

## **MSC MICROBIOLOGY**

### **FIRST YEAR**

<b>PAPERS</b>	<b>Subject</b>	<b>Max. Marks</b>	<b>Exam Hrs</b>
<b>1</b>	<b>Introductory Microbiology</b>	<b>100</b>	<b>3</b>
<b>2</b>	<b>Microbial Physiology</b>	<b>100</b>	<b>3</b>
<b>3</b>	<b>Microbial Ecology and Bio-degradation</b>	<b>100</b>	<b>3</b>
<b>4</b>	<b>Microbial Genetics and Molecular biology</b>	<b>100</b>	<b>3</b>
<b>5</b>	<b>Immuno Hematology and Immuno Pathology</b>	<b>100</b>	<b>3</b>
<b>Practical 1</b>	<b>Paper I &amp; II</b>	<b>100</b>	<b>6</b>
<b>Practical 2</b>	<b>Paper III, IV &amp; IV</b>	<b>100</b>	<b>6</b>

### **SECOND YEAR**

<b>PAPERS</b>	<b>Subject</b>	<b>Max. Marks</b>	<b>Exam Hrs</b>
<b>1</b>	<b>Clinical Microbiology</b>	<b>100</b>	<b>3</b>
<b>2</b>	<b>Fermentation Technology</b>	<b>100</b>	<b>3</b>
<b>3</b>	<b>Applied Industrial and Dairy Microbiology</b>	<b>100</b>	<b>3</b>
<b>4</b>	<b>Soil and Agricultural Microbiology</b>	<b>100</b>	<b>3</b>
<b>Practical 1</b>	<b>Paper VI</b>	<b>100</b>	<b>3</b>
<b>Practical 2</b>	<b>Paper VII, VIII &amp; IX</b>	<b>100</b>	<b>6</b>

## **I<sup>ST</sup> - YEAR**

### **Paper – 1**

#### **INTRODUCTORY MICROBIOLOGY**

##### **UNIT – I HISTORICAL DEVELOPMENT OF MICROBIOLOGY**

- First observation of bacteria
- Spontaneous generation
- The Germ theory of disease of disease
- Contributions Louis Pastuer, Robert Koch and others to the field of microbiology
- Comparison of Prokaryotic and Eukaryotic microbial cells
- A classification of living world from Kingdom through Phyla
- Structural classification of bacteria

##### **UNIT – II MICROSCOPY**

- Light microscope
- Compound microscope
- Phase contrast microscope
- \*Flourescent microscope
- Electron microscope

##### **UNIT – III BASICS OF MICROBIOLOGICAL PRACTICE**

- Sterilization and Disinfection – Physical and chemical methods, Filtration, Radition
- Culture media – Preparation of culture media, aerobic and anaerobic culture methods,
- Types of media
- A note on animal culture, tissue culture egg inoculation for viruses.

##### **UNIT – IV IDENTIFICATION OF BACTERIA**

- Isolation of organisms in pure culture.

- Bacterial colony morphology.
- Staining , Spore staining, Flagellar staining.
- Biochemical characteristics
- Serologic Reactivity.

**UNIT – V      ACTIONS OF CHEMOTHERAPEUTIC AGENTS**

- Properties of an antibiotic
- Mechanisms of action
- Antibiotics acting on cell wall, cell membrane, DNA, protein synthesis
- Metabolic antagonism – competitive and non competitive inhibition
- Antibiotic assay and Antimicrobial assay.

## **Paper – 2**

### **MICROBIAL PHYSIOLOGY**

#### **UNIT – I CELL STRUCTURE OF MICROORGANISMS**

- The bacterial surface-Capsules, The cell wall, The cell membrane, flagella, Pili or fimbriae
- Inside the cell – The nucleus, Mitochondria, Spores, Granules, ribosomes

#### **UNIT – II GROWTH AND NUTRITION**

- The process of cell reproduction, the measurement of bacterial growth
- The growth cycle-Phases of cycle
- The steady state, synchronized cell division, Mixed population
- Essential Nutrition, Specific Nutritional Requirements-Minerals and Vitamins

#### **UNIT – III DEHYDROGENATION AND RESPIRATION**

- Dehydrogenation
- Respiration, the pathway to Gaseous Oxygen – Directed Oxidation, The direct cytochrome pathway, The indirect cytochrome pathway
- The functions of the Respiration pathway – The Pasteur Effect, Oxidative phosphorylation
- Oxidation-Reduction potentials
- The strict anaerobes

#### **UNIT – IV MECHANISMS OF SURVIVAL**

- The endospore
- The L Forms of bacteria
- Impermeability and Detoxification
- Resistance to mutation

#### **UNIT – V VIRULENCE FACTORS**

- The character of virulence
- Bacterial capsules and Toxins
- Extracellular enzymes and Activators-Alpha toxin, Hyaluronidases, coagulases, streptokinase, Haemolysins, Proteinases.
- Nutritional dependence and Virulence.

## **Paper – 3**

### **MICROBIAL ECOLOGY & BIODEGRADATION**

#### **UNIT – I**

Introduction to environmental microbiology – microbial community and neighborhood involvement-prokaryotic diversity, form eco-physiology and habitat.

Methodology : Overview on general methodology, analytical microscopy, cultivation of bacterial, fungi algae, protozoa, cultivation and assay of animal virus, cultivation of microbial consortia – emerging technologies like bioreporters, biosensors, microprobes.

#### **UNIT – II WATER MICROBIOLOGY IN PUBLIC HEALTH**

Waterborne transmission of infectious agents, detection of microbes in environmental fresh waters and drinking waters-microbial indicators of marine recreational waters – Control of microorganisms in source water and drinking water – assessing the efficacy of water treatment.

#### **UNIT – III AQUATIC MICROBIOLOGY**

Overview – primary producers – bacterial secondary producers – sulfur cycling – microbial nitrogen cycling – phosphorus cycling – metal requirements and tolerance.

#### **UNIT – IV SOIL MICROBIOLOGY**

Introduction – soil rhizosphere and phyllosphere – microbial sampling of soil – isolation and culture of arbuscular mycorrhizal fungi – assessment of enzymatic activity in soil.

#### **UNIT – V AERBIOLOGY**

Introduction – sampling – airborne fungi and mycotoxins – Legionella and Legionnaires Disease – airborne viruses – aerbiology of agricultural pathogens.

#### **UNIT – VI BIODEGRADATION**

Biotransformation and biodegradation Overview – Methods of determining degradability – measuring physicochemical limitation on biodegradations – hydrocarbon degradations – Bioaugmentation – use of fungi in biodegradation – biodegradation on aromatic compounds, PAH, Halogenated solvents – agricultural chemicals – Poly chlorinated Biphenyls – Ecology of Iron reducing bacteria – microbiology of metal mining industry.

## **Paper – 4**

### **MICROBIAL GENITCS AND MOLECULAR BIOLOGY**

#### **UNIT – I MOLECULAR BASIS OF GENETICS**

- The Bacterial chromosome – Structure of DNA
- DNA Replication – The replicon, the origin and direction of replication
- Decodnign the chromsosome-Transcription, Promoters
- Genetic code-tRNA and codon recognition, the structure of tRNA
- Protein synthesis-Processing of mRNA : initiation, elongation, termination and post translational modifications.

#### **UNIT – II GENETIC VARIATION AND GENE TRANSFER**

- Mutation and variation –mutagenesis, mutagens, bacteria as indicators of mutagenic of carcinogenic compounds
- Repair of Genetic damage-photo reactivation, excision repair, Helicase 11, mismatch repair, SOS inducible repair
- Genetic suppression-direct and indirect suppression
- Gene transfer-transformation, conjugation (the formation of Hfr cells from F++ cells), formation of f' cells.
- Transduction-generalized, specialized and abortive transduction.

#### **UNIT – III MOLECULAR ASPECTS OF RECOMBINANT DNA TECHNOLOGY**

- Episomes AND Plasmids-bacteriocinogenic factors, drug resistance, pencillinase plsmids The Genetics and Enzymology of Genetic Recombination
- Cloning vectors and cloning strategies
- Mechanisms of recombination
- Construction of genomic library

#### **UNIR – IV REGULATION OF GENE EXPRESSION**

- Regulatory elements-Operon (promoters, operators, attenuator regions)
- Positive regulation of enzyme synthesis

- Catabolite-sensitive promoters and catabolite repression
- Regulation of biosynthetic systems-trp operon, auto regulation of enzyme synthesis
- Metabolic regulation-simple and product regulation, metabolite activation
- Mechanism of end product inhibition and metabolite activation

#### **UNIT – V PHAGE, YEAST AND FUNGAL GENETICS**

- T4, T7 and I phages
- P22, φx 174, MS2 phages
- Yeast and fungal genetics
- Genetics of streptomycetes

## **Paper – 5**

### **IMMUNOLOGY, IMMUNOHAEMATOLOGY AND IMMUNOPATHOLOGY**

#### **UNIT – I IMMUNE SYSTEM AND IMMUNITY**

History of Immunology; structures, composition and function of cells and organs involved in immune system; host parasite relationships; microbial infections; Virulence and host resistance; Immune response-innate immunity, acquired immunity.

#### **UNIT – II ANTIGENS AND ANTIBODIES**

Antigens – structure and properties – types – iso and allo – haptens, adjuvants-antigen specificity. Vaccines and toxoids. Immunoglobulins – structure – heterogeneity – types and subtypes-properties (physical, chemical & biology); Theory of antibodies production. Complement – structure – components – properties and functions of complement components; complement pathway and biological consequences of complement activation.

#### **UNIT – III ANTIGEN-ANTIBODY REACTIONS**

In vitro methods – Agglutinations, precipitation, complement fixation. Immunofluorescence, ELISA. Radio Immune Assays; In vivo method: skin test and Immune complex Tissue demonstration applications of these methods in diagnosis of microbial disease.

#### **UNIT – IV IMMUNOHAEMATOLOGY AND IMMUNOPATHOLOGY**

Blood groups, Blood transfusion and Rh incompatibilities. Hypersensitivity Reactions : Antibody mediated type-1. Anaphylaxis type-2. Antibody dependent cell cytotoxicity type-3. Immune complex mediated reaction type-4. Cell mediated hypersensitivity reaction.

Tumor immunology – tumor antigens, cells involved severe combined deficiency Autoimmune diseases-possible mechanisms of autoimmunity : sequestered antigens, altered self, lack of suppressor T cells.

Human autoimmune disease-systemic lupus erythematosus, Myasthenia Gravis MHC and Disease-HLA association with disease, mechanisms of disease association.

#### **UNIT – V IMMUNOCHEMICAL TECHNIQUES**

Preparation of serum from blood

Purification and analysis of Ig G—Ammonium Sulfate Precipitation, DEAE

Anion exchange chromatography



Precipitation analysis in gel-Ouchterlony double diffusion,

Immuno-electrophoresis, Radial Immunodiffusion

Protein Blotting – Dot blotting, Western blotting

Enzyme Linked Immunosorbant Assay : ELISA

## FIRST YEAR PRACTICALS

### PRACTICAL – I

1. Culture media preparation
2. Staining methods – simple staining, Gram's staining. Capsular staining, Acid-Fast staining, endospore staining.
3. Isolation and enumeration of microbes from soil, air and water-pallete count method
4. Antibiotic sensitivity test
5. Antibiotic assay
6. Biochemical reactions-IMViC reactions, carbohydrate fermentation and gas production, TSI, H<sub>2</sub>S production, catalase production, starch hydrolysis.
7. Bacterial growth curve
8. Yeast growth curve
9. Effect of pH, Temperature and salinity on growth of microorganisms
10. Biotreatment of domestic water
11. Biodegradation of hydrocarbons
12. analysis of drinking water by MPN method.
13. BOD

### PRACTICAL – 2

1. Isolation of Nucleic acids
2. Isolation of Plasmids
3. Isolation of Antibiotic resistant mutants
4. Induction of mutants of radiation
5. Induction of mutants by chemicals
6. Transformation of E. COLI by plasmid DNA
7. Demonstration of plaque formation
8. Plotting one step growth curve of lytic bacteriophage
9. Agglutination reactions-WIDAL Blood grouping
10. Precipitation reactions – VDRL
11. Purification of IgG- Ammonium sulphate precipitation
12. PAGE analysis of IgG subunit structure

13. Ouchterlony Double Diffusion

14. Immunoelectrophoresis

15. Radial immunodiffusion

## **SECOND YEAR**

### **Paper – 6**

#### **MEDICAL AND CLINICAL MICROBIOLOGY**

This involves study of medically important bacteria, fungi and virus; classification of bacteria, fungi, protozoan and viruses.

##### **UNIT – I**

Bacteria : Streptococci, Staphylococci, clostridia, Mycobacterium, Yesinia, Salmonella, Shigella, Escherichia, Vibrio, Campylobacter, Pseudomonas, Bacillus, Brucella, Neisseria, Spirochetes, Leptospira, Chlamydoa, Mycoplasma, Rickettsiae bome disease.

##### **UNIT – II**

Fungi : All Medically important fungal diseases and respective causative agents.

##### **UNIT – III**

Parasites – Malaria and major disease causing Protozoa and Helminths prevalent in India.

##### **UNIT – IV**

Viruses : Adeno virus, Rhino virus, corona virus, Orthomyxo and paramyxo viruses, Picorna virus, Herpes virus, Hepatitis Family of Viruses, Rhabdo virus, Rubella, Parvoiridae, Pox virus, Toga virus, Flavivirus, Retro virus, Bunya virus, filo and Orbivirus and other slow viruses.

##### **UNIT – V**

Clinical microbiology : Types of specimens relied on, transport of specimens, processing of specimens, cultivation, differentiation, identification procedures of major bacteria and protozoa's. General procedures for viruses and specific methods and techniques like ELISA, RIA, DOT BLOT, WEATERN BLOT, NORTHERS BLOT, OTHER HYBRIDISATION TECHNIQUES, Immuno fluorescent techniques used in identification and quantification.

## **Paper – 7**

### **FERMENTATION TECHNOLOGY**

**UNIT – I:** An introduction to fermentation processes :

Processes – microbial biomass, microbial enzymes, microbial metabolites, recombinant products, transformation process – chronological development of fermentation industry.

**UNIT – II** : Microbial growth kinetics

Batch culture, Continuous culture, Fed-Batch culture with respective examples.

**UNIT – III** : isolation and preservation of industrially important

Screening-enrichment process – storage – quality control of preserved stocks – improvement of industrial microorganisms, mutations, recombinant process – other properties defining the process success – strain stability, resistance to phage infection-non-foaming strains – low oxygen tolerance – devoid of undesirable products.

**UNIT – IV** : Media for industrial fermentation. Introduction, typical media, medium formulation, Water, energy sources, Carbon sources, Nitrogen sources, Minerals, Growth factors, Buffers, Medium optimization – trace elements, Osmolality, pH, Non-nutritional media supplement.

**UNIT – V** : Sterilisation

Introduction – Medium sterilization – Batch sterilization – del factor, holding time, Richards rapid method, scale up of process. Design of continuous sterilization – Of media, air, exhaust gas, theory and design of depth filters.

**UNIT – VI** : Development of inoculum

INTRODUCTION, Criteria for inoculums transfer, for bacterial and fungal processes, spore inoculums, vegetative fungi inoculums, aseptic inoculums transfer, lab scale and plant scale.

**UNIT – VII** : Design of Fermenter

Introduction – aseptic operations – body construction – aeration and agitation – maintenance of aseptic conditions – valves and steam traps – other fermenter designs – Waldhof fermenter , Acetators and cavitators, tower fermenter, air-lift fermenter, packed tower. Scale-up and scale-down methods.

**UNIT – VIII** : Recovery of fermentation products

Centrifugation, Cell disruption, liquid extraction, Super critical fluid extraction, Chromatography, membrane processes, Drying, Crystallization.

**UNIT – IX** : Instrumentation and control

Measuring process variables – temperature – flow measurement – pressure measurement – safety valves – agitator power – foam sensing and control – Weight – pH – redox – inlet and out let gas – carbon dioxide measurement. Online analysis of other chemical factors – mass spectrometers, infrared spectroscopy, enzyme and microbial electrodes – ion specific sensors. Controls – manual and automatic controls and types of controls – complex controllers – Data logging – data analysis – Process control.

## **Paper – 8**

### **APPLIED INDUSTRIAL AND DAIRY MICROBIOLOGY**

#### **UNIT – I : Cultures**

Isolation, screening for metabolites, culture preservation and inoculum development, solid and liquid fermentation, strain improvement.

#### **UNIT – II : Process**

Aerobic and anaerobic fermentation, continuous culture, cell culture.

#### **UNIT – III : Recombinant DNA Applications**

Bacterial genomics, tools used in recombinant DNA applications, polycistronic operons in E. Coli, folding of recombinant proteins.

#### **UNIT – IV : Environmental Biotechnology**

Bioprospecting, biomarkers and bioreporters to track microbes and monitor their gene expression, bioremediation, biofilms and biocorrosion.

#### **UNIT – V : Secondary Metabolites**

Engineering antibiotic biosynthetic pathways, genes for biosynthesis of microbial secondary metabolites, bacteriocins and their use in industrial applications.

#### **UNIT – VI : Dairy Microbiology**

Common microbes encountered in dairy products, tracing for the sources of microbes, microbial limits of dairy products tests used for ascertaining the quality of raw material to finished product – preserved milk, UHT milk, spray dried milk powder, cheese types of cheese and their production, curd butter milk. Processing of Ice creams and other frozen milk food. Microbial catalysts used in specialized dairy product production, new area of functional foods-probiotic in animal feed and human digestive therapy.

## Paper – 9

### SOIL AND AGRICULTURE MICROBIOLOGY

#### UNIT – I : Organisms in Soil

- Number and kinds of organism in soil
- Functions of organisms in soil
- Biology of soil
- Quantitative and Qualitative assay of organisms in soil
- Classification of soil bacteria

#### UNIT – II : Mineralization

- Nitrogen cycle, Phosphorus cycle
- Production of ammonia – nitrifying organisms
- Digestion of cellulose – organisms involved
- Biological N<sub>2</sub> fixation – symbiotic and non-symbiotic N<sub>2</sub> fixation
- Iron oxidizing bacteria

#### UNIT – III : Photosynthesis

- Bacterial Photosynthesis
- Green sulfur bacteria
- Purple sulfur bacteria

#### UNIT – IV : Plant Disease

- Economic importance of plant diseases
- How pathogens enter into plants
- Classification of plant pathogens – Necrotrophs and Biotrophs
- Vectors of plant pathogens
- Hemiptera, (Psyllidae, aphididae, Cicadellidae, Fulgoridae, Pseudococcidae)
- Thysanoptera (thripidae)
- Diptera (Tephritidae, Anthomyiidae, Agromyzidae)
- Coleoptera (Chrysomelidae, Scolytidae)
- Hymenoptera (Apidae, Formicidae)

#### UNIT – V : Control of Plant Diseases

- Survival of plant pathogens



- Disease control
- Pesticides
- Breeding resistant plants
- Biological control – microbial pesticides
- Microbial degradation of pesticides.

## SECOND YEAR PRACTICALS

### PRACTICAL – 3

#### 1. Identification of

- a. STAPHYLOCOCCI
- b. STREPTOCOCCI
- c. E. COLI
- d. PROJETUS sp – isolation, staining, culture and biochemical reactions.

#### 2. Preparation of Blood smear of malarial parasite

#### 3. Demonstration of eggs and ova of Round worm, Hook worm, Tape worm and Entamoeba sp.

### PRACTICAL – 4

1. production of antibiotics
2. production of Amylase
3. production of alcohol
4. production of Vinegar
5. microbial production of biogas
6. development of SCP and Biofertilizer
7. Recovery and purification of fermentation products – enzymes, antibiotics and alcohol
8. Scales up from flask to lab fermentor
9. Pasteurization of milk and test for it.
10. Isolation of plant pathogens form diseased plants : fungal and bacterial
11. Isolation of N<sub>2</sub> fixing bacteria from Rhizosphere.