



DEPARTMENT OF MICROBIOLOGY, OSMANIA UNIVERSITY
MSc MICROBIOLOGY
CHOICE BASED CREDIT SYSTEM (CBCS)
 Schedule for Instruction and Examination
 (Proposed Scheme for Academic year 2016 onwards)

| SEMESTER – I | | | | | | |
|----------------------------|---|----------------|---------------------------|--------------------------------|--------------------------|--------------|
| Syllabus Ref No | Subject | Credits | Teaching Hours | Marks | | |
| | | | | Internal Assessment | Semester Exam | Total |
| THEORY | | | | | | |
| MB 101 | General Microbiology & Microbial Physiology (Core) | 4 | 4 | 20 | 80 | 100 |
| MB 102 | Virology (Core) | 4 | 4 | 20 | 80 | 100 |
| MB 103 | Research Methodology & Techniques (Core) | 4 | 4 | 20 | 80 | 100 |
| MB 104 | Microbial Biochemistry (Core) | 4 | 4 | 20 | 80 | 100 |
| PRACTICALS | | | | | | |
| MB 151 | General Microbiology & Microbial Physiology | 2 | 4 | -- | 50 | 50 |
| MB 152 | Virology | 2 | 4 | -- | 50 | 50 |
| MB 153 | Research Methodology & Techniques | 2 | 4 | -- | 50 | 50 |
| MB 154 | Microbial Biochemistry | 2 | 4 | -- | 50 | 50 |
| Total | | 24 | 32 | 80 | 520 | 600 |

| SEMESTER – II | | | | | | |
|------------------------|---|----------------|-----------------------|----------------------------|----------------------|--------------|
| Syllabus Ref No | Subject | Credits | Teaching Hours | Marks | | |
| | | | | Internal Assessment | Semester Exam | Total |
| THEORY | | | | | | |
| MB 201 | Molecular Biology and Microbial Genetics (Core) | 4 | 4 | 20 | 80 | 100 |
| MB 202 | Environmental & Agriculture Microbiology(Core) | 4 | 4 | 20 | 80 | 100 |
| MB 203 | Immunology (Core) | 4 | 4 | 20 | 80 | 100 |
| MB 204 | Pharmaceutical Microbiology (Core) | 4 | 4 | 20 | 80 | 100 |
| | | | | | | |
| PRACTICALS | | | | | | |
| MB 251 | Molecular Biology and Microbial Genetics | 2 | 4 | -- | 50 | 50 |
| MB 252 | Environmental & Agriculture Microbiology | 2 | 4 | -- | 50 | 50 |
| MB 253 | Immunology | 2 | 4 | -- | 50 | 50 |
| MB 254 | Pharmaceutical Microbiology | 2 | 4 | -- | 50 | 50 |
| | Total | 24 | 32 | 80 | 520 | 600 |

| SEMESTER – III | | | | | | |
|------------------------|---|----------------|-----------------------|----------------------------|----------------------|--------------|
| Syllabus Ref No | Subject | Credits | Teaching Hours | Marks | | |
| | | | | Internal Assessment | Semester Exam | Total |
| THEORY | | | | | | |
| MB 301 | Food Microbial Technology (Core) | 4 | 4 | 20 | 80 | 100 |
| MB 302 | Medical Bacteriology (Core) | 4 | 4 | 20 | 80 | 100 |
| MB 303 | DSE A. Industrial Microbiology (or) B. Microbial Proteomics | 4 | 4 | 20 | 80 | 100 |
| MB 304 | DSE A. Microbial Ecology & Plant Microbe Interactions (or) B. Advances in Biotechnology | 4 | 4 | 20 | 80 | 100 |
| PRACTICALS | | | | | | |
| MB 351 | Food Microbial Technology | 2 | 4 | -- | 50 | 50 |
| MB 352 | Medical Bacteriology | 2 | 4 | -- | 50 | 50 |
| MB 353 | C. Industrial Microbiology (or) Microbial Proteomics | 2 | 4 | -- | 50 | 50 |
| MB 354 | Microbial Ecology & Plant Microbe Interactions (or) Advances in Biotechnology | 2 | 4 | -- | 50 | 50 |
| | Total | 24 | 32 | 80 | 520 | 600 |

| SEMESTER – IV | | | | | | |
|------------------------|---|----------------|-----------------------|----------------------------|----------------------|--------------|
| Syllabus Ref No | Subject | Credits | Teaching Hours | Marks | | |
| | | | | Internal Assessment | Semester Exam | Total |
| THEORY | | | | | | |
| MB 401 | Cell & Molecular Biotechnology (Core) | 4 | 4 | 20 | 80 | 100 |
| MB 402 | Medical Virology & Parasitology (Core) | 4 | 4 | 20 | 80 | 100 |
| MB 403 | GE (IDSE) A. Microbial Biotechnology (or) Bioinformatics and Nanotechnology | 4 | 4 | 20 | 80 | 100 |
| MB 404 | DSE A. Applied Microbiology (or) B. Project work | 4 | 4 | 20 | 80 | 100 |
| PRACTICALS | | | | | | |
| MB 451 | Cell & Molecular Biotechnology | 2 | 4 | -- | 50 | 50 |
| MB 452 | Medical Virology & Parasitology | 2 | 4 | -- | 50 | 50 |
| MB 453 | Microbial Biotechnology (or) Bioinformatics and Nanotechnology | 2 | 4 | -- | 50 | 50 |
| MB 405 | Applied Microbiology (or) Project | 2 | 4 | -- | 50 | 50 |
| | Total | 24 | 32 | 80 | 520 | 600 |
| | GRAND TOTAL | 96 | 128 | 320 | 2080 | 2400 |

M.Sc. I Semester (CBCS)
Paper I General Microbiology and Microbial Physiology (Core) (CBCS)
(4 HPW-4 Credits)

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

Unit II

Methods of sterilization and disinfection: Physical methods and chemical methods.

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.

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, Bergy's manual and its importance, general properties of bacterial groups.

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

Unit IV

Microbial growth: The concept of growth and definition, formation of protoplasm, building of macromolecules from elemental nutrients, supramolecules, orgnelles 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.

I Semester Practical Paper I
General Microbiology & Microbial physiology (CBCS)
(4 HPW-2 Credits)

1. General instructions, Microbiology laboratory and its discipline
2. Handling of microscopes, Calibration and measurement of microscopic objects
3. Staining techniques for bacteria – simple, differential and special 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
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 of growing cultures and generation time determination
12. Study of bacterial growth curve
13. Factors effecting the microbial growth (pH and temperature)

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.
Structure and Reproduction of Algae, Vol. I & II by Fritsch, F.E.
Introduction to Algae by Morris, I.
Products and Properties of Algae by Zizac.
Fresh water algae of the United States by Smith, GM.
Introductory Mycology, by Alexopolus, 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)
(4 HPW - 4 Credits)

Unit I

History of virology (latest Scientific investigations), Viral classification and nomenclature (Baltimore and ICTV system of classification). Virus structure and morphology. Detection of viruses: physical, biological, immunological, serological and molecular methods.

Propagation, purification, isolation, characterization, 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.

Evolutionary importance of virus. Metagenomics for virus characterization: RNA-DNA hybrid virus

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. Cellular interactions—clathrin coated pits, lipid rafts, endocytosis and virus uncoating mechanisms. Comparison of Lytic cycle and lysogeny cycle (T2 Bacteriophage, Lambda).

Morphology, Ultrastructure, Genome organization and Replication strategies of Group I Adenovirus; Group II – Banana bunchy top virus, Group III – Reovirus, Group IV- TMV, Group V – Influenza virus, Group VI – HIV, Group VII – 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

Silver lining: viruses as therapeutic agents, viruses for gene delivery, viruses to destroy other viruses. Importance of studying modern virology.

I Semester Practical Paper II

Virology (CBCS)

(4 HPW - 2Credits)

1. Isolation of phage from different soil samples using laboratory bacterial cultures (*Staphylococcus*, *Bacillus*)
2. Isolation of phage from sewage using *Pseudomonas* and *E. coli* as host.
3. Cultivation and preservation of phages.
4. Quantification of phages
5. Growth phages of phage and burst size (Demonstration)
6. Phage induction
7. Cultivation of animal viruses in egg allantoic, amniotic and CAM
8. Symptomatic observations / slides plant viral infections
9. Demonstration of cytopathological changes of animal virus (slides/pictures)

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 Rickettsial 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

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

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.

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

I Semester Practical Paper III
Research Methodology and Techniques (CBCS)
(4 HPW-2Credits)

1. Creating documents using word processor
2. Usage of spread sheet to biological applications
3. Biochemistry calculations and statistics
4. Absorption maxima of proteins, NA, tyrosine and riboflavin (Determination of molar extinction coefficient, calculations based on Beer Lambert's Law)
5. Estimation of inorganic and organic phosphate by Fiske-Subbarow method
6. Estimation of protein concentration by UV-vis spectrophotometry and Folin Lowry 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

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 et al

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 Programing language by Bajaraman

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)
(4 HPW - 4Credits)

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.

Unit II

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, stereoisomerism, anomers and epimers.

Sugar derivatives, deoxy sugars, amino sugars, and sugar acids.

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

Control of enzymes. 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 Semester Practical Paper IV
Microbial Biochemistry (CBCS)
(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 K_m for partially purified enzyme
11. 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 amd Mirsky series

Biochemistry lab manual by Jayaraman

M.Sc. Microbiology II Semester (CBCS)
Paper I Molecular Biology & Microbial Genetics (Core) (CBCS)
(4 HPW - 4credits)

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 Recombinations-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.

II Semester Practical Paper I
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

Recommended books

Molecular biology by Robert Weaver

Molecular Biology By Upadhyay and Upadhyay

Molecular biology by David and Freifelder

Microbial genetics by David and Freifelder

molecular biology malacinski

Molecular biology of thee gene by Watson et al

The Lehninger Biochemistry

Molecular biotechnology by Primrose

Molecular Biotechnology by Bernard R. Glick and Jack J Pasternak

Molecular Genetics of Bacteria by Larry Snyder and Wendy Champness

M.Sc. Microbiology II Semester (CBCS)
Paper II Environmental and Agricultural Microbiology (Core) (CBCS)
(4 HPW – 4 Credits)

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

Soil properties (physical, chemical and biological), Soil microorganisms, Methods of enumeration and
activity of microbes in environment/soil; Microbes and plant interactions – Rhizosphere, Phyllosphere
and Mycorrhizae; Strategies for bioremediation technologies, Microbial degradation of organic
pollutants with a special emphasis on pesticides like DDT and 2,4-D.

Unit III

Degradation of carbonaceous materials in soil – cellulose, hemicellulose and lignin decomposition,
factors governing the decomposition and biochemistry of decomposition, 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.

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.

II Semester Practical Paper II
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 CO₂ 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 cellulase activity
8. Estimation of ammonifiers, nitrifiers and denitrifiers in soil by MPN METHOD
9. Isolation and culturing of Rhizobium sp from root nodules and Azospirillum from grasses (Cyanodon)
10. Isolation and observation of phyllosphere microflora
11. Isolation and observation of rhizosphere microflora
12. Observation for Mycorrhizae

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 Lynch

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

J.M. Helawell - Biological indicators of freshwater pollution and environmental management.

Elsevier Applied Science Publishers, London. (1986). 546p

F. Mason - Biology of freshwater pollution. Third edit. Longman Group (1996). 356p

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

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, inflammation.

Major Histocompatibility Complex (MHC). Human leucocyte antigen (HLA) restriction

Processing and presentation of antigen by MHC. Transplantation immunity,

Immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections,

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, immunoflourescence. Flow cytometry (Fluorescence activated cell sorter) and its applications in Immunology. Development Of immuno diagnostic kits.

UNIT –IV

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 Practical Paper III
Immunology (CBCS)
(4 HPW- 2 Credits)

1. Agglutination reactions – Widal, VDRL, HA, Blood typing – tube method
Precipitation test: Ring interphase, single radial diffusion.
2. Ouchterlony double diffusion.
3. Immuno-electrophoresis.
4. Neutralization test – Plaque neutralization, Haemadsorption test.
5. WBC and RBC count and differential blood picture.
6. Separation of serum proteins.
7. Blot transfer and detection of protein on blot by staining.
8. ELISA
9. Purification of IgG from serum
10. Lymphocyte culture, viable staining and heamocytometer count.
11. Indirect agglutination (Pregnancy hCG Ag)

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

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

Unit I

Microorganisms affecting pharmaceutical industry – The atmosphere, water, skin & respiratory flora of personnel, raw-materials, packing, equipments, 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 (Betalactam – eg. Penicillin), membrane inhibitors (polymyxins), macromolecular synthesis inhibitors (streptomycin), antifungal antibiotics (nystatin)

Unit IV

The drug resistance – The phenomenon, clinical basis of drug resistance, biochemistry of drug resistance, genetics of drug resistance in bacteria.

Microbiological assays: Assays for growth promoting substances, nutritional mutants and their importance, vitamin assay, amino acid assay

Assay for growth inhibiting substances – Assay for non-medicinal antimicrobials (Phenol coefficient/RWC). Drug sensitivity testing methods and their importance. Assay for antibiotics – Determination of MIC, the liquid tube assay, solid agar tube assay, agar plate assay (disc diffusion, agar well and cylinders cup method).

Introduction to pharmacokinetics and pharmacogenomics.

II Semester Practical Paper IV
Pharmaceutical Microbiology (CBCS)
(4 HPW- 2 Credits)

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. Chemical assays for antimicrobial drugs
5. Testing for antibiotic/drug sensitivity/resistance
6. Determination of MIC valued for antimicrobial chemicals
7. Microbiological assays for antibiotics (Liquid tube assay, agar tube assay, agar plate assays)
8. Efficacy testing of preservatives like parabens

Reference/Recommended Books for MB Pharmaceutical Microbiology

Disinfection, sterilization and preservation. Block, S.S. (ed). Lea and Febigor, Baltimore
Pharmaceutical Microbiology. Huger, W.B. and Russel, AD. Blackwell Scientific, Oxford
Principles and methods of sterilization in health sciences. Perkins, JK. Pub: Charles C. Thomas, 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.

Antiviral Drugs. Kargor, S.

Burger's Medicinal chemistry Vol. I – III. Ed. Nanfield E. World.

The control of antibiotic resistant bacteria. Stuart, Harris and Harris.

Indian Pharmacopeia; United States Pharmacopeia; British Pharmacopeia.

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

Unit I

Introduction to fermented foods; Health aspects of fermented foods; Fermented vegetables: Processing and fermentation of Sauerkraut and pickles; Cereal and legume based fermented products-bread, Soya Sauce, Tempeh; Microbiology of bread and idly; Production and significance of Silage; Mushrooms – production and cultivation of different types of mushrooms.

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; Probiotics and Prebiotics: Properties and beneficial effects of probiotics and prebiotics; Screening methods of Probiotics; Genetically Modified Probiotics.

Unit III

Spoilage of foods and factors governing the spoilage; 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 preservation methods and food safety issues.

Unit IV

Food Quality: Importance and functions of quality control. Methods of quality assessment of foods-Sampling, qualitative and quantitative microbiological analysis; Bacteriological examination of fresh and canned foods; Screening and Enumeration of spoilage microorganisms. Detection of pathogens in food.

III Semester Practical Paper I
Food Microbial Technology (CBCS)
(4 HPW-2Credits)

1. Microbiological examination of fresh and canned foods
2. Microbiological examination of spoiled foods and fruits
3. Microbiological examination of milk by Breeds method
4. Microbiological quality testing of milk (MBRT test)
5. Extraction of Mycotoxins from contaminated grains/foods.
6. Detoxification of mycotoxins.
7. Isolation, Screening and Identification of bacterial probiotics like LAB
8. Isolation, Screening and Identification probiotic yeast
9. Microbiological examination of mushrooms

Recommended books

Food Microbiology by Frazier

Biotechnology: Food Fermentation : Microbiology, Biochemistry, and Technology by VK Joshi and Ashok Pandey

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

Food Quality Assurance: Principles and Practices by Inteaz Alli (CRC Press)

Foodborne Pathogens and Food Safety by Md. Latiful Bari, Dike O. Ukuku (CRC Press)

Recent Published papers on advances in relevant area to be referred

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

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 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 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 – B-Haemolytic streptococco, Pneumococci, *Corynebacterium diphtheriae*, *Mycobacterium tuberculosis*, *Mycobacterium leprae*, *Neisseria meningitides*, *haemophilus influenzae*.

Sexually transmitted diseases caused by bacteria, *Treponima pallidum*, *Neisseria gonorrhoea*.

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 cholerae*.

Wound infections – *Staphylococcus aureus* & MRSA, *Clostridium tetani*, *Clostridium welchi*, *Pseudomonas*.

III Semester Practical Paper II
Medical Bacteriology (CBCS)
(4 HPW-2 Credits)

1. Preparation of different types of culture media/observation. Blood Agar, Chacolate Agar, Mannitol salt agar, Blair Parker medium, MacConkey agar, Lowensten-Jension 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.

Recommended Books

Review of Medical Microbiology by Jawitz, Melnick and Adelberg

Diagnostic Microbiology by Bailey and Scott

Medical Microbiology by Cruickshank et al Vol I & II

Text book of Microbiology by Ananthanarayanan and Jayaram Paniker

M.Sc. III Semester Microbiology (CBCS)
Paper III Industrial Microbiology (Elective-I)
(4 HPW-4Credits)

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.

Unit II

Inoculum media, inoculum preparation

Raw materials Saccharides, starchy and cellulosic materials

Fermentation media and sterilization.

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

Unit III

Batch, fed batch and continuous fermentations. Direct, dual or multiple fermentations.

Scale-up of fermentations.

Fermentation type reactions, alcoholic, lactic acid, mixed acid, propionic acid, butandiol and acetone-butanol types, Product recovery methods.

Detection and assay of fermentation products. Physico-chemical methods and biological assays.

Unit IV

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.

III Semester Paper III
Industrial Microbiology (Practicals) (CBCS)

Screening for amylase producing organisms
Screening for organic acid producing microorganisms
Isolation of antibiotic producing microorganisms by crowded plate technique
Isolation and culturing of yeasts
Separation of amino acids by chromatography
Estimation of glucose by DNS method
Estimation of ethanol by dichromate method
Estimation of maltose
Immobilization of microbial cells by entrapment method

Recommended Books

Industrial Microbiology by Casida, LE
Industrial Microbiology by Patel, AH
Industrial Microbiology by Miller, BM and Litsky
Industrial Microbiology by Prescott and Dunn
Microbial Technology by Pepler, 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

**M.Sc. III Semester Microbiology (CBCS)
Paper III Microbial Proteomics (Elective-II)
(4 HPW-4Credits)**

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 signaling 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.

III Semester Practical Paper III
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
4. Overexpression of heterologous protein in E.coli.
5. Purification of cloned protein in E.coli.
6. Protein identification by immunoblotting

Reference 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 DetectionMethods (Principles andPractice), T. Rabilloud (Editor), 2000, Springer Verlag
Introduction to Protein Architecture: The Structural Biology of Proteins, M.Lesk, 2001, Oxford University Pres
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 Lemanceau, Peter Bakker & Jos Raajimakers

M.Sc. III Semester Microbiology (CBCS)
Paper IV Microbial Ecology and Plant Microbe Interactions (Elective-I)
(4 HPW-4Credits)

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).

Unit II

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).
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.

Unit-III

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. 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

Unit-IV

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

III Semester Practical Paper IV
Microbial Ecology and Plant Microbe Interactions

1. Isolation of plant growth promoting bacteria (PGPB) from soil, compost, vermicompost
2. Screening PGPB for nitrogen fixation, P-solubilization, Zn 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 two layer method
10. Isolation of antagonistic microbes using dual-culture method
11. Pseudomonas and its metabolites for anti-fungal activity
12. Bacillus and its metabolites for anti-fungal activity
13. Trichoderma and its metabolites for anti-fungal activity
14. Detection of QS compounds in Bacteria.

Reference Books

Research papers and review articles

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 DetectionMethods (Principles andPractice), T. Rabilloud (Editor), 2000, Springer Verlag

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

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

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 Lemanceau, Peter Bakker.

M.Sc. III Semester Microbiology (CBCS)
Paper IV Advances in Biotechnology (Elective-II)
(4 HPW-4Credits)

Unit-I

Transgenic plants, Plants as bioreactors, Biosafety concerns of transgenic plants, Biotic Stress Tolerance- Herbicide resistance, Glyphosate, Insect Resistance, Bt toxin, Disease Resistance, Virus resistance
Abiotic Stress Tolerance-- Drought, Flooding, Salt and temperature.
Manipulation of—Photosynthesis, Nitrogen fixation, Nutrient uptake efficiency.
For quality improvement-Protein, Lipids, carbohydrates, vitamins and minerals.

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.
Transgenics and knockouts: Transgenic cattle, Transgenic birds, Transgenic fish, Transgenic mice: i) Retroviral method ii) DNA microinjection method iii) Engineered Embryonic Stem cell method

Unit-III

Introduction to nanoparticles/nanotechnology, Properties of nanomaterials.
Synthesis of nanostructures - physical, chemical and biological, microbiological Methods, Biomolecules as nanostructures.

Unit-IV

Gene therapy-concept, vectors, gene targeting and tissue-specific expression, Antisense Technology
Introduction to Pharmacogenetics and toxicogenomics
Genetic counseling, Social- genetic discrimination: insurance and employment, human cloning, foeticide, Sex determination,
Tissue Engineering, Methods of Synthesis, Biomolecular Engineering

III Semester Practical Paper IV Advances in Biotechnology

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
Method(Chemical),using Neem Extact(plants) & Bacteria(Microbiological)
5. Characterisation of Nanosilver by UV spectrometry
6. Characterisation of Nanosilver by microscopic methods

References: Unit I

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

References: Unit II

1. Animal Cell Culture by Ian Freshney
2. Basic Cell Culture. Ed.J.M.Davis 2nd.Ed 2007. Oxford press
3. Animal Cell Culture Sudha Gangal
4. Principles of biotechnology and applications-Glick and Pasternack

References: Unit III

1. Nanobiotechnology by David Goodsell. John Wiley
2. Handbook of Nanostructured biomaterials and their applications in nanobiotechnology by Nalwa HS 2005. American scientific publishers
3. Nanobiotechnology by Niemeyer CM & Mirkin CA 2005 .Wiley Interscience

References: Unit IV

1. Jogdand S. N., Medical Biotechnology, Himalaya Publishing House, Mumbai, (2008)
2. Judit Pongracz, Mary Keen, Medical Biotechnology, Churchill Livingstone, Elsevier (2009)
3. Pratibha Nallari & V. Venugopal Rao, Medical Biotechnology, Oxford University Press, India (2010)
4. U. Satyanarayana. Biotechnology

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

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 & cGMP.

Steroid/peptide hormone regulation, tissue specific regulation.

Protein folding and the roles of Molecular chaperones.

Unit II

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*, Cloning in *Bacillus subtilis*, Cloning in Yeast promoters, Vectors, cloning strategy, Transformation, Selection, Expression and detection of cloned genes.

Unit III

Molecular techniques: Analysis of Protein-protein and protein-DNA interactions.

Biochips (DNA chips and Protein chips).

Polymerase chain reaction and Quantitative real time PCR

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.

Introduction to Omics techniques: Metagenomics, Transcriptomics and proteomics.

Unit IV

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; Whole genome sequence; Genome Annotation and Gene Prediction; Primer Designing; Phylogenetics analysis and Tree construction; Protein Sequence Analysis; Approaches for Protein Structure Prediction- Homology modeling of protein; Energy Minimization Methods; Active site identification; Structure Based Drug Design and Ligand Based drug Design; Docking studies; ADMET and Toxicity calculations.

IV Semester Practical Paper I
Cell and Molecular Biotechnology (CBCS)
(4 HPW-2 Credits)

1. Isolation of Plasmid DNA, RNA and Proteins from *E.coli*.
2. Restriction mapping
3. PCR technique.
4. Preparation of competent cells and transformation
5. Gene cloning in bacteria (Demonstration).
6. Recombinant confirmation (Gel shift assays, blue white selection).
7. Southern blotting – demonstration
8. Demonstration of RFLP/AFLP
9. Separations of Proteins by Column chromatography
10. Primer Design
11. Protein Modeling
12. Demonstration of Docking studies

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 Primerose
Molecular Biotechnology by Bernard R. Glick and Jack J Pasternak
DNA Microarrays Ed. M. Schena

M.Sc. IV Semester Microbiology (CBCS)
Paper II Medical Virology and Parasitology (Theory)-CBCS
(4 HPW-4 Credits)

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.

IV Semester Practical Paper II
Medical Virology and Parasitology (CBCS)
(4 HPW-2Credits)

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

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 Rickettsial 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

M.Sc. IV Semester Microbiology (CBCS)
Paper III Microbial Biotechnology (Elective-I)
(4 HPW-4Credits)

Unit I

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 down stream processing.

Unit III

Antibiotics – Commercial production of benzyl penicillin, uses, microorganism, inoculum preparation, production medium, fermentation, recovery and semi-synthetic penicillins.

Fermentative production of tetracyclines – uses, chlortetracycline, oxy-tetracycline, tetracycline and semisynthetic tetracyclines, structures, microorganisms, inoculum preparation, production medium, fermentation and recovery methods.

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 eg. Insulin.

IV Semester Paper III
Microbial Biotechnology (Practicals) (CBCS)

Production of ethanol by flask fermentation, recovery of ethanol by distillation and calculation of fermentation efficiency
Preparation of wine from grapes/fruits by fermentation
Production of citric acid by fungal fermentation, recovery and estimation
Production of amino acid (Glutamic acid/lysine) by fermentation
Production of amylase by fermentation, recovery and estimation
Production and estimation of penicillin by flask fermentation
Immobilized bacteria/yeast/enzyme in fermentation
Scale up of fermentation.

Recommended Books

Industrial Microbiology by Casida, LE
Industrial Microbiology by Patel, AH
Industrial Microbiology by Miller, BM and Litsky
Industrial Microbiology by Prescott and Dunn
Microbial Technology by Pepler, 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

M.Sc. IV Semester
Paper III Bioinformatics and Nanotechnology (Elective-II)
(4 HPW-4Credits)

Unit 1

- 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
- Primer Designing

Unit 2

- Transcriptomics and sequencing a transcriptome, microarrays
- 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 modeling of protein; Energy Minimization Methods; Active site identification;
- Protein engineering
- Structure Based Drug Design and Ligand-based drug Design; Docking studies;

Unit 3 – Basic concepts of Nanobiotechnology

1. Nanoparticles -Origin and their classification, Nanoscale systems
2. Nano structures-Carbon nanotubes, quantum dots, Semiconductor nano particles, metal based nanostructures, nanowires- polymerbased nanostructures, gold nanostructres.

Unit 4 - Nano particles: Synthesis and Characterization

1. Synthesis of nanostructures – physical, chemical and biological
2. Methods of biological synthesis- Use of plants, bacteria,algae, fungi, actinomycetes for nanoparticle synthesis.
3. Characterization techniques for nanaomaterials
Optical- UV–Visible spectroscopy, X-ray diffraction
Imaging and Size- Scanning Electron Microscope (SEM), Transmission Electron Microscopy (TEM), Atomic Fluorescence Microscopy (AFM),

IV Semester Practical Paper III
Bioinformatics and Nanotechnology (CBCS)
(4 HPW-2Credits)

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

Recommended Books

1. Lesk M.A. (2008) Introduction to Bioinformatics. Oxford Publication, 3rd International Student Edition
2. Rastogi S.C., Mendiratta N. and Rastogi P. (2007) Bioinformatics: methods and applications, genomics, proteomics and drug discovery, 2nd ed. Prentice Hall India Publication
3. Primrose and Twyman (2003) Principles of Genome Analysis & Genomics. Blackwell
4. Ghosh, Z. and Mallick, V. (2008) Bioinformatics- Principles and Applications. Oxford University Press.
5. Bionanotechnology: Lessons from Nature by David S. Goodsell
6. Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology - Hari Singh Nalwa
7. Nanomaterials for Biosensors, Cs. Kumar, Wiley – VCH, 2007
8. Nanostructures and Nanomaterials: Synthesis, properties and applications. Ghuzang G.Cao . 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: Biocompatibility by Robert A. Freitas

M.Sc. IV Semester
Paper IV Applied Microbiology (Elective-I)
(4 HPW-4 Credits)

Unit I

Respiration (Aerobic and anaerobic). Glycolysis (EMP, HMP and ED) pathways. TCA Cycle and its integration. Exploitation of metabolic pathways in fermentation technology and strain improvement.

Unit II

Production of Microbial products-Bacteriocins and Bioemulsifiers. Production of Microbial Enzymes-Lipases and Protease. Rapid detection techniques for pathogenic microorganisms–Total ATP measurement, PCR and Immunological based assays.

Unit III

Plant Pathology and pests. Introduction to Phytiatary science and its importance.
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.

Unit IV

Nanobiotechnology-Introduction. Development of nanobiotechnology. Nanoparticuar carrier systems, Micro and Nanofluidics.
Applications: Biosensors, drug and gene delivery systems, chip technologies, nano imaging, Nanomedicine and Cancer diagnostics and treatment.

IV Semester Practical Paper IV
Applied Microbiology (CBCS)
(4 HPW-2Credits)

1. Isolation of Bacteriocin from Lactic Acid Bacteria
2. Isolation of Proteolytic bacteria
3. Isolation of Lipolytic bacteria
4. Estimation of Protease activity
5. Estimation of Lipase activity
6. Isolation of plant pathogenic fungi *S. rolfsi*, *M. phaseolina*, *Fusarium* spp. etc. on specific media
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.
9. Characterisation of Nanosilver by UV spectrometry

References:

1. Microbiology by Prescott
2. Medical Microbiology by Ananthnarayan
3. Text book of Microbiology by Pelczar
4. Industrial Microbiology by A.H.Patel
5. Food Microbiology by Frazier
6. Food Microbiology by Casida
7. Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology
- Hari Singh Nalwa
8. Nanomaterials for Biosensors, Cs. Kumar, Wiley – VCH, 2007
9. Nanostructures and Nanomaterials: Synthesis, properties and applications. Ghuzang G.Cao . Imperical College Press, 2004
10. Biosensors: A Practical Approach, J. Cooper & C. Tass, Oxford University Press, 2004
11. Nanotoxicology: Characterization, Dosing and Health Effects, Informa Healthcare. Nancy A. Monteiro – Riviere and C. Lang Tran, 2007.
12. Nanomedicine, Vol. IIA: Biocompatibility by Robert A. Freitas
- 13.** Biological control of crop diseases Volume 89 of Books in soils, plants, and the environment by S. S. Gnanamanickam

IV Semester
PMB 405: Project Work (CBCS)
(8 HPW-6 Credits)

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 (Not exceeding 5 students per group).
2. Project work will involve experimental work and the student will have to complete this in stipulated time.
3. The final evaluation of the project work will be through a Panel involving internal and external examiners.
4. Guidelines provided for executing and evaluation of project work will be final.
5. 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.

Project work will be offered in lieu of expertise and infrastructural facilities of the department and will be evaluated for 6 credits.

6. The distribution of marks for project work will be:

Project work in lieu of one theory paper: 100 Marks (80 marks for dissertation + 20 marks for internal assessment for research skills) and 50 marks for research work presentation.