

**M.Sc. MICROBIOLOGY SYLLABUS**  
**GURUKULA KANGRI UNIVERSITY**  
*(w.e.f. Session 2008-2009)*

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

<u><b>SEMESTER-I</b></u>	<u><b>Max Marks</b></u>
<u><b>Theory</b></u>	
MB 101: Bacteriology	60
MB 102: Virology	60
MB 103: Mycology and Phycology	60
MB 104: Microbial Physiology and biochemistry	60
EL 105: Fundamentals of Immunology	60
<u><b>Practical</b></u>	
P101. General Microbiology	50
P102. Analytical Biochemistry and Immunology.	50
<b>Total</b>	<b>400</b>
 <u><b>SEMESTER-II</b></u>	
<u><b>Theory</b></u>	
MB 201: Molecular Biology	60
MB 202: Microbial Genetics	60
MB 203: Food Microbiology	60
MB 204: Microbial Diversity and Extremophiles	60
EL 205: Environmental Microbiology	60
<u><b>Practical</b></u>	
P201 Molecular biology, Microbial Genetics & Food Microbiology	50
P202 Environmental Microbiology & Microbial Diversity	50
<b>Total</b>	<b>400</b>
 <u><b>SEMESTER-III</b></u>	
<u><b>Theory</b></u>	
MB 301: Cellular Microbiology	60
MB 302: Recombinant DNA Technology	60
MB 303: Medical Microbiology	60
MB 304: Pharmaceutical Microbiology and Microbial Technology	60
EL 305: Fermentation technology	60
<u><b>Practical</b></u>	
P301. Cellular Microbiology, rDNA Technology & Medical Microbiology	50
P302. Pharmaceutical Microbiology & Microbial and Fermentation Technology	50
<b>Total</b>	<b>400</b>
 <u><b>SEMESTER IV</b></u>	
Project work/Dissertation	
Evaluation	200
Viva voce	100
Seminar	100
<b>Total</b>	<b>400</b>

<b>Grand Total 1600</b>
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**Schedule of Semesters**

<b>Semester</b>	<b>Duration</b>	<b>Examination</b>
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 of three months duration will be carried out in any national laboratory or industry (entrepreneurship). Every student has to submit the Project Work by 15<sup>th</sup> 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 theory paper will be of Three Hours. The duration of each practical will be of 4 hours.*

## **FIRST SEMESTER**

### **MB101: Bacteriology**

**UNIT I : Classification of Microorganisms:** 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 Carl Woese; Basis of Microbial classification, molecular approaches in microbial classification, concept of microbial species; Classification and silent features of bacteria on the basis of *Bergey's manual of Determinative bacteriology*; Cyanobacteria and Prochlorons.

**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.

**UNIT III: Structure and function of cell appendages and inclusions-** Capsule types, composition and function; flagella, fimbriae, pili, cilia, gas vesicles, chromosomes, carboxysomes, magnetosomes, phycobilisomes, nucleoid, plasmids (types of plasmids and function); Endospores and exospores, cysts, heterocyst.

**UNIT IV: Cytoplasmic inclusions and Reserve food materials-** Polyhydroxybutyrate (PHB), Polyphosphate granules, oil droplets, cyanophycean granules and sulphur inclusions; magnetosomes

**UNIT V: Cultivation of Bacteria:** Aerobic, anaerobic, shaker, still cultures, nutritional types, culture media; Growth curve, generation time, asynchronous, synchronous, batch and continuous culture; Measurement of growth and factors affecting growth, Control of bacteria by physical and chemical agents; Maintenance and preservation methods.

### **MB102: Virology**

**UNIT I: General features** – Brief out lines on discovery of viruses, morphology of viruses; nomenclature and classification, distinctive properties, morphology, ultrastructure, capsid and its arrangements, types of envelops and its composition; Viral genomes, its type and structure; Viroids – host range, genome and origin of viroids; cyanophages- morphology, growth cycle, mycoviruses- types of mycoviruses, replication, example of mycoviruses (mycoviruses of mushrooms and pathogenic fungi); Isolation and cultivation of viruses; prions- spread of prions and diseases.

**UNIT II: General methods of diagnosis and serology** – Cultivation of viruses in embryonated eggs, cell cultures and cell lines; Serological methods – haemagglutination, complement fixation, immunofluorescent method, ELISA and Radioimmunoassay; Assay of viruses- physical and

chemical methods (protein; nucleic acid and radioactive tracer, electron microscopy), infectivity assay (plaque method, end point method)

**UNIT III : Bacteriophages-** Structural organization, multiplication cycle; one step growth curve; DNA replication, eclipse phase, phage production, burst size, lysogenic cycle, bacteriophage typing, application in bacterial genetics; M13, Mu, T4,  $\Phi$ x174, phage  $\lambda$  in brief; Application of bacteriophages in health- bacteriophage therapy, bacteriophage typing.

**UNIT IV: Plant viruses** – Classification and nomenclature of plant viruses; Disease symptoms- histology, physiology and cytology of plants; common virus 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, diagnostic techniques in seeds, seed stocks and diseased plants (seed morphology, seed symptomology, serological methods, histochemical tests and fluorescent microscopy); indicator plants, prevention of crop-loss using virus-free planting material; vector control.

**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, SV 40, Hepatitis viruses; Viral vaccines (conventional), interferons.

### **MB103 : Mycology and Phycology**

**UNIT I: Introduction** – History and development of mycology, structure and cell differentiation; Myxomycota – general account only; brief account of Eumycota – Mastigomycotina- chytridiomycetes, hypochytridiomycetes, oomycetes; Zygomycotina- zygomycetes, trichomycetes, evolutionary trends in lower fungi.

**UNIT II : General account of Ascomycotina** – Hemiascomycetes, plectomycetes, pyrenomycetes, discomycetes, laboulbeniomycetes, laculoascomycetes; **Basidiomycotina-** teliomycetes, hymenomycetes, gasteromycetes; **Deuteromycotina-** hyphomycetes, coelomycetes, blastomycetes.

**UNIT III:** Heterothalms, Sex hormones in fungi; physiological specialization in fungi, fungal succession on decomposing litter; inoculum theory, inoculum potential, inoculum density and disease.

**UNIT IV: Fungi and Plant disease:** Disease symptoms; the concept of virulence and resistance, mechanical and chemical barriers of infection, Pathogenesis, hypersensitive response, Early and late blight of potato; loose smut of wheat, false smut of paddy, rust of linseed, Fusarial wilt, powdery mildew of pea, red rot of sugarcane.

**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.

### **MB104 : Microbial Physiology and Biochemistry**

**UNIT I: Enzymes-** Classification, multistep reaction and rate limiting steps, enzyme inhibition allosteric, allosterism, kinetic analysis of allosteric enzymes, principles of allosteric regulation.

**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,  $G$ ,  $G^0$ ,  $G^1$  equilibrium;

**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.

**UNIT IV: Lipid and Nitrogen Metabolism:** Oxidation of fatty acid ( $\alpha$ ,  $\beta$ ,  $\omega$ ), Assimilation of nitrates, ammonia assimilation; amino acid biosynthesis- glutamate family, serine family, aspartate family, histidine biosynthesis- glutamate family serine family, aspartate family, histidine biosynthesis.

**UNIT V: Bacterial photosynthesis and nitrogen fixation :** Photosynthetic bacteria, Phytosynthetic pigments; metabolism in phytosynthetic bacteria; Phytosynthetic electron transport system; mechanism of photosynthesis, Dark reaction (Calvin –Benson cycle); Asymbiotic and symbiotic nitrogen fixation systems- root nodulating symbiotic bacteria (process of root nodule formation ), Leghemoglobin, nitrogenase types – structure and function; alternative nitrogenase, substrates for nitrogenase, hydrogen evolution.

### **EL 105 : Fundamentals of Immunology**

**UNIT I: Immune system and Immunity:** History of immunology, structure, composition and function of cells and organs involved in immune system; Host-parasite relationships; Microbial infection; virulence and host resistance; immune response – naturally acquired immunity; artificially acquired immunity; immunohaematology- blood groups, blood transfusion and Rh incompatibility.

**UNIT II: Antigens and Antibodies-** Antigens- structure and properties (types, iso and allo- haptens, adjuvants); antigen specificity; Immunoglobulins (antibodies)- structure, heterogeneity – types and subtypes, properties (physico-chemical and biological); theories of antibody production; complement pathways and biological consequences of complement activation; Hybridoma technology- monoclonal antibodies and its uses, Immunotoxins; vaccines and toxoids.

**UNIT III: Antigen-Antibody reactions – *In vitro* methods-** agglutination, Widal test, haemagglutination, precipitation, complement fixation, immunofluorescence; enzyme linked immunosorbent assay (ELISA), radioimmunoassay; *in vivo* methods – skin test and immune complex tissue demonstrations; application of these methods in diagnosis of microbial diseases.

**UNIT IV: Major histocompatibility complex (MHC) and tumour immunology-** Structure and functions of MHC and HLA system; gene regulation and Ir-genes; HLA and tissue transplantation; Tissue typing methods for organ and tissue transplantation in humans; graft versus host reaction and rejection; Autoimmunity- theories, mechanisms and diseases with its diagnosis; Tumour immunology- tumour specific antigens, immune response to tumour, immunodiagnosis of tumour- detection of tumour markers-alpha foetal proteins, carcinoembryonic antigens, etc.

**UNIT V: Hypersensitivity reactions-** Antibody-mediated Type I; anaphylaxis: Type II; Antibody dependent cell toxicity, Type III; Immune complex mediated reactions; Type IV; Cell mediated hypersensitivity reactions and the respective disease, immunological methods of their diagnosis; lymphokines and cytokines- its assay methods.

### **P 101: General Microbiology**

1. Principle operation and study of various components of microscope and their calibration (micrometry).
2. Sterilization technique of glassware, material and culture media and preparation of culture plates and tubes.
3. Preparation of cotton plugs, learning of culture technique, adjustment of pH, buffer, pure culture preparation and subculturing.
4. Microbial growth measurement by cell count method, serial dilution method, turbidity method and standard plate count method.
5. Preparation of various types of stains.
6. Staining technique- simple, gram's staining, negative staining, flagella staining, spore staining.

7. Isolation and identification of bacteria (*E. coli*; *Rhizobium*; *Salmonella*; *Pseudomonads* and *Bacillus*).
8. Isolation and identification of microorganisms- *Aspergillus*, *Penicillium*, *Fusarium*, *Alternaria*, *Nostoc*, *Anabaena*, *Osillatoria*, *Microcystis*.
9. Isolation of actinomycetes from soil by dilution plate method.
10. Culturing of bacteriophages by double layer technique.

### **P 102: Analytical Biochemistry and Immunology.**

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. Separation of haemoglobin and blue dextran by gel filtration.
6. Determination of bacterial growth curve of given bacterial sample.
7. Effect of pH on bacterial growth.
8. Effect of osmotic pressure on bacterial growth.
9. Effect of temperature on bacterial growth.
10. Study of factors affecting enzyme activity-substrate, temperature, pH etc.
11. Separation and characterization of serum and lymphocytes from blood.
12. Demonstration of agglutination reaction with reference to blood grouping, Widal test and Haemagglutination.
13. Determination of Rh factor of blood samples.
14. Demonstration of agglutination reaction by means of known antigens and antibodies.
15. Fermentation of glucose, sucrose and lactose.

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## **M.Sc. (Microbiology) SECOND SEMESTER**

### **MB201. Molecular Biology**

**UNIT I: Nature of Nucleic acids-** Nucleic acids as genetic information carriers (evidences from bacteria, bacteriophages, bacterial conjugation, RNA viruses); DNA structure- historical aspects and current concepts, 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.

**UNIT II: Replication of 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; retroviruses and its unique mode of DNA synthesis.

**UNIT III: DNA damage and repair -** Gene diversity; split genes, overlapping gene; DNA damage and repair- types of damage (deamination, oxidative damage, alkylation, pyrimidine dimers); repair pathways- methylation -directed mismatch repair, very short patch repair, nucleotide excision repair, base excision repair, recombination repair, SOS repair.

**UNIT IV: Gene Expression -** 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; Protein synthesis in prokaryotes and eukaryotes; Inhibitors of protein synthesis.

**UNIT V: Maturation and processing of RNA, and 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; antitermination- N protein and Nut sites in I. DNA binding proteins, enhance sequence and control of transcription; identification of protein binding sites on DNA, foot printing; Regulation by small molecules e.g. ppGpp and cAMP Post-translational processing (removal of *fmet* from polypeptide; ribosome editing; protein folding); Signal hypothesis

## **MB202. Microbial Genetics**

**UNIT I: Essentials of Genetics:** Genetic notations- prototrophs and auxotrophs; Genes as unit of mutation and recombination, molecular nature of mutation, origin of spontaneous mutation; genetic analysis of microorganisms-bacteria and yeast.

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

**UNIT III: Genetic recombination** – Mechanism of recombination General recombination (Holliday model); General conversion; site specific recombination; Transposable elements – Classes of transposable elements; nomenclature of transposable elements, insertion sequence (IS elements), Transposon family (structure, mechanism of transposition).

**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  $\lambda$ ,  $\Phi$ X 174).

**UNIT V: Microbial genetics and design of vaccines** – BCG and design of vaccines for TB and leprosy; DNA vaccines, design and advantages; genetic recombinant vaccines used in national immunization programmes, newer generation vaccines.

## **MB203. Food Microbiology**

**UNIT I: Food ad substrate for microorganisms** – Microorganisms and their importance in food microbiology - molds, yeast, bacteria, general features, classification; principles of food preservation; asepsis- removal of microorganisms (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.

**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.

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

**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.

**UNIT V: Food produced by microorganisms:** Fermented food, microbial cells as food (SCP), mushroom cultivation; fermented beverages – beer and wine; steroid conversion- industrial

enzymes production – amylases, proteinases, cellulases, amino acid production- glutamic acid and lysine; fermented vegetables, pickles, olives, soy sauce, genetically modified (GM) foods.

## **MB204. Microbial Diversity and Extremophiles**

**UNIT I: Ecological groups of microorganisms:** Microbial diversity- distribution, abundance and ecological niche: oxidative transformation of metals- sulphur oxidation, iron oxidation, ammonia oxidation, hydrogen oxidation,

**UNIT II: Culturable and non-culturable bacteria** - conventional and molecular methods of studying microbial diversity.

**UNIT III: Extremophiles-** Psychrophiles, acidophiles, alkaliphiles, thermophiles, barophiles and osmophiles, halophiles- membrane variation, electron transport; Application of extremophiles; Methanogens and biogas production; *Rumen microbiology*- rumen anatomy and action, rumen microorganisms, microbial fermentation in rumen.

**UNIT IV: Stress microbiology:** Environmental stress (density-dependent and density- independent) stress, stress sequestration in halophiles, osmophiles, thermophiles, barophiles, xerophiles and heavy metal detoxicants (metal-microbe interaction, biosorption, bioaccumulation and metal scavenging by microbes).

**UNIT V: Chemolithotrophs:** - Methanotrophs and methylotrophs; Microbial leaching (bioleaching)- microbes and mechanism of bioleaching of iron, copper and uranium; Use of nucleotides as nitrogen source for growth of certain microbes (nucleic acid break down pathway).

## **EL 205. Environmental Microbiology**

**UNIT 1: Aeromicrobiology :** Droplet nuclei, aerosol, assessment of air quality, brief account of air-borne microbes- bacteria, fungi, viruses, their diseases and preventive measures; Phylloplane and Phyllosphere microflora.

**UNIT II: Soil Microbiology:** Classification of soil-physical and chemical characteristics, soil as a habitat for microorganisms, microflora of various soil types, Rhizosphere and rhizoplane microflora and its estimation, root exudates, its composition and effects on plants; Microbial interactions- symbiosis, mutualism, commensalisms, amensalism, competition, antibiosis; Predaceous fungi and its application; Actinorrhiza; Mycorrhizal fungi and its effect on plants; Molecular markers for ecological study of soil microorganisms.

**UNIT III: 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.

**UNIT IV: Waste treatment** – Types of wastes–, characterization of solid and liquid wastes, physical, chemical and biological (aerobic, anaerobic- primary, secondary, tertiary) treatment; Solid waste treatment; Utilization of solid wastes – food (SCP, mushroom); fuel (methanol, methane), fertilizer (composting); Liquid waste treatment- trickling, activated sludge, oxidation ponds, Bioremediation of xenobiotics- hydrocarbons; Biomagnifications.

**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 paints, building material; Biodegradation of hydrocarbons and xenobiotics.

## **P201 Molecular Biology, Microbial Genetics & Food Microbiology**

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 Tn5 mutagenesis and induction of Kanamycin resistance in *Rhizobium*.
5. Isolation of plasmid from given bacterial sample.
6. Demonstration of agarose gel electrophoresis.
7. Isolation of genomic DNA from bacteria.

8. One step growth curve of bacteriophages T2.
9. Estimation of protein by Lowery method.
10. Estimations of reducing sugar by glucose by dinitro salysilic acid (DNSA method)
11. Bacterial examination of milk by SPC methylene blue reductase test of milk.
12. Determination of lactose, calcium and phosphorous in milk.

### **P202 Environmental Microbiology & Microbial Diversity**

1. Isolation and enumeration of bacteria and fungi from air samples by exposure plate method.
2. Isolation of microorganism from rhizosphere and Rhizoplane regions.
3. Isolation of *Rhizobium* from root nodule using Yeast Extract Agar Medium (YEMA).
4. Study of antagonism of microorganism by dual culture inoculation method (Bacterium Vs. Bacterium; Bacterium Vs. Fungus; Fungus Vs. fungus).
5. Microbial examination of water by coliform, MPN method.
6. Determination of BOD of water (Raw/treated/ Sewage).
7. Detection of dissolved oxygen (DO).
8. Isolation of bacteria from sodic (alkaline) soil.
9. Demonstration of salt tolerance level in bacteria
10. Isolation of drought tolerant bacteria from soil.

## **M.Sc. (Microbiology) THIRD SEMESTER**

### **MB301. Cellular Microbiology**

**UNIT I: Introduction** – Bacterial diseases, emergence of cellular microbiology, cellular biology underlying prokaryotic and eukaryotic interactions- ultrastructure, genomic expression, pathogenicity island.

**UNIT II: Prokaryotic and eukaryotic signalling mechanism** – Eukaryotic cell to cell signalling, endocrine signalling, prokaryotic signalling; quorum sensing and bacterial pheromones, intracellular signalling, signalling pathways.

**UNIT III: Infection and cell-cell interaction** – Bacterial adherence, basic principles, effect of adhesion on bacteria, effect of adhesion on host cells, bacterial invasion of host cells – mechanism, consequences of invasion, survival after invasion, protein toxins, agents of diseases.

**UNIT IV: Immune response to bacterial infection** – Innate response- complement, acute phase proteins, macrophages, cytokines and interferons; acquired immune response, cell mediated immune response, humoral response.

**UNIT V: Cellular microbiology future directions** – comparative genomics and functional genomics, genome evolution in microbes; phylogenetic trees.

### **MB302. Recombinant DNA Technology**

**UNIT I: Enzymes** – Essential enzymes used in rDNA technology, nucleases, restriction endonucleases, alkaline phosphatases, DNA polymerase terminal transferases, ligase, reverse transcriptase, etc.; Restriction digestion, ligation, transformation.

**UNIT II: 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.

**UNIT III: Specialised cloning strategies** –Expression vectors, promoter probe vectors, vectors used for construction of library- artificial chromosomes; BAC vectors, YAC vectors; Working principle of PCR, requirements, types of PCR, application of PCR.

**UNIT V: DNA sequencing** – Methods of DNA sequencing- Maxam & Gilbert’s method, Sanger and Coulson’s method, sequence assembly; Automated DNA sequencing; Genome sequencing and physical mapping of genomes of microorganisms.

**UNIT V: Techniques of molecular biology and recombinant products-** Electrophoresis; Blotting techniques- Southern blotting, Northern blotting, Western blotting; Nucleic acid hybridization technique; Non-radioactive labeling.; Recombinant products- human growth hormone (insulin, somatotropin), vaccines (hepatitis B virus vaccine, FMD vaccine), interferons, tPA.

### **MB303. Medical Microbiology**

**UNIT I: General account** – Early discovery of pathogenic microorganisms; development of bacteriology as scientific discipline, contribution made by eminent scientists; classification of medically important microorganisms; normal microflora of human body; role of resident flora and the human host; characteristics of infectious diseases; disease cycle (sources of disease, reservoirs, carriers); transmission of pathogens.

**UNIT II : Infection** - Establishment, spreading, tissue damage and antiphagocytic factors; mechanism of bacterial adhesion, colonization and invasion of mucous membrane of respiratory, enteric and urogenital tracts; role of aggressions, depolymerising enzymes, organotropism, variation and virulence, organ and cell involved in immune system and immune response; Intoxications (exotoxins and endotoxins and their mechanism of action).

**UNIT III: Pathogenic bacteria (a brief discussion only)-** Morphology, cultural characteristics of the causal organisms, prophylaxis treatment of diseases caused by members of Enterobacteriaceae, *Salmonella typhi*, *Vibrio*, *Mycobacterium*, *Treponema pallidum*.

**UNIT IV: Viral and fungal diseases-** Virus host interaction, symptoms and control of diseases caused by viruses e.g. Herpes viruses; Adeno viruses; Rhabdo viruses; Hepatitis viruses; AIDS; *Dermatophytes*: classification of pathogenic fungi; Laboratory diagnosis of Candidiasis and Otomycosis.

**UNIT V: Laboratory control of antimicrobial therapy-** Various methods of drug susceptibility testing, antibiotic assay in body fluids; brief account on available vaccines and schedules; passive prophylactic measures; nosocomial infection; diagnosis and control of common types of hospital infection.

### **MB304 Pharmaceutical Microbiology & Microbial Technology**

**Unit I: Biotechnology innovations in the chemical industry** – Biocatalyst in organic chemical synthesis; efficiency of growth product formation, growth stoichiometry, maintenance energy requirement and maximum biomass yield; P/O quotients, metabolic overproduction and growth efficiency.

**UNIT II:** Shake flask, fermentor systems, stirred tank bioreactors, airlift fermentor, solid state fermentors, fed batch, continuous and immobilized cell reactor; stirring and mixing.

**UNIT III :** Metabolic pathways and metabolic control mechanism, industrial production of citric acid, enzymes, ethanol, acetic acid production and diversification of antibiotics, steroid biotransformation.

**UNIT IV:** Industrial strains, strategies for selection and improvement, maintenance, contaminant and recombinant organisms, large scale production using recombinant microorganisms; product recovery.

**UNIT V:** 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.

## **MB305. Fermentation Technology**

**UNIT I: General considerations** – Metabolic pathways and metabolic control mechanisms; primarily metabolites (alcohols, vitamins, enzymes and organic acids) and secondary metabolites (antibiotics and toxins); substrates for industrial fermentation.

**UNIT II: Fermentation-** Fermentation in batch culture, growth kinetics of microorganisms, 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 microorganisms,

**UNIT III: 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, downstream processing.

**UNIT IV: Computer application** - Computer basics, operating system-windows; Hardware, software; Internet-local area network, wide area network and computer application in microbiology.

**UNIT V: Biostatistics and bioinformatics-** Mean, mode, media; Standard deviation and standard error; analysis of variance (ANOVA); correlation and regression analysis; Overview of bioinformatics- NCBI, EMBL, PDB; Homology algorithms (BLAST) and FASTA.

### **P301: Cellular & Medical Microbiology and rDNA Technology**

1. Isolation and identification of microorganism from ear and sputum (growth on Blood agar; Chocolate agar; MacConcky agar; Nutrient agar).
2. Isolation and identification of microorganism from clinical sample- urine (growth in alkaline peptone water, Blood agar; Chocolate agar; MacConkey agar)
3. Demonstration of ODD (Ouchterlony Double diffusion).
4. Differential test of *Streptococci* through growth on agar plates (Mannitol agar plate method, coagulase test method)
5. Isolation of bacteria from UTI patient and determination of their antibiotic sensitivity.
6. Preparation of buffers (citrate and phosphate buffer).
7. Estimation of DNA by diphenyl amine method.
8. Separation of proteins by gel electrophoresis method.
9. Demonstration of southern and Northern blotting techniques.
10. Restriction digestion of bacterial DNA and preparation of electrophorogram.
11. DNA sequencing, sequence analysis and construction of phylogentic tree.

### **P302: Pharmaceutical Microbiology & Microbial and Fermentation Technology**

1. Sterility testing of injectables and pharmaceutical smples.
2. Demonstration of working of different types of fermentors and its components.
3. Batch fermentation of microbial enzymes/organic acids/antibiotics.
4. Microbial assay of vitamin B12 and streptomycin.
5. Production of wine from grapes using yeast.
6. Estimation of alcohol contents in fermented products.
7. Production and estimation of citric acid (using *Aspergillus niger*) by titerimetric method.
8. Production of rhizobial bio-inoculants and study of its shelf life.
9. Demonstration of mushroom cultivation.
10. Demonstration of bacterial endotoxin test or LAL (*Limulus* amoebocyte lysate) endotoxin test.
11. Determination of MIC of given antibiotics using pathogenic bacteria.
12. Antimicrobial activity of given chemo-therapeutic substance.
13. Preparation of chart, 3D diagram, bar diagram and line diagram using computer.
14. Learning bioinformatics tools and techniques.

**FORTH SEMESTER**  
(Project Work/ Dissertation)

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