs – Cell wall inhibitors (Beta lactam – e.g. Penicillin), membrane inhibitors (polymyxins), macromolecular synthesis inhibitors (streptomycin), antifungal antibiotics (nystatin)

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**arse Outcomes:**

**tudents will be able to**

**PMB 204 CO1.** Analyze microbial spoilage, prevention and preservation of pharmaceutical products, GMP

**PMB 204 CO2.** Discriminate the mode of actions of various anti-microbial agents

**PMB 204 CO3.** Use Practical skills in preservation and testing of various industrial products.

**PMB 204 CO4.** Perform microbiological assays in pharmaceutical industry

**II Semester Practical Paper III**
**PMB 254 Pharmaceutical Microbiology (CBCS)**
**(4 HPW-3Credits)**

1. Sterility testing methods for pharmaceutical and cosmetic products
2. Tests for disinfectants (Phenol coefficient/RWC)
3. Determination of antibacterial spectrum of drugs/antibiotics
4. Determination of MIC valued for antimicrobial chemicals
5. Chemical assays for antimicrobial drugs – Streptomycin, Sulphamethoxyzole, Trimethoprim

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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 | Food Microbial technology **(Core)** | 4 | 4 | 30 | 70 | 100 |
| PMB 302 | Medical bacteriology **(Core)** | 4 | 4 | 30 | 70 | 100 |
| PMB 303 | **DSE**<br>A. Microbial Ecology and Plant Microbe Interactions<br>Or<br>B. Advances in Biotechnology | 4 | 4 | 30 | 70 | 100 |
| PMB 304 | **DSC**<br>Industrial Microbiology | 2 | 2 | 15 | 35 | 50 |
| PMB 305 | MOOCS on line course | 2 | 2 | | 50 | 50 |
| | **PRACTICALS** | | | | | |
| PMB 351 | Food Microbial technology | 2 | 4 | | 50 | 50 |
| PMB 352 | Medical Bacteriology | 2 | 4 | | 50 | 50 |
| PMB 353 | Microbial Ecology and Plant Microbe Interactions& Industrial Microbiology | 2 | 4 | | 50 | 50 |
| PMB 354 | Project course work | 2 | 4 | | 50 | 50 |
| | **Total** | **24** | 32 | **105** | **495** | **600** |

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**M.Sc. (Final) Microbiology III Semester (CBCS)**
**PMB 301 Paper I Food Microbial Technology** (Core)
**(4 HPW-4Credits)**

**Overall Course Objectives:** To summarize on Fermented foods, Preservation methods, Dairy Microbiology, Probiotics, Prebiotics and Food poisoning

**Course Objectives:**

**The student will be able to**

**Cob 1**. Understand the conceptof fermented foods and food spoilage mechanisms
**Cob 2.** Articulate the overall concept of role of microorganisms in Dairy Microbiology displaying its different types, significance and control.
**Cob3.** Discuss in detail the concept of Prebiotics and Probiotics displaying their health benefits.
**Cob4.** Discuss the phenomenon of bacterial and fungal food intoxication and integrate the mechanism of toxicity and detoxification of mycotoxins.

**Unit I**
Introduction to fermented foods; Fermented vegetables, Fermented vegetables, Health aspects of fermented foods; Processing and fermentation of Sauerkraut and pickles; Cereal and legume based fermented products- Soya Sauce, Tempeh; Microbiology of bread and idly; Food preservation methods and food safety issues. Spoilage of foods and factors governing the spoilage.

**Unit II**
Dairy Microbiology - Types of microorganisms in milk, significance of microorganisms in milk, Microbial products of milk- Acidophilus Milk, Bifidus Milk, Bulgarian milk, Kefir, Kumiss, Microbiology of cheese, butter, yogurt; Microbiological examination of milk, Control of microbial flora of milk. Microbes and animal interactions- Rumen Microbiology, Production and Significance of Silage.

**Unit III**
Probiotics and Prebiotics: Properties and beneficial effects of probiotics and prebiotics; Screening methods of Probiotics; Genetically Modified Probiotics.Mushrooms production: Cultivation of different types of Mushrooms; Edible Mushrooms; Therapeutic value of edible Mushrooms.

**Unit IV**
Screening and Enumeration of spoilage microorganisms, Detection of pathogens in food. Bacteriological examination of fresh and canned foods; Microbial Food poisoning, risks and hazards; Mycotoxins: Groups of mycotoxins, effects on human and animal health, Detoxification Methods (Physical, Chemical and biological) and Mechanism of toxicity. Food Quality: Importance and functions of quality control. Food packing techniques.

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**Recommended books**

Recent Published papers on advances in relevant area to be referred
Food Microbiology by Frazier
Bibek Ray and Arun Bhunia ( 2008) Fundamental Food Microbiology 4th Ed. CRC Press.
Adams M R and Moss M O (2008) Food Microbiology 3rd Ed. RSC Publishing.
Microbial Ecology – A conceptual approach by Lynch and Poole
Basic food microbiology (Abridged edition) by George J. Banwart
Brock's Biology of Micro organisms by Madigan et al
Probiotics 3 by R. Fuller, G. Perdigon (Kluwer Academic Publishers)
Probiotics and Prebiotics: Scientific Aspects by Gerald W. Tannock *University of Otago, Dunedin, New Zealand (*Caister Academic Press*)*
Biotoxicology by Kamal narayan and Vohra.Laboratory experiments in microbiology by Gopal Reddy et al.

**III Semester Practical Paper I**
**PMB 351 Food Microbial technology (CBCS)**

1. Microbiological examination of fresh and canned foods and mushrooms.
2. Microbiological examination of spoiled foods and fruits.
3. Microbiological examination of milk and milk products.
4. Microbiological quality testing of milk (MBRT test).
5. Isolation and cultivation of anaerobic microbes from Rumen
6. Extraction of Mycotoxins from contaminated grains/foods.
7. Isolation and identification of bacterial probiotics like LAB.
8. Isolation and Identification of probiotic Yeast.
9. Screening of probiotic organisms for co-cultural and antagonistic activity; Production of probiotic biomass.
10. Production of Mushrooms.

**Outcome:**

**The student will be able to**

**PMB 301 CO1.** Discussthe significance of fermented foods in daily lives and describe the overall role of microbes involved in food processing.

**PMB 301 CO2.** Explain Dairy Microbiology and measure the role of different types of microbes and their significance.

**PMB 301 CO3.** Validate the concept and importance of Probiotics and Prebiotics.

**PMB 301 CO4.** Comprehend the overall concept involved in Microbial Intoxication (Bacterial and Fungal) and review detoxification measures.

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**Recommended Books**

Review of Medical Microbiology by Jawitz, Melnick and Adelberg
Diagnostic Microbiology by Bailey and Scott
Medical Microbiology by Cruckshanak et al Vol I & II
Text book of Microbiology by Ananthanarayanan and Jayaram Paniker

**III Semester Practical Paper II**
**PMB 352Medical Bacteriology (CBCS)**

1. Preparation of different types of culture media/observation. Blood Agar, Chocolate Agar, Mannitol salt agar, Blair Parker medium, MacConkey agar, Lowenstein-Jensen medium, Wilson Blair Bismuth sulphite medium, Biochemical media.
2. Staining techniques – Gram's staining, AFB staining, Albert Staining, Capsular staining
3. Isolation and identification of various pathogenic bacteria by microscopic, macroscopic, biochemical, enzymatic and serological tests (Coagulase, Catalase, WIDAL,VDRL tests.)
4. Examination of pathogenic bacteria /permanent slides.
5. Bacteriological examination of urine, pus, throat swab etc from patients for diagnosis.
6. PCR based diagnosis.

**Course Outcomes:**

**The student will be able to**

**PMB 302 CO1**. Explainthe clinically important microorganisms and Normal flora of human body

**PMB 302 CO2.** Describethe nature and basic concepts of pathogenic microorganisms, infection and process of diagnosis and perform the requisite diagnostic protocols

**PMB 302 CO3.** Discuss of air borne and sexually transmitted bacterial pathogens bacterial pathogens.

**PMB 302 CO4.** Illustratewater borne bacterial pathogens and wound infections of bacteria.

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**M.Sc. (Final) Microbiology III Semester (CBCS)**
**Paper II PMB 302 Medical Bacteriology (Core)**
**(4 HPW-4Credits)**

**Overall Course Objective:** To summarize on clinical significance of pathogenic bacteria

**Course Objectives:**

**The student will be able to**

**Cob 1.**Understandmedical importance andClassification of microorganisms and Normal flora of human body
**Cob 2.** Discuss basic concept on Properties of pathogenic microorganisms and infections. Introduction to Diagnostic microbiology
**Cob 3.** Describe Bacterial air borne infections and sexually transmitted diseases caused by bacteria
**Cob 4.** UnderstandSystematic bacteriological study on Water borne infections and Wound infections

**Unit I**
Principles of Medical Microbiology:
Classification of medically important microorganisms. Normal flora of human body – Origin of normal flora, factors that influences normal flora, role of the resident flora, effect of antimicrobial agents on normal flora, characteristics of normal flora
Distribution and occurrence of normal flora (Skin, conjunctiva, nose, nasopharynx, sinuses, mouth, upper respiratory tract, intestinal tract, urogenital tract)
Bacteria in the blood and tissues.

**Unit II**
Properties of pathogenic microorganisms. Factors that influence pathogen city
Type of infections, source of infections, different modes/means of infections
Diagnostic microbiology – Types of specimens, specimen collection, transportation of specimen, processing, laboratory investigations, specific lab. Tests, non-specific lab tests, diagnosis and report. Use of lab animals in diagnostic microbiology.

**Unit III**
Systematic bacteriology – Detailed study of morphology, cultural characteristics, antigenic structure, pathogenesis, diagnostic lab tests (conventional and molecular), epidemiology, prevention and treatment of the following bacterial pathogens.
Bacterial air borne infections: Beta-Hemolytic Streptococci, Pneumococci, *Corynebacteium diphtheriae, Mycobacterium tuberculosis, Mycobactterium leprae, Neisseria meningitides, Haemophilus influenzae.*
Sexually transmitted diseases caused by bacteria, *Treponema pallidum, Neisseria gonorrhea.*

**Unit IV**
Systematic bacteriology – Detailed study of morphology, cultural characteristics, antigenic structure, pathogenesis, diagnostic lab tests (conventional and molecular), epidemiology, prevention and treatment of the following pathogenic bacteria:
Water borne infections – *E. coli, Salmonella typhi, Shigella dysenteriae, Vibrio choleraae.*
Wound infections – *Staphylococcus aureus, Clostridium tetani, Clostridium welchi, Pseudomonas.*

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**M. Sc. III Semester Microbiology (CBCS)**
**Paper III PMB 303: Microbial Ecology and Plant Microbe Interactions DSE (A)**
**(Elective-I)**
**(4 HPW-4Credits)**

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

**Objectives:**

**The student will be able to**
**Cob 1.**Understandconcepts of microbial distribution and diversity in natural environmentsand molecular methods for microbial diversity analysis.
**Cob 2.**Appreciatethe Role of PGPR and PGPM in agriculture, applicationof Microbialformulations and detection of bioinoculants.
**Cob 3.** Identify bacterial and fungal pathogens and their control strategiesand significance of integrated pest management.
**Cob 4.** Understand molecular interactionsbetween plant & microbe, two-component Signalling,systemic and induced resistance, Quorum sensing Systems in Microorganisms and their role in Pathogenesis.

**Unit I**
Microbial ecology: Concept of habitat and niche. Concept of population and community. Development of microbial communities. Microbial growth curve representing r and k reproductive strategies. Planktonic growth and Biofilm formation.
Concept of plant probiotics (Seed endophytes and plant endophytes). Microbial community diversity analysis: Phylogenetic based approach (16s rRNA, Internal transcribed region), Taxon based approach (gene diversity index, Shannon's diversity index), Sequence based approach (Pyrosequencing, NGS).

**Unit II**
Plant growth promoting microorganisms (PGPM): Plant growth promoting rhizobacteria (PGPR): Direct and Indirect mechanisms of plant growth promotion.
Microbial formulations (peat, lignite, talc) and mode of inoculation in soil conditions.
Detection of microbial inoculants by staining, biochemical and molecular methods.
Plant-microbe beneficial interactions: Pseudomonas-Plant Interaction and Bacillus Plant Interactions and Trichoderma-Plant Interactions.
Role of biotic and abiotic factors in plant- microbe interactions

**Unit-III**
Plant Pathology and pests. Plant Disease Triangle. Diseases caused by fungi: *Sclerotium rolfsii* and *Macrophomina phaseolina* (collar rot disease, charcoal rot), bacteria: *Xanthomonas campestris* (black rot), actinomycetes: *Streptomyces scabies* (common scab).
Infections caused by pest: *Helicoverpa armigera* and*Spodoptera litura*
Biological and chemical control methods for plant diseases and pest management.

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**Unit-IV**

Molecular plant microbe-interactions: Impact of root-beneficial microbe interactions on aboveground plant phenotypic plasticity. Two-component signal transduction system (Gac S and Gac A) in plant growth promoting bacteria

Cell signalling and Quorum sensing in Gram negative bacteria, acylated homoserine lactones (AHLs), Gram positive bacteria (peptides), yeast (Farnesols), Fungi (Oxylipins). Intra and inter species communication, Inter-kingdom signalling.

Host-pathogen interactions. Basic concept of plant immunity (MAMPs, PAMPs). Plant defence mechanisms (induced systemic resistance (ISR); systemic acquired resistance (SAR).

**Recommended Books:**

PGPR: biocontrol and biofertilization by Zaki A. Siddiqui

Plant-bacteria interactions: strategies and techniques to promote plant growth by Iqbal Ahmad, John Pichtel, S. Hayat

Plant Growth and Health Promoting Bacteria by Dinesh K. Maheshwari

Microbes For Sustainable Agriculture by K.V.B.R. Tilak, K.K. Pal, Rinku Dey

Biochemical and genetic mechanisms used by plant growth-promoting bacteria by Bernard R. Glick

Plant-microbe interactions, Volume 1 by Gary Stacey and Noel T. Keen

Biological control of crop diseases Volume 89 of Books in soils, plants, and the environment by S. S. Gnanamanickam

Plant-microbe interactions and biological control Volume 63 of Books in soils, plants, and the environment by Greg J. Boland, L. David Kuykendall

New Perspectives and Approaches in Plant Growth-Promoting Rhizobacteria Research by Philippe Clemenceau, Peter Bakker & Jos Raajimakers

**III Semester Practical Paper III PMB 353**
**Microbial Ecology and Plant Microbe Interactions DSE (A) (Elective I)**

1. Isolation of plant growth promoting bacteria (PGPB) from soil, compost, vermicompost
2. Screening PGPBfor nitrogen fixation, P-solubilisation, Siderophore production on selective medium
3. Isolation of Pseudomonas on Kings B medium and microscopic identification
4. Isolation of Actinomycetes on selective medium and microscopic identification
5. Isolation of Trichoderma on selective medium and microscopic identification
6. Isolation of bacteria with ability to produce plant growth hormone Indole acetic acid (IAA)
7. Quantification of IAA by spectrophotometric method
8. Quantification of phosphate by spectrophotometric method
9. Isolation of antagonistic microbes using dual-culture method
10. Pseudomonas and its metabolites for anti-fungal activity
11. Bacillus and its metabolites for anti-fungal activity
12. Trichoderma and its metabolites for anti-fungal activity
13. Isolation of plant pathogenic fungi*S. rolfsi*, *Fusarium* spp. etc. on specific media
14. Detection of QS compounds in Bacteria.

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**M.Sc. III Semester Microbiology (CBCS)**
**Paper III PMB 303Advances in Biotechnology DSE (B)(Elective-II)**
**(4 HPW-4Credits)**

**Overall Course Objectives:**To introducePlant genetic engineering, Principle and applications of Animal cell culturing, Genetic diseases and testing, Gene therapy, Tissue engineering.

**Course Objectives:**

**The student will be able to**

**Cob 1.** Learn Biotic and abiotic stress tolerance and transgenic plants
**Cob 2.** Understandin animal cell culturing methods, Cloningtechniques & Applications in Stem Cell Technology
**Cob 3.** ClassifyNanoscale systems and synthesis of nanomaterials, Applications of Nanoparticular carrier systems.
**Cob 4.** Identify methods ofGenetic Testing of diseases and disorders, Gene therapy, Pharmacogenomics, Tissue and Biomolecular Engineering.

**Unit-I**
Plant Genetic Engineering for Productivity and Performance—
Biotic Stress Tolerance- Herbicide resistance, Glyphosate, Insect Resistance, Bt Toxin, Disease Resistance, Virus resistance
Abiotic Stress Tolerance-- Drought, Flooding, Salt and temperature.
By manipulation of—Photosynthesis, Nitrogen fixation, Nutrient uptake Efficiency. For Quality Improvement-Protein, Lipids, carbohydrates, vitamins and Minerals. Biosafety concerns of transgenic plants
Plants as bioreactors.

**Unit-II**
Animal Tissue Culture: Primary culture, Organ culture, Embryo Culture, Established Cell lines
Scale up, Cryopreservation, Culture Collections
Risks and Safety, Bioethics.
Stem Cell Technology, Cloning techniques Applications.
Transgenic and knockouts: Transgenic cattle, transgenic birds, transgenic fish
Applications: Transgenic mice: i) Retroviral method ii) DNA microinjection Method iii) Engineered Embryonic Stem cell method

**Unit-III**
Nanoscale systems, nanoparticles, nanowires, thin films and multilayers; Properties of nanomaterials.
Synthesis of nanostructures - physical, chemical and biological, microbiological methods
Biomolecules as nanostructures.
Nanoparticular carrier systems, Micro and Nanofluidics.
Applications: Biosensors, drug and gene delivery systems, chip technologies, nano imaging, Nanomedicine and Cancer diagnostics and treatment.

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**Course Outcomes:**
**The student will be able to**

**PMB 303CO1.** Describemicrobial diversity and calculate statistical indices for diversity and explain molecular methods of diversity analysis.

**PMB 303CO2.** Explain direct and indirect mechanisms of plant growth promotion by PGPR and develop microbial formulations for field application

**PMB 303CO3.** Detectdifferent bacterial and fungal pathogens based on signs and symptoms of plant diseases and their management using integrated pest control.

**PMB 303CO4.** Explain molecular mechanism of pathogen recognition, induced and systemic resistance in plants and describe different quorum sensing circuits of microbes.

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**III Semester Practical Paper III**
**PMB (B) 353 Advances in Biotechnology DSE(B)(Elective-II)**

1. Terminology, Laboratory design of Animal tissue culture laboratory
2. Preparation of complete medium, Sterilization and sterility checking.
3. Chick embryo fibroblast culture, viable staining.
4. Preparation of Nanosilver By Wet reduction
5. Method(Chemical),using Neem Extract (plants) & Bacteria(Microbiological)
6. Characterization of Nanosilver by UV spectrometry and microscopic methods
7. Antimicrobial effect of Ionic silver and Nanosilver prepared by above methods.
8. Study of Nanosilver coated Gauze/textiles for antimicrobial effect on different bacteria.

**Course Outcomes:**

**The student will be able to**

**PMB 303CO1.** Describe Biotic and abiotic stress tolerance, quality improvement in plants by genetic engineering methods .
**PMB 303CO2.** Explainanimal cell culturing methods, cloning techniques & Applications in stem cell technology .
**PMB 303CO3.** Discussthe Nanoscale systems and synthesis of nanomaterials, Applications of Nanoparticular carrier systems, Micro and Nanofluidics
**PMB 303CO4.** Narratemethods ofTesting for Genetic diseases, Gene therapy and explain significance of Tissue and Biomolecular Engineering

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**Unit-IV**

Genetic testing of diseases and disorders, Cancer genetics. Immunogenetics; prenatal Diagnosis-chorionic villus sampling, amniocentesis, Pre-implantation Diagnosis. Genetic counselling.
Gene therapy-concept, vectors, gene targeting and tissue-specific expression, Antisense Technology
Introduction to pharmacogenomics, Pharmacogenetics and toxicogenomics
Social- genetic discrimination: insurance and employment, human cloning, Foeticide, Sex determination
Tissue Engineering, Methods of Synthesis, Biomolecular Engineering

**Recommended Books**

1.Plant Biotechnology: The genetic manipulation of plants,2005,A.Slater ,N.Scott & M.Fowler, Oxford Univ Press, Oxford.
2. Introduction to Plant Biotechnology(3rd Edtn), H.S. Chawla
3. Roberta Smith, Plant Tissue Culture: Techniques and Experiments,2nd Edtn,Academic Press,2000
4. H.K.Das(ed),Textbook of Biotechnology,Wiley India,2004
5. J.H.Hammond, P.Mcgarvey, and V.Yusibov(eds), Plant Biotechnolgy,Springer Verlag,Heidelberg,2000
6. B.B.Buchanan, W.Gruissen and R.L.Jones(eds), Biochemistry and Molecular Biology of Plants,American Society of Plant Biology,Rockville,USA,2000.
7. Plant Biotechnology and Agriculture:Prospects for the 21st Century, Arie altman ,Paul Michael Hasegawa,
8. Plant Biotechnology and Genetics:Principles, Techniques & Applications, Stewart, C.Neal,June 2008,John Wiley &Sons
9. Animal Cell Culture by Ian Freshney
10. Basic Cell Culture. Ed.J.M.Davis 2nd.Ed 2007. Oxford press
11. Animal Cell Culture Sudha Gangal
12. Principles of biotechnology and applications-Glick and Pasternack
13. Nanobiotechnology by David Goodsell. John Wiley
14. Handbook of Nanostructured biomaterials and their applications in nanobiotechnology by Nalwa HS 2005. American scientific publishers
15. Nanobiotechnology by Niemeyer CM & Mirkin CA 2005 .Wiley Interscience
16. Jogdand S. N., Medical Biotechnology, Himalaya Publishing House, Mumbai, (2008)
17. Judit Pongracz, Mary Keen, Medical Biotechnology, Churchill Livingstone, Elsevier (2009)
18. Pratibha Nallari & V. Venugopal Rao, Medical Biotechnology, Oxford University Press, India (2010)
19. U. Satyanarayana. Biotechnology

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**M.Sc. III Semester Microbiology (CBCS)**
**Paper IV PMB-304 Industrial Microbiology (DSC)**
**(2 HPW-2 Credits)**

**Overall Course Objectives:**Update knowledge in new frontiers of Industrial Microbiology and Microbial Technology

**Course Objectives:**
**The student will be able to**

**Cob 1.** Understandindustrially important microorganisms and their products, fermenter design and its types,learn screening microbes of industrial importance, Detection and assay of fermentation products and strain development strategies.

**Cob 2.** Categorize types of fermentation processes, fermentation type reactions, methods of scale up & down stream processes. Discuss Methods of Immobilization,Advantages and disadvantages.

**Unit I**

Introduction to industrial microbiology. Definition, scope, history, microorganisms, properties and industrial products. Screening for microbes of industrial importance. Primary screening, screening for amylase, organic acid, antibiotic, amino acid and vitamin producing microorganisms. Secondary screening. Further evaluation of primary isolates. Fermentation equipment and its use. Design of fermenter, type of fermenter, agitation, aeration, antifoam, pH and temperature control. Inoculum media, inoculum preparation. Raw materials Saccharides, starchy and cellulosic materials Fermentation media and sterilization.

**Unit II**

Batch, fed batch and continuous fermentations. Direct, dual or multiple fermentations.
Scale-up of fermentations. Detection and assay of fermentation products. Physico-chemical methods and biological assays. Product recovery methods. Strain development strategies. Environmental factors and genetic factors for improvement. Immobilization methods – Absorption, covalent linkage, entrapment and cross linkage, types of carriers, advantage and disadvantages.

**Recommended Books**

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

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Microbial Enzymes and Biotechnology by Fogarty WM and Kelly, CT
Comprehensive Biotechnology, All volumes Ed. Murray Moo-Yong
Biotechnology (A text book of industrial Microbiology) Ed.
Cruger&Cruger Advances in Applied Microbiology Ed. Perlman Series
of volumes

**Semester III PracticalPaper IV**
**PMB 353 Industrial Microbiology**

1. Screening for amylase producing organisms
2. Screening for organic acid producing microorganisms
3. Isolation of antibiotic producing microorganisms by crowded plate technique
4. Isolation and culturing of yeasts
5. Separation of amino acidsby chromatography
6. Estimation of glucose by DNS method
7. Estimation of ethanol by dichromate method
8. Estimation of maltose
9. Immobilized bacteria/yeast/enzyme in fermentation

**Course Outcomes:**

**The student will be able to**

**PMB-304CO1.** Describeindustrially important microorganisms,fermenter designs,explain screening methods of industrial important microorganisms &analyse fermentative products and describe optimization of fermentation media.

**PMB-304CO2.** Explain theprocess of fermentation and narratesale up & down stream processes in industry, Microbial bio pesticides, products from genetically modified microbes and immobilization

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

**(2 HPW-2 Credits)**

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

**Semester III**
**PMB 354: Project Course Work (CBCS)**
**(4 HPW-2 Credits)**

**COURSE OBJECTIVES**

**COb1.** To explain the retrieval of research articles from literature databases.
**COb2.** To demonstrate the use of MS office tools to prepare various types of scientific documents.

1. Students will be allocated with a research topic
2. Students will carry out Review of Literature on assigned topic.
3. Practical knowledge of MS Word, MS Excel, MS Power point for preparation of project report.
4. Writing a review of literature related to the selected research problem followed by presentation of data either as power point presentation or as scientific posters.
5. Submission of hard copy of Work plan and Review of literature for evaluation.
6. Awareness on research ethics and plagiarism.
7. Evaluation will be based on seminar presentation at the end of semester on review of literature and test skills on scientific writing.

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## M.Sc. Microbiology Semester IV

| Syllabus Ref No | Subject | Credits | Teaching Hours | Marks | | |
|---|---|---|---|---|---|---|
| | | | | Internal Assessment | Semester Exam | Total |
| | **THEORY** | | | | | |
| PMB 401 | Cell and Molecular Biotechnology**(Core)** | 4 | 4 | 30 | 70 | 100 |
| PMB 402 | Medical virology and Parasitology **(Core)** | 4 | 4 | 30 | 70 | 100 |
| PMB 403 | Microbial biotechnology **(Core)** | 4 | 4 | 30 | 70 | 100 |
| PMB 404 | **DSE**<br>A. Nanobiotechnology& Bioinformatics<br>Or<br>B. Microbial Proteomics | 4 | 4 | 30 | 70 | 100 |
| | **PRACTICALS** | | | | | |
| PMB 451 | Cell Molecular Biotechnology | 1 | 2 | | 25 | 25 |
| PMB 452 | Medical virology and parasitology | 1 | 2 | | 25 | 25 |
| PMB 453 | Microbial biotechnology | 1 | 2 | | 25 | 25 |
| PMB 454 | Nanobiotechnology& Bioinformatics | 1 | 2 | | 25 | 25 |
| PMB 455 | Project | 4 | 8 | | 100 | 100 |
| | **Total** | **24** | **32** | **120** | **480** | **600** |
| | **Grand Total** | **96** | **128** | **480** | **1920** | **2400** |

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**M.Sc. (Final) Microbiology IV Semester (CBCS)**
**Paper I PMB 401: Cell and Molecular Biotechnology (Core)**
**(4 HPW-4Credits)**

**Overall Course Objective:**
This paper is designed to lay foundation in principles and application of cell cycle regulation and cancer induction, r DNA technology, cloning strategies for prokaryotic and eukaryotic organisms and modern methods used in molecular diagnosis and therapy.

**Course Objectives:**
**The student will be able to**
**Cob 1.** Acquaint with concepts in cell cycle regulation, Programmed cell death, Cancer biologyand Insight into Signal transduction pathways.
**Cob 2.** Gain practical knowledge in cloning Vector design, sequencing methods of DNA/Protein, molecularlibraries construction and cloning strategiesin Prokaryotic and eukaryotic systems.
**Cob 3.** Learn Principle and applications of Molecular Techniques like-PCR, RT PCR, RAPD, RFLP, SSR and modern methods like Site directed mutagenesis, Reverse genetics, Gene Silencing.
**Cob 4.**Understandthe methodologies and application of Gene therapy, Transgenic and Gene Knock out in Plants and Animals. Acquaint with novel methods like Stem Cell technology and Genome Engineering.

**Unit I: Cell division**
Cell cycle:Cell division regulation and cancer. Role of protein kinases in cell cycle, Programmed cell death. Genotoxicity assays.
Signal transduction: G-Protein linked receptors. Concept of second messenger, cAMP & cGMP; Steroid/peptide hormone regulation, tissue specific regulation
Cancer biology and genetics: role of oncogenes and tumor suppressor genes – examples, Myc, ras, src, p53, RB, BCR-Abl

**Unit II: rDNA technology**
Vectors in Molecular Biology, Artificial chromosomes,
Enzymes, Polymerase chain reaction, DNA/Protein sequencing,
rRNA/ Genomic/ c DNA Library construction and screening.
Cloning Techniques: cloning in *E. coli*, Yeast and insects, mammalian cells
Cloning strategy, Transformation, Selection, Expression and detection of cloned genes.

**Unit III : Molecular techniques**
Quantitative real time PCR
Molecular techniques: Analysis of Protein-protein and protein-DNA interactions. Biochips (DNA chips and Protein chips). DNA fingerprinting and DNA markers: RAPD, RFLP, AFLP, Simple sequence repeat (SSR) markers. Site directed mutagenesis, Reverse Genetics, Epigenetics, Gene knock out – RNAi and Gene silencing,

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**Unit IV: Applications of molecular biotechnology**

Gene therapy: vectors, safety considerations (SCID,

Transgenic and knockout plants and animals – vectors: i) Retroviral method ii) DNA microinjection method iii) Engineered Embryonic Stem cell method, selection, Bt cotton, Transgenic cattle, Transgenic birds, Transgenic fish, Transgenic mice

Stem Cell Technology, Cloning techniques Applications.

Genome engineering (ZFNs, TALENs, CRISPR)

**Recommended Books**

Molecular biology by Robert Weiver
Molecular biology by David and Freifelder
Microbial genetics by David and Freifelder
Molecular biotechnology by Chanarayppa
Methods in Molecular Cloning by Sambrook.
Genetics of bacteria and their viruses by William Hayes
Molecular biology of the gene by Watson et al
The Biochemistry of nucleic acids by Davidson JN
Molecular biotechnology by Primrose
Molecular Biotechnology by Bernard R. Glick and Jack J Pasternak
DNA Microarrays Ed. M. Schena

**IV Semester Practical Paper I**

**PMB :451 Cell and Molecular Biotechnology (CBCS)**

1. Isolation of Plasmid DNA,
2. Isolation of RNA and Proteins from *E. coli*.
3. Restriction mapping
4. PCR technique.
5. Demonstration of gene cloning in bacteria,
6. Southern Blot,
7. RFLP.
8. Recombinant confirmation (Gel shift assays, blue white selection).

**Course Outcomes:**

**The students should be able to**

**PMB 401CO1.**Describe the mechanism of cell cycle regulation, apoptosis and Cancer induction &inheritance, Signal transduction pathways.

**PMB 401CO2.**Choose appropriatecloning vectors, sequencing methods for DNA /Protein, molecular library construction andcloning techniques in prokaryotes and eukaryotes.

**PMB 401CO3.**Identify the Molecular Techniques like-PCR,RT PCR,RAPD,RFLP, SSR for application in molecular diagnostics and Discuss on Site directed mutagenesis, Reverse genetics, Gene knock and Gene Silencing, Gene therapy.

**PMB 401CO4.** Categorize Transgenic Plants and Animals with their applications; Explain the significance of Stem Cell technology and Genome Engineering applications in biology.

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**M.Sc. (Final) IV Semester Microbiology (CBCS)**
**Paper II PMB 402: Medical Virology and Parasitological (Core)**
**(4 HPW-4Credits)**

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

**Course Objectives:**
**The students should be able to**

**Cob 1.** Understand to Diagnostic microbiology anddescribe studyon Viral air borne infections
**Cob 2.**Perform Systematic study on Water borne and Zoonotic viral infections
**Cob 3.** Describe study on viral Sexually transmitted diseases
**Cob 4.**Gain knowledge onParasitic and Mycotic infections.

**Unit I**
Diagnostic virology – Cultivation of pathogenic viruses in lab animals and tissue culture Identification of pathogenic viruses and establishment of viral etiology
Structure, cultivation, pathogenicity, lab diagnostics, prevention and control of air borne viral infections – Influenza virus, Rhinovirus, Corona virus, Rubella virus, Adeno virus (type 2), Mumps virus and Measles virus.

**Unit II**
Structure, cultivation, pathogenicity, lab diagnostics, prevention and control of viruses transmitted by water - Hepatitis (HAV), Polio myelitis
Structure, cultivation, pathogenicity, lab diagnostics, prevention and control of viruses transmitted by Zoonosis – Rabies, Japanese encephalitis

**Unit III**
Structure, cultivation, pathogenicity, lab diagnostics, prevention and control of contact and sexually transmitted viral diseases – Small pox, Herpes (Herpes simplex virus), Hepatitis viruses and their diseases
Acquired immunodeficiency syndrome (AIDS)

**Unit IV**
Structure, cultivation, pathogenicity, lab diagnostics, prevention and control of Malaria, Amoebiasis, Trichomoniasis, Helmithic infections (Round worms, Hook worms).
Medical Mycology – Dermatomycosis, Systemic mycosis.

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**Recommended Books**

Review of medical microbiology by Jawitz et al
Medical laboratory Manual for tropical countries Vol I & II by Monica Cheesbrough
Text Book of Microbiology by Ananthanarayanan and Jayaram Paniker
Viral and Ricketsial infections of Man by Horsfall and Jam
Text book of Virology by Rhodes and Van Royan
Virological Procedures by Mitchal hasking
Virology by Wilson and Topley

## IV Semester Practical Paper II
## PMB 452: Medical Virology and Parasitology

1. Tissue culture techniques (demonstration)
2. Microscopic studies of viruses infected materials (demonstration)
3. Examination of pathogenic fungi
4. Examination of stool for Hookworm, Round worm
5. Examination of stool for *Entamoeba histolytica*
6. Examination of blood smear by Leishman stain for Malarial parasites
7. Immunodiagnosis - Tridot test for HIV, Hepatic test for HBV, ELISA.

**Course Outcomes:**

**The students should be able to**

**PMB 402 CO1.**Explainthe process of diagnosis and perform the requisite diagnostic procedures for identification of virusesand list out air borne viral pathogens
**PMB 402 CO2.**Classifywater borne viral pathogens andZoonotic viral pathogens
**PMB 402 CO3.**Describesexually transmitted viral pathogens
**PMB 402 CO4.** Categorizeparasitic and mycotic infections

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**M.Sc. IV Semester Microbiology (CBCS)**
**Paper IV PMB-403 Microbial Biotechnology (Core)**
**(4 HPW-4 Credits)**

**Overall Course Objective:** Update knowledge in the frontiers of Microbial Fermentative Products

**Objectives:**
**The students should be able to**
**Cob 1.** Learn commercial production and down streaming processing of citric acid, Vitamin B12, glutamic acid, benzyl penicillin, and semi-synthetic Penicillin, Tetracycline.
**Cob 2.** UnderstandFermentative production of alcohol, beer and wine.
**Cob 3.** Gain knowledge on large scale production and application of microbial enzymes.
**Cob 4.** Acquaint with major microbiological disciplines like steroid transformation, Microbial Biopesticides, immobilization, Microbial products from Genetically modified organisms

**Unit I**
Types of fermentations processes – Solid state, surface and submerged fermentations
Fermentation type reactions, alcoholic, lactic acid, mixed acid, propionic acid, butanediol and acetone-butanol types
Fermentative production of industrial alcohol, uses, raw materials, microorganisms, inoculum preparation, preparation of wort, fermentation and recovery.
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.
Principles of wine making – Fruit selection, picking, crushing, sulphite addition, processing, fermentation, aging and bottling.

**Unit II**
Fermentative production of citric acid, uses, microorganism, inoculum preparation, medium preparation, fermentation, recovery and mechanism of citric acid production.
Fermentative production of vitamin B12 – Uses, structure of vit-B12, microorganisms, inoculum preparation, medium preparation, fermentation and recovery.
Fermentative production of glutamic acid – Uses, microorganism, inoculum preparation, production medium, fermentation and downstream processing.

**Unit III**
Antibiotics – Commercial production of benzyl penicillin, uses, microorganism, inoculum preparation, production medium, fermentation, recovery and semi-synthetic penicillin.
Fermentative production of tetracyclines – uses, chlortetracycline, oxy-tetracycline, tetracycline and semisynthetic tetracyclines, structures, microorganisms, inoculum preparation, production medium, fermentation and recovery methods.

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**Unit IV**

Production and application of microbial enzymes. – Amylases and proteases, uses, microorganisms, inoculum preparation, production medium, fermentation and recovery
Steroid transformations – Substrates, typical structures, microorganisms, inoculum preparation, 11-hydroxylation, process and recovery.
Principles of vaccine production and types of vaccines, Microbial biopesticides
Microbial products from genetically modified (cloned) organisms e.g., Insulin.

**Recommended Books**


1. Industrial Microbiology by Casida, LE Industrial Microbiology by Patel, AH
2. Industrial Microbiology by Miller, BM and Litsky Industrial Microbiology by Prescot and Dunn Microbial Technology by Peppler, JH and Perlman, D.
3. Biochemistry of Industrial Microorganisms, by Rainbow and Rose
4. Economic Microbiology by Rose Vol I – V
5. Microbial Enzymes and Biotechnology by Fogarty WM and Kelly, CT Comprehensive Biotechnology, All volumes Ed. Murray Moo-Yong Biotechnology (A text book of industrial Microbiology)
6. Ed.Cruger & Cruger Advances in Applied Microbiology Ed. Perlman Series of volumes


**Semester IV Paper IV Practical**
**PMB 453 Microbial Biotechnology**

1. Production of ethanol by flask fermentation, recovery of ethanol by distillation and calculation of fermentation efficiency
2. Preparation of wine from grapes/fruits by fermentation
3. Production of citric acid by fungal fermentation, recovery and estimation.
4. Production of amino acid (Glutamic acid/lysine) by fermentation
5. Production of amylase by fermentation, recovery and estimation
6. Production and estimation of penicillin by flask fermentation
7. Scale up of fermentation.

**Course Outcomes:**
**The students should be able to**
**PMB-403CO1:** Explainfermentative production of alcohol, beer and wine with upstream and downstream processing.
**PMB-403CO2:** Describefermentativeproduction processof citric acid, Vitamin B 12, and Glutamic acid.
**PMB-403CO3:** Discussfermentative production of antibioticsi.e., penicillin and tetracycline with their upstream and downstream processing.
**PMB-403CO4:** Describeproduction and commercial application of microbial enzymes,steroid transformations,Vaccine production,Microbial Biopesticides and production of Insulin from Genetically modified microbes.

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**M.Sc. (Final) IV Semester Microbiology (CBCS)**
**Paper III PMB 404Nanobiotechnology& Bioinformatics (Elective 1)**
**(4 HPW-4Credits)**

**Overall Course Objective:**The students will summarize the applications of nanotechnology and demonstrate the BLAST search for nucleic acid and protein databases.

**Objectives:**
**The students should be able to**
**Cob 1.** Understandthe properties of Nanoparticles and synthesis of Nanoparticles
**Cob2.** Learnthe characteristics of nanoparticles and applications in Environmental bioremediation and medicine
**Cob 3.** Acquaint withbiological databases and the Human Genome Project
**Cob 4.** Classifyvariety of coding and non-coding RNAs and Learn to create proteins with novel properties using protein databases

**Unit 1: Structure, Properties and Synthesis of Nanoparticles**
Introduction and Development of Nanobiotechnology.
Nanoscale systems- Definition and Features; Nanoparticles - Classification and Properties
Properties and applications of Nano structures- Carbon nanotubes, Quantum dots, Semiconductor nano particles, Metal based nanostructures, Nano wires- polymer based nanostructures, Gold nano structures, and Protein based nanostructures
Synthesis of nanostructures – Concept of Top down and Bottom-up Approach
Physical- High Energy Ball Milling, Melt Mixing, Solvothermal process, Physical Vapor Deposition, Laser Ablation, Sputter deposition, Electric Arc,
Chemical – Co-precipitation method, Sol-Gel Method, Micro emulsions
Biological- Synthesis using plant extracts, Microorganisms, Enzymes and agricultural waste.

**Unit 2: Characterization and Applications of Nanoparticles**
Nanoparticles Characterization techniques based on Structure, Light scattering ability, Surface topography and Composition: Optical Methods - UV–Visible spectroscopy, X-ray diffraction; Imaging and Size- Scanning Electron Microscope (SEM), Transmission Electron Microscopy (TEM), Atomic Fluorescence Microscopy (AFM), STEM, Vibrational analysis- FTIR Spectroscopic analysis, Dynamic Light Scattering (DLS), X- Ray Diffraction (XRD).
Nano filtration – Water purification and Desalination; Nanobiotechnological applications in Environmental Bioremediation;
Nano biosensors- DNA based biosensors.
Nanotechnology in Medicine: Nano biocides, Nanoparticles in Cancer therapy, Nanostructures in drug discovery and drug delivery.

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**Unit 3:Bioinformatics and genomics**

Introduction to Bioinformatics and Molecular Databases

Primary Databanks – NCBI, EMBL, DDBJ; Secondary Databases – UNIPROT; Structural Database –PDB

Database similarity search (FastA, BLAST); Alignment: Pairwise and Multiple sequence alignment, Phylogenetics analysis and Tree construction

Genomics and whole genome sequencing;

HGP, Genome Annotation and Gene Prediction

Primer Designing

SNPs, WGA (WGS) (Whole genome analysis and whole genome studies)

**Unit 4: Transcriptomics and proteomics**

Transcriptomics and sequencing a transcriptome, microarrays

ENCODE

Proteomics and sequencing a proteome

Protein folding *in vivo* and the roles of Molecular chaperones.

Protein Sequence Analysis; Approaches for Protein Structure Prediction (folding *in silico*)-Homology modelling of protein; Energy Minimization Methods; Active site identification; Protein engineering

Structure Based Drug Design and Ligand-based drug Design; Docking studies

**Recommended books:**

Bio nanotechnology: Lessons from Nature by David S. Goodsell

Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology-Hari Singh Nalwa

Nanomaterials for Biosensors, Cs. Kumar, Wiley – VCH, 2007

Nanostructures and Nanomaterials: Synthesis, properties and applications. Ghuzang G.Cao . Imperical College Press, 2004

Biosensors: A Practical Approach, J. Cooper & C. Tass, Oxford University Press, 2004

Nanotoxicology: Characterization, Dosing and Health Effects, Informa Healthcare. Nancy A. Monteiro – Riviere and C. Lang Tran, 2007.

Nanomedicine, Vol. IIA: Biocompatibilityby Robert A. Freitas

Lesk M.A. (2008) Introduction to Bioinformatics. Oxford Publication, 3rd International Student Edition

Rastogi S.C., Mendiratta N. and Rastogi P. (2007) Bioinformatics: methods and applications, genomics, proteomics and drug discovery, 2nd ed. Prentice Hall India Publication

Primrose and Twyman (2003) Principles of Genome Analysis & Genomics. Blackwell

Ghosh, Z. and Mallick, V. (2008) Bioinformatics- Principles and Applications. Oxford University Press.

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**Semester IV Paper IV Practical**
**PMB 454 Nanobiotechnology and Bioinformatics**

1. Chemical and Microbiological Synthesis of Nano Biomaterials:
2. Green synthesis of metal nanoparticles - Copper, Zinc and Silver using plants extracts
3. Characterization of Nanoparticles by UV spectrometry
4. Antimicrobial effect of Ionic silver and Nano silver prepared by above methods
5. Database searching
6. BLAST and MSA
7. Primer Design
8. Protein Modelling

**Course Outcomes:**

**The students should be able to**

**PMB 404CO1:** Review the properties of Nanoparticles and compare various methods involved in the synthesis of Nanoparticles.
**PMB 404CO2:** List the characteristics of nanoparticles and explain the therapeutic and bioremediation applications of nanoparticles.
**PMB 404CO3:** Explain the Human Genome Project and identify the biological databases and its application.
**PMB 404CO4:** Distinguish coding and non-coding RNAs and illustrate proteins with novel properties using protein databases.

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**M.Sc. IV Semester Microbiology (CBCS)**
**Paper IV PMB 404 (B) Microbial Proteomics DSE (B): (Elective-I)**
**(4 HPW-4Credits)**

**Overall Course Objectives:** This paper provides foundation in protein structure and folding, interactions, analytical methods and clinical proteomics and protein engineering.

**Objectives:**

**The students should be able to**

**Cob 1:** Studyin Protein structure, Function and Protein - Protein interactions.
**Cob 2:** Learnto protein separation techniques, Protein identificationmethods.
**Cob 3:** Gainknowledge in Microbial pathogenesis at the proteome level.
understand importance of Antibiotics and Immunomodulators.
**Cob 4:** Acquaint withProtein-Protein interaction, Protein-DNA interactions.
Update on recent trends in Clinical Proteomics, Protein engineering, Drug design.

**Unit I**

Protein structure – Different levels of protein structure, Protein Folding and unfolding, Active sites and effects of pH, temperature, substrate concentrations, inhibitors and activators on activity. Protein functions, e.g., structural, storage, transport, hormonal, receptor, contractile, defensive, enzymatic. Protein interaction in cell signalling neurotransmitters and membrane channel opening and closing.

**Unit II**

Separation techniques – 2-D gel and polyacrylamide gel electrophoresis (PAGE)
Biological mass spectrometry -MALDI-MS, ESI-MS, LC-MS/MS Finger printing.
Protein identification – Peptide mass fingerprinting (PMF), Electro blotting and sequencing
Determination of 3-D structures by x-ray crystallography, NMR and homology modeling.

**Unit III**

Microbial pathogenesis at the proteome level. Proteomics of *Saccharomyces cerevisiae*-cell wall & transport, differential expression in stress. Proteomics of probiotic lactobacilli-intestinal epithelial cells interactions, Lantibiotics and Immunomodulators. Proteomic Identification of *Mycobacterium tuberculosis*

**Unit IV**

Protein-Protein interaction, Protein-DNA intereactions. Yeast two hybrid system.Protein micro arrays- Protein Markers, Clinical Proteomics, Small peptides, Personalized medicine, Protein engineering, Drug design. Proteomic strategies in Cancer, Prions.

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**Recommended Books**

Principles of Protein structure, Schultz, G. E., and Schirmer, R. H. Dr. ShaktiSahi
Proteomics, Daniel C. Leibler
Microbial Proteomic, Marjo Poutanen
Proteins: Structures and Molecular Principles (2d ed.), TE Creighton
Organic spectroscopy, William Kemp
Proteome Research: Two-Dimensional Gel Electrophoresis and Detection Methods (Principles and Practice), T. Rabilloud (Editor), 2000, Springer Verlag
Introduction to Protein Architecture: The Structural Biology of Proteins, M.Lesk, 2001, Oxford University Press

**Semester Practical Paper III PMB (B) 455**

**Microbial Proteomics**

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

**Course Outcomes:**

**The students should be able to**

**PMB 404 CO 1.** DescribeProtein structure and Function, Knowledge on protein – protein interactions
**PMB 404 CO 2.** Classifyprotein separation techniques, and Protein identification methods
**PMB 404 CO 3.** Identifythe microbial pathogenesis at the proteome level, discuss the importance of Lantibiotics and Immunomodulators
**PMB 404 CO 4.** Distinguish between Protein-Protein and Protein-DNA interactions, Describe the significance of Clinical Proteomics, Protein engineering, Drug design.

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**IV Semester**
**PMB 455: Project Work (CBCS)**
**(8 HPW-4Credits)**

1. Number of students who will be offered project work will vary batch to batch depending upon the infrastructural facilities and may vary each year.
2. The college shall announce regarding the number of seats for project work well in advance and may select the students for the same based on merit.
3. Project work will involve experimental work and the student will have to do this in stipulated time.
4. The final evaluation of the project work will be through a Panel involving internal and external examiners.
5. Guidelines provided by college for executing and evaluation of project work will be final.
6. Students will be asked their choice for Project work at the beginning of IV semester and all formalities of topic and mentor selection will be completed by this time.
7. Project work will be offered in lieu of expertise and infrastructural facilities of the department and will be evaluated for 3 credits.

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