

M.Sc. MICROBIOLOGY SYLLABUS
ASSAM UNIVERSITY
(w.e.f. session 2009-2010)
(modified 2013)

Syllabus prescribed for the degree of Master of Science in Microbiology as per UGC Model Curriculum. The following are the details for the Examination:

SEMESTER – I

Max Marks

Theory

MB 101: General Microbiology	100* (75+25)
MB 102: Mycology and Phycology	100 (75+25)
MB 103: Virology	100 (75+25)
MB 104: Microbial Physiology and Biochemistry	100 (75+25)

Practical

MB105. General Microbiology, Virology, Mycology and Phycology	50 (37.5+12.5)
MB106. Analytical Biochemistry	50 (37.5+12.5)

SEMESTER – II

Total 500

Theory

MB 201: Cellular Microbiology and Immunology	100 (75+25)
MB202: Molecular Biology and Recombinant DNA Technology	100 (75+25)
MB 203: Choice based/ Open- Microbial and Enzyme Technology	100 (75+25)
MB 204: Microbial Genetics	100 (75+25)

Practical

MB205. Cellular Microbiology and Immunology	50 (37.5+12.5)
MB206. Microbial genetics and Molecular biology	50 (37.5+12.5)

Total 500

SEMESTER – III

Theory

MB 301: Parasitology, Medical and Veterinary Microbiology	100 (75+25)
MB 302: Food Microbiology	100 (75+25)
MB 303: Choice based/ Open- Microbial Genomics	100 (75+25)
MB 304: Elective/ Optional/ Special 01	100 (75+25)
1. Bioinstrumentation and Computer Applications	
2. Microbial Technology	
3. Microbial Diversity	

Practical

MB305. Parasitology, Medical, Veterinary and Food Microbiology	50 (37.5+12.5)
MB306. Practical on Major elective 01	50 (37.5+12.5)

Total 500

SEMESTER – IV

MB401: Soil and Environmental Microbiology	100 (75+25)
MB 402: Industrial Microbiology and Fermentation Technology	100 (75+25)
MB 403: Environmental, Soil and Industrial Microbiology (Practical)	50 (37.5+12.5)
MB: 404 Elective/ Optional/ Special 02	
1. Clinical Microbiology	
2. Veterinary Microbiology	
3. Agricultural Microbiology	
MB 405: Project Work / Dissertation	100 (75+25)
MB 406 Practical on Elective 02	50 (37.5+12.5)

Total 500

Grand Total 2000

Course Structure

Categories of Courses:

There shall be four categories of courses:

- a) Core papers: These papers are compulsory for the students
- b) Elective/ Optional/ special (304 and 404): Students has to opt for a paper each in 3rd and 4th semester from three optional papers (Specialization) in the corresponding semesters within the department.
- c) Choice based/ Open (203 and 303): Students has to opt for a paper each in 2nd and 3rd semester of their choice from other departments of related field.
- d) Project Work / Dissertation (405): Students has to carry out a dissertation/ project in the 4th semester.

First Semester

Course no.	Course components	Name of the course	Semester	Lectures	Credits	Maximum marks	
						CIA	External
MB 101	Core	General Microbiology	I	60	5	25	75
MB 102	Core	Mycology and Phycology	I	60	5	25	75
MB 103	Core	Virology	I	60	5	25	75
MB 104	Core	Microbial Physiology and Biochemistry	I	60	5	25	75
MB 105	Core	Practical	I	60	2.5	12.5	37.5
MB 106	Core	Practical	I	60	2.5	12.5	37.5
				Total	25	500	

Second Semester

Course no.	Course components	Name of the course	Semester	Lectures	Credits	Maximum marks	
						CIA	External
MB 201	Core	Cellular Microbiology and Immunology	II	60	5	25	75
MB 202	Core	Molecular Biology and Recombinant DNA Technology	II	60	5	25	75
MB 203	Choice based/ Open Course 01	Microbial and Enzyme Technology			5	25	75
MB 204	Core	Microbial genetics	II	60	5	25	75
MB 205	Core	Practical	II	60	2.5	12.5	37.5
MB 206	Core	Practical	II	60	2.5	12.5	37.5
				Total	25	500	

Third Semester

Course no.	Course components	Name of the course	Semester	Lectures	Credits	Maximum marks	
						CIA	External
MB 301	Core	Parasitology, Medical and Veterinary Microbiology	III	60	5	25	75
MB 302	Core	Food Microbiology	III	60	5	25	75
MB 303	Choice based/ Open Course 02	Microbial Genomics	III	60	5	25	75
MB 304	Elective/ Optional/ Special 01	Bioinstrumentation and Computer Applications/ Microbial Technology/ Microbial Diversity	III	60	5	25	75
MB 305	Core	Practical	III	60	2.5	12.5	37.5
MB 306	Core	Practical	III	60	2.5	12.5	37.5
				Total	25	500	

Fourth Semester

Course no.	Course components	Name of the course	Semester	Lectures	Credits	Maximum marks	
						CIA	External
MB 401	Core	Soil, Agriculture and Environmental Microbiology	IV	60	5	25	75
MB 402	Core	Industrial Microbiology and Fermentation Technology	IV	60	5	25	75
MB 403	Core	Practical	IV	60	2.5	12.5	37.5
MB 404	Elective/ Optional/ Special 02	Clinical Microbiology/ Veterinary Microbiology/ Agricultural Microbiology	IV	60	5	25	75
MB 405	Project + Viva voce	Project/Dissertation	IV	-	5	25	75
MB 406		Practical on Major elective 02	IV	60	2.5	12.5	37.5
				Total	25	500	

Schedule of Semesters

Semester	Duration	Examination
First	July – November	December
Second	January – April	April/May
Third	July – November	December
Fourth	January – April	May/June

There will be a week preparatory leave, but inter-semester breaks and gaps between theories and practical will be minimum possible (6 days including holidays).

Two practical examinations in first, second and third semesters will be held each carrying 50 marks. In the fourth semester project work or industrial training (dissertation) of three months duration will be carried out in department or any national laboratory or industry (entrepreneurship). Every student has to submit the Project Work by 15th May in the same session, which will be evaluated by an external examiner working in any area of microbiology. Seminar and *viva voce* examination shall be carried out by the same evaluator.

Note: *There shall be FIVE UNITS in each theory paper. Each theory paper shall consist of 10 questions. Two questions will be set up from each unit. The candidate will have to attend FIVE questions in all, selecting ONE question from Each Unit. The duration of each paper will be of Three Hours. The duration of each practical will be of 4 hours.*

FIRST SEMESTER

MB101: General Microbiology

60 Lectures

UNIT I: Classification of Micro-organism: History of bacterial classification. Haeckel's three kingdom concept, Whittaker's five kingdom concept, three domain concept of Carl Woese; Basis of microbial classification, molecular approaches in microbial classification, concept of microbial species; Principle and classification of bacteria on the basis of *Bergey's manual of Determinative bacteriology*; Cyanobacteria and Prochlorons.

10 Lectures

UNIT II: Morphology and fine structure of Bacteria: Morphological types – size, shape and arrangements; cell walls of archaea, Gram negative, Gram positive eubacteria, eukaryotes; L forms – cell wall synthesis, antigenic properties, cell membranes – structure, composition and properties. Reserve materials, inorganic and organic inclusions.

15 Lectures

UNIT III: Structure and function of cell appendages and inclusions: capsule types, composition and function; flagella, fimbriae, pili, cilia, gas vesicles, chromosomes, carboxysomes, magnetosomes, phycobillosomes, nucleoid, plasmids (types of plasmids and function); Bacterial spores: Regulation of spore formation.

10 Lectures

UNIT IV: Aerobic, anaerobic, shaking, static cultures, nutritional types, culture media, culture methods- pure culture techniques, Growth curve, generation time, synchronous, batch and continuous culture; Measurement of growth and factors affecting growth, Sterilization and disinfection- heat, UV radiation, ionizing radiation, filtration. Chemical disinfectants.

15 Lectures

UNIT V: Microbial diversity and extremophiles: Microbial diversity, distribution ecological niche, abundance and density. Extremophiles – Psychrophiles, acidophiles, alkaliphiles, thermophiles, barophiles etc., non-culturable bacteria (Metagenomics). Methanogens, Methanotrophs and Methylotrophs.

10 Lectures

Suggested books:

1. Microbiology by Lansing M Prescott, Donald A Klein, John P Harley, Mc Graw Hill
2. Principles of Microbiology by Ronald M. Atlas (1995), Amy Mc Cullen
3. Microbiology: Principles and Explorations by Jacquelyn Black
4. General Microbiology by Roger Y Stanier, John L Ingraham, Mark L Wheelis
5. Microbiology by Michael J Pelczar
6. Fundamental Principles Of Bacteriology A J Salle
7. General Microbiology by Power and Dagainawala, Himalaya Publishing House,
8. Foundations in Microbiology by Kathleen park Talaro, McGraw Hill. science
9. Microbiology: An Introduction by Gerard J Tortora, Berdell R Funke, Christine L Case, Dorling Kindersley (india) Pvt Ltd
10. Microbiology by Stuart Walker, W B Saunders

MB102: Mycology and Phycology**60 Lectures**

UNIT I: History and development of mycology, structure and cell differentiation, Criteria for fungal classification: Habitat morphology and reproduction of Slime molds, oomycetes, Zygomycotina, Ascomycotina, Basidiomycotina, Mastigomycotina and Deuteromycotina

10 Lectures

UNIT II: Homothallism and Heterothallism, Heterokaryosis, Sex hormones in fungi physiological specialization in fungi, fungal succession on decomposing litter Mycorrhiza - ectomycorrhiza, endo mycorrhiza and vesicular arbuscular mycorrhiza. Role of Mycorrhiza in agriculture. Lichens.

10 Lectures

UNIT III: Fungi and Plant disease – Disease symptoms; the concept of virulence and resistance, mechanical and chemical barriers of infection, Study the pathogenesis symptom and control of following diseases: Early and late blight of potato; loose smut of wheat, false smut of paddy, Fusarial wilt, red rot of sugarcane.

15 Lectures

UNIT IV: Fungi and animal disease – Dermatophytes and agents of superficial mycoses. Yeasts of medical importance. Mycotoxins, antifungal agents. Dimorphic fungi causing systemic mycoses, Dimatiaceous fungi. Opportunistic hyaline hypomycetes, agents of zygomycosis, Fungi causing eumycotic mycetoma. Mode of actions of antifungal agents.

15 Lectures

UNIT V: Phycology – Distribution of algae, Classification of algae; thallus organization in algae; reproduction in algae; Brief account of Chlorophyta, Bacillariophyta; Phaeophyta; Rhodophyta; Algal ecology and algal biotechnology.

10 Lectures

Suggested Books:

1. Topley And Wilson's Microbiology And Microbial Infections by Collier, Balows, Sussman. Edward Arnold.
2. Introductory Mycology by Constantine J. Alexopoulos
3. Text Book Of Medical Mycology by Jagdish Chander, Mehta Publishers, New Delhi
4. An Introduction to mycology by Mehrotra. New Age International.
5. Fungi: Diversity and Biotechnology by Rai.

MB103: Virology

60 Lectures

UNIT I: General features, morphology of viruses - ultra structure, capsid and its arrangements, types of envelopes and its composition; nomenclature and classification of viruses, Viral genomes, its type and structure; Viroids, virusoids, -brief details. prions – spread of prion diseases. Antiviral agents and interferons. **10 Lectures**

UNIT II: Bacteriophages – Structural organization, multiplication cycle; eclipse phase, phage production, burst size, lytic and lysogenic cycle, bacteriophage typing, application in bacterial genetics; Application of bacteriophages in health – bacteriophage therapy. **08 Lectures**

UNIT III: General methods of diagnosis and serology – Cultivation of viruses in animal inoculation, embryonated eggs, cell cultures and cell lines; Serological methods – haemagglutination, haemagglutination inhibition, complement fixation, immunofluorescent method, ELISA etc; Assay of viruses – physical and chemical methods (protein; nucleic acid and radioactive tracer, electron microscopy), infectivity assay (plaque method, end point method). **10 Lectures**

UNIT IV: Plant viruses – Classification and nomenclature of plant viruses; Disease symptoms – histology, physiology and cytology of plants; common viral disease of paddy, tomato and sugarcane, Type species of plant viruses (e.g. TMV, Cauliflower mosaic virus and potato virus X), transmission of plant viruses & their preservation, diagnostic techniques (serological methods, histochemical tests and fluorescent microscopy). **12 Lectures**

UNIT V: Animal viruses – classification and nomenclature of animal and human viruses; epidemiology, life cycle, pathogenicity, diagnosis, prevention and treatment of viruses; *RNA viruses*-Picornaviruses, Orthomixoviruses, Paramyxoviruses, Arthropod-borne viruses, Rhabdoviruses, Rotaviruses, HIV and other oncogenic viruses; *DNA viruses* – Pox viruses, Herpesviruses, Adenoviruses, Hepatitis viruses; Viral vaccines (conventional) **20 Lectures**

Suggested Books:

1. Textbook of Virology by A J Rhodes. The Williams & Wilkins
2. Matthews' Plant Virology by Roger Hull, Elsevier
3. Understanding Viruses by Shors, J & B.
4. Principle of virology by Flint.
5. Clinical Virology Manual by Specter. ASM.

MB104: Microbial Physiology and Biochemistry

60 Lectures

UNIT I: Amino acid; classification, chemical reaction, physical properties, primary, secondary, tertiary, and quaternary structure. Enzymes – Classification, multistep reaction and a rate limiting steps, enzyme inhibition, mechanism of action. Kinetics of enzymes, allosteric, allosterism, kinetic analysis of allosteric enzymes, principles of allosteric regulation.

15 Lectures

UNIT II: Bioenergetics and strategy of metabolism – Strategy of energy production in the cell; oxidation – reduction reactions, coupled reactions and group transfer; standard redox potential, law of thermodynamics, entropy, enthalpy and free energy of reaction and ATP; spontaneity of reaction, G^0 , G^1 equilibrium.

13 Lectures

UNIT III: Carbohydrate metabolism – Anabolism, catabolism, ATP (phosphorylation, oxidative phosphorylation, substrate level phosphorylation), electron transport; Metabolic pathways – Glycolysis, Pentose phosphate pathway, Entner Doudoroff pathway, TCA cycle, Glyoxalate cycle.

12 Lectures

UNIT IV: Lipid and Nitrogen Metabolism – Oxidation of fatty acid (α , β , γ), Assimilation of nitrates, ammonia assimilation; amino acid biosynthesis – glutamate family, serine family, aspartate family, histidine biosynthesis – glutamate family, serine family, aspartate family, histidine biosynthesis.

10 Lectures

UNIT V: Bacterial photosynthesis– Characteristic of Photosynthetic bacteria, Photosynthetic pigments; metabolism in Photosynthetic bacteria; Photosynthetic electron transport system; mechanism of photosynthesis, Dark reaction (Calvin-Benson cycle)

10 Lectures

Suggested Books:

1. Lehninger Principle of Biochemistry
2. Biochemistry by Lubert Stryer
3. Plummer, An introduction to practical Biochemistry
4. Biochemistry by Harper
5. Microbiology by Stuart Walker, W B Saunders

MB105: General Microbiology, Virology, Mycology and Phycology

1. Principle, operation and study of various components of microscope.
2. Examination of micro organism by micrometry.
3. Sterilization technique of glassware, material and culture media and preparation of culture plates and tubes.
4. Culture methods, pure culture preparation and sub culturing technique.

5. Microbial growth measurement by direct cell count method, serial dilution method, turbidity method and standard plate count method.
6. Staining technique-simple, Gram's staining, negative staining, flagella staining, spore staining, Acid fast staining. Staining of Fungus.
7. Determination of bacterial motility
8. Isolation and identification of *Aspergillus*, *Penicillium*, *Fusarium*, *Alternaria*, *Nostoc*, *Anabaena*, *Oscillatoria*, *Microcystis*.
9. Isolation of actinomycetes from soil by dilution plate method.
10. Study of DNase, phosphatase and gelatinase activity by bacteria.
11. Culture of bacteriophage by double layer technique.

MB106: Analytical Biochemistry

1. Preparation of buffer and chemical solutions and stains.
2. Principles of colorimetry, its calibration and estimation of O.D.
3. Separation of amino acids by paper chromatography.
4. Isolation of lipid from a given sample and its separation by TLC.
5. Determining of bacterial growth curve.
6. Effect of pH, temperature and chemicals on bacterial growth.
7. Study of factors affecting enzyme activity-substrate, temperature, pH.
8. Estimation of protein by Lowry method.
9. Estimations of reducing sugar by glucose by dinitro salicylic acid (DNSA method).

SECOND SEMESTER

MB201: Cellular Microbiology and Immunology

60 Lectures

UNIT I: Prokaryotic and eukaryotic signaling mechanism: Eukaryotic cell to cell signaling, endocrine signaling, prokaryotic signaling; quorum sensing and intercellular signaling,

08 Lectures

UNIT II: History and scope of immunology: Types of immunity – innate and acquired, passive and active. Physiology of immune response- Humoral and cell mediated immunity, Lymphoid organs. Immunohaematology of blood groups, ABO and RH compatibility. **10 Lectures**

UNIT III: Antigens and Antibodies: structure and properties (types, iso and allo). haptens, adjuvants; antigen specificity; Immunoglobulins (antibodies) – structure, heterogeneity – types and subtypes, properties (physico-chemical and biological). Immunotoxins; vaccines and its types, toxoids national immunization programmes, newer generation vaccines **15 Lectures**

UNIT IV: Antigen – Antibody reactions; agglutination, haemagglutination, precipitation, Complement fixation, immunofluorescence; enzyme linked immunosorbent assay (ELISA), radioimmunoassay. Hybridoma technology – monoclonal antibodies and its uses.

UNIT V: Complement pathways. Hypersensitivity-anaphylaxis, cytotoxic reaction. Autoimmunity, Transplantation immunology and tumor immunology. HLA tissue typing, major histocompatibility complex.

15 Lectures

12 Lectures

Suggested Books:

1. Immunology by Janis Kuby
2. Essential immunology by Roitt
3. Immunology: A short course by Eli Benjamini, Wiley.
4. Laboratory immunology & serology. Neville J. Bryant
5. Foundations in Microbiology by Kathleen park Talaro, McGraw Hill. Science

MB202: Molecular Biology and recombinant DNA technology

60 Lectures

UNIT I: Organization of DNA in eukaryotic cell; palindromic DNA; Types of RNA-rRNA; mRNA (the 5' cap, non-coding region, initiation codon, coding region, termination codon; Poly (A) region, differences between prokaryotic and eukaryotic mRNA; tRNA (structure of tRNA-clover leaf model); superhelicity in DNA. Dispersive, conservative and semi-conservative models; Watson and Crick's model of DNA replication (experimental evidence); Enzyme involved in DNA replication (DNA polymerase I, Pol II, Pol III, DNA ligase); Mechanism of DNA replication; Models of DNA replication, inhibitors of DNA replication. Exonuclease and endonuclease.

20 Lectures

UNIT II: Gene diversity; split genes, overlapping gene; DNA damage and repair – types of damage (deamination, oxidative damage, alkylation, pyrimidine dimmers); repair pathways – methylation – directed mismatch repair, nucleotide excision repair, base excision repair, recombination repair, SOS repair.

10 Lectures

UNIT III: Central dogma; RNA polymerase; Site of transcription. Transcription – chain initiation, chain elongation, chain termination, RNA turn over; translation – charging of tRNA, initiation of polypeptide synthesis, elongation of polypeptide chain, translocation, termination of polypeptide chain;

10 Lectures

UNIT IV: Cloning vectors – Plasmids, phages and cosmids, phagemids, Ti plasmids, other viral vectors (M13 and retroviruses); Cloning strategies, cloning and selection of individual genes; Gene libraries– cDNA and genomic libraries. Expression vectors, promoter probe vectors, vectors used for construction of library – artificial chromosomes; BAC vectors, YAC vectors.

12 Lectures

UNIT V: Working principle of PCR, requirements, types of PCR, application of PCR, Sequencing of DNA and protein in brief. Recombinant products – human growth hormone (insulin somatotropin), vaccines (hepatitis B virus vaccine, FMD vaccine), interferons, tPA.

08 Lectures

Suggested Books:

1. Molecular Genetics of Bacteria: Snyder & Champness
2. Molecular Biology by Freifelder
3. Genomes 3: T. A. Brown
4. Principles of gene manipulation by Old and Primerose
5. Topic related recent review articles

MB 203: Choice based/ Open Course 01

60 Lectures

Microbial and Enzyme Technology

UNIT I: Enzymes from microbial sources, large scale production of enzymes, recovery of enzymes, enzyme purification methods - enzyme precipitation, separation by chromatography

UNIT II: Immobilized enzymes: Physical and chemical methods of immobilization, Enzyme catalysis in apolar medium, reverse micellar entrapment of enzymes and its applications.

UNIT III: Application of enzymes: synthesis of chemicals using enzymes, food technology and medicine. Enzymes in diagnostic assays. Enzyme electrodes, immunoenzyme techniques

UNIT IV: Commercial products of microbes: Antibiotics, biopolymers, biosensors, biopesticides, Production of biofuels.

UNIT V: Microbial toxins: Types, biochemical and molecular basis of toxin production, implications. Genetically engineered microbes, anti-HIV, anticancer, antifungal, antiparasitic, anti-inflammatory compounds.

MB204: Microbial Genetics

60 Lectures

UNIT I: Essentials of Genetics- Genetic notations – prototypes and auxotypes; Genes as unit of mutation and recombination, molecular nature or mutation, origin of spontaneous mutation; genetic analysis of micro-organisms bacteria and yeast.

10 Lectures

UNIT II: Gene transfer mechanisms- Bacterial transformation (detection of transformation, development of competence, mechanism of transformation, transfection); conjugation-effective contact and pilli in conjugation, F-factor, the conjugal transfer process; high frequency recombination (Hfr) strains; the order of chromosome transfer; formation of F prime (F'); transduction – generalized transduction; abortive transduction; specialized transduction. Sex duction.

10 Lectures

UNIT III: Genetic recombination – Mechanism of recombination. General recombination (Holiday model); General conversion; site specific recombination; Transposable elements – Classes of transposable elements; nomenclature of transposable elements, insertion sequence (IS elements),

10 Lectures

UNIT IV: Genetics of Bacteriophages – F – factors and their uses in genetic analysis, Col plasmid and colicins; cryptic plasmids, penicillinase plasmid, heavy metal resistance plasmids, degradative plasmids, Ti-plasmids and Ri-plasmids; bacteriophages – lytic phages (T4, T7), lysogenic phages (phage λ , Φ X 174). **10 Lectures**

UNIT V: Gene regulation – Post transcriptional processing of RNAs – methylation, polyadenylation and splicing of mRNA; cutting and modification of tRNA degradation system; Catalytic RNA, Group I and Group II intron splicing; Gene regulation – negative regulation – *E. coli lac* operon (structural, operator, promoter and repressor genes), Positive regulation – *E. coli trp* operon; Regulation by small molecules e.g. ppGpp and cAMP Post-translational processing (removal of *fmet* from polypeptide; ribosome editing: protein folding); Gene silencing (RNAi): An introduction and its application. **20 Lectures**

Suggested Books:

1. Microbial genetics by Freifelder
2. Gene Cloning by T A Brown
3. Principles of gene manipulation by Old and Primerose
4. Genes IX Lewin
5. Molecular Biology of the Gene: Watson et al

MB205: Cellular Microbiology and Immunology

1. Determination of blood groups and Rh factor.
2. Demonstration of agglutination reaction with reference to, widal test
3. Demonstration of precipitation with reference to VDRL.
4. Demonstration of haemagglutination with reference to *Treponema pallidum* Haemagglutination test.
5. Demonstration of ODD (Ouchterlony Double Diffusion).
6. Separation and characterization of serum by serum electrophoresis method.
7. Demonstration of Antigen Antibody reaction by Counter current Immunoelectrophoresis and Rocket electrophoresis.
8. Separation and characterization of lymphocytes from blood.
9. Demonstration of Antigen antibody reaction by ELISA.

MB206: Molecular Biology and Microbial Genetics.

1. Demonstration of replica plating technique.
2. Determination of expression of betagalactosidase in *E. coli*.
3. Isolation of antibiotic resistant *E. coli* by gradient plate method.
4. Demonstration of mutagenesis in microorganisms.
5. Isolation of plasmid from given bacterial sample.

6. Isolation of genomic DNA from bacteria.
7. Separation of DNA by agarose gel electrophoresis.
8. Separation of DNA by Native PAGE and separation of protein by SDS PAGE
9. Restriction digestion of bacterial DNA.
10. Estimation of DNA by diphenyl amine method.
11. Demonstration of Western, Southern and Northern blotting techniques.

THIRD SEMESTER

MB 301: Parasitology, Medical and Veterinary Microbiology **60 Lectures**

UNIT I: Introduction to medical parasitology-classification. Pathogenesis, transmission, life cycle, lab diagnosis, treatment of Protozoa-*Entamoeba*, *Toxoplasma*, *Cryptosporidium*, *Leishmania*, *Trypanosoma*, *Plasmodium*, *Giardia*, *Trichomonas* and *Balantidium*.

10 Lectures

UNIT II: Discovery of pathogenic micro-organisms; normal microflora of human body; role of resident flora. Host-parasite relationships, Infection, type and source. Disease cycle (sources of diseases, reservoirs, transmission of pathogens); Intoxications (exotoxins and endotoxins and their mechanism of action). Antimicrobial agents and antibiotics: Antiseptics, chemotherapeutic agents, effect of antibiotics on protein, nucleic acid, cellwall and cytoplasmic membrane.

10 Lectures

UNIT III: Morphology, classification, cultural characteristics, pathogenicity and laboratory diagnosis of Staphylococci, Streptococci, Pneumococci, Neisseriae (Gonococci and Meningococci), *Haemophilus*, *Bordetella*, *Corynebacterium*, *Clostridium*.

12 Lectures

UNIT IV: Study of Enterobacteriaceae (*E. coli*, *Klebsiella*, *Salmonella*, *Shigella*, *Proteus*), Vibrios and Nonfermenting Gram negative bacilli. Emerging communicable diseases (Plague, Anthrax) - symptom, identification, monitoring and surveillance and quarantine administration.

13 Lectures

UNIT V: Introduction to *Mycobacteria*, *Brucella*, *Listeria*, *Pasturella* and Erysepelas. Spirochetes, *Rickettsiae*, *Chlamydia*, *Mycoplasma* and *Ureoplasma*.

15 Lectures

Suggested Books:

1. Text Book Of Medical Mycology by Jagdish Chander, Mehta Publishers, New Delhi
2. Sherris Medical Microbiology : An Introduction to Infectious Diseases by Kenneth Ryan, McGraw-Hill Medical
3. Jawetz, Melnick, & Adelberg's Medical Microbiology (Lange basic), McGraw-Hill Medical

4. Medical Microbiology by Patrick R. Murray, Michael A. Pfaller, & Ken S. Rosenthal, Elsevier
5. Text book of microbiology by Ananthanarayan and Paniker
6. Medical Microbiology by Cedric Mims, John Playfair and Ivan roitt. Mosby-wolfe

MB302: Food Microbiology

60 Lectures

UNIT I: Micro-organisms and their importance in food microbiology – molds, yeast, bacteria, general features, classification; principles of food preservation; asepsis – control of micro-organisms (anaerobic conditions, high temperature, low temperature, drying); factors influencing microbial growth in food – extrinsic and intrinsic factors; chemical preservation and food additives; canning process for heat treatment.

15 Lectures

UNIT II: Contamination and Spoilage – Cereals, Sugar products, vegetables, fruits, meat and meat products; milk and milk products, fish and sea food, poultry spoilage of canned food; detection of spoilage and characterization.

10 Lectures

UNIT III: Food-borne infections and intoxications – bacterial: *Brucella*, *Bacillus*, *Clostridium*, *Escherichia*, *Shigella*, *Staphylococcus*, *Vibrio*, *Yersinia* and non-bacterial intoxication (with examples of infective and toxic types) – Protozoa, algae, fungi and viruses; food borne outbreaks – laboratory testing procedures, preventive measures, GMP and Hazard Analysis and Critical Control Point. Food control agencies and its regulations; Employee's health standards, waste treatment, disposal and quality control.

15 Lectures

UNIT IV: Food fermentation – Bread, vinegar, fermented vegetables, fermented dairy products; experimental and industrial production methods; spoilage and defects of fermented dairy products; oriental fermented foods – its quality standard and control.

10 Lectures

UNIT V: Microbial cells as food (Single cell protein), mushroom cultivation; fermented beverages – beer and wine; steroid conversion – industrial enzymes, production of amylases, proteinases, cellulases, amino acid production – glutamic acid and lysine; pickles, olives, soy sauce, genetically modified (GM) foods.

10 Lectures

Suggested Books:

1. Food Microbiology by William C Frazier. Tata Mgraw Hill
2. Food Microbiology by dams and Moss. Springer Verlag
3. Basic food microbiology by Banwart. Cbs Publishers & Distributors Pvt Ltd.
4. Principles of Microbiology by Ronald M. Atlas (1995), Amy Mc Cullen
5. Fundamental Principles Of Bacteriology A J Salle

MB 303: Choice based/ Open Course 02
Microbial Genomics

60 Lectures

UNIT I: Tools for studying DNA/genes: Specialized vectors and molecular cloning strategies for Genome analysis. DNA libraries, fluorescent in situ hybridization (FISH), denaturing gradient gel electrophoresis (DGGE). **10 Lectures**

UNIT II: Genomes: Size, physical structure, Whole genome shotgun sequencing, General characteristics of bacterial genome, metagenomics. **10 Lectures**

UNIT III: Mapping of genome: Physical mapping strategies-PFGE, methods based on DNA hybridization, Linkage mapping strategies – mapping by conjugation and transduction. **15 Lectures**

UNIT IV: Tools for DNA Finger printing: restriction fragment length polymorphism (RFLP), randomly amplified polymorphic DNA (RAPD), simple sequence length polymorphism (SSCP), amplified fragment length polymorphism (AFLP). Single nucleotide polymorphism (SNP). **10 Lectures**

UNIT V: Functional genomics: Genome annotation, entire genome expression analysis-microarrays, expressed sequence tags (ESTs), serial analysis of gene expression (SAGE), Proteomics. **15 Lectures**

Suggested Books:

11. Microbiology by Lansing M Prescott, Donald A Klein, John P Harley, Mc Graw Hill
12. Bacterial Genomes and Infectious Diseases, by V. L. Ricky Chan, Philip M. Sherman, Billy Bourke, Springer, 2006
13. Microbial Population Genetics by Jianping Xu, Caister Academic Press
14. Brock Biology of Microorganisms by Madigan et al.

MB 304: Elective/ Optional/ Special 01

1. Bioinstrumentation and Computer Applications
2. Microbial Technology
3. Microbial Diversity

Elective/ Optional/ Special 01

Special Paper 1: Bioinstrumentation and Computer application

60 Lectures

UNIT I Electrochemistry: pH and Buffers Potentiometric and Conductometric titration. Principal and application of Light, phase contrast, Fluorescence Scanning and Transmission electron microscopy, confocal microscopy, cytophotometry and flow cytometry, Preparation samples for microscopy.

10 Lectures

UNIT II Principle Methodology and applications of gel filtration, ion exchange and affinity chromatography, Thin layer and gas chromatography, High performance liquid chromatography, FPLC, Centrifugation: Basic principal and application, differential – density gradient and ultra centrifugation.

12 Lectures

UNIT III: Principle of biophysical method for analyzing biopolymer structure, X ray diffraction Fluorescence, UV ORD/CD Visible IR, NMR and ESR spectroscopy, Atomic absorption and plasma emission spectroscopy, MS and MALDI –TOF

15 Lectures

Unit IV: Electrophoresis, Principle and application of Native, SDS Agarose and 2D gel Electrophoresis. Blotting techniques – Southern blotting, Northern blotting, Western blotting.

10 Lectures

UNIT V: Biostatistics and bioinformatics – Mean, mode, median; Standard deviation and standard error; analysis of variance (ANOVA); correlation and regression analysis; Computer application - Computer basics, operating system – Windows, Hardware, Software; Internet – local area network, wide area network and computer application in microbiology. Overview of bioinformatics-NCBI, EMBL, PDB; homology algorithms (BLAST) and FASTA.

13 Lectures

Suggested Books:

1. Biochemistry by Lubert Stryer
2. Biostatistics And Microbiology: A Survival Manual by Daryl S. Paulson. Springer Verlag
3. Sharma BK, Instrument method of chemical analysis
4. DA Skoog , Instrument method of analysis
5. Plummer, An introduction to practical Biochemistry
6. Chatwal and Anand, Instrumentation
7. Boyer, Modren experimental Biology
8. Principles and Techniques Of Biochemistry And Molecular Biology, Keith Wilson, John Walker. Cambridge University Press India Pvt. Ltd.

Elective/ Optional/ Special 01

Special Paper 2: Microbial Technology

60 Lectures

UNIT I: Protein structure / properties determination Experimental techniques- X-ray crystallography: Isolation and purification of proteins, crystallization of proteins, basic principles of x-ray diffraction, Phase determination NMR spectroscopy: Basic Principles of NMR, NMR applications in Biology Mass spectroscopy: Principles of operation and types of spectrometers, Biological applications, MALDI-TOF.

10 Lectures

UNIT II: Waste utilization: Waste water treatment - Aerobic and Anaerobic processes, Treatment schemes for waste waters of dairy, distillery, tannery, antibiotic industries. Sewage disposal, compost making, methane generation. Microbiology of degradation of xenobiotics in environment: hydrocarbons, oil pollution, surfactants, pesticides, Microorganism for waste treatment.

10 Lectures

UNIT III: General concepts of microbial biotechnology. Microorganisms as factories for the production of novel compounds, Nature of microbial polysaccharides, mechanism of synthesis; Biopolymers and bioplastics, Bioprocess technology, beer brewing, cheese manufacture, mold-modified foods, Wine, Vinegar, The fermentation process, procedure and equipments, Ideal bioreactors, Batch, fed batch, CSTR, PFR, Multiphase bioreactors, packed bed, bubble column fluidized trickle bed, immobilization. Aseptic, septic and anaerobic fermentors.

15 Lectures

UNIT IV: Microbes in agribiotechnology (livestock and transgenic plants); Commercial products of microbes: biosensors, biopesticides. microbes in production of alternative energy; Bioconversion of cellulosic and non-cellulosic wastes. Agrobyproducts; Bioremediation of rubber, plastics. Production of biofuels, Use of microbes in mineral beneficiation and oil recovery.

15 Lectures

UNIT V: Enzymes from microbial sources, large scale production of enzymes, recovery of enzymes, enzyme purification methods - enzyme precipitation, separation by chromatography, enzyme reactors. Immobilized enzymes: Physical and chemical methods of immobilization, immobilization supports, Enzyme and cell immobilization and their industrial applications

10 Lectures

Suggested Books:

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006) Biochemistry. 6th Edition. Freeman, New York.
2. Drenth, J. (2007) Principles of protein X-ray crystallography. 3rd Ed. Springer, Germany.
3. Keeler, J. (2002) Understanding NMR Spectroscopy. John Wiley & Sons, England.
5. Wilson Keith and Walker John (2005) Principles and Techniques of Biochemistry and Molecular Biology, 6th Ed. Cambridge University Press, New York.

Elective/ Optional/ Special 01

Special Paper 3: Microbial Diversity

60 Lectures

UNIT II: Introduction to Microbial Diversity. Defining microbial diversity: a changing paradigm. Large scale evolution: The Big Tree. Molecular characterization of organisms. Overview of phylogenetic diversity. Principal of molecular phylogeny Methods in Taxonomy of Bacteria, Archaea and Fungi morphological Methods Chemotaxonomy. Genetic Methods Methodology of rRNA sequencing. **10 Lectures**

UNIT II: Methodology of identification of unknown pure cultures: Strategy and methods Diversity The expanse of microbial diversity, estimates of total number of species, measures and indices of diversity. Newer approaches for exploring unculturable bacteria from environmental samples like sewage. Culture independent molecular methods. **15 Lectures**

UNIT III: Metabolic diversity among microorganisms: Photosynthesis; Chemolithotrophy; Hydrogen-iron nitrite- oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis. Fermentations-diversity, Purple and green bacteria, cyanobacteria, acetic acid bacteria, Pseudomonads, lactic and propionic acid bacteria, endospore forming rods and cocci; Mycobacteria and Mycoplasmas. Archaea: Halophiles; Methanogens; Hyperthermophilic archaea; Thermoplasma. **15 Lectures**

UNIT IV: Introduction to microbial ecosystems Ecological niches. Interactions between microbe-microbe and microbe-host in different model systems. Food web: relation to microbes, Competition vs. succession. Predation, symbiosis and other influences on food web dynamics **10 Lectures**

UNIT V: Bioinformatics- Sequence alignment, scoring matrices, local and global alignment, dynamic methods, Needleman and Wunsch algorithm, Smith-Waterman algorithm, database search for homologous sequences, BLAST and FASTA versions. **10 Lectures**

Suggested books:

1. Barnett, H. L. and Hunter, B. B. 1960. Illustrated Genera of Imperfect Fungi. Burgess Publishing Co., Minnesota.
2. Breed and Buchanan. Bergey's Manual of Systematic Bacteriology. 2nd Edition, (Volumes. 1 – 5) (2001 – 2003).
3. Cook T. (2002) Microbial Biodiversity: Saving Bacteria to save ourselves, Harvard Science Review, 26-28.
4. Keller M. and Zengler K. (2004) Tapping in to Microbial Diversity. Nature Reviews 2, 141-150.
5. Pace N. (1997) A Molecular View of Microbial Diversity and the Biosphere, Science, 276, 734-740.
6. Baldi, P. and Brunak, S. (2001) Bioinformatics: The machine learning approach. Bradford Book, MIT Press, Cambridge.

7. Ewens Warren J. and Gregory R. Grant. (2004) *Statistical Methods in Bioinformatics, An Introduction*, Springer, New York.

MB305. Parasitology, Medical, Veterinary and Food Microbiology

1. Examination of ova/cysts in faecal sample
2. Biochemical tests for identification of medically important organisms (Catalase, Oxidase, Indole, Methyl Red, Voges Prauskaeur, Citrate, Urease, Triple Sugar Iron and Sugar fermentation tests).
3. Isolation and Identification of *Escherichia coli*, *Klebsiella*, *Salmonella*, *Shigella*, *Proteus*, *Vibrio* and *Pseudomonas*.
4. Differentiation of staphylococci and streptococci by colony morphology and confirmatory tests.
5. Determination of Antimicrobial susceptibility by Stokes method, Kirby Bauer disc diffusion technique and Minimum Inhibitory Concentration (MIC) method.
6. Isolation of micro organisms from food samples.
7. Microbial examination of water (Coliform count) by MPN method.
8. Determination of milk quality by Methylene blue reduction test.

MB306. Practical on elective/optional/special 01 Special Paper 1 (Bioinstrumentation and Computer Applications)

1. Learning bioinformatics tools and techniques.
2. Preparation of chart, 3D diagram, bar diagram and line diagram using computer
3. Study of chromatographic techniques
4. Separation of macromolecules by electrophoresis
5. Sectioning and samples preparation for electron microscope
6. Analysis of biopolymer by spectroscopy
7. Demonstration of various blotting techniques

MB306: Practical on elective/optional/special 01 Special Paper 2: (Microbial Technology)

1. Isolation and purification of protein from given samples by precipitation
2. Study of immobilization techniques
3. Demonstration of NMR spectroscopy
4. Isolation and characterization of micro organisms from given wastewater samples
5. Demonstration of composting methods
6. Demonstration of solid state fermentation
7. Demonstration of Ideal bioreactor
8. Demonstration of bioconversion of given lignocellulosic biomass
9. Separation of protein by column chromatography
10. Demonstration of large scale production of enzymes

**MB 306: Practical on elective/optional/special 01
Special Paper 3 (Microbial Diversity)**

1. Isolation of halophiles from given samples
2. Isolation of thermophiles from given samples
3. Isolation and characterization of cyanobacteria
4. Identification of unknown pure culture
5. Identification of microorganisms by metagenomics
6. Demonstration of microbe host interaction using animal model
7. Study of sequence homology using BLAST search
8. Study of similarity index

FOURTH SEMESTER

MB401: Soil and Environmental Microbiology

60 Lectures

UNIT I: Aero-microbiology - droplet nuclei, aerosol, assessment of air quality, brief account of air-borne microbes – bacteria, fungi, and viruses, their diseases and preventive measures; Phylloplane and Phyllosphere microflora.

8 Lectures

UNIT II: Soil Microbiology – Classification of soil-physical and chemical characteristics, soil as a habitat for micro-organisms, microflora of various soil types, Rhizosphere and rhizoplane. Nitrogen fixation: Asymbiotic and symbiotic nitrogen fixation systems – root nodulation symbiotic bacteria (process of root nodule formation), Leghemoglobin. Microbial interactions- symbiosis, mutualism, commensalisms, amensalism, competition, antibiosis; Actinorrhiza; Mycorrhizal fungi and its effect on plants.

12 Lectures

UNIT III: Production of biofertilizers and biopesticides – Quality control, BIS norms of biofertilizers; Biofertilizers (rhizobial inoculants, mass production and method of application); Biopesticides (viral, bacterial and fungal biopesticides); Biopolymers – Polyhydroxybutyrate (PHB), xanthan gum.

10 Lectures

UNIT IV: Aquatic Microbiology – Water ecosystems – types, fresh water (pond, lakes), marine habitats (estuaries, deep sea, hydrothermal vents); Eutrophication, food chain; potability of water, microbial assessment for water quality, water purification, physical, chemical, microbiological characteristics of sewage. Characterization of solid and liquid wastes, physical, chemical and biological (aerobic, anaerobic – primary, secondary, tertiary) treatment; Solid waste treatment; Liquid waste treatment – trickling, activated sludge, oxidation ponds. Formation of biofilm. Biomagnifications.

20 Lectures

UNIT V: Role of microbes in environment – Organic matter decomposition, factors affecting litter decomposition; Biogeochemical cycling of C, N, P and S; Microbial biomass and soil fertility; Biodegradation of hydrocarbons and xenobiotics, Microbial leaching of iron and copper.

10 Lectures

Suggested Books:

1. Microbiology: Principles and Explorations by Jacquelyn Black
2. Soil Microbiology by Subba Rao. India Book House Pvt Ltd
3. Environmental Microbiology by Raina M. Maier, Ian L. Pepper, Charles P. Gerba. Academic Press
4. Fundamental Principles Of Bacteriology A J Salle
5. Topic related recent review articles

MB402: Industrial Microbiology and Fermentation Technology**60 Lectures**

UNIT I: Brief History of Industrial Microbiology, suitability of microbes in industrial processes and their sources types of fermentation and bioreactors, Recent development in industrial microbiology, structure of fermentor, Economic aspects of fermentation processes.

08 Lectures

UNIT II: Isolation, selection, improvement and maintenance of industrial important strain. Metabolic pathways and metabolic control mechanisms; primary metabolites (alcohols, vitamins, enzymes and organic acids) and secondary metabolites (antibiotics and toxins); substrates for industrial fermentation

15 Lectures

UNIT III: Batch culture in fermentation, growth kinetics of micro-organisms, classification of fermentation process; growth and nutrient, growth and product formation, heat evolution, effect of environment (temperature, pH, high nutrient concentration), media formulation and sterilization, kinetics of thermal death of micro-organisms.

12 Lectures

UNIT IV: Continuous culture and scale up – Continuous culture system, productivity, product formation, power requirement oxygen transfer kinetics, foam and antifoam-instrument control, physical and chemical environment sensors.

12 Lectures

UNIT V: Downstream processing objectives and criteria, foam separation Precipitation methods filtration devices industrial scale centrifugation and cell disruption methods. liquid -liquid extraction solvent I recovery chromatography. Two phase aqueous extraction, super critical fluid extraction, ultrafiltration drying devices crystallization and whole broth processing, IPR and bioethics.

13 Lectures**Suggested Books:**

1. Industrial Microbiology by Prescott and Dunn. Agrobios (India)

2. Industrial Microbiology: An Introduction. Michael J. Waites, Neil L. Morgan, Gary Higton. Wiley-blackwell
3. Industrial Microbiology by Patel. Macmillan Publishers India
4. Principles of Fermentation Technology. Stanbury Pf, Whitaker A, Hall Sj. Elsevier India P Ltd
5. Industrial Microbiology by Casida
6. Industrial Microbiology by Cruger & Cruger
7. Principles of Fermentation Technology. Stanbury Pf, Whitaker A, Hall Sj. Elsevier India P Ltd

MB 403: Environmental, Soil and Industrial Microbiology (Practical)

1. Isolation and enumeration of bacteria and fungi from air samples by exposure plate method.
2. Isolation of micro-organism from rhizosphere and rhizoplane regions.
3. Isolation of *Rhizobia* from root nodule using Yeast Extract Agar Medium (YEMA).
4. Study of antagonism of micro-organism by dual culture inoculation method (Bacterium Vs Bacterium; Bacterium Vs fungus; Fungus Vs Fungus).
5. Determination of BOD of water (Raw/Treated/Sewage).
6. Detection of dissolved oxygen (DO).
7. Isolation of bacteria from acidic and sodic (alkaline) soil.
8. Demonstration of salt tolerance level in bacteria.
9. Isolation of drought tolerant bacteria from soil
10. Demonstration of working of different types of fermentors and its components.
11. Batch fermentation of microbial enzymes/organic acids/antibiotics.
12. Microbial assay of vitamin B12 and streptomycin.
13. Production of wine from grapes using yeast.
14. Estimation of alcohol contents in fermented products.
15. Production and estimation of citric acid (using *Aspergillus niger*) by titrimetric method.

MB: 404 Elective/ Optional/ Special 02

1. Clinical Microbiology
2. Veterinary Microbiology
3. Agricultural Microbiology

Elective/ Optional/ Special 02

MB 404 Special Paper 1: Clinical Microbiology

60 Lectures

UNIT I: Host pathogen interaction: The role of the microbial flora, Pathogenesis of infection: colonization and invasion. Role of microbiology laboratory in the diagnosis and control of infections. Management, safety and quality control in medical microbiology laboratory.

10 Lectures

UNIT II: Specimen collection and processing: Basic principles of specimen collection, preparation of container and swabs for collection of specimens for microbiological examination, preservation storage and transport of specimens, documentation of specimen. Microbiological examination of clinical specimens: Microscopic examination, use of colonial morphology for presumptive identification, biochemical identification of micro organisms. Immunodiagnosis of infectious diseases: Principles of immunological assays, use of serological testing in specific diseases (WIDAL, VDRL, TPHA, ASO, TORCH- profile, HBs ELISA, HIV- ELISA). Application of molecular diagnostics: Nucleic acid hybridization, nucleic acid amplification.

15 Lectures

UNIT III: Clinical syndromes and their laboratory diagnosis: Upper and Lower respiratory tract infections (Pharyngitis, otitis media, pneumonia), Skin and soft tissue infection (Impetigo, folliculitis, furuncle, carbuncle, cellulites and erysipelas), Infection of central nervous system (Meningitis and Encephalitis). Bacteremia and sepsis, Pyrexia of unknown origin (PUO).

15 Lectures

UNIT IV: Laboratory diagnosis of clinical syndromes: Gastrointestinal infection and food poisoning, Urinary tract infections, Sexually transmitted diseases, Infection in special populations (Malignancy, AIDS, Tuberculosis and leprosy). Zoonotic diseases-epidemiology, diagnosis, control and prevention.

10 Lectures

UNIT V: Epidemiology, surveillance and control of community and hospital infections. Antimicrobial chemotherapy, emergence of drug resistance (MRSA, ESBL and MDR TB). Methods of prevention and control- isolation of patients, quarantine and incubation period of various infectious diseases. Management of patients in infectious diseases hospital.

10 Lectures

Suggested Books:

1. Clinical Microbiology by Wiley B S Nagoba, Bi Publications Pvt Ltd
2. Manual of Clinical Microbiology by Patrick R. Murray, American Society Microbiology
3. Bailey & Scott's Diagnostic Microbiology by Betty A Forbes, Daniel F Sahm, Alice S Weissfeld.
Mosby Year Book Inc
4. Sherris Medical Microbiology : An Introduction to Infectious Diseases by Kenneth Ryan,
McGraw-Hill Medical
5. Jawetz, Melnick, & Adelberg's Medical Microbiology (Lange basic), McGraw-Hill Medical

Elective/ Optional/ Special 02

MB 404: Special Paper 2: Veterinary Microbiology

60 Lectures

UNIT I: Bacterial and Mycotic Zoonosis: Important zoonotic diseases in India caused by bacteria & and fungus: Brucellosis, Tuberculosis, Plague, Anthrax, Pastuerellosis, Salmonellosis, Leptospirosis and Aspergillosis, Rhinosporidiosis, Cryptococcosis.

10 Lectures

UNIT II: Viral and Rickettsial Diseases: Important Viral and Rickettsial diseases of India- Ranikhet, F.M.D, Q-Fever, Rocky Mountain Spotted Fever, Rift Valley fever, Bird flu and Swine flu.

15 Lectures

UNIT III: Parasitic diseases of India caused by parasites- Taeniasis, Hydatidosis, Coccidiosis, Malaria.

10 Lectures

UNIT IV: Natural Disasters and Animal health- Definition and concept of disaster. Principles of disaster management, Relief methods, recovery and rehabilitation of disaster affected animal population.

15 Lectures

UNIT V: Diseases of animals with special reference to North-East India. Non-infectious diseases of animals- Arteriosclerosis, Diabetes, Asthma, Immediate and Delayed Hypersensitivity.

10 Lectures

Suggested Books:

1. Progress in Veterinary Microbiology and Immunology. Editor R.Pandey. Vol. I & II.
2. Laboratory immunology & serology. Neville J. Bryant
3. Animal Microbiology. Buxton & Fraser. Vol. I & II
4. Veterinary Bacteriology and Virology. Merchant Packer
5. Microbiology. 3rd edition. Bernard D. Davis, Renato Dulbecco, Herman N. Eisen, Harold S. Ginsberg
6. Textbook of Immunology. 2nd Edition. Peter A. Miescher & Hans J. Muller-Eberhard
7. A textbook of Veterinary Bacteriology & Bacterial diseases. Dilip K. Sarma.
8. Fundamental Principles of Bacteriology. 7th Edition. A.J Salle

Elective/ Optional/ Special 02

MB 404: Special Paper 3: Agriculture Microbiology

60 Lectures

UNIT I: Soil microorganisms in agro ecosystems: Types of microbial communities; soil microbial diversity: significance and conservation; effect of agricultural practices on soil organisms. Biological nitrogen-fixation: The range of nitrogen fixing organisms; mechanism of nitrogen fixation (biochemistry of nitrogenase); genetics of nitrogen-fixation; Rhizobium-Legume Association; Symplasmids, N₂ fixation by non-leguminous plants. **15 Lectures**

UNIT II: 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; Azolla. **10 Lectures**

UNIT III: Microbial products and plant health: PGPR (plant growth promoting rhizobacteria); significance of mycorrhizae; toxin producing microbes (antibiotics, aflatoxin, etc.); microbial herbicides; biological control. Bioindicators – their relevance and utility; Measurement of Microbial activity in environmental samples; Microbial transport and bioaugmentation.

15 Lectures

UNIT IV: Microorganisms and organic pollutants; Biodegradation, Bioremediation; Microorganisms and metal pollutants; Emerging Technologies in environmental microbiology and its application; Bioreporters, Biosensors, and Microprobes; Microbial Fuel Cell; Environmental Risk assessment of GMOs; IPRs.

10 Lectures

UNIT V: Microbial transformations: The carbon cycle, The Nitrogen cycle, transformation of phosphorus, sulphur, iron and other related transformations. Fossil fuels: coal, petroleum, natural gas, L.P.G., Introduction to Bio-fuels and energy scenario of India, Bio-diesel crops of India. In vitro technology and vegetative propagation of bio-fuel crops. **15 Lectures**

Suggested Books:

1. Microbiology: Principles and Explorations by Jacquelyn Black
2. Soil Microbiology by Subba Rao. India Book House Pvt Ltd
3. Environmental Microbiology by Raina M. Maier, Ian L. Pepper, Charles P. Gerba. Academic Press
4. Fundamental Principles Of Bacteriology A J Salle
5. Topic related recent review articles

MB 405: Project Work / Dissertation

I. Project Work Evaluation	50(37.5+12.5)
II. Project Work Seminar	25 (18+7)
III. Project Viva Voce	25(18+7)

- I. Project work evaluation:** The project work will be evaluated by both external and internal examiner based on experiment designed and thesis writing.
- II. Project work seminar:** Every student has to present their work under following subheadings viz. objective, methodology, results and conclusion.
- III. Project viva voce:** Viva voce will be conducted on the basis of project work and presentation.

MB 406 Practical on elective/optional/special 02

Special Paper 1: Clinical Microbiology

1. Collection, transport and preservation of different clinical; specimens (Sputum, CSF, Blood, Urine, Stool and swabs from different sites of infection)
2. Isolation and identification of micro organism from different clinical specimens.
3. Study of viral egg inoculation techniques.
4. Diagnosis of viral infection by ELISA, PCR and blotting techniques.
5. Detection of Malarial Parasite from blood sample.
6. Detection of ova/cyst from stool sample.
7. Identification of *Candida* by microscopical examination (Staining and germ tube formation) and cultural characteristics.
8. Rapid detection tests in Microbiology
 - i) Dip stick test for detection of Malarial parasite
 - ii) Dot EIA for detection of Typhoid fever.
 - iii) Comb assay for detection of *Mycobacterium tuberculosis*

MB 406 Practical on elective/optional/special 02

Special Paper 2: Veterinary Microbiology

1. Collection, transport and preservation of different samples from animal sources.
2. Isolation of microorganisms from animal sources.
3. Identification and characterization of microorganisms.
4. Control measures-
 - (i). Study of antibiogram
 - (ii). Study of LD₅₀ against disinfectants.
5. Molecular diagnosis of important disease related organisms.
6. DNA Fingerprinting methods for epidemiological studies.
7. Demonstration of Negri bodies.
8. Collection of milk samples from infected milking cowshed areas and application of COB (Clot on boiling) Test and MR (Milk Ring) Test to study the level of adulteration of milk in Barak Valley.

MB 406 Practical on elective/optional/special 02

Special Paper 3: Agricultural Microbiology

1. Isolation and enumeration of bacteria and fungi from soil samples
2. Isolation of micro-organism from rhizosphere and rhizoplane regions
3. Isolation and characterization of *Azotobacter* from soil samples
4. Characterization of microbial toxins
5. Isolation of *Rhizobia* from root nodule using Yeast Extract Agar Medium (YEMA).
6. Study of antagonism of micro-organism by dual culture inoculation method (Bacterium Vs Bacterium; Bacterium Vs fungus; Fungus Vs Fungus).
7. Determination of soil texture.
8. Mass cultivation of biofertilizers