Shiksha Mandal's

Bajaj College of Science, (Autonomous)
Wardha

M.Sc. I. (Sem I and II)

Syllabus

Microbiology

2023-2024

(As per NEP)

COURSE CATEGORY	PAPER CODE	SEMESTER – I
DSC-1	PMB511T	MICROBIAL METABOLISM (MM)
DSC-2	PMB512T	ENZYMOLOGY AND TECHNIQUES (ET)
DSC-3	PMB513P	PRACTICAL-I
DSC-4	PMB514P	PRACTICAL-II
DSE-1	PMB515T	ADVANCE TECHNIQUES IN MICROBIOLOGY (ATM) OR MEMBRANE STRUCTURE AND SIGNAL TRANSDUCTION (MSST)
RM	PMB516T	RESEARCH METHODOLOGY

CORE PAPER:	PAPER CODE	SEMESTER – II
DSC-5	PMB521T	MEDICAL MICROBIOLOGY AND PARASITOLOGY (MMP)
DSC-6	PMB522T	IMMUNOLOGY AND IMMUNODIAGNOSTICS (IID)
DSC-7	PMB523P	PRACTICAL-III
DSC-8	PMB524P	PRACTICAL-IV
DSE-2	PMB525T	MICROBIAL METABOLITES (MMT) OR MICROBIAL METHODS FOR ENVIRONMENT MANAGEMENT (MMEM)
OJT or FP or CS	PMB527P	APPRENTICESHIP OR FIELD PROJECT OR CASE STUDY

Abbreviations: Discipline Specific Course: DSC, Discipline Specific Elective: DSE, On Job Training (Apprenticeship): OJT,
Field Project: FP, Case Study: CS, Research Methodology: RM

SEMESTER- I

DICIPLINE SPECIFIC COURSE (DSC)

– 1

Microbial Metabolism (MM)

PMB511T

Course outcomes:

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

CO1: Students will be able to correlate specific aspects of Bioenergetics andMetabolism

CO2: Students will be able to identify and differentiate between major classes ofbiological molecules like protein and Nucleic acids with its chemistry and metabolism

CO3: Students will be able to Gain an understanding of photosynthesis, anoxygenicphotosynthesis and chemolithotrophy.

CO4: Students will be aware of the mechanism and types of Nitrogen and Sulphurmetabolism and methanogenesis.

CO5: Overall the course describes the Microbial metabolism in detail

UNIT-I: - Bioenergetics and metabolism

Concept of entropy, enthalpy, Redox potential, ATP as 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, De Novo and salvage pathway, Inhibitors.

UNIT-III: - Photosynthesis

Anoxygenic photosynthesis: - Green sulphur and purple phototrophic bacteria.

Oxygenic photosynthesis: - Cyanobacteria.

CO_2 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. Mechanism of nitrogen fixation and role of nitrogenase enzyme, Sulphate reduction. Methanogenesis, Acetogenesis.

DICIPLINE SPECIFIC COURSE (DSC) – 2

Enzymology and Techniques (ET)

PMB512T

Course outcomes:

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

CO1: Students will be able to understand general characteristics of enzymes (Terminologies) and

CO2: Students will learn the different mechanisms of enzyme catalysis.

CO3: Students will be able to Gain an understanding of enzyme kinetics and regulation]

CO4: Students will be able to understanding the various biochemical techniques based on enzymes like biosensors

CO5: Overall the course describes the Enzymology and Techniques in detail

UNIT-I: - Fundamentals of Enzyme

Classification and Nomenclature of enzymes, Membrane bound enzymes, isoenzymes and marker enzymes. Constituitive and inducible enzymes, Multienzyme complexes (PDH, FAS), Abzymes, Ribozymes

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

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. Immobilized Enzymes: Concept, Methods of Immobilization, Kinetics, Immobilized bioreactor.

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 (Amylase, Protease, Cellulase), Protein Engineering: Concept and methods with examples of therapeutic protein

DICIPLINE SPECIFIC ELECTIVE (DSE) – 1

Advance Techniques in Microbiology (ATM)

PMB515T

Course outcomes:

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

CO1: Students will be able to understand the important aspects of advancebiophysical techniques used in microbiology

CO2: Students will learn the working and principles of various instruments like electrophoresis, centrifugation and chromatography

CO3: Students will gain knowledge of important microscopy techniques from basic toadvanced one.

CO4: Students will be able to understand the applications of advanced technique indifferent aspects of life sciences.

CO5: This course overall gives the understanding of instrumentation in life sciences,which is needed in industry as well as research laboratories.

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, transcriptional start point mapping, fluorescence photobleaching recovery, flow cytometry, In-situ localization by techniques such as FISH & GISHS.

DICIPLINE SPECIFIC ELECTIVE (DSE) – 1

Membrane structure and Signal Transduction (MSST)

PMB515T

Course outcomes:

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

CO1: Students will be able to understand the important aspects of cell biology likemembranes and organelles.

CO2: Students will learn the structure and function of membranes and organelles

CO3: Students will understand the important things about cellular transport and theirenergetics.

CO4: Students will learn about the detailed concept of signal transduction.

CO5: This knowledge will increase students' interest in research based on cell biologyand signal transduction and they can be hired on such research projects

UNIT-I: - Structure and organization of membrane and cell organelles

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.

Research methodology (RM)
PMB516T

Course Outcomes:
After learning research methodology course, students will be able to

1. Identify and describe the characteristics of different types of research, including basic, applied, and patent-oriented research.
2. Apply scientific thinking and problem identification techniques in the research process.
3. Apply descriptive and inferential statistical analysis techniques to analyze and interpret research data and understand the concept of hypothesis and its importance in research, and apply appropriate research methods.
4. Develop skills in technical writing, research reporting, and the proper structure and organization of research documents and gain awareness of research ethics, academic integrity, and the importance of avoiding plagiarism and academic malpractice.

Module 1: Research basics and perception of research

1.1 Definition: research, research methodology, discovery, invention and innovation
1.2 General and specific characteristics of research, types of research (basic, applied and qualitative, quantitative, conceptual, empirical, patent oriented).
1.3 Steps of Action (basic) research, objectives of basic research, characteristics of investigators.
1.4 Scientific thinking- characters, steps in process of scientific thinking, Steps in problem identification, criteria for selecting problem, and sources of scientific problems.
1.5 Review of literature- meaning, need, and objectives, structure of review of literature, sources of literature collection, Simple rules of structuring (writing) literature review. Identifying gaps in present knowledge

Module 2: Biostatistics and Data Analysis

2.1 Definition of statistics and biostatistics, Statistical terms and notations: Population, Sample, variable, types of variables (Qualitative, quantitative), parameter, observation, Data etc
2.2 Methods of data collection: Sampling, methods of sampling, sampling errors, non sampling errors
2.3 Central tendency and Measures of central tendency: Mean, Arithmatic, Geomatric, Harmonic, Average of positions: mode, and median, Merits and demerits and their applicability
2.4 Measures of variance and dispersion: range, standard deviation, standard error
2.5 Application of Microsoft Excel in statistical analysis (statistical functions and spreadsheets in MS-Excel)

Module 3: Scientific Writing and IPR

3.1 Research report- Concept and need of research report and scientific writing, Types of research report, Essential steps for writing scientific manuscript/research paper, structure of project report, structure of project proposal, structure of thesis, use of software's for writing thesis
3.2 Types of Scientiffic publications: magazines, journals, reviews, newsletters
3.3 Layout of research paper, various reference styles, Annotated Bibliographies
3.4 Research Indicators and Metrics: Impact factor, Cite score, h-index, i10 index, Citation index
3.5 Intellectual Property Rights (IPR): Introduction to IPR, Patents, Trademarks, Geographical Indicators, Copyrights. Importance of IPR

Module 4: Techniques for Research, ethics and plagiarism

4.1 Methods to search research information, Online research tools: N-List, PubMed, Google Scholar
4.2 Softwares for research data presentation: MS Word and Excel, Graph and chart preparation, Power point presentation, OriginLab. Reference management softwares like Zotero/Mendley
4.3 Academic integrity, research ethics, Skills (rules) for good academic practice, Plagiarism: Understanding

plagiarism and academic malpractice, detection of plagiarism using softwares

DICIPLINE SPECIFIC COURSE (DSC) – 3

PRACTICAL-I

LABORATORY EXERSICE 1
PMB513P

Course outcomes:

CO1: This course explains the enzyme activity determination of important hydrolyticenzymes
CO2: Students will learn about the effect of different physical factors
CO3: Students will able to isolate and purify the enzyme
CO4: Students will able to isolate and identify Nitrogen fixing bacteria such asAzotobacter ,Rhizobium etc
CO5: students will be able to isolate Siderophore producing bacteria.

1) Detection of Uraease enzyme activity,
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.

DICIPLINE SPECIFIC COURCE (DSC) – 4

PRACTICAL-II

LABORATORY EXERCISE 2
PMB514P

Course outcomes:

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

CO1: This course explains the techniques of Genetics and protein biology

CO2: Students will learn about Subcellular organelles and isolation of Markerenzymes.

CO3: The performance of various molecular techniques will be understood

CO4: Students will learn various techniques of protein isolation and analysistechniques

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 Western blotting technique
10) Ion exchange chromatography
11) Separation of Subcellular organelles and isolation of Marker enzymes
12) Demonstration of HPLC and GC.

Minimum seven experiments must be performed in the semester.

SEMESTER-II

DICIPLINE SPECIFIC COURSE (DSC) – 5

Medical Microbiology and Parasitology (MMP)
PMB521T

Course outcomes:

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

CO1: Students will gain good knowledge on Types, stages of infection, process of infection. Mechanism of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts.

CO2: Students will also get knowledge on Morphological characteristics, Pathogenesis and Laboratory diagnosis of various pathogenic micro-organisms

CO3: Students will learn about pathogenic bacteria pathogenic fungi , Parasites ,Helminths

CO4: Students will also learn about New emerging infections like Streptococcus suis;community associated Methicillin resistant *Staphylococcus aureus* (MRSA), *Bordetella pertusis, Clostridium difficile*, 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;, Corynebacterium diphtheriae

UNIT-III: - Mycology and Parasitology

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

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

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

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

UNIT-IV: - New emerging Infections

New emerging infections: -*Streptococcus suis; community associated Methicilin resistant Staphylococcus aureus* (MRSA), *Bordetella pertussis,*, H1N1, *Multi drug resistant tuberculosis. Candida auris, Vancomycin resistant enterococci*

DICIPLINE SPECIFIC COURSE (DSC) –6

Immunology and Immunodiagnostics (IID)

PMB522T

Course outcomes:

CO1: Students will be able to understand the Overview of the Immune system, Cells involved in immune system, brief concept of Hematopoiesis and about immune cells.

CO2: Students will gain detail knowledge on Complement System, Inflammation,
Cell Mediated Immunity Antibody-Dependent cell mediated cytotoxicity T-Cell dependent and T-cell independent defense mechanisms.Students will also get knowledge on Transplantation Immunology

CO3: Students will understand the concepts of Immunodeficiency disorders, autoimmune diseases in detail.

CO4: Students will learn about different immunodiagnostic techniques like Radioimmuno assay, 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, Role of MHC Complex, Mechanism of Graftrejection. 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,

Autoimmunity and autoimmune diseases: -General Consideration, Etiology, Clinical Categories,

Dignosis and Treatment. RA (Rheumatoid arthritis); SLE (Systemic Lupus Erythematosus); Mysthenia gravis; Grave's disease;Goodpasture syndrome, .
Hypersensitivity:- Type I, Type II, Type III & Type IV

UNIT-IV: - Immunodiagnostics
Concept of Affinity and Avidity, Zone of equivalence
Precipitation reactions: Immunodiffusion,
Agglutination reactions: Bacterial Agglutination, Hemagglutination, Passive agglutination, Reverse passive agglutination and agglutination inhibition.
Immunodiagnostic techniques: Radioimmuno assay, ELISA, Chemiluminiscenceimmuno assay, Complement fixation test, Immunofluorescene, Immunoelectron microscopy.

DICIPLINE SPECIFIC ELECTIVE (DSE) – 2

Microbial Metabolites (MMT)
PMB525P

Course outcomes:

CO1: Students will be able to understand the important aspects of General account ofmetabolites, secondary metabolites. Classification, structure and mode of action of secondary metabolites. Plants secondary metabolites: Digitoxine, Salicylic acid, Mycotoxins-Aflatoxin, Ochratoxin,Patulin.
CO2: Students will gain good knowledge on the structure and function of a variety of drugs used to control the growth of microorganisms and they will understand the mechanism of action of different drugs like Aminoglycosides, Carbapenems, Microlids,Nitrofuran.
CO3: Students will also get knowledge on the 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.
CO4: Knowledge on role of vitamins in life, structure, function and chemistry of different vitamins : Retinol (vitaminA), Riboflavin (vitaminB2), Cyanocobalamin (VitaminB12) and ascorbic acid (vitamin C) will help students to understand the mechanism of deficiency diseases.
CO5: The knowledge gained from this course will be helpful for students while facing the interviews in pharmaceutical industries.

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 (vitamin A), Riboflavin (vitaminB2), Cynocobalamine(VitaminB12) and ascorbic acid (vitamin C).

Deficiency diseases in humans:

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

DICIPLINE SPECIFIC ELECTIVE (DSE) – 2
Microbial Methods for Environment Management (MMEM)
PMB525P

Course outcomes:

CO1: Students will be able to understand the microbial changes induced by organic and inorganic pollutants, factors influencing the eutrophication process and control ofeutrophication. Students will also know about the concept of biodeterioration, biodeterioration of woods and pharmaceutical products.
CO2: Students will understand the important things about the concept and consequences of Biomagnification of chlorinated hydrocarbons and pesticides.

CO3: Students will learn about biotransformations of metals and metalloids, mercury transformations, biotransformation of pesticides such as hexachlorobenzene.
CO4: Students will learn about the important branch of microbiology viz: Geomicrobiology in which they would gain detailed understanding of bioleaching of ores, leaching techniques and applications.
CO5: Students will understand the concept of Bioremediation, its types and applications. Biomarker gene (antibiotic and heavy metal resistance genes, ice nucleation genes), Bioreporter genes. This knowledge will be helpful for students during their research as the bioremediation approach is having great demand in research.

UNIT-I: - Eutrophication, Biodeterioration
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.

UNIT II :- Biomagnification Biodegradation
Biomagnification: concept and consequences, Biomagnifications of chlorinated hydrocarbons andpesticides.
Biodegradation: Biodegradation of plastics, Xenobiotics (naphthalene, Polycyclic aromatic hydrocarbons (PAHs)

UNIT-III - Biotransformation and Bioleaching
Biotransformations: Concept of metals and metalloids, mercury transformations, biotransformation of pesticidessuch as hexachlorobenzene **Bioleaching:** Bioleaching of copper and uranium, leaching techniques and applications.

UNIT IV
Bioremediation: Concept, its types and applications. Biomarker gene (antibiotic and heavy metal resistance genes, ice nucleation genes), Bioreporter genes. Environmental impact of steel production, Effects of heavy metals on environment.

UNIT-V: - 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-VI: - Global Environmental Problems

Current scenario and Causes of Global warming and climate change: -ozone depletion, UV-B, green house effect, acid rain, their impact and biotechnological approaches for management. Acid mine drainage and associated problems

DICIPLINE SPECIFIC COURCE (DSC) – 7

PRACTICAL-III

LABORATORY EXERCISE 3

PMB523P

Course outcomes:

CO1: students will be able to perform different staining techniques.

CO2: Students will learn about isolation of pathogens from clinical samples.

CO3: Students will learn conventional and rapid methods of isolation and identificationof pathogenic bacteria, fungi and parasites

CO4: Students will learn Antibiotic sensitivity testing by various methods

1. Growth curve of bacteria/yeast by spectrophotometric turbidity measurement
2. Determination of biological oxygen demand (BOD) in waste water.
3. Determination of chemical oxygen demand (COD) in waste water.
4. Bacterial degradation of aromatic compounds.
5. Membrane Filtration Technique for *Fecal Streptococci*
6. Conventional and rapid methods of isolation and identification of following pathogenic bacteria and fungi

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

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

7. Antibiotic sensitivity testing by various methods
   a) Kirby-Bauer's disc diffusion method.
   b) Well plate method.
   c) E-strip method for MIC testing.

DICIPLINE SPECIFIC COURCE (DSC) – 8

PRACTICAL-IV

LABORATORY EXERCISE 4
PMB524P

Course outcomes:

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

CO1: Students will learn principles & methods of diagnostic immunology

CO2: students will be able to perform the immunodiffusion technique.

CO3: students will be able to perform the technique of immunoelectrophoresis.

CO4: Students will be able to perform the technique of Enzyme linked immunosorbent assay (ELISA)

Diagnostic immunologic principles and methods of followings:-

1) Total Leucocyte count (TLC)
2) Differential Leucocyte count (DLC)
3) Immunodiffusion
4) Immunoelectrophoresis
5) Blood grouping
6) Widal [slide and tube] tests.
7) TRUST [Toludine Red Unheated Serum Test]
8) Pregnancy test.
9) ELISA [Enzyme Linked Immunosorbent Assay]
10) RPR [Rapid Plasma Reagin] Test
11) Estimation of Hemoglobin by Sahli's Method

OJT or FP or CS
Apprenticeship/ OJT or Field Project or case study
PMB527P

Course outcomes:

After completion of OJT students will able to:

- Learn about practical knowledge and instrument handling
- Get work experience in industries, Laboratory, Institute etc

- 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.

Present and discuss the work experience as well as the knowledge and arguments that form the basis of their work experience

List of recommended books

- The Biochemistry of copper By: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.

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Shiksha Mandal's
Bajaj College of Science, (Autonomous)
Wardha

M.Sc. II (Sem III and IV)
Syllabus

Microbiology
2023-24

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		
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-	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		
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

PRACTICALS

PRACTICAL-VII PG- MB (08)- S4-P1

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

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, M13and 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.
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