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Shiksha Mandal's

Bajaj College of Science, (Autonomous) Wardha

M.Sc. Syllabus

Microbiology

2021-22

CORE PAPER: -	PAPER CODE	SEMESTER – I
PAPER-I	PG- MB (08)- S1-T1	MICROBIAL METABOLISM (MM)
PAPER-II	PG- MB (08)- S1-T2	ENZYMOLOGY AND TECHNIQUES (ET)
PAPER-III	PG- MB (08)- S1-T3	ADVANCE TECHNIQUES IN MICROBIOLOGY (ATM)
PAPER-IV	PG- MB (08)- S1-T4	MEMBRANE STRUCTURE AND SIGNAL TRANSDUCTION (MSST)

PRACTICALS

PRACTICAL-I PG- MB (08) - S1-P1

PRACTICAL-II PG- MB (08) - S1-P2

CORE PAPER:	PAPER CODE	SEMESTER – II
PAPER-V	PG- MB (08)- S2-T1	MICROBIAL METHODS FOR ENVIRONMENT MANAGEMENT (MMEM)
PAPER-VI	PG- MB (08)- S2-T2	MICROBIAL METABOLITES (MMT)
PAPER-VII	PG- MB (08)- S2-T3	MEDICAL MICROBIOLOGY AND PARASITOLOGY (MMP)
PAPER-VIII	PG- MB (08)- S2-T4	IMMUNOLOGY AND IMMUNODIAGNOSTICS (IID)

PRACTICALS

PRACTICAL-III PG- MB (08) - S2-P1

PRACTICAL-IV PG- MB (08) - S2-P2

CORE PAPER: -	PAPER CODE	**SEMESTER-III**
PAPER-IX	PG- MB (08)- S3-T1	MOLECULARBIOLOGY AND GENETICS (MBG)
PAPER-X	PG- MB (08)- S3-T2	RECOMBINANT DNA TECHNOLOGY AND NANOBIOTECHNOLOGY (RDTN)
ELECTIVE PAPER:-		
PAPER-XI	PG- MB (08) - S3-T3-EL1	ANY ONE OF THE FOLLOWING:- 1) MICROBIAL DIVERSITY,EVOLUTION AND ECOLOGY (MDEE) -I 2) BIOINFORMATICS (BIF) –I
FOUNDATION COURSE:-		
PAPER-XII	PG- MB (08) - S3-T4-FC1	ANY ONE OFTHEFOLLOWING:- 1) GENERAL MICROBIOLOGY (GM) (To be opted by students of other subjects only) 2) DRUGS AND DISEASE MANAGEMENT (DDM) (**CORE SUBJECT CENTRIC-1**) (To be opted by students of Microbiology only)

PRACTICALS

PRACTICAL-V PG- MB (08)- S3-P1

PRACTICAL-VI PG- MB (08)- S3-P2

CORE PAPER: -	PAPER CODE	**SEMESTER-IV**
PAPER-XIII	PG- MB (08) - S4-T1	VIROLOGY (VIR)
PAPER-XIV	PG- MB (08) - S4-T2	MICROBIAL FERMENTATION TECHNOLOGY (MFT)
ELECTIVE PAPER:-		
PAPER-XV	PG- MB (08) - S4-T3-EL2	ANY ONE OF THE FOLLOWING:- 1) MICROBIAL DIVERSITY, ECOLOGY AND BIOSTATISTICS (MDEB) -II 2) BIOINFORMATICS (BIF)-II
FOUNDATION COURSE:-		
PAPER-XVI	PG- MB (08) - S4-T4-FC2	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 PG- MB (08)- S4-P1
PROJECT WORK PG-MB (08)-S4-PJ

SEMESTER- I
Paper-I
Microbial Metabolism (MM)
PG- MB (08) - S1-T1

Course outcomes:
After successfully completing this course, students will be able to:

- Learn specific aspects of Bioenergetics and Metabolism
- Understand major classes of biological molecules like protein and nucleic acids
- Understand anoxygenic photosynthesis and chemolithotrophy, Nitrogen, Sulphur metabolism and methanogenesis

UNIT-I: - Bioenergetics and metabolism
Concept of entropy, enthalpy, Redox potential, Why ATP is energy currency, 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.
Oxygenic photosynthesis:- Cyanobacteria.
CO_2 fixation-C_3, C_4 and CAM pathways
Chemolithotrophy:- Hydrogen oxidation and autotrophy in hydrogen bacteria. Iron oxidation.
Bioluminiscence

UNIT-IV:-Nitrogen and Sulphur metabolism and methanogenesis.
Nitrification and Anammox. Nitrate reduction and Denitrification. Nitrogen fixation: Symbiotic, nonsymbiotic. Sulphate reduction. Methanogenesis, Acetogenesis.

Paper-II
Enzymology and Techniques (ET)
PG- MB (08)- S1-T2

Course outcomes:
After successfully completing this course, students will be able to:

- Understand general characteristics of enzymes(Terminologies) and
- Learn the different mechanisms of enzyme catalysis.
- Understand enzyme kinetics and regulation and about the industrial applications of enzymes.

UNIT-I: - Catalytic mechanisms
General characteristics of enzymes (Terminologies)
Classification of enzymes, Concept of active site, Membrane bound enzymes, isoenzymes and marker enzymes. Constituitive 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
Techniques for isolation and purification of enzymes, methods for enzyme assay.
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.

Paper –III
Advance Techniques in Microbiology (ATM)
PG- MB (08) - S1-T3

Course outcomes:
After successfully completing this course, students will be able to:

- Understand the important aspects of advance biophysical techniques used in microbiology
- Learn the working and principles of various instruments like electrophoresis, centrifugation and chromatography
- Learn important microscopy techniques from basic to advanced one.
- Understand the applications of advanced technique in different aspects of life sciences.

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, flouroscencephotobleaching recovery, flow cytometry, In-situ localization by techniques such as FISH & GISH.

Paper-IV
Membrane structure and Signal Transduction (MSST)
PG- MB (08) - S1-T4

Course outcomes:
After successfully completing this course, students will be able to:

- Understand the important aspects of cell biology.
- Learn the structure and function of membranes and organelles.
- Understand the process of cellular transport and their energetics.
- Learn mechanism and different pathways of signal transduction.

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
PG- MB (08) - S1-P1
LABORATORY EXERSICE 1

Course outcomes:
After successfully completing this course, students will be able to:

- This course explains the enzyme activity determination of important hydrolytic enzymes
- Learn about the effect of different physical factors
- Learn how to isolate and purify the enzyme
- Learn how to isolate and identify Nitrogen fixing bacteria such as Azotobacter ,Rhizobium etc

1) Detection of enzyme activity of lipase, Urease, invertase, protease.
2) Determination of kinetic constant of amylase:- Amylase activity,Vmax.Km.
3) Effect of pH and temperature on amylase activity.
4) Effect of inhibitors on amylase activity.
5) Estimation of protein by Lowry's method.
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.

Minimum seven experiments must be performed in the semester.

PRACTICAL-II
PG- MB (08)- S1-P2
LABORATORY EXERCISE 2

Course outcomes:
After successfully completing this course, students will be able to:

- Understand the techniques of genetics and protein biology
- Learn about separation of sub cellular organelles and isolation of Marker enzymes.
- Understand how to perform various molecular techniques
- Learn various techniques of protein isolation and analysis techniques

1) Separation of DNA by agarose gel electrophoresis
2) 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 (MMEM)
PG- MB (08) - S2-T1

Course outcomes:
After successfully completing this course, students will be able to:

- Understand process of eutrophication.
- Understand the concept of biodeterioration of woods and pharmaceutical products.
- Understand the important things about the concept and consequences of Biomagnification of chlorinated hydrocarbons and pesticides.
- Learn about biotransformations of metals and metalloids and concept of Bioremediation.

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. Environmental impact of steel production, Effects of heavy metals on environment.

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.

Paper –VI
Microbial Metabolites (MMT)
PG- MB (08) - S2-T2

Course outcomes:
After successfully completing this course, students will be able to:

- Understand the structure and mode of action of secondary metabolites.
- Learn the structure and mode of action of different drugs.
- Understand the structure and function of Hemoglobin, Myoglobin, and Melanin etc.
- Understand the role of vitamins in life, structure, function and chemistry of different vitamins.

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, dextran, Gellan, Pullulan, curdlan and hyluronic 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), macrolids (Azithromycin), Nitrofuran (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 (vitaminB_2),Cynocobalamine (VitaminB_{12}) and ascorbic acid (vitaminC).
Deficiency diseases in humans:
Xerophthalmia, BeriBeri.Pellegra,Scurvey,Keratomalacia,osteoporosis,Osteomalacia,Cheilosis ,Glossitis, Pernicious anemia and Erythroidhypoplassia.

Paper-VII
Medical Microbiology and Parasitology (MMP)
PG- MB (08) - S2-T3

Course outcomes:
After successfully completing this course, students will be able to:

- Learn types, stages and process of infection.
- Understand mechanism of bacterial adhesion, colonization and invasion.
- Learn morphological characteristics, Pathogenesis and Laboratory diagnosis of various pathogenic micro-organisms.
- Learn about new emerging infections like *Streptococcus suis; community associated Methicilin resistant Staphylococcus aureus* (MRSA), *Bordetella pertusis, Clostridium Multi drug resistant tuberculosis.*

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.Aggresssins 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 perfringes; 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;-
Microsporum; Trichophyton; Histoplasmacapsulatum; Blastomycesdermatitidis; Candida albicans; Cryptococcus neoformans; Pneumocystis carinii.
Parasites: *Entamoeba histolytica; Giardia Lamblia; Plasmodium vivax; Leishmaniadonovani.*
Helminths*: Taeniasaginata; Taeniasolium; Hymenolepis nana; Schitosomahaematobium*

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. Candida auris, Vancomycin resistant enterococci*

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Paper –VIII
Immunology and Immunodiagnostics (IID) PG-
MB (08) - S2-T4

Course outcomes:
After successfully completing this course, students will be able to:

- Understand in detail about immune system.
- Learn in detail about complement system, inflammation, Cell Mediated Immunity, Antibody-dependent cell mediated cytotoxicity etc.
- Understand various immunodeficiency disorders, autoimmune diseases in detail.
- Learn about different immunodiagnostic techniques like RIA, ELISA, Immunofluorescence.

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; Mysthenia 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, Chemiluminiscenceimmuno assay, Western blotting technique, Complement fixation test, Immunofluorescene, Immunoelectron microscopy.

PRACTICAL-III
LABORATORY EXERCISE 3
PG- MB (08) - S2-P1

Course outcomes:

After successfully completing this course, students will be able to:

- Learn about methods for examination of quality of water
- Learn about biodegradation of chemical compounds.
- Learn conventional and rapid methods of isolation and identification of pathogenic bacteria, fungi and parasites
- Learn Antibiotic sensitivity testing by various methods.

1. Determination of biological oxygen demand (BOD) in waste water.
2. Determination of chemical oxygen demand (COD) in waste water.
3. Bacterial degradation of aromatic compounds.
4. Conventional and rapid methods of isolation and identification of following pathogenic bacteria, fungi and parasites.

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

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

5) 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
LABORATORY EXERCISE 4
PG- MB (08) - S2-P2

Diagnostic immunologic principles and methods of followings:-

1) Immunodiffusion
2) Immunoelectrophoresis
3) Blood grouping
4) Widal [slide and tube] tests.
5) TRUST [Toludine Red Unheated Serum Test]
6) Syphcard test
7) Australian latex antigen test.
8) Antistreptolysin 'o'test [ASO]
9) Pregnancy test.
10) Rhematoid arthritis test [RA]
11) RPR [rapid plasma reagin] test.
12) Treponema pallidum haemagglutination test (TPHA).
13) ELISA [Enzyme Linked Immunosorbent Assay]

SEMESTER-III
Paper-IX
Molecular Biology and Genetics (MBG)
PG- MB (08) - S3-T1

Course outcomes:
After successfully completing this course, students will be able to:

- Understand the process of Replication and Recombination
- Understand the concept of gene expression by transcription and translation process AND operon systems in bacteria
- Understand in detail about various types of DNA repair mechanisms in eukaryotes and prokaryotes.
- Learn about gene mapping by using conjugation, transduction and transformation.

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. Holiday model, recombinase mechanism.

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 (detail definition and functions).
Gene inhibition expression advanced techniques: Knockout, Knockdown, Introduction to CRISPER genome editing
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. Molecular markers as advanced technique: Mapping by using molecular markers, Restriction fragment length polymorphism (RFLP), Random amplified polymorphic DNA (RAPD), molecular docking.

Paper –X
Recombinant DNA technology and Nano Biotechnology (RDTN)
PG- MB (08) - S3-T2

Course outcomes:
After successfully completing this course, students will be able to:

- Understand the important aspects of rDNA technology like cloning, gene sequencing, and other molecular tools.
- Learn the important molecular techniques like polymerase chain reaction.
- Understand important things about nanobiotechnology and its applications.
- Students will also learn about tissue culture and stem cell technology.

UNIT-I: - Molecular Cloning Methods.
DNA cloning, restriction enzymes, cloning vectors, genomic library, c DNA library and chromosome libraries. Screening and identification of genes, Expression vectors, heterologous probes, oligonucleotide probes, microarrays.
PCR: Steps, advantages, limitations, application, Real time (RT)-PCR, Next generation sequencing.

UNIT-II: - Other molecular tools for studying genes
Restriction mapping: DNA sequencing dideoxy and pyrosequencing, DNA fingerprinting.
S1 Mapping, primer expressions, Dnase footprinting, 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.
Gene therapy, Types of stem cells.

UNIT-IV:- RDT Products and Nanobiotechnology
Tissue plasminogen activator [TPA]. Tissue growth actor B.
Dnase; PDGF. GEMS/GMO.
Transgenic plants and plant products, Comparative account, Concept of nano biotechnology and its application. DNA and mRNA vaccine as r-DNA technology products.
Types on nanomaterials & biological nanoparticles.

Paper –XI
CORE ELECTIVE
Microbial Diversity, Evolution and Ecology (MDEE) – I
PG- MB (08) - S3-T3-EL1

Course outcomes:
After successfully completing this course, students will be able to:

- Understand the evolutionary processes and theories based on evolution.
- Learn the important molecular techniques for determining the evolutionary relationships viz: 16S rRNA sequencing.
- Lean in detail about diversity of microorganisms.

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, phyllogenetic probes, microbial community analysis.
Derivation of Microbial Phyllogeny:- characteristics of domain of life, classical taxonomy, chemotaxonomy, bacterial speciation.

UNIT-II: -Microbial Diversity: Archaea
General Metabolism and Autotrophy in archea
Phylum Euryarchaeota:-Halophilicarchaea, methanogens, thermoplasma.
Phylum Crenarchaeota:-Energy metabolism, Thermoproteales, sulfolobales, desulfolobales.
PhyllumNanoarchaeota:-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.

Paper–XI
CORE ELECTIVE
Bioinformatics (BIF)-I
PG- MB (08) - S3-T3-EL1

Course outcomes:
After successfully completing this course, students will be able to:

- Understand the basic concepts of computer organization, Internet, Browser, Homepage.
- Understand the concept of phylogenetics.
- Learn about genomics and gene recognition.

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, reassociationkinetics.
Data researches and pairwise alignments:-
Dot Plots, Simple alignments, Dynamic programming global and local alignments BLAST,FASTA,Scoringmatrices,and alignment scores. Multiple sequence alignments.Pattern of substitution within genes, substitution number estimations, molecular clocks.

UNIT-III: - Phyllogenetics
Phyllogenetic trees,Pair wise alignment, distance matrix method, maximum likelihood approach,multiple sequence analysis,
Parsimony,Inferred ancestral sequence, consensus tress,comparison of phyllogenetic 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, Tranposition, Repetetive elements, gene density.

FOUNDATION COURSE IN MICROBIOLOGY

Paper –XII
GENERAL MICROBIOLOGY (GM)
(To be opted by students of other subjects only)
PG- MB (08) - S3-T4-FC1

Course outcomes:

After successfully completing this course, students will be able to:

- Understand the morphology of bacteria, fungi, protozoa and algae
- Understand basic nutritional requirements, nutritional classifications, bacterial growth curve.
- Learn microbiostatic and microbiocidal agents, physical& chemical techniques for control of bacteria, antibiosis and common antibiotic agents.
- Understand bacteriological analysis of water by Membrane filter technique, MPN, Basic water treatment process for generation of potable water, waste water treatment process**.**

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)
Paper –XII
Drugs and Disease Management (DDM)
PG- MB (08) - S3-T4-FC1

Course outcomes:
After successfully completing this course, students will be able to:

- Learn the concept of prodrug & drug latentiation.
- Learn about the mechanism of action of different Anti infective agents like Iodophores (providone-Iodine),Benzylkonium chloride, genital violet,
- Understand the mechanism of action of different antifungal agents, antitubercular, antiprotozoal, antimalarial & antihistaminic agents

UNIT-I: -
Drug latentiation 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:- Antimicrobial agents (chemistry & mode of action)
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: - Antiparasitic agents (chemistry & mode of action)
Antiprotozoal agent: Metranidazole, 8-hydroxyquinoline
Antimalarials: Quininesulphate, Chloroquine, Primaquine phosphate, Pyrimethamine.

UNIT-IV:- Anti-inflammatory agents (chemistry & mode of action)
Histamines and Antihistaminic agents: Cimetidine, Ramitidine, Omeprazole.
Analgesic agents: Morphine and their derivatives
anti-inflammatory analgesics- Phenylbutazone and oxyphenbutazone, Prostaglandins.

PRACTICAL-V
LABORATORY EXERCISE 5
PG- MB (08) - S3-P1

Course outcomes:

After successfully completing this course, students will be able to:

- Learn how to isolate genomic and plasmid DNA.
- Understand DNA amplification & restriction digestion, DNA ligation etc.
- Learn about bacterial transformation and cloning

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 ligation.
6) Demonstration of cloning
7) Demonstration of bacterial transformation.
8) Demonstration of UV induced mutagenesis in *E.coli*.

PRACTICAL-VI
LABORATORY EXERCISE 6
PG- MB (08) - S3-P2

Course outcomes:

After successfully completing this course, students will be able to:

- Prepare the plant tissue culture media.
- Understand how to isolate a single cell from intact plant organs.
- Learn how to determine the starch in plant tissue.
- Understand phytochemical analysis (qualitative detection) of plant

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.
7) Plant DNA isolation and its barcoding.

SEMESTER IV
Paper-XIII
Virology (VIR)
PG- MB (08) - S4-T1

Course outcomes:
After successfully completing this course, students will be able to:

- Learn discovery, Origin and evolution of viruses.
- Learn Morphology, structure and chemical composition of viruses.
- Understand life cycle of different bacteriophage like ΦX174,T4, lambda, M13 etc.
- Learn about life cycle, pathogenesis and laboratory diagnosis of plants and animal viruses.

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 (Regenmortelet.al.2005, 8thReportof 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. Concept of Viriods

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 ΦX174, T4, lambda, $M_{13}$and MU Phages. Bacteriophage typing, One step growth curve.

UNIT-III:-Animal and Plant viruses
Lifecycle, pathogenesis and laboratory diagnosis of following viruses.
Animal Viruses:-
RNA viruses: Rhabdovirus, HIV, Coronaviridae (SARS, MERS, Corona)
DNA viruses: Pox, Herpes,Adeno and Hepatitis viruses.
Oncogenic viruses: Papovaviruses, EBvirus, HTLV viruses.
Plant virus: TMV, Cauliflowermosaic virus, potato virus.

UNIT-IV:-General methods of Diagnosis and antiviral drugs
General, Serological and Molecular methods of diagnosis:- Haemadsorption inhibition; haemagglutination;Haemagglutination inhibition (HAI);Complement fixation, Imunofluroscene methods. ELISA and Radioimmunoassays(RIA). PCR, RT PCR, Electron Microscopy (TEM)
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.

Paper-XIV
Microbial Fermentation Technology (MFT)
PG- MB (08) - S4-T2

Course outcomes:
After successfully completing this course, students will be able to:

- Learn in detail about bioreactors & its types & different types of fermentation.
- Understand in detail about fermentation kinetics, downstream processes, types of processing units and systems, storage and packaging methods.
- Understand methods for production of valuable products viz: Biofuels, antibiotics, organic acids, and also food and healthcare products.

UNIT-I:-General Principles of Fermentation
Bioreactors: Bioreactor types, immobilized bioreactors, types of fermentation.
Fermentation kinetics and Monods 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, Packet Burman design, One factor at a time design, rheology of fermentation fluid, oxygenation, and oxygen transfer kinetics. chemostat, turbidostat.

UNIT-II:-Downstream Processing and scaleup.
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 production from cellulosic substrates, Hydrogen, Methane
Antibiotics:-β-lactum antibiotics (Synthetic penicillin), Streptomycin, Cephalosporin.
Biopreservative: Lactobacillus sakei. Biopolymers:-Xanthan, Polyhydroxy alkanotes.
Thermostable enzymes:-Proteases. Biosurfectants: a comparative account.

UNIT-IV:-Food and Health care products
SCP- Various types and processes. Carotenoides
Aminoacids:-Lysine, Glutamic acid.
Vitamins:-riboflavin, Vit.B12. Fatty acids (Palmetate, oleate).

Paper –XV CORE
ELECTIVE

Microbial Diversity, Ecology and Biostatistics (MDEB)-II
PG- MB (08) - S4-T3-EL2

Course outcomes:
After successfully completing this course, students will be able to:

- Understand in detailabout concepts of Microbial Ecosystems, Population, communities, homeostasis, Diversity indices, dominance indices, information statistics indices, Shannon index, Brillouin Index, Learn about genetic structure of population & Hardy-Weinberg Law
- Learn about different microbial interactions like Competition, coexistence, syntrophy, commensalism, Mutualism, predation, parasitism, antagonism.
- Understand the concept of sustainable development.

UNIT-I: - Microbial Ecosystems and Interactions
Population, guilds, communities, homeostatis, Environment and microenvironment. Biofilms. Terrestrial environment, deep surface microbiology. Fresh water environment, lake and river microbiology. Marine Microbiology and Hydrothermal vents.
Microbial Interactions: Interaction with plants and animals, Competetion and coexistence, Gause hypothesis,syntrophy, commensalism and Mutualism, predation, parasitism, and antagonism.

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, Genetics and Sustainable development
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.
Concept of sustainable development: Management and improvement of waste land/barren land. Oil spills, damage and management petroleum and oil shore management.

UNIT-IV: -Biostatistics

Introduction: Statistical terms and notations: Population, Sample, variable, types of variables (Qualitative, quantitative) parameter, observation, Data etc

Collection and presentation of data, preparation of frequency distribution table, Class interval: mid point, overlapping, Non-overlapping

Measures of central tendency: Mean, Arithmatic, Geomatric, Harmonic, Average of positions: mode, and median, Merits and demerits.

Methods of sampling, sampling error, non-sampling errors, standard error.

Measures of dispersion: range, mean deviation, standard deviation.

Chi-square test, meaning of correlation and regression.

Cluster analysis: phylogenetic clustering by simple matching coefficients.

Presentation of statistical data: tabulation (simple tables, frequency distribution table); charts and diagrams (bar charts, histograms, pie charts, dendrogram.

Paper – XV CORE ELECTIVE
Bioinformatics (BIF)-II
PG- MB (08) - S4-T3-EL2

Course outcomes:

After successfully completing this course, students will be able to:

- Learn the important aspects Data Mining, data mining problems, cluster analysis, data mining techniques and tools, data mining methods.
- Learn the structure of proteins, protein motifs and folding, protein folding modeling, protein structure prediction**.**
- Understand the structure of RNA, types of RNA, RNA structure prediction**.**

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- free energy minimization

UNIT-IV:-
Computer aided drug designing, in silico inhibitors designing, empirical methods of ligand screening, prediction techniques, post translational modification prediction.

FOUNDATION COURSE IN MICROBIOLOGY
SEMESTER-IV
PAPER-XVI
ADVANCE MICROBIOLOGY (AM)
(To be opted by students of other subjects only)
PG- MB (08) - S4-T4-FC2

Course outcomes:

After successfully completing this course, students will be able to:

- Learn the industrially important micro-organisms, batch and continuous fermentation processes, kinetics of fermentation.
- Learn the methods for industrial production of ethanol, penicillin, lysine, vit.B12, acetone butanol, vinegar, alcoholic beverages including beer, wine, whiskey, rum, vodka.
- Understand the role of agriculturally important microorganisms like mycorriza, phosphate solubilising bacteria,
- Learn medically important pathogenic bacteria and viruses

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 bevergeses including beer, wine, whiskey, rum, vodka and gin.

UNIT-III: -

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

UNIT-IV:-

Medically important pathogenic bacteria and viruses, diseases of respiratory tract, gastro intestinal tract, urinogenital 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)
PG- MB (08) - S4-T4-FC2

Course outcomes:

After successfully completing this course, students will be able to:

- Understand the important aspects of vaccines & about active and passive prophylactic measures.
- Learn the contents and immunization schedule of important vaccines like BCG, Hepatitis vaccine, Influenza vaccine, Polio vaccine, DPT, MMR etc.
- Learn about the advanced vaccines & vaccines delivery system.

UNIT-I: -Vaccines

Definition and discovery of vaccines, Active and passive prophylactive measures.

General account on:-

Exhaltation & 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
Epstain 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
LABORATORY EXERCISE 7
PG- MB (08) - S4-P1

Course outcomes:

After successfully completing this course, students will be able to:

- Learn how to isolate viruses from water sources.
- Learn how to carry out microbiological examinations of food samples.
- Understand the production of penicillin in the lab and its estimation.
- Understand Determination of microbial reaction kinetics in a fed batch system.
- Learn about how to immobilize Enzymes.

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 fedbatch system.
5) Determination of the parameters of oxygen transfer.
6) Immobilization of cells/Enzymes.

PROJECT WORK
PG-MB (08)-S4-PJ

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 copperBy:JackPeisach,PhillipAisen.
- Biochemistry:- By Rex Montgomery.
- Lehninger Principles of BiochemistryBy:-David L. Nelson and Cox
- Metabolic Pathways By:-David M.Greenberg.
- Harper's BiochemistryBy:RobertK.Myrray.
- Enzymes: By Trevor Palmer.
- Enzyme structure and mechanism By:AlanFersht.
- 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 MicrobiologyBy:A.H.Patel
- Industrial MicrobiologyBy:L.E.Casida.
- Food Microbiology.By:WilliamC.Frazier,DennisC.Westhaff.
- Prescott and Dunns Industrial microbiology.By;Gerald Reed.
- Basic Food Microbiology.By:Georgej.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;CamilaLocht and Michel Simonet.
- Medical Microbiology.By:David Greenwood.
- Medical Microbiology.By:J.P.Dugaid.
- Small Dnatumorviruses.By:Kevin Gaston.
- Viruses and Interferon;currentresearch.By:KarenMossam
- Lentiviruses and Macrophages:Molecular and Cellular intereactions.By:MoiraDesporf.
- The Biology of Animal viruses.By;C.A.mims.
- Animal virology.By:DavidBaltimore,A.Huang,c.fox
- Oncogenic viruses and host cell genes.By:E.Kurstak,KarlMaramorosch.
- Bacterial and Bacteriophage Genetics.By:EdwardA.Birge.
- Molecular Genetics of Bacteria.By:J.W.Dale.
- Molecular Biology of the gene.By:J.D.Watson,N.h.Hoppkins,J.W.Roberts,J.A.Steitz&A.M.Weiner.
- Microbial Genetics.By:Maloy{T.A}.Jones and Bartlett publications.
- Mobile DNA.By;NancyCraig,MartinGelletallan,lambowitz.
- Methods of General and Molecular biotechnology.By:Philip Gerhardt ASM publication.
- Recombinant DNA.By;Watson J.D. Essentials of Molecular Biology.By:Malcimski.
- 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 EngineeringBy:SandyaMitra.
- Environmental MicrobiologyBy:RalphMitchell,John Wiley and Sops.Inc.
- Environmental BiotechnologyBy:C.F.Froster and D.A.JohnWase,ElisHorwood.
- Biocatalysis and Biodegradation: Microbial Transformation of organic compounds. 31 y:Lawrencep.Wacekett.
- A manual of environment Microbiology.By:ChristonJ.hurst,ASM publication.
- Biodegradation and bioremediation Academic pressBY:San Diego.
- Biotechnology in the sustainable environment,Plenumpress,NY
- Basic principles of Geomicrobiology. By:A.D.Agate.
- Environmental MicrobiologyBy: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:DonaldJ.voet,JudithG.Voet,CharlotteW.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,Michaelschweizer,LilianM.Schweizer.
- Ecology,Theories and applications.By:PeterStiling.
- Environmental Science working with the Earth.By:Miller.
- Genetics A Molecular Approach.By:PeterJ.Russell.
- Culture of Animal Cells; a manual of basic technique.By:R.IANFreshney.
- Molecular Biology.RobertF.Weaver.
- Microbial Biotechnology,Principles and Applications.Lee Yuan Kun.
- Microbial Biotechnology,Fundamentals of Applied Microbiology. By:AlexanderN.Glazer.HiroshiNikaido.
- Process Biotechnology Fundamentals.By:S N Mukhopadhay.
- Textbook of Organic Medicinal and Pharmaceutical Chemistry.By:JaimeN.Delgado William A.Remers.
- KubyImmunologyBy:Kindt,Goldsey,Osborne.
- ImmunologyBy:Roitt,Brostoff,male.
- ImmunologyBy:DavidMale,Jonathanbrostoff,DAVID B ROTH,IvanRoitt.
- The elements of ImmunologyBy:FahimHalim Khan.
- ImmunologyBy:RichardA.Goldsby,Thomas J Kindt,Barbaraa.Osborne,Janiskuby.
- Fundamental immunologyWilliamE.Paul.
- Biophysical ChemistryBy:UpadhayaUpadhyayaNath.
- Biostatistics and Microbiology: A Survival manual Daryl S.Paulson Springer

- CSIR-NET LIFE SCIENCES Sure success Series: B.L.Chaudhary,KailashChaudhary, ArunChaudhary: 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 indiapvtltd.Newdelhi.
- Organic Chemistry of Drug Design and Drug Action" by Silverman
- A Textbook of Drug Design and Development" by PovlKrogsgaard-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.