

RAIGANJ UNIVERSITY
Department of Microbiology



Master of Science (M.Sc.) Course in Microbiology

Raiganj University
Master of Science (M.Sc.) Course in Microbiology

DURATION: Two years (divided into 4 semesters)

CURRICULUM

Semester I

Theoretical				
Sl No.	Paper code	Course Title	Full marks	Credits
1	MB-1.1	Biophysical methods & Biomolecular structures	50	4
2	MB-1.2	Diversity of microbes & cell biology	50	4
3	MB-1.3	Molecular Biology & Microbial metabolism	50	4
Practical				
1	MB-1.4	Biochemistry and Analytical Technique	50	4
2	MB-1.5	General Microbiology	50	4
3	MB-1.6	Microbial Metabolism and Molecular Biology	50	4
Continuing Evaluation				
1	MB-1.7	Class Tests	75	6
2	MB-1.8	Seminar	25	2
Total			400	32

Semester II

Theoretical				
Sl No	Paper code	Course Title	Full marks	Credits
1	MB-2.1	Genetics and Genetic Engineering	50	4
2	MB-2.2	Agricultural & Environmental Microbiology	50	4
3	MB-2.3	Industrial & Food Microbiology	50	4
Practical				
1	MB-2.4	Genetics and Genetic Engineering	50	4
2	MB-2.5	Agricultural and Environmental Microbiology	50	4
3	MB-2.6	Bioprocess Engineering and Food Microbiology	50	4

Continuing Evaluation				
1	MB-1.7	Class Tests	75	6
2	MB-1.8	Seminar	25	2
Total			400	32

Semester III

Theoretical				
Sl No	Paper code	Course Title	Full marks	Credits
1	MB-3.1	Virology & Immunology	50	4
2	MB-3.2	Medical Microbiology	50	4
3	MB-3.3	Biostatistics and Bioinformatics	50	4
Practical				
1	MB-3.4	Virology and Immunology	50	4
2	MB-3.5	Medical Microbiology	50	4
3	MB-3.6	Biostatistics and Bioinformatics	50	4
Continuing Evaluation				
1	MB-3.7	Class Tests	75	6
2	MB-3.8	Seminar	25	2
Total			400	32

Semester IV

Theoretical				
Sl No	Paper code	Course Title	Full marks	Credits
1	MB-4.1	Genomics and Proteomics	50	4
2	MB-4.2	Bioethics and Intellectual Property Rights	25	2
Continuing Evaluation				
1	MB-4.3	Dissertation/Review	150	12
2	MB-4.4	Class Test	50	4
	MB-4.5	Seminar	50	4
	MB-4.6	Summer/Industrial training	75	6
Total			400	32

Grand Total:	1600	128
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DETAILED SYLLABUS**SEMESTAR 1****Paper MB-1.1(Theory)****Biophysical Methods and Biomolecular Structures***Thermodynamics and Instrumentation*

Thermodynamics in biology, First law of thermodynamics, Enthalpy, Second law of thermodynamics, Entropy, Gibbs free energy, Free energy and equilibrium, Thermodynamics and macromolecular structure-Basic principle, Molecular mechanics. Molecular potentials, Bonding and non-bonding potentials

Microscopy: Theory and applications in biological sciences ,Dark-field, phase contrast and interference, polarization, Confocal, Atomic force ,Fluorescence and Electron (SEM and TEM) microscopy, Fluorescence activated cell sorter.

Radioactivity measurement: Radioactive decay, Liquid scintillation counter-y ray detection and its applications; Use of stable isotopes in Biological sciences; Autoradiography

Chromatography: Basic principle; Agarose gel electrophoresis, Poly-acrylamide gel electrophoresis, counter current electrophoresis, Immuno-electrophoresis, isoelectric focusing

Centrifugaion: Basic principle; RCF and Sedimentation Coefficient; Types of Centrifugation-High speed and Ultracentrifugation, Differential and Density-gradient centrifugation; Analytical centrifugation and applications

Spectroscopy: Theory and applications; UV-visible, Fluorescence, IR, FTIR, NMR, Mass, Raman and atomic absorption spectroscopy; Fluorescence polarization

Enzymology

Chemical basis of life: composition of living matter; Water properties; pH; ionization and hydrophobicity: Biomolecular hierarchy

Protein: Amino acids-structure and functional group properties; Covalent structure of Peptide; Hierarchy in protein structure; Elucidation of primary and higher order structures.

Carbohydrates: Mono, di and polysaccharides, Glycosylation of other biomolecules- glycoproteins and glycolipids.

Lipids: Structure and properties of important members of storage and Membranes lipids, Lipoproteins.

Nucleic acid: Components of DNA and RNA, structure of DNA and RNA. Watson-Crick model, alternate double helical structures of DNA. Supercoiling of double helix, DNA renaturation kinetics.

Enzyme catalysis: Definition of enzyme, active site, substrate, coenzyme, cofactor and different kind of enzyme inhibitors, Michaelis-Menten kinetics; methods of plotting enzyme kinetics Lineweaver-Burk, Hanes-Woolf, Edie-Hofstee and Dixon plot, Two substrate kinetics, deviation from linear kinetics; Ligand binding studies, rapid kinetics, association and dissociation constants; factors influencing catalytic efficiency- effect of pH, temperature and isotopically labeled substrates on enzyme activity, solvent effects; Allosteric model of enzyme regulation, substrate induce conformational change in enzyme.

Recommended Books:

1. Physical Chemistry: With Applications to the life sciences by D. Eisenberg and D. Cum (Benjamin/ Cummings)
2. Biochemistry,6e, by J.M. Berg, J.L.Tymoczko and L.Stryer (W.H.Freeman)
3. Biophysics, 3e, by W.Hoppe et al, (Springer-Verlag)
4. Biochemistry,4e, by D.Voet and J.G.Voet(Wiley)
5. Biochemistry,4e, by G.Zubay (William C.Brown)
6. Physical Biochemistry,2e,by K.E.Van Holde (Prentice Hall)
7. Lehninger Principles of Biochemistry,2e,by David L.Nelson, Michael M.Cox
8. Principles and Techniques of Practical Biochemistry,7e,by Keith Wilson and John Walker
9. Physical Biochemistry: Applications to Biochemistry and Molecular Biology,2e,by David Freifelder
10. Biophysical Chemistry: Part III: The Behaviour of Biological Macromolecules, by Charles R.Cantor and R.Schimmel

Paper MB-1.2(Theory)

Diversity of microbes & cell biology

Diversity of Prokaryotic and Eukaryotic Microbes

Biodiversity: Concepts and levels; Role of biodiversity in ecosystem functions and stability ; speciation and extinction

Microorganisms: Classification and survey; General characteristics, Modes of reproduction, Classification - Criteria, Numerical taxonomy and Bergey's Manual; Microbial phylogeny as revealed by rRNA sequencing; Metagenomics; Extremophiles.

General characteristics of various groups of prokaryotes: Archea, Bacteria- Mycoplasmas, Rickettsiae, Chlamydiae, Spirochaetes, Cyanobacteria and Actinomycetes.

General characteristics, Structure, classification, life cycles (imp forms), sexual and asexual reproduction and evolution of Algae.

General characteristics, Structure, classification, life cycles (imp forms), sexual and asexual reproduction of Yeasts and Moulds.

General characteristics, classification and importance of Protozoa

Cell Biology

Cell theory; Cell morphology and significance of being small in size.

Cytoplasmic membrane: Structure, function and composition; Membrane transport systems; cellular junction and adhesion; Protein trafficking in Endoplasmic reticulum and Golgi apparatus

Variation in microbial cell wall structures

Molecular basis of chemotaxis; Functional biology of Cilia and Flagella

Biogenesis of Chloroplast and Mitochondria

Nucleus: Structure and function of Nuclear envelop. Lamina and Nucleolus; Nucleoid

Inclusion bodies; Carbon storage polymers; Other storage materials

Gas vacuoles: structure and functions

Cell cycle regulation in Prokaryotes and Eukaryotes

Cell signaling: Cell signaling receptors, GPCR, Enzyme linked receptors

Recommended books:

1. General Microbiology, 5e, by R.Y. Stanier (Palgrave Macmillan)
2. Microbiology, 5e, by M.J. Pelczar (Tata McGraw-Hill)
3. Microbiology, 9e, by L.M. Prescott (William C. Brown)
4. Brock Biology of Microbiology, 14e, by M. Madigan et al. (Benjamin Cummings)
5. Biodiversity of Microbial life, by J.T. Staley and A.L. Ragsdale (John Wiley)
6. Microbial Ecology: Fundamentals and Applications, 6e, by R.M. Atlas and R. Bartha (Benjamin Cummings)
7. Bacterial Metabolism, 2e, by G. Gottschalk (Springer)
8. Microbial Physiology, 2e, by I.W. Dawes and I.W. Southern (Blackwell)
9. Prokaryotic development, by Y.V. Brun and L.J. Shimkets, eds (ASM Press)
10. Molecular biology of the cell, 4e, by B. Alberts (Garland)

Paper MB- 1.3 (Theory)

Molecular Biology & Microbial metabolism

Growth and Microbial Metabolism

Microbial growth kinetics: Growth curve; Measurement of growth; Continuous culture; Influence of environmental factors on growth; Microbial growth in natural environments; Counting viable but non-culturable prokaryotes; Quorum sensing; Growth under starvation

Growth control of Microorganisms: Pattern of microbial growth; Condition influencing the effectiveness of antimicrobial agents activity; Use of physical and chemical methods in control

Nutritional types of Microorganisms; Culture media

Carbohydrate Metabolism: Fermentation, anaerobic and Aerobic respiration-Enter Doudoroff pathway, TCA Cycle, Pentose Phosphate pathway, Hexose Monophosphate shunt, Glyoxylate cycle, Regulation of sugar degradation pathway; Glycogenesis; Gluconeogenesis; Electron transport systems and ATP generation

Lipid Metabolism: Biosynthesis of Fatty acids, Triacylglycerols, Membrane phospholipids, Oxidation of Fatty acids

Amino acid Metabolism: Lysine, Glycine, Proline, Tryptophan, Ornithin cycle; Urea cycle

Biosynthesis of Nucleic acids: Salvage and de novo pathways

Peptidoglycan biosynthesis; Oxygenic and anoxygenic photosynthesis

Autotrophy; Photolithoautotrophy ; Energy conservation in Chemolithotrophic bacteria

Heterotrophic CO₂ assimilation: Acetogenesis; Methanogenesis; Hydrogen production

Nitrogen Metabolism: Nitrification, Denitrification; Nitrogen fixation - Symbiotic and asymbiotic; Ammonification

Dissimilatory and assimilatory Sulphur metabolism

Molecular Biology

Organization of genomes: Genes and Chromosomes; Satellite DNA, Euchromatin, Heterochromatin, Palindromes and Inverted repeats

DNA Replication: General principle; Semiconservative and semidiscontinuous nature of replication; Okazaki fragments; Enzymes and accessory proteins; Initiation, Elongation and Termination of replication, Models of replication-Eyes, Rolling circles and D loops; Topology of DNA replication

Recombination and Repair : Homologous, non-homologous and site specific recombination; Holiday junction; Cre/Lox recombination; DNA repair enzymes, Photoreactivation ; Excision repairs; Mismatch repair, SOS repair

Mutation: Nonsense, missense and point mutation; Intragenic and Intergenic suppression; Physical, Chemical and biological mutagens; Role of Transposons in mutation

Transcription: Prokaryotic transcription- Transcription Unit; Enzymes and accessory proteins; Initiation, Elongation and Termination-rho dependent and rho independent termination of RNA chains; Attenuation and Anti-termination; Eukaryotic transcription-Promoter, Enhancer, General Transcription factors

Translations in Prokaryotes and Eukaryotes: Translational machinery, Ribosome, Genetic code- Degeneracy of codons, Wobble hypothesis; Activation of amino acids; Mechanism of Initiation, Elongation and Termination; Post-translational modifications

Recommended Books:

1. Genes XI, by Benjamin Lewin (Oxford University Press)
2. Molecular Biotechnology, 2e, by S.B.Primrose (Wiley-Blackwell)
3. Molecular Biology of the Gene, 7e, by J.D.Watson et al. (Benjamin Cummings)
4. Recombinant DNA Methodology II, by R.Wu,ed. (Academic Press)
5. Molecular Biology of Cell,2e, by David P.Clark (Academic Press)
6. General Microbiology,5e, by R.Y.Stanier(Palgrave Macmillan)
7. Microbiology,5e,by M.J.Pelczar
8. Microbiology, 9e , by L.M.Prescott (William C. Brown)
9. Brock Biology of Microorganisms, 14e, by M.Madigan et al.(Benjamin Cummings)

Paper MB-1.4 (Practical)**Biochemistry and Analytical Technique**

1. Standard buffer solution preparation and pH determination
2. Phase contrast microscopy (demonstration)
3. Fluorescence microscopy (demonstration)
4. Isolation of photosynthetic pigments and study of their absorption spectra
5. Techniques of Thin layer, Ion exchange and Gel filtration chromatography
6. Estimation of carbohydrates and proteins
7. Isolation and partial purification of bacterial enzyme
8. Determination of specific activity and stability of partially purified enzymes
9. Effect of substrate concentration, pH, temperature , salt concentration, activator, and inhibitor on enzyme activity
10. Determination of K_m and V_{max} with and without competitive and non-competitive inhibitors for partially purified enzyme
11. SDS-Polyacrylamide gel electrophoresis of protein

Paper MB-1.5 (Practical)**General Microbiology**

1. Microbial staining techniques (Simple staining; Gram staining; Endospore Staining; Flagella Staining; Cell wall Staining; Negative Staining) and Microscopic studies of microbial morphology (shape, size, arrangement etc.)
2. Enrichment and morphological study of Endospore-forming bacteria, Phototrophic bacteria, Myxobacteria

3. Isolation of Microbiota from different habitats - Aliquot preparation, Dilution techniques, Streak method, Enrichment method by using selective media and by modifying microenvironments, Identification of isolated bacteria (microscopic, cultural, biochemical and physiological tests)
4. Isolation of Protozoa from soil
5. Isolation of Bacteriophage

Paper MB - 1.6 (Practical)**Microbial Metabolism and Molecular Biology**

1. Study of Microbial Growth Curves; Determination of generation time; Estimation of growth- Plate count method (Viable colony count of microbes), MPN Technique, Turbidometry, Microscopic counts with Haemocytometer, Dry weight Estimation; Di-auxic growth curve.
2. Effect of environmental factors (temperature, pH, carbon and nitrogen sources) on growth of Microorganisms
3. Isolation of genomic and plasmid DNA - preparation of 'cot' curve
4. Absorption spectra of isolation protein and DNA
5. Induction of mutation, and selection of mutants using Replica plating Technique
6. Auxotrophic mutant isolation

Paper MB - 1.7 (Class Test)

Average of continuing class test scores on all the theoretical and practical subjects taught in semester I

Paper MB - 1.8 (Seminar)

A Seminar topic will be allotted to individual student according to his/her area of interest (students are also suggested to propose topics with relevant published information during the time of allotment), on which a report should be prepared and submitted after presentation as per schedule.

SEMESTER II**Paper MB-2.1 (Theory)
Genetics and Genetic Engineering***Genetics*

DNA as genetic material; Physical basis of heredity; Chromosomes; Cell division
Gene transfer mechanisms: Transformation, Conjugation, Transduction
Extra-chromosomal genetic elements and their inheritance; Mitochondrial DNA
IS element and Transposons

Genetic analysis of Bacteriophages: general outline (lambda and T4)

Regulation of gene expression in prokaryotes and eukaryotes: Operon concept-
lac, ara and trp operons, nif regulon; Environmental factors of gene regulation;
Chromosome remodeling; RNA dittoing; SiRNA and RNA Interference.

Outline of Mendelian genetics; Linkage and Chromosome mapping; Cross over,
chi square test for linkage; Recombination frequency and map construction;
Tetrad analysis in yeasts and recombination mapping with tetrad; Mapping with
molecular markers.

Genetic Engineering

Basic concepts: Restriction enzymes; DNA ligase, Klenow enzyme, T4 DNA
ligase, Polynucleotide kinase, Alkaline phosphatase, Linkers and Adaptors;
Labelling of DNA - Nick Translation, Random priming, Radioactive and non-
radioactive probes; Northern and Southern hybridization; DNase foot printing;
DNA sequencing methods

Cloning vectors: Plasmid (pBR322, pUC, Blue Script), Phagemid, Lambda
vectors, Cosmid; Artificial chromosomes (YAC, BAC); Bacterial Expression
vectors (pMal, pET based vectors); Cloning in yeast, Yeast vector development,
YEp, YRp, YCp and Yip, 2 μ plasmid, Transformation in yeast; Shuttle vector;
Agrobacterium tumefaciens; Genetic elements present in Ti plasmid, disarmed Ti
plasmid, Plant transformation-binary and cointegrate vectors

Cloning Methodologies: Insertion of Foreign DNA into host cells, Genomic and
cDNA library; Expression cloning

PCR: Principle, Thermostable DNA polymerase, Proof reading enzymes, Primer
design; Types of PCR-Reverse transcriptase, Real Time PCR, Degenerate PCR,

Inverse PCR: Cloning of PCR products, TA-cloning, PCR based mutagenesis, Application of PCR in bacterial and viral detection

Recommended Books:

1. Principal of Gene Manipulation, 6e, by S.B. Primrose, R.M. Twyman and R.W. Old
2. Genetic Engineering, 3e, by S. Rastogi and N. Pathak (Oxford University Press)
3. Molecular Cloning, A Laboratory Manual 4e, by J.Sambrook and D.W. Russel (CSHL Press)
4. Genetics as a Tool in Microbiology, vol. 31, by S.W. Gloover and D.A. Hopwood (Cambridge University Genetics as a Tool in Microbiology, vol.31, by S.W. Gloover and D.A. Hopwood (Cambridge University Press)
5. Molecular Genetics of Bacteria, 4e, by L. Snyder and W. Champness (ASM Press)
6. Genetics of Bacteria, by A. Galizzi, ed. (Academic Press)
7. Molecular Biology of the Gene, 7e, by J.D. Watson et al. (Benjamin Cummings)
8. Principles of Genetics. 8e. by Gardner, Simmons, Snustad

Paper MB- 2.2 (Theory)

Agricultural & Environmental Microbiology

Agriculture Microbiology

Soil microorganisms in Agro-ecosystems: Types of microbial communities; soil microbial diversity; significance and conservation; Effect of agriculture practices on soil organisms

Biological Nitrogen fixation: Diversity of nitrogen-fixing organisms, Rhizobium-legume association, Nitrogenase, Mechanism of nitrogen-fixation

Chemical transformation by microbes: organic matter decomposition, Nutrient mineralization and immobilization; Transformation of carbon and carbon compounds; Availability of Phosphorus, Sulfur, Iron and trace elements to plants; Biodegradation of Herbicides and Pesticides.

Biofertilizer: Mass cultivation of microbial inoculants; Green manuring; Algalization; Biopesticides

Introduction to Phytopathogens: Symptoms, Pathogenesis, Molecular aspects of plant pathogens interactions, Host defence mechanism; Mycotoxins and Aflatoxin; Disease forecasting and assessment of losses; Prevention of epidemics and disease control

Symbiotic associations: Mycorrhizae; Lichens and PGPR

Environmental Microbiology

Microbiome: Microbes in terrestrial, aquatic, atmospheric and biological environments; Animal as an environment-microbial population of alimentary canal, skin and rumen

Eutrophication and its control; Biofilm reactors and its ecological implications
Significance of microbial activities in the environment: Role of microorganisms in the cycling of bioelements; Biotransformation; Microbial degradation of recalcitrant chemicals and xenobiotics (petroleum and hydrocarbons)

Bioremediation: Biomagnification; Bioaugmentation; Microorganisms in mineral recovery

Structure and development of microbial communities and ecosystem-succession of microbiota in decomposing plant materials

Biological interactions: Microbe-microbe interaction

Microorganism and pollution: Microbial aspects of air and pollution; Role of microbes in biomonitoring of water quality – Indicator organisms, Single species laboratory bioassays, A brief idea of various stages of wastewater treatment- Tricking filter- community, design and operation, Activated sludge; Oxidation pond, Facultative ponds, Anaerobic treatment of wastewater and sludge; Methane production; Use of microbes for removing toxic metal ions from waste water- mechanisms, absorption and desorption, batch and continuous systems; Microbial toxins in the environment, Biosensors.

Recommended books:

1. Microbial Ecology: Fundamentals and applications, 6e, by R.M. Atlas and R. Bartha (Benjamin Cummings)
2. Biology of industrial Microorganisms, 3e, by A.L. Demain and N.A. Solomon, eds (Benjamin Cummings)
3. Waste Water Treatment for Pollution Control, 2e, by S.J. Arceivala (McGraw-Hill)

4. Biodegradation and Bioremediation, 2e, by M. Alexander (Academic Press)
5. Manual of Environmental Microbiology, 3e, C.J. Hurst et al., eds (ASM Press)
6. Microbial Mineral Recovery (Environmental Biotechnology), by H.L. Ehrlich and C.L. Brierley (McGraw-Hill)
7. Biochemistry and Molecular Biology of Plants, 2e, by Buchanan et al (ASPP, Maryland)
8. Soil Microbiology, Ecology and Biochemistry, by Eldor Paul (Academic Press)
9. Plant Pathology, 5e, by George N. Agrios, (Elsevier Science)
10. Agricultural Microbiology, by D.J. Bagyaraj and G. Rangaswami
11. Microbiology Interactions in Agriculture and Forestry by N.S. Subbarao and Y.R. Dommergues (Science publishers).

Paper MB-2.3 (Theory)
Industrial and Food Microbiology

Bioprocess Engineering and Industrial Microbiology

Suitability of microbes in industrial processes and their source; Type of fermentations and bioreactors; Substrates for industrial fermentations; Growth kinetics in batch and continuous fermentation processes; Strain improvement Design of fermentor; Instrumentation and control; Methods for the recovery and purification of fermentation products (downstream processing); Economic aspects of fermentation processes

Production aspects (Microbial stains, Substrate, Flow diagrams, Products optimization, and Applications) of the following: Industrial alcohol and alcoholic beverages and glycerol; Organic acids-citric, lactic, acetic, propionic, gluconic acid; Amino acids- glutamic acid, lysine; Enzymes-extracellular amylases and proteases; Vitamins-Vit.B12 and riboflavin; Antibiotics-B-lactam, whole cell and enzyme immobilization and their industrial application

Single cell protein; Polysaccharides; Recombinant DNA products-Insulin; Somatostatin; Interferon; Microbial insecticides

Biogas from wastes: Anaerobic digestion and Methanogenesis; Microbiota involved anaerobic digestion; Ensilaging and methane generation; Bio-hydrogen; Techno-economics of biogas generation from fruits and vegetable wastes

Food Microbiology

Factors effecting the growth and survival of microorganisms in foods: Intrinsic factors-Nutrient content, pH, E_h . Antimicrobials and A_w ; Extrinsic factors-Relative humidity; temperature, and gaseous atmosphere

Methods of studying microbes and their products in food stuffs.

Spoilage Of fruits and vegetables; Fresh and processed meats and poultry; Miscellaneous foods such as Bakery products, Dairy products, Beer and wines, Fermented solid-substrate foods, and canned

Microbiology and foods preservation with chemicals, irradiation, low and high temperatures, high pressure, modified atmosphere, low humidity and drying
Manufacture of fermented foods: Dairy products(Acidophilus milk, Cheese and Yogurt),Meat and fishery products (Dry sausages and Fish sauces); Plant products (Cocoa beans, Coffee beans, Olives, Pickles, Sauerkraut, Soy sauce, Tempe and Idli); Breads; Beverages(Cider, Sake, Vinegar and PlumWines)

Food-borne diseases and food poisoning by microbial agents: *Clostridium perfringens*; Helminthes and Nematodes; Protozoa (*Giardia*, *Entamoeba*); Toxigenic fungi (*Penicillium* and *Fusarium*)

The hazard analysis and critical control point (HACCP) concept in controlling microbiological quality of foods; Predictive models; Law in terms of food preservation and regulation

Recommended Books:

1. Biology of Industrial Microorganisms, by A.L. Demain and N.A. Solomon, eds (Benjamin/Cummings)
2. Food Microbiology: Fundamentals and Frontiers, 3e, by M.P. Doyle and L.R.Beuchat (ASM Press)
3. Food Microbiology, 3e, by M.R.Adams and M.O.Moss (Royal Society of Chemistry)
4. Microbial Energetics,2e, E.A.Dawes (Chapman & Hall)
5. Principles of Fermentation Technology, 3e, by P.F. Stanbury et al. (Butterworth-Heinemann)
6. Microbiology,9e, by L.M. Prescott (William C. Brown)
7. Brock Biology of Microorganisms, 14e, by M.Madigan et al.(Benjamin Cummings)

Paper MB-2.4 (Practical)
Genetics and Genetic Engineering

1. Isolation of bacterial genomic DNA and plasmid
2. Bacterial transformation and conjugation
3. Pedigree analysis
4. PCR and TA Cloning
5. Bacterial expression of proteins
6. Restriction enzyme digestion of DNA
7. RT-PCR

Paper MB-2.5 (Practical)
Agricultural and Environmental Microbiology

1. Enumeration of soil microorganisms: bacteria, actinomycetes, fungi by standard plate count
2. Isolation of cellulose decomposing microbes and estimation of cellulose activity
3. Specimen study of some plant diseases
4. Isolation of plant pathogens (fungi, bacteria, and viruses) from different plant parts
5. Physico-chemical analysis of water - pH, TDS, DO, COD, BOD, phosphate, $\text{NH}_4^+ - \text{N}$, $\text{NO}_3^- - \text{N}$
6. Estimation of organic carbon
7. Determination of ammonification, nitrification and denitrification rates in soil and water
8. Sampling and quantification of microorganisms from air
9. Analysis of soil: Texture, pH, Moisture content, Water-holding capacity, Percolation, Nitrogen and Organic matter
10. Determination of microbial activity in soil and composting plant materials
11. Isolation of microbes from rhizosphere, rhizosphere and phylloplane
12. Tests for presence of enzymes in soil: dehydrogenase, amylase, invertase and catalase

Paper MB - 2.6 (Practical)
Bioprocess Engineering and Food Microbiology

1. Detection and enumeration of indicator and index organisms for foodborne pathogenesis (Total Enterobacteriaceae, Total coliforms, Faecal coliforms, *Escherichia coli*, and Aerobic sporeformers)
2. Microbiological examination of processing plant, equipment, working surfaces etc.
3. Quantifying the thermal death point of microorganisms (D and z values)
4. Bioassay of vitamin B12
5. Mushroom production
6. Determination of the role of yeasts in bread making
7. Determination of the role of moulds in tempe making
8. Isolation of antibiotic producing microorganisms by crowded plate technique
9. Immobilization of microbial cells by entrapment methods
10. Ethanol production from whey, fruit wastes, malt etc.
11. Production and estimation of citric acid from pineapple waste in solid state fermentation using a selected strain of *Aspergillus*
12. Saccharification of agro-based industry waste materials by fungal cellulases and hemicellulases

Paper MB - 2.7 (Class Test)

Average of continuing class test scores on all the theoretical and practical subjects taught in semester I

Paper MB - 2.8 (Seminar)

A Seminar topic will be allotted to individual student according to his/her area of interest (students are also suggested to propose topics with relevant published information during the time of allotment), on which a report should be prepared and submitted after presentation as per schedule.

SEMESTER - III**Paper MB-3.1 (Theory)
Virology and Immunology***Virology*

Classification and general properties of major families of viruses including their modes of replication

Detailed study viz. Pathology, pathogenesis, symptoms, epidemiology, transmission, diagnosis, prevention and control of important genera of viruses causing diseases in man, animals, plants and insects included in the following families- DNA (Herpes, Hepatitis B, Adenovirus, SV40, CAMV, Baculo Virus) and RNA (Polio, Influenza, Retro, TMV) viruses

Mechanism of virus entry into plant cells; Methods of assay of plant viruses

Biochemical changes induced by virus in plant cells; Biology and mode of transmission of plant viruses

Immunology

Cells and organs of immune system; Antibody specificity, diversity, memory, and self and non-self discrimination; Theories of antibody production; Immunogens, Immunoglobulins-fine structure, classification, function, synthesis and evolutionary aspects; Hybridoma production; Monoclonal antibodies- general properties and applications; Antigen-antibody reactions

Complement system; Basic biology of B cells and T cells - their ontogeny, subsets and functions; Phagocytosis; Triggering of immune response-both humoral and cell-mediated antibody formation; Mechanism of cell-mediated immunity; Mitogens; Adjuvants; Immune tolerance, developing and mechanism; Immunosuppression; Immunological hazards of transfusion

Immunological methods - Immunofluorescence, Immuno-electrophoresis, Counter current Immuno-electrophoresis, RIA, ELISA, and Immunoblotting

Immunogenetics: Structure, distribution and function of histocompatibility antigens; Major histocompatibility gene complex, gene complex, HLA and H-2 systems; MHC Restriction; Immune response genes; HLA and disease; Immunogenetics of tissue transplantation; HLA-typing

Immunopathology: Classification of immunopathological disorders; General account of immune deficiency disorders- both primary and secondary types;

Acquired immune deficiency syndrome (AIDS); Atopy, Allergy and Hypersensitivity reaction; Auto-immunity; Mechanism of development of autoimmune diseases; Vaccines

Tumour immunology: Host-tumour interactions; Classification of tumour specific transplantation antigens; Antibody dependent cell cytotoxicity; Natural killer cells; Immune surveillance; Tumour escape mechanisms; Blocking antibodies; Immunotherapy of cancer; Immunotoxins

Recommended books:

1. Immunology, 8e, by J. Kubly, Goldsby, T.J. Kindt, Barbara, A. Osborne (W.H. Freeman)
2. Basic Virology. 3e, by Edward K. Wagner, M.J. Hewlett, D.C. Bloom, D. Camerini (Wiley-Blackwell)
3. Introduction to modern Virology, 6e, N.J. Dimmock, A.J. Eastern and K.N. Lepard (Blackwell)
4. Fields, Virology I and II, 6e by Bernard N Fields, David M. Knipe, Peter Howley
5. Principles of Virology, 3e, by S. June Flint et al.
6. Virus Taxonomy by M.V. Van Regenmortel, C.M. Fauquet, D.H.L. Bishop (Academic Press)
7. Roitt's essential immunology, 12e, by P.J. Delves, S.J. Martin, D.R. Burton, I. M. Roitt.

Paper MB-3.2 (Theory)

Medical Microbiology

History of Medical Microbiology: Koch postulates; Microflora in human body in relation to pathogenesis and epidemiology

Study of the following genera of bacteria in relation to pathogenesis: *Corynebacterium*; *Staphylococcus*; *Escherichia*; *Klebsiella*; *Shigella*; *Vibrio*; *Campylobacter*; *Pseudomonas*; *Pasteurella*; *Haemophilus*; *Bordetella*; *Bacillus*; *Clostridium*; *Mycobacterium*; *Actinomyces*; *Nocardia*; *Listeria*; *Legionella*

General description, biological properties and diseases caused by the following groups of pathogens: *Mycoplasmas*; L-phase variants; *Rickettsiae*; *Chlamydiae*; *Spirochetes*

General account of diseases caused by pathogenic fungi: *Candidiasis*, *Aspergillosis*

Preliminary account of biology, prevention and infectious potential of protozoa: *Entamoeba*; *Plasmodium*, *Giardiasis*

A general account of routinely employed diagnostic tests in microbial diseases- Culture, Smear, Biochemical tests, Antimicrobial testing, Introduction to animal inoculation, Skin tests and Serological tests (Precipitation, Immuno-electrophoresis, Flocculation-VDRL, Agglutination- Widal, Immunofluorescence, Haemagglutination, Neutralization and ELISA)

Antibiotics and Chemotherapeutics

Chemical non-medicinal antimicrobials: Sanitizers; Disinfectants; Antiseptics
Bactericidal and bacteriostatic agents; Factors affecting static and cidal activity;
Phenols and phenolic compounds; alcohols; Halogens; Heavy metals; Dyes;
Detergents; Aldehydes

Synthetic medicinal agents (drugs): Sulphonamides; Antitubercular compounds;
Nitrofurans; Nalidixic acid; Metronidazoles

Antibiotics: Definition of antibiotics; Types (chemical) of antibiotics;
Classification of antibiotics on the basis of mode of action; Non-medical use of
antibiotics

Antimicrobial spectrum and mode of action of common antibacterial antibiotics-
Penicillins, Cephalosporins, Chloramphenicol, Streptomycin, Rifampicin,
Tetracycline, Erythromycin, Polmyxins, Vancomycin, Nalidixic acid,
Ethambutol, Novobiocin

Qualitative assay of drugs (Drug sensitivity testing); Quantitative assays; Choice
drug determination; dosage; Route of administration; Combined drug therapy;
Policies of antibiotic usage

Antifungal antibiotics: Chemical nature, Mode of action and Action spectra of
Amphotericin B, Nystatin, Neofulvin, Flucytocin and Ketoconazole

Antiviral agents; Interferon and its action; Chemical antiviral agents

Mechanism and prevention of drug resistance in bacteria

Paper MB- 3.3 (Theory)
Biostatistics and Bioinformatics

Biostatistics

Concept of matrix; Matrix as an operator; Types of matrices; Matrix diagonalization; Determination of matrix; Rank of a matrix

Frequency and distribution of biological variations ; Measures of central tendency- Mean, Median, Mode; Measures of dispersion- Range, Standard deviation and standard error

Classification and identification of probability; Laws of probability; Theorems of total probability

Binomial distribution, Normal distribution, Poisson and Gaussian distribution; Fitting of observed distribution to a theoretical distribution.

Statistical models; Methods and applications; Sampling and N on-paired-data; Heterogeneity of variance

Test of hypothesis and tests of significance: z-test(large samples), t-test (small samples), confidence limits of mean, F-test and analysis of variance(ANOVA) in one way and two way classification, Least significance difference (LSD), Chi-square (X-square) goodness of fit tests

Correlation and regression- definition, formulae and statement of properties; Performance of biostatistics on MS excel and SPSS software

Computer Applications and Bioinformatics

Basic concepts of computers: Architecture-Input, Output, CPU, ALU etc; MATLAB; Generations of hardware and software; A brief introduction on input-output devices-disks, printers, CD-ROMS and other storage media etc.; Operating systems- WINDOWS and UNIX; System and application software; Basics of internet- LAN, MAN and WAN; Concepts of websites

Electronic spread sheet: Creating, opening and saving files; Working with worksheets; Creating formulae; Working with charts; Summarizing data in lists and tables; Analyzing data with Pivot tables; Analyzing sample statistical data; Validating cells

Genomics and Proteomics data analysis: Entire genome expression analysis- Microarrays, Expressed sequence tags (EST), Single nucleotide polymorphism

(SNP), and Serial nucleotide polymorphism (SNP), and Serial analysis of gene expression (SAGE); Gen bank; Protein data bank, Pair wise sequence comparison; Sequencing genomes and proteomes; Sequence assembly; Multifunctional tools for sequence analysis; Multiple sequence alignments; Genomes and proteomes on the web; Sequence queries against biological databases - BLAST and FASTA; Annotating and analyzing genome and proteome sequences; Biological pathway databases; Swissprot; Phylogenetic alignment; Profiles and motifs

Homology modeling, Threading, Structure prediction, Structure-structure Comparison of macromolecules, stimulated docking, Ligand data base

Paper MB-3.4 (Practical)

Virology and Immunology

1. Isolation and enumeration of bacteriophages (using double agar layer technique)
2. Determination of one-step growth curve of bacteriophage
3. Haemagglutination test for presence of antigens (microorganisms)
4. Infectivity of plant viruses (using local lesion method)
5. Study of cytopathic effect of viruses
6. Serological tests of diagnostic importance including complement fixation, precipitin reaction, slide agglutination test, Widal test, Tuberculin test and ELISA
7. Counter electrophoresis
8. Blood examination for ABO groups and Rh factors
9. Haemagglutination inhibition test
10. To perform western blotting
11. To study morphological and staining characteristics of lymphocytes, neutrophils, monocytes, eosinophiles and basophiles

Paper MB-3.5 (Practical)**Medical Microbiology**

1. Estimation of urine bacteria by calibrated loop-direct streak method and pour plate method
2. Urine culture and microbial analysis for antibiotic sensitivity
3. Isolation of enteric pathogens from stools by direct plating method
4. Study of antimicrobial spectrum of antimicrobials
5. Determination of cidal and static activity
6. Screening of antibiotic producing microbes
7. Production, Separation and detection of antibiotics by bioautographic methods
8. Microbiological assay of antibiotics using tube dilution, well diffusion and agar dilution method

Paper MB- 3.6 (Practical)**Biostatistics and Bioinformatics**

1. Frequency distribution : Measures of central tendency and dispersion; Sampling; Analysis of variants; Testing of hypothesis, Correlation and Regression; Fitting an observed distribution to a theoretical distribution; Application of computers in biostatics; Usages of statistical packages
2. Basics of computers: basic commands – file creation, copying, moving and deleting in Linux and Windows; Creating spread sheet to biological applications ; using browsers; search engine; Pubmed; Using biological databases; Swissprot; Protein data bank and gene bank; Different type of sequence analysis queries in BLAST and FASTA; Multiple sequence alignments and phylogenetic alignments; Protein structure prediction software; Genome and proteomes available on the web and their use; Computer simulation of bimolecular structure; Statistical software available on the web and their use

Paper MB-3.7 (Class Tests)

Average of continuing class tests scores on all the theoretical and practical subjects taught in semester III

Paper MB-3.8 (Seminar)

A seminar topic will be allotted to individual student according to his/her interest , on which a report should be prepared and submitted after presentation as per schedule.

SEMESTER IV

Paper MB-4.1 (Theory)

Genomics and Proteomics

Genome sequencing projects, Next generation and its applications

Molecular markers: VNTR, SNTR, RELP, AFLP, EST, SNP

DNA Microarray and its applications

Comparative genomics of bacteria, Horizontal gene transfer and microbial evolution, Hardy Weinberg principle

Pharmacogenomics: High throughput screening in genome for drug discovery- identification of gene targets, Pharmacogenetics and drug development

Protein concentration; protein sequencing; 2D electrophoresis of protein; isoelectro focusing; LC/MS-MS, MALDI-TOF for identification of proteins; protein-protein interaction- yeast two hybrid system, Phage surface display; Applications of proteomics in research

Protein microarray and its applications

Paper MB-4.2 (Theory)

Bioethics and Intellectual Property Rights

The importance of needs of bioethics; Bioethical business practices; Laws and bioethics; Environmental protection; Creating awareness and safeguarding health of consumers; Fair trade practices; Combating plagiarism

Concept of property, rights/protection, duties, and their correlation; History and evaluation of intellectual property rights (IPR); Distinction among various forms of IPR

Introduction of intellectual properties and the Indian Legal System; Indian Trademark fundamentals, management, practice, and procedures; Contemporary and comparative perspective in different jurisdictions; Copyright fundamentals, practice and perspective

Introduction to patents; Key concepts ; International law of Patents; Indian Patent Act and practice; types of patents ; WIPO treaties

International registration systems; Patent application; Documentation and search; Revocation of patent; Infringement or violation; Remedies against infringement; Drafting, Litigation; Commercialization

Law and practice; Trade secrets and confidential informations; plant varieties protection law; biodiversity law and traditional knowledge; legal implications and public concern in genetic modification in foods; Computer and Software IP, Semiconductor and cheap law

Paper MB-4.2 (Dissertation/Review)

Each student will required to undertake dissertation/review work assigned to her related R&T any area of microbiology under supervision of a faculty member. In principle, the research work will be carried out by the student himself/herself taking advice from his/her supervisor when problem arises. The work will be allotted at the beginning of the 4th semester specifying the different aspects to be carried out by the students. At the end of the semester the student will submit a report on her work in soft copy and hard copy (bound form). Evaluation shall include oral presentation and viva-voce.

Paper MB-4.3 (Class Tests)

Average of continuing class tests scores on all the theoretical and practical subjects taught in semester IV.

Paper MB-4.4 (Seminar)

A seminar topic will be allotted to individual student according to his/her interest, on which a report should be prepared and submitted after presentation as per schedule

Paper MB 4.5 (Summer/Industrial Training)

In -plant training in a microbiology-based industry or an advanced centre of learning is to be undertaken by each student. A report on the training is required to be submitted. On the basis of written report and industry manger/lab-in-charge's report, a viva-voce will be conducted for evaluation of the student.
