

Bajaj College of Science, (Autonomous) Wardha



M.Sc. Syllabus

Microbiology
2019-20

SYLLABUS FOR M.Sc Microbiology I

| CORE PAPER: | PAPER CODE | <u>SEMESTER – I</u> |
|-------------|---------------|---|
| PAPER-I | MB1-T001 | MICROBIAL METABOLISM (MM) |
| PAPER-II | MB1-T002 | ENZYMOLGY AND TECHNIQUES (ET) |
| PAPER-III | MB1-T003 | ADVANCE TECHNIQUES IN MICROBIOLOGY (ATM) |
| PAPER-IV | MB1-T004 | MEMBRANE STRUCTURE AND SIGNAL TRANSDUCTION (MSST) |

PRACTICALS

PRACTICAL-I MB1-LAB1

PRACTICAL-II MB1-LAB2

| CORE PAPER: | SEMESTER – II | |
|-------------|---------------|--|
| PAPER-V | MB2-T005 | MICROBIAL METHODS FOR ENVIRONMENT MANAGEMENT (MEM) |
| PAPER-VI | MB2-T006 | MICROBIAL METABOLITES (MMT) |
| PAPER-VII | MB2-T007 | MEDICAL MICROBIOLOGY AND PARASITOLOGY (MMP) |
| PAPER-VIII | MB2-T008 | IMMUNOLOGY AND IMMUNODIAGNOSTICS (IID) |

PRACTICALS

PRACTICAL-III MB2-LAB3

PRACTICAL-IV MB2-LAB4

SEMESTER – III

| | | |
|----------------------|----------|--|
| CORE PAPER: - | | |
| PAPER-IX | MB3-T009 | MOLECULAR BIOLOGY AND GENETICS (MBG) |
| PAPER-X | MB3-T010 | RECOMBINANT DNA TECHNOLOGY AND NANOBIO TECHNOLOGY (RDTN) |

ELECTIVE PAPER:-

PAPER-XI MB3-T011 ANY ONE OF THE FOLLOWING: -
1) MICROBIAL DIVERSITY, EVOLUTION AND ECOLOGY (MDEE) - I
2) BIOINFORMATICS (BIF) -I

FOUNDATION COURSE:-

PAPER-XII MB3-T012 ANY ONE OF THE FOLLOWING: -

1) GENERAL MICROBIOLOGY (GM)
 (To be opted by students of other subjects only)

2) DRUGS AND DISEASE MANAGEMENT (DDM) (**CORE SUBJECT CENTRIC -I**)
 (To be opted by students of Microbiology only)

PRACTICALS

PRACTICAL-V MB3-LAB5

PRACTICAL-VI MB3-LAB6

SEMESTER – IV

CORE PAPER: -

PAPER-XIII MB4-T013 VIROLOGY (VIR)

PAPER-XIV MB4-T014 MICROBIAL FERMENTATION TECHNOLOGY (MFT)

ELECTIVE PAPER:-

PAPER-XV MB4-T015 ANY ONE OF THE FOLLOWING: -
1) MICROBIAL DIVERSITY, EVOLUTION AND ECOLOGY (MDEE) - II
2) BIOINFORMATICS (BIF) - II

FOUNDATION COURSE :-

PAPER-XVI MB4-T016 ANY ONE OF THE FOLLOWING: -
1) ADVANCE MICROBIOLOGY (AM)
(To be opted by students of other subjects only)
2) VACCINES AND DELIVERY SYSTEM (VD) (CORE SUBJECT CENTRIC -2)
(To be opted by students of Microbiology only)

PRACTICALS

PRACTICAL-VII MB4-LAB7

PROJECT WORK MB4-PROJ

SEMESTER-I
Paper-I
Microbial Metabolism (MM)

UNIT-I: - Bioenergetics and metabolism

Glycolysis, TCA Cycle, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers. Biosynthesis of cell wall polysaccharides and bacterial peptidoglycan.

Lipid:-Membrane lipids, biosynthesis of membrane phospholipids, ketone bodies.

UNIT-II: - Proteins and Nucleic acids

Proteins:-Determination and characteristics of alpha-helix and β -sheets. Concept of protein domain and motif, common motifs and their role in metabolism, protein folding and denaturation curves, role of Chaperones and chaperonins, Conformation of Proteins: Ramchandran plot.

Nucleic acids:-Confirmation of nucleic acids: helix (A, B, Z), t-RNA, micro-RNA). secondary structure of RNA, purine and pyrimidine biosynthesis, degradation and regulation, salvage pathway, Inhibitors.

UNIT-III: - Photosynthesis

Anoxygenic photosynthesis:-Green sulphur and purple phototrophic bacteria.
bacteria. **Oxygenic photosynthesis:**-Cyanobacteria.

CO₂ fixation:-C₃, C₄ and CAM pathways

Chemolithotrophy:- Hydrogen oxidation and autotrophy in hydrogen bacteria. Iron oxidation.

Bioluminescence

UNIT-IV:-Nitrogen and Sulphur metabolism and methanogenesis.

Nitrification and Anammox. Nitrate reduction and Denitrification.

Nitrogen fixation: Symbiotic, nonsymbiotic. Sulphate reduction.

Methanogenesis, Acetogenesis.

SEMESTER-I
Paper-II
Enzymology and Techniques (ET)

UNIT-I: - Catalytic mechanisms

General characteristics of enzymes(Terminologies),

, Classification of enzymes, Concept of active site, Membrane bound enzymes, isoenzymes and marker enzymes. Constitutive and inducible enzymes, Multienzyme complexes(PDH, FAS)

UNIT-II: - Catalytic mechanisms :

Acid –base catalysis, covalent catalysis, metal ion cofactors, proximity and orientation effects, preferential binding. mechanism of action of lysozyme and serine proteases.

UNIT-III: - Enzymes kinetics and regulation

Overview of Michaelis-Menten equation and its transformation, Evaluation of kinetic parameters, Kinetics of bisubstrate reaction, multistep reactions, kinetics of enzyme inhibition , Allosterism: Kinetic analysis of allosteric enzymes Covalent Modification, Feed -back inhibition.

UNIT-IV: - Techniques

Protein: ligand binding studies: association and dissociation constants, co-operative ligand binding MWC or concerted model, sequential model.

Enzyme biosensors: General concept, glucose biosensor. **Industrial applications of enzymes.**
Protein engineering.

SEMESTER-I
Paper –III
Advance Techniques in Microbiology (ATM)
MB1-T003

UNIT-I: - Biophysical Techniques-I

Analysis of biomolecules: UV/visible spectrophotometer, fluorescence, circular dichroism,
Structure determination: X-ray diffraction and NMR; analysis using light scattering, different types of
mass spectrometry and surface plasma resonance methods

UNIT-II: -Biophysical Techniques-II

Electrophoresis: Agarose Gel, SDS-page, two-dimensional gel electrophoresis, capillary
electrophoresis, immuno-electrophoresis. Centrifugation and ultracentrifugation, Chromatography:
Principle, design and applications of TLC, HPTLC, GC, HPLC, Gel filtration.

UNIT-III: -Microscopical Techniques.

Electron Microscopy: SEM, TEM. Fluorescent Microscopy, Laser scanning, confocal
microscopy. Scanning tunneling and atomic force microscopy. Immunoelectron microscopy, cryoelectron
microscopy.

UNIT-IV: -Other advance techniques

Western, southern and northern blotting techniques, Radioimmunoassay, transcriptional start point
mapping, fluorescence photobleaching recovery, flow cytometry, In-situ localization by techniques such
as FISH and GISH

SEMESTER-I
Paper-IV
Membrane structure and Signal Transduction (MSST)
MB1-T004

UNIT-I: - Structure and organization of membranes

Structure of Model Membrane, Lipid bilayer and membrane proteins, **Structural organization and function of intracellular organelles** (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility).

UNIT-II: - Membrane Transport

Active and Passive transport, uniport, ATP powered pumps, non-gated ion channels, cotransport by symporters and antiporters, transepithelial transport.

UNIT-III: - Signal Transduction I

General concept of cell signaling, G-protein coupled receptors and their effectors. RTK and MAP Kinases. Down regulations of pathways, JAK-STAT pathway

UNIT-IV: - Signal Transduction II

Basic two component system in bacteria and plants, Histidine kinase pathway, Sporulation as a model of bacterial signal transduction. Osmoregulatory pathways, Light signaling in plants, Heat shock proteins, Mating types of yeast.

PRACTICAL-I
MB1-LAB1
LABORATORY EXERCISE 1

- 1) Detection of enzyme activity of lipase, Urease, invertase, protease.
- 2) Determination of kinetic constant of amylase: -Amylase activity, V_{max} , K_m .
- 3) Effect of pH and temperature on amylase activity.
- 4) Effect of inhibitors on amylase activity.
- 5) Estimation of protein.
- 6) Production, isolation and purification of enzyme and determination of fold purification (any one enzyme)
- 7) Estimation of sucrose in presence of glucose.
- 8) UV absorption of proteins, DNA and RNA.
- 9) Isolation and identification of Nitrogen fixing bacteria such as Azotobacter, Rhizobium etc.)
- 10) Isolation of Siderophore producing bacteria.
- 11) Preparation of Biofertilizers and Biopesticides and their quality control

Minimum seven experiments must be performed in the semester.

PRACTICAL-II
MB1-LAB2
LABORATORY EXERCISE 2

- 1) Separation of DNA by agarose gel electrophoresis
- 2) Partial purification of enzymes
- 3) Separation of amino acids by paper chromatography.
- 4) Separation of serum proteins by paper electrophoresis.
- 5) Thin layer chromatography .
- 6) SDS-Page of proteins.
- 7) Performance of affinity chromatography.
- 8) Performance of Gel filtration chromatography.
- 9) Demonstration of blotting technique.[any one].
- 10) Ion exchange chromatography
- 11) Separation of Subcellular organelles and isolation of Marker enzymes.

Minimum seven experiments must be performed in the semester.

SEMESTER-II
Paper-
V
Microbial Methods for Environment Management (MEM)
MB2-T005

UNIT-I: - Eutrophication, Biodeterioration and Biomagnification

Eutrophication: Microbial changes induced by organic and inorganic pollutants, factors influencing eutrophication process and control of eutrophication.

Biodeterioration: Definition and concept of biodeterioration, biodeterioration of woods and pharmaceutical products.

Biomagnification: concept and consequences, Biomagnifications of chlorinated hydrocarbons and pesticides.

UNIT-II: - Biotransformation and Bioleaching, Biodegradation

Biotransformations: metals and metalloids, mercury transformations, biotransformation of pesticides such as hexachlorobenzene.

Bioleaching: Bioleaching of ores, leaching techniques and applications.

Biodegradation: Biodegradation of plastics.

Bioremediation :Concept,its types and applications. Biomarker gene (antibiotic and heavy metal resistance genes, icenucleation genes), Bioreporter genes.

UNIT-III: - Pollution Management

Waste water management using activated sludge, aerated lagoons, trickling filter, rotary biological contractors, fluidized bed reactors, stabilization ponds. Significance of waste water treatment processes.

UNIT-IV: - Global Environmental Problems

Ozone depletion, UV-B, green house effect, acid rain, their impact and biotechnological approaches for management. Acid mine drainage and associated problems. Global warming and climate change.

SEMESTER-II
Paper –VI
Microbial Metabolites (MMT)
MB2-T006

UNIT-I:- Overview of metabolites

Metabolites: General account of metabolites, secondary metabolites. Classification, structure and mode of action of secondary metabolites. Plants secondary metabolites: Digitoxine, Salicylic acid, Mycotoxins-Aflatoxin, Ochratoxin, Patulin.

Microbial biopolymers: chitin, Xanthan, dextrin, Gellan, Pullulan, curdlan and hyaluronic acid.

Polyamines: Brief outline and functions of polyamines. Synthesis of linear polyamine-putrescine, cadoverine, spermidine and spermine.

UNIT-II:- Antimicrobial drugs: Secondary metabolites

Antibiotics: History and discovery of antibiotics, Antibiotic resistance, Mechanisms of antibiotic resistance.

Structure and mode of action of antibiotics:

Aminoglycosides(Amikacin),Carbapenems(Imipenim),microlids(Azithromycin),Nitrofurantoin(nitrofurantoin),Penicillin(Amoxicillin),Quinolones(gatifloxacin/Ciprofloxacin),Sulphonamides(sulfamethoxazole),Tetracyclines(doxycyclines),Chloramphenicol,Fucanazole.

UNIT-III:-Pigments as secondary metabolites

Structure and function of Hemoglobin, Myoglobin, Melanin and bile pigments. Microbial pigments: Bacteriochlorophylls, Carotenoids of prokaryotes, rhodopsin and accessory pigments(Pulcherrimin, indigoidin, voalecin) Defensive role of pigments.

UNIT-IV:-Microbial vitamins

Characteristics of fats and water soluble vitamins.

Structure, function and chemistry of: Retinol (vitaminA), Riboflavin (vitaminB₂),Cynocobalamine (VitaminB₁₂) and ascorbic acid (vitaminC). **Deficiency diseases in**

humans:Xerophthalmia,BeriBeri.Pellegra,Scurvey,Keratomalacia,osteoporosis,Osteomalacia,Cheilosis ,Glossitis, Pernicious anemia and Erythroidhypoplassia.

SEMESTER-II
Paper-
VII
Medical Microbiology and Parasitology (MMP)
MB2-T007

UNIT-I: - Infection

Infection: Definition, Types, stages of infection, process of infection.

Establishment of pathogenic microorganisms: Entry, spread and tissue damage. Mechanism of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts. Aggressins and toxins.

UNIT-II: - Bacteriology

Pathogenic Bacteria: Morphological characteristics, Pathogenesis and Laboratory diagnosis including rapid methods of following pathogenic bacteria;

Klebsiella pneumoniae; Proteus Vulgaris; Clostridium perfringens; Shigella dysenteriae; Pseudomonas aeruginosa; Vibrio Cholerae; Streptococcus pneumonia, Salmonella typhi.

UNIT-III: - Mycology and Parasitology

Pathogenic Fungi: Morphological characteristics, pathogenesis and laboratory diagnosis of following pathogenic fungi;-

Microsporium; Trichophyton; Histoplasma capsulatum; Blastomyces dermatitidis; Candida albicans; Cryptococcus neoformans; Pneumocystis carinii.

Parasites: *Entamoeba histolytica; Giardia Lamblia; Plasmodium vivax; Leishmania donovani.*

Helminths: *Taenia saginata; Taenia solium; Hymenolepis nana; Schistosoma haematobium*

UNIT-IV: - New emerging Infections

New emerging infections: *-Streptococcus suis; community associated Methicilin resistant Staphylococcus aureus (MRSA), Bordetella pertusis, Clostridium difficile, Multi drug resistant tuberculosis.*

SEMESTER-II
Paper –
VIII
Immunology and Immunodiagnostics (IID)
MB2-T008

UNIT-I: - Overview of the Immune system and CMI

Cells involved in Immune system: Hematopoiesis, Lymphocytes, mononuclear phagocytes, Antigen presenting cells, Granulocytes.

Lymphoid organ: Lymphatic system, Primary and Secondary lymphoid organs.

Complement System: Pathways of complement activation, regulation of complement system, Biological functions of complement system.

Inflammation: Intracellular cell adhesion molecules, Mechanism of cell migration, Inflammation. Pathways of antigen processing and presentation.

Cell Mediated Immunity: General properties of effector T cells, Cytotoxic T Cells, Natural Killer cells, Antibody-Dependent cell mediated cytotoxicity. T-Cell dependent and T-cell independent defense mechanisms.

UNIT-II: - Cancer and transplantation immunology.

Cancer: Origin and Terminology, Malignant Transformation of cells, oncogenes and cancer induction, Tumor Antigens, Immune surveillance theory, Tumor evasion of the Immune system, Cancer Immunotherapy

Tolerance: Central and peripheral tolerance to self antigens, Mechanism of induction of natural tolerance

Transplantation Immunology: Immunological basis of Graft Rejection, Mechanism of Graft rejection. Immunosuppressive therapy: General and specific. Clinical Transplant.

UNIT-III: - Immune Dysfunction

Immunodeficiency disorders: - Phagocytic cell defect (Chediak-Higashi syndrome); B-cell deficiency (Bruton's X-linked hypogammaglobulinemia); T-cell deficiency disorder (DiGeorge Syndrome); Combined B-cell & T-cell deficiency disorder (SCID-Severe combined immunodeficiency diseases, Wiskott-Aldrich syndrome); Complement deficiencies and secondary immunodeficiency conditions carried by drugs, nutritional factors & AIDS.

Autoimmunity and autoimmune diseases:-General consideration, Etiology, Clinical categories, Diagnosis and treatment. RA(Rheumatoid arthritis); SLE (Systemic Lupus Erythematosus); Guillain-Barre Syndrome; Multiple sclerosis; Myasthenia gravis; Grave's disease; Goodpasture syndrome, Autoimmune haemolytic disease; Pernicious anaemia.

Hypersensitivity :- Type I, Type II, Type III & Type IV

UNIT-IV: - Immunodiagnostics

Precipitation reactions: Immunodiffusion, immunoelectrophoresis,

Agglutination reactions: Bacterial Agglutination, Hemagglutination, Passive agglutination, Reverse passive agglutination and agglutination inhibition.

Immunodiagnostic techniques: Radioimmuno assay, ELISA, Chemiluminiscence immuno assay, Western blotting technique, Complement fixation test, Immunofluorescence, Immunoelectron microscopy.

PRACTICAL-III
MB2-LAB3
LABORATORY EXERCISE 3

1) Different staining:

- a) Acid fast staining,
- b) Giemsa staining,
- c) Leishmann staining,
- d) Fluorochrome staining
- e) Special staining methods to demonstrate granules, capsule and spores.

2) Isolation of pathogens from clinical samples pus, blood and urine.

3) Conventional and rapid methods of isolation and identification of following pathogenic bacteria, fungi and parasites.

Bacteria: *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumoniae*, *Proteus vulgaris*, *Proteus mirabilis*, *Salmonella typhi*, *Salmonella paratyphi*, *Shigella dysenteriae*, *Shigella flexneri*, *Pseudomonas aeruginosa*, *Vibrio cholerae*. {Any five}

Fungi: *Candida albicans*, *Cryptococcus neoformans*, *Microsporum trichophyton*, *Histoplasma capsulatum*. [any one]

Parasite: *Entamoeba histolytica*, *Giardia lamblia*, *Plasmodium spp.*, *Trichomonas vaginalis*; *Taenia solium*, *Taenia saginata* [any one].

4) Antibiotic sensitivity testing by various methods:

- a) Kirby-Bauer's disc diffusion method.
- b) Well plate method.
- c) Broth dilution method.
- d) Agar dilution method.
- e) E-strip method for MIC testing.

PRACTICAL-IV
MB2-LAB 4
LABORATORY EXERCISE 4

Diagnostic immunologic principles and methods of followings:-

- 1) Immunodiffusion
- 2) Immuno-electrophoresis
- 3) Blood grouping
- 4) Widal [slide and tube] tests.
- 5) TRUST [Toluidine Red Unheated Serum Test]
- 6) Syphcard test
- 7) Australian latex antigen test.
- 8) Antistreptolysin 'o' test [ASO]
- 9) Pregnancy test.
- 10) Rheumatoid arthritis test [RA]
- 11) RPR [rapid plasma reagin] test.
- 12) Treponema pallidum haemagglutination test (TPHA).
- 13) One step test for Qualitative detection of HBs.
- 14) ELISA [Enzyme Linked Immunosorbent Assay]-HIV and HBs.

SEMESTER-III
Paper-IX
Molecular Biology and Genetics (MBG)
MB3-T009

UNIT-I: - Replication Repair and Recombination

Replication:-Initiation-Priming in E.Coli and Eukaryotes.

Elongation:-Holoenzyme and processivity of replication.

Termination:-In prokaryotes and eukaryotes.

DNA Repair:-Direct reversal of DNA damage, Base excision repair by nucleotide excision.

Homologous recombination:-Rec BCD; gene conversion.

UNIT-II: - Gene Expression

Transcription:-Comparative study of prokaryotic and eukaryotic transcription process, Class I, II, III promoters, Enhancers and silencers, General and specific transcription factors.

Post transcriptional events:-mRNA, rRNA and tRNA processing through splicing mechanism, trans splicing, RNA editing, post transcriptional control of gene expression, gene silencing, RNA interference, Catalytic RNA and antisense RNA.

Translation:-Initiation, elongation and termination mechanism. Post translational modifications.

UNIT-III: - Gene Regulation Expression

Lac, Arabino and trp.operons.

Chromatin remodeling and mRNA and protein degradation control.

UNIT-IV:- Genetics of Bacteria and Bacteriophages

Gene mapping in bacteria by conjugation, transformation and transduction.

Mapping bacteriophage gene by recombination analysis, deletion mapping and complementation.

Transposons: Bacterial, P elements and retroposons

SEMESTER - III
Paper –X
Recombinant DNA technology and Nano Biotechnology (RDTN)
MB3-T010

UNIT-I: - Molecular Cloning Methods.

DNA cloning, restriction enzymes, cloning vectors, genomic library ,cDNA library and chromosome libraries.

Screening and identification of genes, Expression vectors, heterologous probes, oligonucleotide probes, microarrays.

PCR: Steps, advantages, limitations, application, RT-PCR

UNIT-II:- Other molecular tools for studying genes

Restriction mapping: DNA sequencing dideoxy and pyrosequencing, DNA fingerprinting.

S1 Mapping, primer expressions, Dnasefootprinting, DMS footprinting.

Nuclear run on transcription, reporter gene transcription.

UNIT-III:- Tissue Culture and stem cell technology

Tissue culture: Tissue culture media and supplements, serum-free media, cell lines and cryopreservation of cells. Primary culture, subculture, suspension culture techniques, transformation and immortalization. Quantitation and characterization of cells.

Stem cell technology-embryonal stem cell and multipotent stem cells, present perspective.

UNIT-IV:- RDT Products.

Tissue plasminogen activator [TPA].Tissue growth factor B. Dnase; **PDGF**.

GEMS/GMO.

Transgenic plants and plant products, Comparative account, **Concept of nano biotechnology and its application.**

SEMESTER - III
Paper –XI CORE
ELECTIVE
Microbial Diversity, Evolution and Ecology (MDEE) - I
MB1- T011

UNIT-I: - Microbial Evolution and Systematic

Evolution of Earth and early life forms.

Primitive life forms:-RNA world, molecular coding, energy and carbon metabolism, origin of Eukaryotes, endosymbiosis.

Methods for determining evolutionary relationships:-Evolutionary chronometers, Ribosomal RNA sequencing, signature sequences, phylogenetic probes, microbial community analysis.

Derivation of Microbial Phylogeny:- characteristics of domain of life, classical taxonomy, chemotaxonomy, bacterial speciation.

UNIT-II: -Microbial Diversity: Archea

General Metabolism and Autotrophy in archea

Phylum Euryarchaeota:-Halophilicarchaea, methanogens, thermoplasma.

Phylum Crenarchaeota:-Energy metabolism, Thermoproteales, sulfolobales, desulfolobales.

Phylum Nanoarchaeota:-Nanoarchaeum.

Heat stable biomolecules and extremophiles, Evolutionary significance of hyperthermophiles.

UNIT-III :-Microbial Diversity: Bacteria

Phylum Proteobacteria:-Free living N₂ fixing bacteria, purple phototrophic bacteria nitrifying bacteria, sulphur and iron oxidizing bacteria, sulphate and sulphur reducing bacteria.

Phylum prochlorophytes and cyanobacteria,

Phylum: Planctomyces,

Phylum; Verrucomicrobia.

UNIT-IV :- Microbial Diversity.

Phylum: Cytophaga, Phylum: Green Sulfur Bacteria. Phylum: Deinococci.

Phylum: Green non –sulfur bacteria.

Phylum: Branching Hyperthermophiles, Thermotoga and Aquifex.

Phylum: Nitrospira and Deferribacter.

SEMESTER - III
Paper –XI
CORE ELECTIVE
Bioinformatics (BIF) - I
MB3-T011

UNIT-I: -

Basic Concept of Computer Organization, Internet, File Transfer Protocol, Browser, Home Page, Hyper text transfer protocol, Uniform Resource Locator, Hyperlink and Web Applications.

UNIT-II: -

Database types, levels of omics, genome projects.

C-value paradox, reassociation kinetics.

Data researches and pairwise alignments:-

Dot Plots, Simple alignments, Dynamic programming global and local alignments

BLAST, FASTA, Scoring matrices, and alignment scores. Multiple sequence alignments. Pattern of substitution within genes, substitution number estimations, molecular clocks.

UNIT-III: - Phylogenetics

Phylogenetic trees, Pair wise alignment, distance matrix method, maximum likelihood approach, multiple sequence analysis,

Parsimony, Inferred ancestral sequence, consensus trees, comparison of phylogenetic methods.

UNIT-IV:- Genomics and Gene recognition

Prokaryotes genomes, prokaryotic gene structure GC content prokaryotic gene density, eukaryotic genomes, eukaryotic gene structure, ORF, GC content expression, Transposition, Repetitive elements, gene density.

**FOUNDATION COURSE IN MICROBIOLOGY
SEMISTER- III
Paper –XII**

**GENERAL MICROBIOLOGY (GM)
(To be opted by students of other subjects only)**

UNIT-I: -

Morphology of bacteria, fungi, protozoa and algae. Gram staining, acid fast staining and endospore staining. Synthetic and non synthetic media, autoclave and its application in sterilization.

UNIT-II: -

Basic nutritional requirements, nutritional classifications, determination of basic nutritional requirements, bacterial growth curve, factors determining bacterial growth. Determination of bacterial growth.

UNIT-III: -

Control of bacteria- microbiostatic and microbiocidal agents, physical techniques for control of bacteria, chemical techniques for control of bacteria, antibiosis and common antibiotic agents.

UNIT-IV: -

Bacteriological analysis of water- MTFT, Membrane filter technique, MPN, Basic water treatment process for generation of portable water, definition of waste water, waste water treatment process.

Core Subject Centric – 1
(To be opted by students of Microbiology only)
SEMESTER - III
Paper –XII
Drugs and Disease Management (DDM)
MB3-T012

UNIT-I: -

Drug latention and Prodrug: History, carrier-linked prodrugs, bioprecursorsprodrugs, carboxylic acids and alcohols, amines, carboxyl compounds.

Drug-microbe: Host relationship, mechanism of drug action and drug resistance including MDR.

UNIT-II:-

Antiinfective agents:Iodophores (providone-Iodine),Benzylkonium chloride, genital violet, mercury compounds.

Antifungal agents:Clotrimazole, Ketoconazole, Tolnaftate, Amphotericin B, Nystatin, Griscofulvin.

Antitubercular agents: Isoniazid, Ethambutol, rifamycin ,cycloserine.

UNIT-III: -

Antiprotozoal agent:Metranidazole, 8-hydroxyquinoline

Antimalarials:Quininesulphate, Chloroquine, Primaquine phosphate, Pyrimethamine.

UNIT-IV:-

Histamines and Antihistaminicagents: Cimetidine, Ramitidine, Omeprazole.

Analgesic agents:Morphine and their derivatives anti-inflammatory analgesics- Phenylbutazoneamdoxyphenbutazone, Prostaglandins.

PRACTICAL-V
MB3-LAB 5
LABORATORY EXERCISE 5

- 1) Isolation of genomic DNA of bacteria.
- 2) Isolation of plasmid DNA.
- 3) Amplification of DNA by PCR.
- 4) Restriction digestion and RFLP
- 5) Demonstration of bacterial transformation.
- 6) Demonstration of cloning
- 7) Demonstration of UV induced mutagenesis in *E.coli*.
- 8) Demonstration of ligation.

PRACTICAL-VI
MB3-LAB 6
LABORATORY EXERCISE 6

- 1) Preparation of plant tissue culture media.
- 2) Growth of Callus.
- 3) Isolation of single cell from intact plant organs.
- 4) Microscopic observation of cultured cells.
- 5) Determination of starch in plant tissue.
- 6) To study Phytochemical analysis (qualitative detection) of plant.

SEMESTER-IV
Paper-XIII
Virology (VIR)
MB4-T013

UNIT-I: - History, Classification and composition of viruses

Brief outline on discovery of viruses (Origin and evolution), Terminology, Differentiation with other groups of microorganisms.

Nomenclature and classification of viruses (Regenmortel et.al.2005, 8th Report of ICTV).

Genetic classification

Morphology and structure of viruses (size and shape/symmetry).

Chemical composition of viruses (viral capsid, spikes, envelopes and types of viral nucleic acids).

Assay of Viruses.

UNIT-II:-Bacterial viruses

Bacteriophages- Structural organization; life cycle (Extracellular phase; attachment, penetration of nucleic acid, transcription, translation, replication, maturation and release of phage particles) of Φ X174, T4, lambda, M₁₃ and M_UPhages. Bacteriophage typing, One step growth curve.

UNIT-III:-Animal and Plant viruses

Life cycle, pathogenesis and laboratory diagnosis of following viruses.

Animal Viruses:-

RNA viruses: Picorna, Orthomyxo, Rhabdovirus and HIV.

DNA viruses: Pox, Herpes, Adeno and Hepatitis viruses.

Oncogenic viruses: Papova viruses, EB virus, HTLV viruses.

Plant virus: TMV, Cauliflower mosaic virus, potato virus.

UNIT-IV:-General methods of Diagnosis and antiviral drugs

Serological methods: -Haemadsorption; Haemadsorption inhibition; haemagglutination; Haemagglutination inhibition(HAI); Complement fixation, Immunofluorescence methods. ELISA and Radioimmunoassays(RIA).

Antiviral agents: Types of IFN, induction and Molecular basis of antiviral effect of interferon

Structure and Mechanism of action of:

Amantadine, Rimantidine, Vidarabine, Acyclovir, Ganciclovir, Ribavirin, Foscarnet, Stavudine, Lamivudine.

NNRTIS(non-nucleoside RT inhibitors)- Nevirapine; Delavirdine and Efavirenz.

Protease inhibitors- Saquinavir, Indinavir and Ritonavir.

SEMESTER-IV
Paper-
XIV
Microbial Fermentation Technology (MFT)
MB4-T014

UNIT-I:- General Principles of Fermentation

Bioreactors: Bioreactor types, immobilized bioreactors, types of fermentation.

Fermentation kinetics and Monod's Model: -Growth kinetics and Monod's Model, Substrate accelerated death, specific growth rate, stringent response, Ntr and Pho system, growth limiting substrate, maintenance energy, growth yield and product formation.

Process optimization: factors of optimization, rheology of fermentation fluid, oxygenation, and oxygen transfer kinetics. chemostat, turbidostat.

UNIT-II:- Downstream Processing and scale up.

Downstream processes: types of processing units and systems, Storage and packaging methods.

Scale up; scale down, criteria involved in scale up.

Productivity, power requirements Basic control theory.

UNIT-III: - Industrial Fermentation Products

Biofuels: -Ethanol, Hydrogen, Methane

Antibiotics: - β -lactum antibiotics (Synthetic penicillin), Streptomycin, Cephalosporin.

Biopreservative: Lactobacillus sakei. Biopolymers: -Xanthan, Polyhydroxyalkanoates.

Thermostable enzymes: -Proteases. Biosurfactants: a comparative account.

UNIT-IV:-Food and Healthcare products

SCP, various types and processes. Carotenoids

Amino acids: -Lysine, Glutamic acid.

Vitamins: -riboflavin, Vit. B12. Fatty acids (Palmitate, oleate).

SEMESTER - IV
Paper –XV CORE
ELECTIVE
Microbial Diversity, Evolution and Ecology (MDEE) - II
MB4-T015

UNIT-I: - Microbial Ecosystems

Population, guilds, communities, homeostasis, Environment and microenvironment.
Biofilms. Terrestrial environment, deep surface microbiology. Fresh water environment, lake and river microbiology. Marine Microbiology and Hydrothermal vents.

UNIT-II: - Diversity, stability and succession

Diversity indices, dominance indices, information statistics indices, Shannon index, Brillouin Index, Rank abundance diagrams, community similarity analysis, Jaccard Coefficient, Sorensen coefficient, cluster analysis. Community stability, stability hypothesis, Intermediate-disturbance hypothesis.
Meaning of succession: Tolerance and inhibition patterns of succession, theories of succession.

UNIT-III: - Ecology and Genetics

Genetic structure of population:- Genotype frequency, allele frequencies.
Hardy-Weinberg Law: - Assumptions, predictions, derivation, extension and natural selection.
Measuring genetic variation at protein level, measuring genetic variation at DNA level.
Factors effecting gene frequencies:- Mutation, Random genetic drift, migration, Hardy-Weinberg natural selection, Assortative mating, Inbreeding.

UNIT-IV: -Interactions and Ecosystem Management

Microbial Interactions: Competition and coexistence, Gause hypothesis, syntrophy, commensalism and Mutualism, predation, parasitism, and antagonism, Interaction with plants and animals.
Concept of sustainable development: microbial technology and sustainable development.
Management and improvement of waste land/barren land.
Oil spills, damage and management petroleum and oil shore management.

SEMESTER - IV
Paper –XV CORE
ELECTIVE
Bioinformatics (BIF) - II

MB4-T015

UNIT-I: -

Data Mining- Definition, data mining problems, cluster analysis, data mining techniques and tools, data mining methods.

UNIT-II: -

Structure of proteins- primary, secondary, tertiary, quaternary. Protein motifs and folding, protein folding modeling, protein structure prediction.

UNIT-III: -

Structure of RNA, secondary structure of RNA, types of RNA, RNA structure prediction.

UNIT-IV: -

Insilico drug designing, insilico inhibitors designing, empirical methods of ligand screening, prediction techniques, post translational modification prediction.

FOUNDATION COURSE IN MICROBIOLOGY
SEMISTER- XVI
ADVANCE MICROBIOLOGY (AM)
(To be opted by students of other subjects only)

UNIT-I: -

Industrially important micro organisms, typical fermentor and layout of fermentation plant, batch and continuous processes, kinetics of fermentation.

UNIT-II: -

Industrial production of ethanol, penicillin, lysine, vit.B12, acetone butanol, vinegar, alcoholic beverages including beer, wine, whiskey, rum, vodka and gin.

UNIT-III: -

Agriculturally important micro organisms, mycorrhiza, phosphate solubilizing bacteria, biofertilizers, biopesticides, composting and its applications.

UNIT-IV: -

Medically important pathogenic bacteria and viruses, diseases of respiratory tract, gastro intestinal tract, urino genital tract, diseases of brain and central nervous system. Active and passive immunity and immunization process.

Core Subject Centric – 2
(To be opted by students of Microbiology only)
SEMESTER - IV
Paper –
XVI
Vaccines and Delivery system (VD)
MB4-T016

UNIT-I: - Vaccines

Definition and discovery of vaccines.
Active and passive prophylactic measures.

General account on :-

Exhalation & attenuation.
Subunit vaccines
DNA vaccines
Vaccines additives and adjuvants

UNIT-II: -

Conventional vaccines

Contents and immunization schedule
BCG
Hepatitis vaccine
Influenza vaccine
Polio vaccine (Inactivated, live attenuated)
DPT
MMR

UNIT-III: -

Advanced vaccines

Vaccines in development.
Malaria vaccines
Epstein Barr virus vaccines
Cytomegalo virus vaccines
HIV vaccines
Herpes simplex viral vaccines

UNIT-IV: - Designing & delivery system.

Drug designing

Non-automated in vitro drug susceptibility testing.
Rapid tests for susceptibility testing, and antibiotic assay in body fluid
Drugs & vaccines delivery system.

PRACTICAL-VII
MB4-LAB 7
LABORATORY EXERCISE 7

- 1) Isolation of viruses from water sources.
- 2) Microbiological examination of foods.
- 3) Production of penicillin in lab and its estimation.
- 4) Determination of microbial reaction kinetics for an inhibitory substrate in a fed batch system.
- 5) Determination of the parameters of oxygen transfer.
- 6) Immobilization of cells/Enzymes.

PROJECT WORK
MB4-PROJ

Course outcomes:

After completion of project work students will able to:

Learn how to do literature survey and to plan

Understand how to locate a problem

Perform research work on various topics that will impart deeper knowledge of facts & methods in Microbiology / life science.

Capable of contributing to research and development work.

Plan and use adequate methods to conduct qualified tasks in given frameworks

Present and discuss the conclusions as well as the knowledge and arguments that form the basis for these findings.

Evaluate their work.

List of recommended books

- The Biochemistry of copper By: Jack Peisach, Phillip Aisen.
- Biochemistry:- By Rex Montgomery.
- Lehninger Principles of Biochemistry By:-David L. Nelson and Cox
- Metabolic Pathways By:-David M.Greenberg.
- Harper's Biochemistry By:Robert K.Myrray.
- Enzymes: By Trevor Palmer.
- Enzyme structure and mechanism By: Alan Fersht.
- Methods in Enzymology By: S.Berger,A.Kimmel.
- Fundamentals of Enzymology By;N.Price,L.stevens.
- Immobilization of Enzymes and cells By: Gordon Bickerstaff.
- Industrial Microbiology By:A.H.Patel
- Industrial Microbiology By:L.E.Casida.
- Food Microbiology.By:William C.Frazier,Dennis C.Westhaff.
- Prescott and Dunns Industrial microbiology.By;Gerald Reed.
- Basic Food Microbiology.By:George J.banwart.
- Medical Microbiology.By:G.F.Brooks,J.S.Butel,S.A.morse.
- Text book of Microbiology.By:Ananthanarayan and Panikar.
- Medical Microbiology.By:B.S.Nagoba and A.Pichare.
- Clinical Microbiology and Infection control.By;Elaine Larson.
- Bacterial Pathogenesis;Molecular and cellular mechanism.By;Camila Locht and Michel Simonet.
- Medical Microbiology.By:David Greenwood.
- Medical Microbiology.By:J.P.Dugaid.
- Small Dna tumor viruses.By:Kevin Gaston.
- Viruses and Interferon;current research.By:Karen Mossam
- Lentiviruses and Macrophages:Molecular and Cellular interactions.By:Moira Desporf.
- The Biology of Animal viruses.By;C.A.mims.
- Animal virology.By:David Baltimore,A.Huang,c.fox
- Oncogenic viruses and host cell genes.By:E.Kurstak,Karl Maramorosch.
- Bacterial and Bacteriophage Genetics.By:Edward A.Birge.
- Molecular Genetics of Bacteria.By:J.W.Dale.
- Molecular Biology of the gene.By:J.D.Watson,N.h.Hopkins,J.W.Roberts,J.A.Steitz&A.M.Weiner.
- Microbial Genetics.By:Maloy{T.A}.Jones and Bartlett publications.
- Mobile DNA.By;Nancy Craig,Martin Gellatallan,lambowitz.
- Methods of General and Molecular biotechnology.By:Philip Gerhardt ASM publication.
- Recombinant DNA.By;Watson J.D. Essentials of Molecular Biology.By:Malcinski.
- Molecular genetics of Bacteria.By:Larry,Synder and Wendy Champness.
- Molecular biology.By;F.Weaver.WCB/MCGraw Hill.
- Molecular Biology of Gene.Watson et al,Benjamin-cumminas,USA.

- Molecular Biotechnology. Glick-1994.
- Genetic Engineering By: Sandya Mitra.
- Environmental Microbiology By: Ralph Mitchell, John Wiley and Sons Inc.
- Environmental Biotechnology By: C.F. Froster and D.A. John Wase, Ellis Horwood.
- Biocatalysis and Biodegradation: Microbial Transformation of organic compounds. 31 y: Lawrence p. Wacekett.
- A manual of environment Microbiology. By: Christon J. Hurst, ASM publication.
- Biodegradation and bioremediation Academic press BY: San Diego.
- Biotechnology in the sustainable environment, Plenum press, NY
- Basic principles of Geomicrobiology. By: A.D. Agate.
- Environmental Microbiology By: R.M. Maier, I.C. Papper and C>P>Gerba.
- Methods in Microbiology: Lynch and Hobbie.
- Experimental Microbial Ecology. By: Arosison Academic Press.
- Advances in Applied microbiology. By: D. Pearlman academic press.
- Microbiology of Extreme environments, edited by Clive Edward, Open University press, Milton Keynes.
- Principles of Biochemistry. By: Donald J. Voet, Judith G. Voet, Charlotte W. Pratt.
- Brock Biology of Microorganisms. By: John M. Martinko.
- Introduction to Genetic analysis. By: Griffiths, Wessler, Lewontin, Gelbart, Suzuki, Miller.
- Biophysical Chemistry VOL: I, II, III;
- The conformation of biological macromolecules. By: Cantor and Schimmel. Hans-Peter schmauder, Michael Schweizer, Lilian M. Schweizer.
- Ecology, Theories and applications. By: Peter Stiling.
- Environmental Science working with the Earth. By: Miller.
- Genetics A Molecular Approach. By: Peter J. Russell.
- Culture of Animal Cells; a manual of basic technique. By: R. IAN Freshney.
- Molecular Biology. Robert F. Weaver.
- Microbial Biotechnology, Principles and Applications. Lee Yuan Kun.
- Microbial Biotechnology, Fundamentals of Applied Microbiology. By: Alexander N. Glazer. Hiroshi Nikaido.
- Process Biotechnology Fundamentals. By: S N Mukhopadhyay.
- Textbook of Organic Medicinal and Pharmaceutical Chemistry. By: Jaime N. Delgado William A. Remers.
- Kuby Immunology By: Kindt, Goldsey, Osborne.
- Immunology By: Roitt, Brostoff, Male.
- Immunology By: David Male, Jonathan Brostoff, DAVID B ROTH, Ivan Roitt.
- The elements of Immunology By: Fahim Halim Khan.
- Immunology By: Richard A. Goldsby, Thomas J Kindt, Barbara A. Osborne, Jani Kuby.
- Fundamental immunology William E. Paul.
- Biophysical Chemistry By: Upadhaya Upadhyaya Nath.
- Biostatistics and Microbiology: A Survival manual Daryl S. Paulson Springer

- CSIR-NET LIFE SCIENCES Sure success Series: B.L.Chaudhary, Kailash Chaudhary, Arun Chaudhary: New Age International Publishers
- Food processing Handbook: Edited by James G. Brenon (Wiley-VCH)
- Advances in Microbial physiology: Robert K. Poole
- Pharmaceutical Microbiology : Reddy A. Venkateswara
- Fundamental Agricultural Microbiology: K.R. Aneja
- Water & waste water technology (3rd edition): Mark J. Hammer & Hommer, Jr. Prentice Hall at India Pvt Ltd. New Delhi.
- Organic Chemistry of Drug Design and Drug Action” by Silverman
- A Textbook of Drug Design and Development” by Povl Krogsgaard-Larsen and Tommy Liljefors
- New Drug Development: Design, Methodology, and Analysis” by J. Rick Turner
- Molecular Mechanisms Of Drug Action: Christopher J. Coulson, CRC Press.