

**Jankidevi Bajaj College of
Science, Wardha**
Syllabus for Autonomous Institution

M.Sc MICROBIOLOGY

2017-18

SYLLABUS FOR M.Sc Microbiology I

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

PRACTICALS

PRACTICAL-I MB1-LAB1

PRACTICAL-II MB1-LAB2

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

PRACTICALS

PRACTICAL-III MB2-LAB3

PRACTICAL-IV MB2-LAB4

SEMESTER – III

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

ELECTIVE PAPER:-

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

FOUNDATION COURSE:-

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

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

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

PRACTICALS

PRACTICAL-V MB3-LAB5

PRACTICAL-VI MB3-LAB6

SEMESTER – IV

CORE PAPER: -

PAPER-XIII MB4-T013 VIROLOGY (VIR)

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

ELECTIVE PAPER:-

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

FOUNDATION COURSE :-

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

PRACTICALS

PRACTICAL-VII MB4-LAB7

PROJECT WORK MB4-PROJ

SEMESTER-I
Paper-I
Microbial Metabolism (MM)

UNIT-I: - Bioenergetics and metabolism

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

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

UNIT-II: - Proteins and Nucleic acids

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

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

UNIT-III: - Photosynthesis

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

CO₂ fixation:-C₃, C₄ and CAM pathways

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

Bioluminescence

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

Nitrification and Anammox. Nitrate reduction and Denitrification.

Nitrogen fixation: Symbiotic, nonsymbiotic. Sulphate reduction.

Methanogenesis, Acetogenesis.

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

UNIT-I: - Catalytic mechanisms

General characteristics of enzymes (Terminologies),

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

UNIT-II: - Catalytic mechanisms :

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

UNIT-III: - Enzymes kinetics and regulation

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

UNIT-IV: - Techniques

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

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

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

UNIT-I: - Biophysical Techniques-I

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

UNIT-II: -Biophysical Techniques-II

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

UNIT-III: -Microscopical Techniques.

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

UNIT-IV: -Other advance techniques

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

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

UNIT-I: - Structure and organization of membranes

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

UNIT-II: - Membrane Transport

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

UNIT-III: - Signal Transduction I

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

UNIT-IV: - Signal Transduction II

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

PRACTICAL-I
MB1-LAB1
LABORATORY EXERCISE 1

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

Minimum seven experiments must be performed in the semester.

PRACTICAL-II
MB1-LAB2
LABORATORY EXERCISE 2

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

Minimum seven experiments must be performed in the semester.

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

UNIT-I: - Eutrophication, Biodeterioration and Biomagnification

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

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

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

UNIT-II: - Biotransformation and Bioleaching, Biodegradation

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

Bioleaching: Bioleaching of ores, leaching techniques and applications.

Biodegradation: Biodegradation of plastics.

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

UNIT-III: - Pollution Management

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

UNIT-IV: - Global Environmental Problems

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

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

UNIT-I:- Overview of metabolites

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

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

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

UNIT-II:- Antimicrobial drugs: Secondary metabolites

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

Structure and mode of action of antibiotics:

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

UNIT-III:-Pigments as secondary metabolites

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

UNIT-IV:-Microbial vitamins

Characteristics of fats and water soluble vitamins.

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

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

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

UNIT-I: - Infection

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

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

UNIT-II: - Bacteriology

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

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

UNIT-III: - Mycology and Parasitology

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

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

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

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

UNIT-IV: - New emerging Infections

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

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

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

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

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

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

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

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

UNIT-II: - Cancer and transplantation immunology.

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

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

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

UNIT-III: - Immune Dysfunction

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

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

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

UNIT-IV: - Immunodiagnostics

Precipitation reactions: Immunodiffusion, immunoelectrophoresis,

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

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

**PRACTICAL III
MB2-LAB3
LABORATORY EXERCISE 3**

1) Different staining:

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

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

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

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

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

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

4) Antibiotic sensitivity testing by various methods:

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

**PRACTICAL-IV
MB2-LAB 4
LABORATORY EXERCISE 4**

Diagnostic immunologic principles and methods of followings:-

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