Department of Microbiology
OSMANIA UNIVERSITY,
HYDERABAD, TELANGANA STATE.
M.Sc Microbiology

ProgramOutcomes (PO):

PO1: Graduates will be able to understand concepts and learn about the microbial world - the hierarchical classification, structural components and discover their phenomena *in vitro*

PO2: Graduates will be able to apply essential perceptions about the microbial physiology, metabolic engineering and gene editing procedures in lab basedpracticals

PO3: Graduates will be able to demonstrate effective communication skills in both written and oral forms.

PO4:. Graduates will be able to impart technical skills and knowledge in research methodologies, computational data and its management.

PO5: Graduates will be able to create prototypes/products or process development in current trends of research in emerging area of microbiology

PO6: Graduates will be able to apply knowledge and skills from microbial sciences to interdisciplinary sciences to address real-world challenges.

PO7: Graduates will be able to demonstrate knowledge and understanding of global perspectives and challenges faced due to climate change, antimicrobial resistance

PO8: Graduates will be able to engage in lifelong learning to take up activities, enhance their skills for meeting the Sustainable Development Goals (SDGs) and circular bioeconomy

PO9: Graduates will be able to use current and emerging technologies to solve problems and create innovative solutions such as novel antibiotics, vaccines for newly emerging pandemics

PO10: Graduates will be able to pursue advanced studies and professional careers at industries, educational and research institutions.

Program Specific Outcome (PSO):

PSO1: Graduates will be able to understand about the importance of microbial world and their use in agriculture, environment, food, medical and pharma sectors.

PSO2: Graduates will be able to apply the microbial system as bio factories for natural and recombinant products such as antibiotics, biosimilars, bio stimulants, vaccines etc.

PSO3: Graduates will be able use different instrumentation techniques for bio-physio-chemical and molecular characterization of microorganisms / biochemical pathways / end products.

PSO4: Graduates will be able to analyze data using statistical methods and software tools to corelate research on microorganisms and their metabolites.

PSO5: Graduates will be able to take up scientific writing, trained to maintain documentation at QC and QA levels at various industries

Program Educational Objectives (PEOs):

PEO1: Graduates will have a strong foundation in the fundamental understanding of microbial systems including bacteria, virus, fungi and use them for interdisciplinary research
.

PEO2: Graduates will be able to develop concepts of research, critical thinking, trouble shooting in experimental research and evaluate the importance of microbial technology.

PEO3: Graduates will have the ability to communicate effectively in both written and oral forms, and plan experiments individually and work collaboratively in diverse teams.

PEO4: Graduates will be trained with instrumentation and analytical studies and be ready for the QC, QA and R and D departments at various pharma and biotech sectors.

PEO5: Graduates will be fortified with ethical and professional principles, patent writing, entrepreneurial skills and knowledge required to pursue higher education.

DEPARTMENT OF MICROBIOLOGY, OSMANIA UNIVERSITY
MSc MICROBIOLOGY
I Semester - CHOICE BASED CREDIT SYSTEM (CBCS)
Schedule for Instruction and Examination
(Proposed Syllabus 2022 and CCE pattern 2023 onwards)

SEMESTER – I						
Paper Code	**Paper Titles**	**Credits**	**Teaching Hours**	**Marks**		
				Internal Assessment	**Semester Exam**	**Total**
THEORY						
MB 101	General Microbiology & Microbial Physiology (Core)	3	3	50	50	100
MB 102	Virology (Core)	3	3	50	50	100
MB 103	Research Methodology & Techniques (Core)	3	3	50	50	100
MB 104	Microbial Biochemistry (Core)	3	3	50	50	100
MB105	Seminar	--	--	--	--	--
PRACTICALS						
MB 151	General Microbiology &Virology	4	8	--	100	100
MB 152	Biochemistry & Research Methodology	4	8	--	100	100
	Total	**20**	**28**	**200**	**400**	**600**

Continuous and Comprehensive Evaluation (CCE)
Internal Assessment Pattern

1st Internal Assessment (10 Marks)	2nd Internal Assessment (10 Marks)	3rd Internal Assessment (10 Marks)	4th Internal Assessment (10 Marks)	% Attendance (10 Marks)	Total 50 Marks
1.) 10 Questions - ½ Mark each MCQ-5 Marks 2.) 10 Questions – ½ Mark each Fill in the blanks – 5 Marks	Short Answer Questions – 10 Questions 1 Mark each	Report writing – 2 Paraphrasing 5 Marks each	1. Assignment - 5 Marks 2. Seminar Presentation – 5 Marks	95-100% 10 Marks 86 ≤ 95% 08 Marks 81 ≤86% 06 Marks 75 ≤81% 05 Marks 65 ≤75% 04 Marks ≤65% (Detained)	
10 M	10 M	10 M	10 M	10 M	50 Marks

Semester end Examination: 50M

M.Sc. (Previous) I Semester (CBCS)
Paper I MB 101 General Microbiology and Microbial Physiology(Theory) **(CBCS)**
(7 Hrs per week = 5 credits)

Course Objectives:

i. The students will learn about microscopyand identification techniques of microorganisms.
ii. The students will understand about bacterial cell structure, growth and multiplication.
iii. The students will obtain information about media and nutritional requirements of microorganisms.

Unit I

Pioneers of Microbiology.
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.
Methods of sterilization: Physical methods and chemical methods.
Microbial identification: staining methods and microscopic. Ecological, Nutritional (cultural) biochemical methods, immunological characteristics, Molecular and genetic characteristics (16s rRNA and ITS).

Unit II

Principles of bacterial taxonomy and classification: - Numerical taxonomy, Bergey's manual and its importance, general properties of bacterial groups.
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 and importance of each growth phase.
Synchronous cultures – methods of synchronous culturing, Continuous culturing methods, factors effecting growth. Methods of growth measurement.

Unit III

Microbiological media - Autotrophic media, defined synthetic mineral media, heterotrophic media. The concept of prototrophs and auxotrophs, prototrophic (minimal) media (defined media), complex media (undefined media).
Cultivation of Bacteria, Fungi and Algae : Routine and special culture methods.
Isolation of pure cultures.
Preservation and Maintenance of Microbial Cultures: Routine methods and Liquid nitrogen preservation, freeze-drying (lyophilization), etc.
Microbial nutrition and metabolism: autotrophy – Photoautotrophy and bacterial photosynthesis
Chemoautotrophy and heterotrophic metabolism.

I Semester MB 151 General MicrobiologyPracticals (CBCS)- PAPER I

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 stainings
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: Biochemical and 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, thioglycollate media culturing, anaerobic glove box and its application
11. Microbial growth experiments – Viable count
12. Calculation of generation time of bacteria
13. Study of bacterial growth curve
14. Effect of temperature on microbial growth
15. Effect of pH on microbial growth

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 byStainier, 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.
Structure and Reproduction of Algae, Vol. I & II by Fritsch, F.E.
Introduction to Algae by Morris, I.
Products and Properties of Algae byZizac.
Fresh water algae of the United States by Smith, GM.
Introductory Mycology, byAlexopolus, C.J.
Dispersal in Fungi by Ingold, CT
Microbial Physiology by Moat,
Laboratory Experiments in Microbiology by Gopal Reddy et al
Microbes in Action by Seoley HW and Van-Demark, PJ
Brock's Biology of microorganisms by Madigan, MT et al

M. Sc. I Semester Microbiology (CBCS)
Paper II Virology(Core) **(CBCS)**
(7Hrs per week = 5 credits)

Course Objectives:

i. The students will learn about historical investigations about virus research, taxonomy and metadata.
ii. The students will be able to understand about viral replication strategies and their cultivation *in vitro.*
iii. The students will appreciate about antiviral agents and use of viral vectors in cloning studies.

Unit I

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

Unit II

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

Unit III

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

I Semester MB 151 Virology Practicals (CBCS)- PAPER I

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

- Recent publications: Research papers and review articles from Google search engine
- General Virology by Luria and Darnel
- Basic Virology. E.K. Wagner
- Virology and Immunology by Jokli
- Laboratory manual of Microbiology and Biotechnology by Aneja, KR
- 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 Christensen
- 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
- Text book of Virology by Rhodes and Van Royan
- Principle of Virology: Molecular Biology, pathogenesis and control of animal viruses.

M.Sc. Microbiology I Semester (CBCS)
Paper III Research Methodology & Techniques (Core) **(CBCS)**
(7Hrs per week = 5 credits)

Course Objectives:

i. The students will learn about different spectroscopic and chromatographic techniques used in research.
ii. The students will understand about statistical packages and methods to be taken up in biological research
iii. The students will be trained in basic computers, operating system and basics of AI in biology.

Unit I

Optical methods:,colourimetry and spectrophotometry, fluorimetry, optical rotation
Circular dichroism, NMR, ESR spectroscopy, x-ray diffraction, types of mass spectrometry.
Electrophoretic techniques and application, counter current distribution.
Chromatographic techniques – HPLC, FPLC paper, thin layer, ion exchange, gel filtration and affinity chromatography.
Diffusion, dialysis, cell disruption methods, centrifugation techniques. Radio isotopes – detection and measurement of radioactivity – scintillation counters, autoradiography, stable isotopes and their use. Safety precautions.

Unit II

Population, samples and sampling procedures, variables, variations and frequency distributions, measures of central tendency and dispersion, element of probability, gausian or normal distribution, binomial distribution, poissondistribution, '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 III

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. Introduction to Machine Learning and Artificial Intelligence in Microbiology Domain

I SemesterMB 152Research Methodology Practicals (CBCS)- PAPER II

1. Creating documents using word processor
2. Usage of spread sheet to biological applications
3. Biochemistry calculations and statistics
4. Absorption maxima of proteins,
5. Absorption maxima of Nucleic acids
6. Absorption maxima of tyrosine
7. Absorption maxima of riboflavin (Determination of molar extinction coefficient, calculations based on Beer Lambert's Law)
8. Estimation of inorganic and organic phosphate by Fiske-Subbarow method
9. Estimation of protein concentration by UV-vis spectrophotometry
10. Estimation of protein by Folin Lowry method
11. Differential centrifugation
12. Paper chromatography of amino acids
13. Dialysis for desalting of proteins
14. Demonstration of Gel filtration technique
15. Demonstration of electrophoresis of proteins and DNA

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 amdMirsky series
- Laboratory experiments in Microbiology by Gopal Reddy et al
- Biochemistry lab manual by Jayaraman
- Introduction to the theory of statistics by Alexander, M Mood and Franklin
- Fundamentals of Biometry byL.N.Balam
- Statistical methods by Snedecor and Cochran
- Introduction to computer and its application by Chae C.Chien
- Basic Programming language byBajaraman
- Biostatistics – A manual of statistical methods for use in Health, Nutrition and Anthropology by K. Vishveshwar Rao

M.Sc. Microbiology I Semester (CBCS)
Paper IV Microbial Biochemistry (Core) **(CBCS)**
(7 Hrs per week = 5 credits)

Course Objectives:

i. The students will understand about the different biomolecules and biological reactions
ii. The students will comprehend theoretical and practical information about nucleic acids, proteins, lipids and purification of enzymes.
iii. The students will be exposed to basics of enzyme kinetics and mechanism of action.

Unit I

pH and its biological relevance
Determination of pH, preparation of buffers
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.
Carbohydrates: Classification, basic chemical structure, monosaccharides, aldoses, and ketoses, cyclic structure of monosaccharides, steroisomerism, anomers and epimers.
Sugar derivatives, deoxy sugars, amino sugars, and sugar acids.

Unit II

Nucleic acids: Structure and properties of purines, pyrimidines, nucleosides and nucleotides.
Metabolism of purines and pyrimidines - Biosynthesis and degradation
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 III

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 feed back mechanisms. Metabolic compartmentalization in relation to enzyme, enzymes and secondary metabolites.

I SemesterMB 152BiochemistryPracticals(CBCS)- PAPER II

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
7. Quantitative estimation fructose
8. Determination of saponification value of fats
9. Partial purification and assay of β-amylase
10. Partial purification and assay of urease
11. Partial purification and assay of catalase
12. Effect of substrate concentration and time on enzyme activity
13. Effect of pH and temperature on enzyme activity
14. Calculation of Km for partially purified enzyme
15. Study for inhibition of enzyme activity

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 amdMirsky series
- Biochemistry lab manual by Jayaraman

Semester – I :Course Outcomes

By the end of this Semester, the students will be able to:

1. Understand the contributions of pioneers in field of microbiology
2. Attain information and knowledge aboutbacterial, virus diversity and structural features.
3. Use statistical tools for different experiments
4. Work on different biomolecules and corelate their significance in different biological systems and various biochemical reactions.
5. Work on different equipment's and tools used in microbiology lab
6. Design experiment to enumerate and cultivate bacteria and virus
7. Perform the staining techniquesand methods to identify microorganisms
8. Use computers for basic operations, about writing of Manuscript and Plagiarism

DEPARTMENT OF MICROBIOLOGY, OSMANIA UNIVERSITY
MSc MICROBIOLOGY
II Semester - CHOICE BASED CREDIT SYSTEM (CBCS)
Schedule for Instruction and Examination
(Proposed Syllabus 2022 and CCE pattern 2023 onwards)

SEMESTER – II						
Paper Code	**Paper Titles**	**Credits**	**Teaching Hours**	**Marks**		
				Internal Assessment	**Semester Exam**	**Total**
THEORY						
MB 201	Molecular Biology and Microbial Genetics (Core)	3	3	50	50	100
MB 202	Immunology (Core)	3	3	50	50	100
MB 203	Industrial Microbiology (Core)	3	3	50	50	100
MB 204	Pharmaceutical Microbiology (Core)	3	3	50	50	100
PRACTICALS						
MB 251	Molecular Biology and Microbial Genetics & Immunology	4	8	--	100	100
MB 252	Industrial &Pharmaceutical Microbiology	4	8	--	100	100
	Total	**20**	**28**	**200**	**400**	**600**

M.Sc. (Previous) Microbiology II Semester (CBCS)
Paper IMB 201 Molecular Biology & Microbial Genetics (core) **(CBCS)**
(7 Hrs per week = 5 credits)

Course Objectives:

i. The students will learn about molecular level aspects of DNA and RNA
ii. The students will understand about concept of gene, regulatory mechanisms and microbial genetics
iii. The students will be trained in genetic engineering and cloning strategies

Unit I

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

Unit II

Concept of gene, Benzers fine structure of gene – muton, cistron, recon. Types of genes – structural, constitutive, regulatory.
Gene regulation and expression – Lac operon, arabinose and tryptophan operons, Gene regulation in eukaryotic systems, repetitive DNA, gene rearrangement, promoters, enhancer elements.
Mutation: Molecular basis of mutations, Physical, chemical and biological mutagens.
Detection and analysis of mutations (Replica plating, Antibiotic enrichment, Ames test, etc).
DNA damage and repair mechanisms. Global response to DNA damage.
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.
Transposable elements – Definition, detection of transposition in bacteria, types of bacterial transposons and applications of transposons.

Unit III

Principles of genetic engineering: Vectors : Plasmids, phagemids/ viral vectors, cosmids, Artificial chromosomes. Restriction Enzymes, Polymerases, ligases, etc.
General methods of gene cloning: Cloning Techniques: cloning in *E-coli*, Cloning in *Bacillus subtilis*, Cloning in Yeast promoters, Vectors, cloning strategy, blue white selection of recombinants, colonies, Selection, Expression and detection of cloned genes. Polymerase chain reaction and Quantitative real time PCR.
rRNA/ Genomic/ c DNA Library construction and screening.

II Semester MB 251
Molecular Biology and Microbial Genetics-Practicals (CBCS) - Paper I

1. Isolation of genomic DNA from E.coli
2. Isolation of genomic DNA from Yeast.
3. Isolation of of genomic DNA from Human Blood.
4. Estimation of DNA (colorimetry)
5. Estimation of RNA
6. Estimation of protein by Folins's method
7. Induction of mutations by physical mutagens (UV)
8. Induction of mutations by chemical mutagens
9. Screening and isolation of mutants
10. Isolation of mutants by Replica plating technique
11. Digestion of DNA by restriction endonucleases
12. Determination of molecular weight of DNA resolved on agarose gel electrophoresis
13. Induction of Lac operon
14. Demonstration of Transformation in bacteria using $CaCl_2$ heat shock method
15. Protoplast preparation, Fusion and regeneration

Recommended books

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

M.Sc. (Previous) Microbiology II Semester (CBCS)
Paper II MB 202 Immunology (core) (CBCS)
(7 Hrs per week = 5 credits)

Course Objectives:

i. The students will learn about immune system, response and inflammation
ii. The students will understand about MHC, antigen- antibody reactions both theoretical and practical protocols
iii. The students will obtain information about hypersensitivity mechanisms, hybridoma technology and cancer biology

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,

Overview of Innate and adaptive immunity

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

Role of inflammasome in innate immune response

Unit II .

Major Histocompatibility Complex (MHC)- MHC restriction and processing and presentation of antigen by MHC. Transplantation immunology: MHC, types of grafts, grafts rejection, GVH reactions, mechanism of graft rejection, and prevention of graft rejection.

Immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, Congenital and acquired immunodeficiencies.

Immunological tolerance-central and peripheral.

Antigen and antibody reactions–Agglutination, Precipitation, neutralization, and function. Labeled antigen-antibody reactions- ELISA, RIA, immune blotting, CFT, immunoflourescence. Flow cytometry (Fluorescence activated cell sorter) and its applications in Immunology. Development Of immuno diagnostic kits.

Classical, alternate and lectin mediated Complement pathways

UNIT –III

Hypersensitivity - immediate and delayed type hypersensitivity reactions.

Autoimmunity – systemic and localized autoimmune disorders

Types 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.

Immunosuppression and its mechanism of action.

Immune evasion by bacteria and viruses.

Tumor immunology. Immuno diagnosis and immune therapy of cancer

II Semester MB 251
Immunology Practicals (CBCS) - Paper I

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 diffusion test
5. Ouchterlony double diffusion test
6. Rocket Immunoelectrophoresis
7. WBC count
8. RBC count
9. Differential leucocyte count
10. Separation of serum proteins
11. Blot transfer and detection of protein on blot by staining
12. Demonstration of ELISA technique
13. Purification of IgG from serum
14. Lymphocyte culture, viable staining and heamocytometer count.
15. Indirect agglutination (Pregnancy hCG Ag)

Recommended Books

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

M.Sc. (Previous) Microbiology II Semester (CBCS)
Paper III MB 203 Industrial Microbiology(Core)(CBCS)
(7 Hrs per week = 5 credits)

Course Objectives:

i. The students will learn about the importance of microbial world and their use in industries
ii. The students will understand about assemblage of fermenter and different process used in fermentation industry
iii. The students will obtain information about immobilization methods, downstream strategies, product recovery

Unit I

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

Unit II

Design of fermenter, type of fermenter, 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.
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 III

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

.II Semester MB 252
Industrial MicrobiologyPracticals (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

- Industrial Microbiology by Casida, LE
- 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
- 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
- Recent Published papers on advances in relevant area to be referred

M.Sc. Microbiology II Semester (CBCS)
Paper IV MB 204 Pharmaceutical Microbiology (Core)(CBCS)
(7 Hrs per week = 5 credits)

Course Objectives:

i. The students will learn about Indian, British and US pharmacopeias
ii. The students will understand different antibiotics, drugs and mode of action
iii. The students will be trained both theoretical and practical techniques of antimicrobial effectiveness testing, determination of MIC and LD_{50}

Unit I

Pharmaceutical industry. Importance of various pharmacopeias with special reference to Indian pharmacopeia, British pharmacopeia, United States pharmacopeiaand international pharmacopeia.Design and layout of sterile product manufacturing unit.

Microbiological issues for inspection of pharmaceutical facilities: Sterilization (D value, z value, F value, F_0 value, survival curve), Depyrogenation, Environmental monitoring, Room design and Equipment,Water purification and Delivery system, Personnel, Product sampling, Method suitability test, Sample analysis (Bioburden, Sterility test. Concept of GxP and Quality Assurance in pharmaceuticals. Introduction to FDA's CAPA (Corrective and Preventive action) steps requirements and regulations, OOPs, SOPs. ISO, WHO and US certification. Understanding the changing dynamics of pharma ecosystem. Digitization of equipment, instrument, air and water systems. Adherence to guidelines like GAMP (Good automated manufacturing practice and 21 CFR (Code of federal regulations).

Unit II

History of chemotherapy –Paul Ehrlich and his contributions. Arsenicals as therapeutics. 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. Selective toxicity, molecular principles of drug targeting. Development of synthetic drugs: Sulphanamides, Chloramphenicol, Antitubercular compounds, Quinolinones, Metranidazole, Anti-tumor drugs.

Mode of action of important drugs – Cell wall inhibitors (Betalactam – eg. Penicillin), membrane inhibitors (polymyxins), macromolecular synthesis inhibitors (streptomycin). Macrolides and antifungal antibiotics. Drug metabolism and Response; Pharmacokinetics (ADME), Pharmacodynamics, pharmacogenomics. Emerging antimicrobial resistance (AMR) and antimicrobial resistance genes (ARG) in different environments

Unit III

Antimicrobial Effectiveness Testing (AET): Microbial contamination and spoilage of certain pharmaceutical products sterile injectable, non-injectable, ophthalmic preparations, implants, Cosmetic products and preservatives (PET). Bacterial endotoxin testing.Non antibiotic antimicrobial compounds: Metals and Biocides (Phenol coefficient/RWC). Drug sensitivity testing methods and their importance. 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).

II Semester MB 252
Pharmaceutical MicrobiologyPracticals (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 ofMIC, LD 50 of antimicrobial chemicals
8. Microbiological assays for antibiotics (Liquid tube, agar tube , agar plate assays)
9. Antimicrobial effectiveness testing
10. Bioassay withGriesofulvin / chloremphenicol
11. Bacterial endotoxin test (BET): Demonstration through kit or tutorial mode
12. Bioassays with any plant / microbial secondary metabolites against Gram positive and Gramnegative bacteria
13. Tests for disinfectants (Phenol coefficient/RWC)
14. Determination of antimicrobial activity of a formaldehyde to that of phenol under Standardized experimental conditions
15. Treatment of bacterial cells with cetrimide, phenol and detection of Leaky substances.

Recommended Books

- Disinfection, sterilization and preservation. Block, S.S. (ed). Lea and Febigor, Baltimore
- Pharmaceutical Microbiology. Huge, W.B. and Russel, AD.Blackwell Scientific, Oxford
- Principles and methods of sterilization in health sciences. Perkins, JK. Pub: Charles C. Thomos, Springfield.
- Compendium of methods for the microbiological examination of foods. Vanderzant, C. and Splittstoesser, D. Pub: American Public Health Association, Washington, D.C.
- Disinfectants: Their use and evaluation of effectiveness. Collins, CH., Allwood, MC., Bloomfield, SF. And Fox, A. (eds). Pub: Academic Press, New York
- Inhibition and destruction of microbial cell by Hugo, WB. (ed). Pub: Academic Press,NY
- Manual of Clinical Microbiology. Lennette, EH. (ed).Pub: American Society for Microbiology, Washington.
- Principles and Practices of disinfection. Russell, AP.,Hugo,WB., and Ayliffe, GAJ.(eds). Publ. Blackwell Sci.
- Biochemistry of antimicrobial action. Franklin,DJ. and Snow, GA.Pub:Chapman& Hall.
- Antibiotics and Chemotherapy. Garrod, L.P., Lambert, HP. And C'Grady, F. (eds). Publ: Churchill Livingstone.
- Antibiotics. Lancini, G. and Parenti, F. publ: Springer-Verlag.
- The Molecular Basis of antibiotic action. Ga.e, EF. Et al. Publ: Wiley, New York.
- Antimicrobial Drug action. Williams, RAD., Lambart, PA. & Singleton, P. Pub:Bios Sci.
- Microbiological Assays. Hewitt.
- Indian Pharmacopea; United States Pharmacopea; British Pharmacopea

Semester – II: Course Outcomes

By the end of this Semester, the students will be able to:

1. Understand the nature and importance of genetic materialDNA and RNA.
2. Comprehend about immunity and disease.
3. Learn the industrial importance ofmicroorganisms and strain improvement strategies.
4. Correlate the different pharma regulations and antibiotic testing methods.
5. Design experiments on restriction digestion and cloning strategies.
6. Perform various antigen antibody reactions *in vitro.*
7. Screen and select microorganisms and scale up strategies used at industrial level.
8. Perform antibiotic susceptibility tests and bacterial endotoxin test.

DEPARTMENT OF MICROBIOLOGY, OSMANIA UNIVERSITY
MSc MICROBIOLOGY
III Semester - CHOICE BASED CREDIT SYSTEM (CBCS)
Schedule for Instruction and Examination
(Proposed Syllabus 2022 and CCE pattern 2023 onwards)

SEMESTER – III						
Paper Code	**Paper titles**	**Credits**	**Teaching Hours**	**Marks**		
				Internal Assess	**Semester Exam**	**Total**
THEORY						
MB 301	Environmental and Agricultural Microbiology (core)	3	3	50	50	100
MB 302	Medical Bacteriology (core)	3	3	50	50	100
MB 303	**Elective-I** **A**. Cell and MolecularBiotechnology **(or)** **B**. Microbial Proteomics	3	3	50	50	100
MB 304	**Elective-II** **A.** Entrepreneurship in Microbial Sciences **(or)** **B.** Applied Biotechnology	3	3	50	50	100
MB 305	Seminar Presentation	2	4	---	25	25
PRACTICALS						
MB 351	Environmental and Agricultural Microbiology &Medical Bacteriology	4	8	--	100	100
MB 352 A*	Cell and Molecular Biotechnology, Entrepreneurship in Microbial Sciences **OR**	2	4		50	50
MB 352 B*	Cell and Molecular Biotechnology, Applied Biotechnology **OR**					
MB 352 C*	Microbial Proteomics, Entrepreneurship in Microbial Sciences **OR**					
MB 352 D*	Microbial Proteomics, Applied Biotechnology					
	Total	**20**	**28**	**200**	**400**	**600**

* Based on the elective selected (choice based) in theory, paper title of practical's need to be considered.

M.Sc.(Final) Microbiology III Semester (CBCS)
Paper I MB 301 Environmental and Agricultural Microbiology (core)
(7 Hrs per week = 5 credits)

Course Objectives:

i. The students will learn about microorganisms present in different ecosystems
ii. The students will understand about bioremediation, nitrogen cycle, climate change
iii. The students will be trained about production of biofertilizers and biopesticides and BIS procedures and integrated pest management

Unit I

Microorganisms in air-Airspora of indoor and outdoor environment, factors affecting airspora, Techniques of trapping air borne microorganisms.Role of microorganisms in climate change (IPCC).Green house gases mitigation, carbon sequestration

Microorganisms in water-Distribution of microorganisms in Fresh and Marine ecosystems.Water-borne pathogenic microorganisms and their transmission; Sanitary quality of water; Water pollution due to organic matter; BOD, Aerobic sewage treatment – Oxidation ponds, trickling filters, activated sludge treatment; Anaerobic sewage treatment – Septic tank. Sewage treatment plant. Reverse osmosis and ultrafiltration.

Microorganisms in soil- Soil properties - (physical, chemical and biological), Soil microorganisms, Methods of enumeration and activity of microbes in environment/soil. Importance of soil microorganisms, nutrient transformation processes. Interactions between microorganisms: Mutualism, commensalism, ammensalism synergism, parasitism, predation, competition.

Unit II

Degradation of carbonaceous materials in soil– Cellulose, hemicellulose and lignin decomposition.Factors governing the decomposition and biochemistry of decomposition. Composting and sustainable agriculture, biogas production, plastic degrading microorganisms as a tool for bioremediation, challenges in waste management. Soil humus formation, Ammonification, Nitrification –Microbes involved, factors influencing nitrification, nitrifying bacteria and biochemical mechanism. Denitrification – microbes involved, factors influencing and the mechanism of denitrification. Nitrate pollution.

Microbial bioremediation of environmental pollutants -Xenobiotics.Bioremediation. Strategies for bioremediation technologies, Microbial degradation of organic pollutants with a special emphasis on pesticides like DDT and 2,4-D. Microbial enhanced oil recovery, bioleaching of copper, goldand uranium, electronic waste management. Hazardous waste management and its treatment.

Unit III

Agricultural Microbiology - Agronomy and production of important crop plants, Green revolution. Biocontrol Agents - Biocontrol agents and their scope in control of plant diseases, Integrated plant pest management (IPPM), concept and component of IPPM. Microbial pesticides – *Bacillus thuringiensis*, structure of BT toxin and their mode of action. Production technology for BT and Baculovirus based pesticide.

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:Types of bio-fertilizers, Screening, selection, establishment. Mass scale production and quality control of bio inoculants, BIS standards recommendation for biofertilizers production and its economics; methods of bio-fertilizer inoculation.Vermiculture and vermicomposting.

III Semester MB 351 Environmental and Agricultural Microbiology Practicals (CBCS)
Paper I

1. Isolation and observation of air, water and soil microflora
2. Enumeration of soil microorganisms (bacteria, actinomycetes, fungi) by standard plate count
3. Estimation of soil microbial activity by CO2 evolution
4. Estimation of COD and BOD
5. Testing for microbial sanitary quality of water (coliform test)
6. Measurement of Total solids (TS), Mixed Liquor Suspended Solids (MLSS), Mixed Liquor Volatile Suspended Solids (MLVSS) of waste water
7. Isolation of cellulose decomposing microbes and estimation of cellulase activity
8. Isolation and culturing of Rhizobium sp. from root nodules and *Azospirillum* from grasses (Cyanodon)
9. Isolation and observation of phyllosphere and rhizosphere microflora
10. Observation of beneficial fungi/algae for biofertilizer application: *Trichoderma*
11. Observation of blue green algae
12. Observation of VAM.

Reference Books

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

Paper II MB 302 Medical Bacteriology (Core)
(7 Hrs per week = 5 credits)

Course Objectives:

i. The students will learn about microbiota associated with humans, normal flora and pathogenic microorganisms
ii. The students will understand about different bacterial pathogens, disease symptoms and prophylaxis.
iii. The students will be trained about diagnostic protocols and pathogens associated with water and wound borne 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.
Properties of pathogenic microorganisms. Factors that influence pathogenicity
Type of infections, source of infections, different modes/means of infections
Diagnostic microbiology – Types of specimen, specimen collection, transportation of specimen, processing, laboratory investigations, specific lab. Tests, non-specific lab tests, diagnosis and report.Use of lab animals in diagnostic microbiology.

Unit II

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 – β-Haemolytic streptococci, Pneumococci, *Corynebacterium diphtheriae, Mycobacterium tuberculosis, Mycobacterium leprae, Neisseria meningitides, Haemophilus influenzae.*
Sexually transmitted diseases caused by bacteria, *Treponema pallidum, Neisseria gonorrhoeae*.

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 pathogenic bacteria:
Water borne infections – *E.coli, Salmonella typhi, Shigella dysenteriae, Vibrio cholerae.* Wound infections – *Staphylococcus aureus, Clostridium tetani, Clostridium welchii, Pseudomonas aeruginosa.*

III Semester MB 351 Medical Bacteriology Practicals (CBCS) Paper I

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

Recommended Books

- 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 JayaramPaniker
- Microbiology by Greenwood, Slack and Peutherer

M.Sc. (Final) Microbiology III Semester (CBCS)
Paper III MB 303 Cell and Molecular Biotechnology (Elective)
(7 Hrs per week = 4 credits)
Elective IA

Course Objectives:

i. The students will learn about cell cycle, signal transduction and molecular chaperones
ii. The students will understand about protein, nucleic acid interactions, marker and omics techniques
iii. The students will be exposed to different bioinformatic tools and docking studies

Unit I

Cell cycle: Cell division regulation and cancer. Role of protein Kinases in cell cycle. Programmed cell death. Geno toxicity assays.

Signal transduction **:**G- Protein linked receptors. Concept of second messenger cAMP and GMP.Steroid/peptide hormone regulation, tissue specific regulation.

Protein folding and the roles of Molecular chaperones.

Unit II

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, Gene knock out – RNAi and Gene silencing, Gene therapy. Emerging omics techniques: Metagenomics, Transcriptomics and proteomics.; Methodology and Applications

Unit III

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 Genome Annotation and Gene Prediction; Primer Designing**;** Phylogenetics analysis and Tree construction (Distance Matrix, UPGMA based tree construction, Neighbor Joining Method); SCOP-protein classification, Protein Sequence Analysis; Approaches for Protein Structure Prediction-Homology modeling of protein (Swiss-Model); Energy Minimization Methods (Ramchandran Plot); Active site identification; KEGG-metabolic pathway, Structure Based Drug Design and Ligand Based drug Design; Docking studies (AutoDock, GOLD); *Insilico* ADME and Toxicity calculations.

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Comment [DAK1]: Energy Minimization Studies by Ramchandran Plot

Comment [DAK2]: Metabolic related informatics

Semester III MB 352 Elective 1A: Cell and Molecular BiotechnologyPracticals (CBCS)
Paper II

1. Isolation of Plasmid DNA from *E. coli*
2. Isolation of nucleic acids, proteins from *E. coli* through tutorial mode
3. Demonstration of mitosis in onion root bud
4. Restriction mapping. Method and problems
5. Preparation of competent cells and transformation of *E.coli*cells and PCR
6. Gene cloning in bacteria (Demonstration) and Recombinant confirmation (blue white selection).
7. Demonstration of RFLP , AFLP
8. Primer Design (Manual and software)
9. Protein Modeling (Swiss Model)
10. Demonstration of BLAST and sequence alignment (multiple and Pair-wise) and Phylogenetic tree construction by MEGA software

Comment [DAK3]: Demonstration of Mitosis in budding onion root tip

Comment [DAK4]: Already there in the II semester

Comment [DAK5]: Detection of Recombinant cells by Blue-White Screening

Comment [DAK6]: Software like primer3

Comment [DAK7]: Phylogenetic tree construction can be added

Recommended Books

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

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

Course Objectives:

i. The students will learn about microbial proteomics and analysis
ii. The students will understand about quantitative proteomics and study on yeast, lactobacilli and *Mycobacterium tuberculosis*
iii. The students will be trained about clinical proteomics and protein engineering.

Unit I

An introduction to proteomics: Evolution from protein chemistry to proteomics 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 Analysis and functions For e.g. structural, storage, transport, hormonal, receptor, contractile, defensive, enzymatic. Protein interaction in cell signaling neurotransmitters and membrane channel opening and closing.

Unit II

Protein separations, protein analyses, Quantitative proteomics - stable isotope labeling by amino acids in cell culture (SILAC), isotope-coded affinity tag (ICAT), isobaric tagging for relative and absolute quantitation (iTRAQ); Identification and analysis of proteins by Two-dimensional fluorescence difference in-gel electrophoresis (DIGE), 2D gel electrophoresis, Isoelectric focusing, Spot visualization and picking, Tryptic digestion of protein and peptide fingerprinting; Mass spectrometry. Functional proteomics: Recombinational cloning, Interactomics - techniques to study protein-protein interactions, yeast two-hybrid, immunoprecipitation, protein microarrays, Nucleic Acid Programmable Protein Array (NAPPA), Label-free nanotechnologies in proteomics, Surface Plasmon Resonance (SPR).Proteomics of *Saccharomyces cerevisiae*-cell wall & transport, differential expression in stress. Proteomics of probiotic lactobacilli-intestinal epithelial cells interactions, Lantibiotics and Immunomodulators. Microbial pathogenesis: Studies at proteome level. Proteomic Identification of *Mycobacterium tuberculosis.*

Comment [DAK8]: Quantitative proteomics

Comment [DAK9]: Functional Proteomics

Unit III

Strategies and studies on Protein-Protein interaction, Protein-DNA interactions. Yeast two hybrid system. Nucleic Acid Programmable Protein Array (NAPPA), Label-free nanotechnologies in proteomics, Surface Plasmon Resonance (SPR); Modificomics: understanding post-translational modifications; Structural proteomics; Protein micro arrays- Protein Markers, Clinical Proteomics, Small peptides, Personalized medicine. Protein engineering. Application of machine learning in protein engineering. Drug Design, Proteomics based plasma markers, molecular markers and cancer diagnostics. Bioinformatics in proteomics, proteome databases; Challenges and future prospects of proteomics research. Prions

Semester III MB 352 Elective 1B: Microbial ProteomicsPracticals (CBCS) Paper II

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

Reference Books

Principles of Protein structure, Schultz, G. E., and Schirmer, R. H. Dr. ShaktiSahi

Proteomics, Daniel C. Leibler

Introduction to Proteomics: Tools for the New Biology. Totowa, NJ: Humana Press. Liebler, D. C. Microbial Proteomic, MarjoPoutanen

Proteins: Structures and Molecular Principles (2d ed.), TE Creighton

Organic spectroscopy, William Kemp

Proteome Research: Two-Dimensional Gel Electrophoresis and DetectionMethods (Principles andPractice), T. Rabilloud (Editor), 2000, Springer Verlag

Introduction to Protein Architecture: The Structural Biology of Proteins, M.Lesk, 2001, Oxford University Pres

Campbell, A. M., &Heyer, L. J. Discovering Genomics, Proteomics, and Bioinformatics. San Francisco: Benjamin Cummings

M.Sc. (Final) Microbiology III Semester (CBCS)
Paper IV MB 304 Entrepreneurship in Microbial Sciences (Elective)
(7 Hrs per week = 4 credits)
Elective II A

Course Objectives:

i. The students will learn about entrepreneurship in microbial sciences, theme of start ups
ii. The students will comprehend on circular bioeconomy and microbial means to achieve SDGs
iii. The students will be trained about the IPR, ethics and biosafety principles

Unit I

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

Entrepreneur, Entrepreneurship, MSMEs, Enterprise &Startups Process of Entrepreneurship Competencies & Skills/ Qualities of an Entrepreneur. Types of Entrepreneurs & Enterprise. Approaches to manage capital & cost of capital . Working capital & cash flow planning. Financial Planning & Budgets Measuring &reporting financial performance.

Entrepreneur management and case studies.Biotechnology entrepreneurship versus general entrepreneurship. Biotech and Pharma industries. Indian and Global scenario and market.

Unit II

Microbial Entrepreneurship: Biobased technology. Use of microorganisms for different industrial products. CRISPR based technologies for metabolic engineering . Biomass resources, renewable feed stocks, agro- lignocellulosic residual material for valorization. Circular economy and sustainable development goals.

Practical aspects to set up of Labs for soil and water analysis. Management of drinking water plant. Sources of contamination. Management strategies for wastes generated from different urban locations and industries for renewable products. Annamox process and waste water treatment.

Documentation, Accreditation and permission protocols to set up clinical diagnostic centre.

Practical aspects, considerations and challenges faced to set up clinical microbiology lab. Handling of samples: Serological, Microbial, Urine and stool. PCR and other diagnosticprocedures. Documentation and report analysis of hematology, serology and pathology.

Unit III

IPR and regulatory issues in relation to microorganisms and / or products / processes; Architecture of a typical patent application. Regulations of National Biodiversity authority (NBA) and Features of Biological Diversity Act 2002. Documentation and deposition of potential microbial strains for patent application.

Funding procedures for Start ups. Typical stages in commercialization aspects of biotechnology processes / products; Financial appraisal of biotechnology projects. TRIPS (Trade – Related Aspects of Intellectual Property Rights) agreement; Alternative models of technology transfer and licensing; Funding mechanisms of commercial projects; Bio safety principles; Bio ethics. Regulations and Bioethical committee.

Semester III MB 352 Elective IIA: Entrepreneurship in Microbial Sciences Practicals (CBCS)
Paper II

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

Recommended Books

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

M.Sc. III Semester Microbiology (CBCS)
Paper IV MB 304 Applied Biotechnology (Elective)
(7 Hrs per week = 4 credits)
Elective II B

Course Objectives:

i. The students will learn about Microbial technology and production of different metabolites
ii. The students will understand about plant based bioreactors, gene editing techniques, generation of transgenic plants
iii. The students will be trained about animal cell line propagation, stem cell techniques, CRISPR techniques, tissue engineering.

Unit-I

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

Unit-II

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

Unit-III

Animal Tissue Culture: Primary culture, Organ culture, Embryo Culture. Established Cell lines and their propagation. Scale-up of cell culture processes; Cryopreservation, Culture Collections.
Stem Cell Technology- adult and embryonic stem cells., Risks and Safety, Bioethics. Genome editing tools CRISPR/Cas9, retroviral methods, DNA microinjection method, etc and their applications (gene therapy). Transgenics and knockouts: Transgenic cattle, Transgenic birds, Transgenic fish, Transgenic mice. Tissue Engineering: cells, scaffold, growth factors and mechanical environment. Types of tissue engineering

Semester III Paper IV MB 352 Elective IIB-Applied BiotechnologyPracticals (CBCS)

Paper II

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

Books Recommended

- 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
- 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
- Plant Biotechnology: The genetic manipulation of plants,2005,A.Slater ,N.Scott&
- M.Fowler, Oxford Univ Press, Oxford.
- Introduction to Plant Biotechnology(3rd Edtn), H.S. Chawla
- Roberta Smith, Plant Tissue Culture: Techniques and Experiments,2ndEdtn,Academic
- Press,2000
- H.K.Das(ed),Textbook of Biotechnology,Wiley India,2004
- J.H.Hammond, P.Mcgarvey, and V.Yusibov(eds), Plant Biotechnolgy,Springer
- Verlag,Heidelberg,2000
- Animal Cell Culture by Ian Freshney
- Basic Cell Culture.Ed.J.M.Davis 2nd.Ed 2007. Oxford press
- Animal Cell Culture SudhaGangal
- Principles of biotechnology and applications-Glick and Pasternack

Semester – III: Course Outcomes

By the end of this Semester, the students will be able to:

1. Understand the microbiota of different ecosystems such as air, water, fresh and marine.
2. Understand about the different pathogenic bacteria, symptoms, disease diagnosis and prophylaxis.
3. Understand about cell cycle, signal transduction, microbial proteomics.
4. Take up entrepreneurship in Microbial Sciences
5. Get the Concept of PoC, startups and funding available
6. Explore microbial, plant and animal biotechnology for different applications
7. Take up bioinformatic studies.
8. Give seminar presentations and group discussions

DEPARTMENT OF MICROBIOLOGY, OSMANIA UNIVERSITY
MSc MICROBIOLOGY
IV Semester - CHOICE BASED CREDIT SYSTEM (CBCS)
Schedule for Instruction and Examination
(Proposed Syllabus 2022 and CCE pattern 2023 onwards)

SEMESTER – IV						
Paper Code	**Paper Titles**	**Credits**	**Teaching Hours**	**Marks**		
				Internal Assessment	**Semester Exam**	**Total**
THEORY						
MB 401	Food Microbial Technology (core)	3	3	50	50	100
MB 402	Medical virology and Parasitology (Core)	3	3	50	50	100
MB 403	**Elective-III** **A:**Microbial Ecology and Host Microbe Interactions (or) **B:**Bioinformatics and Nanotechnology	3	3	50	50	100
MB 404	**Project work**	5	7	50	100	150
PRACTICALS						
MB 451	Food Microbial Technology and Medical Virologyand Parasitology	4	8	--	100	100
MB 452	**Electives*** **IIIA.** Microbial Ecology and Host Microbe Interactions **Or** **IIIB.** Bioinformatics and Nanotechnology	2	4	-	50	50
	Total	**20**	**28**	**200**	**400**	**600**

*****Based on the elective selected in theory, paper title of practical's need to beconsidered.

Project Work Assessment: 5 credits (150 marks)

- ✓ **Internal Assessment: CCE based: 50 marks***
  - * Internal Exam and assignment based on project work: (30 Marks)
  - * ProjectDesign Presentation(20 Marks)
- ✓ **Semester end Assessment: 3 Credits= 100 Marks#**

#Dissertation work and Final presentation (70 Marks)
#Thesis writing and Viva voce (30 Marks)

M.Sc. (Final) Microbiology IV Semester (CBCS)
Paper I MB 401 Food Microbial Technology (Core)
(7 Hrs per week = 5 credits)

Course Objectives:

i. The students will learn about microorganisms associated with fresh and canned foods
ii. The students will understand about microorganisms associated with fermented dairy, vegetable, meat products
iii. The students will be trained about infections associated with contaminated foods and regulatory bodies.

UNIT I

Food associated molds, yeasts, yeast-like fungi and bacteria. Microbial habitat of specific food materials, adaptations and changes in microbiome of vegetables, fruits, milk, fermented and non-fermented milk products, fresh meats, poultry and non-dairy fermented foods.Principles of food preservation -Bacteriological examination of fresh and canned foods; Detection of pathogens in foods. Asepsis – Removal of microorganisms,(anaerobic condition, high temperatures, low temperatures, drying, etc). Factors influencing microbial growth in food: Extrinsic and intrinsic factors.Chemical food preservatives and additives. Canning and processing for Heat treatment.

UNIT II

Dairy Microbiology - Types of microorganisms in milk and their significance, 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.

Fermented foods - Understanding benefits of traditional and non-traditional fermented foods.Health aspects of fermented foods. Production of fermented milk and milk products, plant-based products - Sauerkraut and pickles, cereal and legume based fermented products, bread, soya sauce, tempeh,, fish products, meat products etc.Microbiology, processing and fermentation of bread and idly. Production and significance of Silage.Production of Vinegar and concept of bioactive compounds from fermented foods.Microorganisms as food – single cell proteins, sea weed (algae), Mushrooms. Prebiotics, Probiotics and their screening methods. Beneficial effects of prebiotics, probiotics and postbiotics as nutraceuticals.

UNIT III

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

IV Semester MB 451Food Microbial TechnologyPracticals (CBCS) Paper I

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

Reference books:

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

M.Sc. (Final) IV Semester Microbiology (CBCS)
Paper II MB 402 Medical Virology and Parasitology (Core)
(7 Hrs per week = 5 credits)

Course Objectives:

i. The students will learn about different pathogenic viruses and their cultivation methods
ii. The students will understand different viral diseases, Hepatitis, AIDS, Dengue, HSV, JE
iii. The students will understand about different fungal and parasitic infections and diagnosis

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, Adenovirus (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, Dengue, Japanese encephalitis
Structure, cultivation, pathogenicity, lab diagnostics, prevention and control of contact and sexually transmitted viral diseases – Small pox, Herpes (Herpes simplex virus), Hepatitis viruses
Acquired immunodeficiency syndrome (AIDS)

Unit III

Structure, cultivation, pathogenicity, lab diagnostics, prevention and control of Malaria, Amoebiasis, Trichomoniasis, Helminthic infections - Round worms, Hook worms.
Medical Mycology – Dermatomycosis, Systemic mycosis. Types, pathogenesis and diagnostics. Fungal infections associated with COVID19. Precaution and management.

IV Semester MB 451 Medical Virology and Parasitology (Practicals) Paper I

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

Recommended Books

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

M.Sc. (Final) Microbiology IV Semester (CBCS)
Paper III –MB 403 Microbial Ecology and Host Microbe Interactions - (Elective)
Elective III A
(7 Hrs per week = 5 credits)

Course Objectives:

i. The students will learn about microbial ecology, quorum sensing and diversity indices
ii. The students will understand about microbiome associated with plants
iii. The students will appreciate about human microbiome and one health concept

Unit I

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

Unit II

Host (Plant) -microbeinteractions. Epiphytes andEndophytes, Role of Soil microbiomevs plant Microbiomes for plant health. Plant growth promoting rhizobacteria (PGPR): Direct and indirect mechanisms of microorganisms to promote soil and plant health.Plant microbe beneficial interactions with Pseudomonas, Bacillus and Trichoderma. Role of biotic and abiotic factors in plant- microbe interactions.Two-component regulatory system (Gac S and Gac A) in plant growth promoting bacteria.Microbial formulations(peat, lignite, talc) and mode of inoculation.Detection of microbial inoculants by staining, biochemical and molecular methods.

Plant -pathogen interactions: Bacterial (*Xanthomonas*) and (Fungal) *Macrophomina* infection in plants. Plant pest (Helicoverpa) nematode (Meloidogyne). Root exudates and their role in recruitment of beneficial microbiome. Basic concept of plantimmunity (MAMPs, PAMPs). Plant defense mechanisms: induced systemic resistance (ISR); systemic acquired resistance (SAR).

Unit III

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

Semester IV MB 452 Elective III A
Microbial Ecology and Host Microbe InteractionsPracticals (CBCS)
Paper II

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

Recommended Books / Research articles

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

M.Sc. (Final) Microbiology IV Semester (CBCS)
Paper III –MB 403 Bioinformatics and Nanotechnology (Elective)
Elective III B
(7 Hrs per week = 5 credits)

Unit 1

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

Comment [DAK10]: DDBJ

Comment [DAK11]: This may be added or omitted mam

Unit II

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

Unit III

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

Semester IV MB 452 Elective IIIB Bioinformatics and Nanotechnology Practicals (CBCS)
Paper II

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

Comment [DAK12]: This can be added mam

Recommended Books

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

M.Sc. (Final) Microbiology IV Semester (CBCS)
MB 404 Project work

(7 Hrs per week = 5 credits)

Course Objectives:

i. The students will be given concept of project work, reading of literature and frame hypothesis to work
ii. The students will design different experiments to work on different objectives of the proposed hypothesis
iii. The students will undergo training in lab of the supervisors (faculty members) to work and complete the project proposed.

Its mandate to have project work and the credits to be given are 5

Project Work Assessment: 5 credits (150 marks)

- ✓ **Internal Assessment: 2 credits= 50 marks***
  - * Internal Exam and assignment based on project work: (30 Marks)
  - * ProjectDesign Presentation(20 Marks)
- ✓ **Semester end Assessment: 3 Credits= 100 Marks#**

#Dissertation work and Final presentation (70 Marks)
#Thesis writing and Viva voce (30 Marks)

Semester – IV: Course Outcomes

By the end of this Semester, the students will be ready

1. To enumerate and compare the microorganisms of fresh and canned foods
2. To understand about the different pathogenic viruses, parasites, disease diagnosis and prophylaxis.
3. To comprehend about microbial diversity studies, plant and human microbiome and one health concept.
4. To independently handle project and execute different experiments, solve trouble shooting, thesis writing, seminar presentation.
5. To work in different biotech and pharma sectors
6. To take up responsibility of QC/QA manager in different bio-sectors
7. To work in diagnostic labs
8. To take up higher education in academic and research organizations