Uttrakhand Technical University
Dehradun , Uttrakhand

Syllabus

Master of Science (Microbiology)

Ordinance

COURSE STRUCTURE & ORDINANACES

Faculty – Microbiology

1. Course duration : Four semesters (two years)
2. Objectives: Master of Science in Microbiology programme is designed for developing microbiologists confident and competent enough to shoulder the responsibility to take up challenges of research and education in the field of microbiology. The course is of interdisciplinary nature and has been formulated to impart training in Microbiology, Molecular Microbiology, Industrial Microbiology, Genetics and Biochemistry.
3. Eligibility for admission: Graduation in Science (Chemistry, Botany and Zoology) or Microbiology (Medical / Industrial) or Life Sciences or Medical Laboratory Technology.
   Marks requirement : Minimum 50 % of aggregate (General Category),
   Minimum 45% of aggregate (SC, ST Category) or as per University / Government norms.

2 There shall be fifteen Theory Papers and six Laboratory Practical Examinations comprising of five Theory Papers and two Laboratory Practical Examinations in each of the three semesters as described in the following pages.

3 Each of the theory and laboratory examinations shall be of 100 marks divided into two parts i.e. Internal Assessment (30 marks) and End Term examination (70 marks).

4 Internal assessment shall be determined on the basis of mid term examination conducted by the respective institute after 6 weeks of start of the session.

5 In the fourth semester, all student will be assigned a Research Project under the supervision of a competent faculty member (having Ph. D. degree) of the Department of Microbiology. The students will do research on the topic assigned by the supervisor and submit report in the form of a dissertation at the end of semester.

6 The student shall present the report of his / her research findings in the form of a seminar in the presence of external and internal examiners who shall evaluate the work and presentation and award marks on the basis of dissertation, presentation and viva-voce.

7 The student shall deliver at least one seminar on a recent topic in the subject of microbiology as assigned by the Head of the Department.

8 The minimum pass marks shall be 40% in each of theory paper, practical examination & internal assessment and 50% in aggregate in all examinations in a semester.

9 The division shall be determined on the basis of aggregate marks obtained in all the papers (theory, practical, and dissertation / project work) of both previous and final year prescribed for the degree.

10 Overall division shall be determined be as follows :-

a) First division 60% and above

b) Second division 50% and above but less than 60%

c) Third division 40% and above but less than 50%

11 Supplementary examination for the students who fails in the annual examination will be held within 60 days of the declaration of the result.

Medium of teaching: English will be the teaching medium through out the course.

Attendance: 75% attendance is mandatory to appear in the sessional and the university examination.

The details of papers and scheme of examination is given in the following pages.

Courses Proposed

FIRST YEAR **FIRSTSEMESTER**

S. No.	Course Code	Subject Name	Periods (Hours)		Sessional Exam.	End Term Examination	Total
			L	P			
Theory							
1	MCR - 511	Principles of Bacteriology	4	-	30	70	100
2	MCR – 512	Virology	4	-	30	70	100
3	MCR – 513	General Biochemistry	4	-	30	70	100
4	MCR – 514	Algal and Fungal biology	4	-	30	70	100
5	MCR – 515	Basics of Biostatistics & Computer Applications	4	-	30	70	100
Practical							
1	MCR - 551	Practical I	-	8	30	70	100
2	MCR - 552	Practical II	-	8	30	70	100
Total							**700**

SECOND SEMESTER

S. No.	Course Code	Subject Name	Periods (Hours)		Sessional Exam.	End Term Examination	Total
			L	P			
Theory							
1	MCR - 521	Bacterial & Viral Genetics	4	-	30	70	100
2	MCR - 522	Microbial Physiology and Metabolism	4	-	30	70	100
3	MCR - 523	Immunology	4	-	30	70	100
4	MCR - 524	Food and Dairy Microbiology	4	-	30	70	100
5	MCR - 525	Soil Microbiology	4	-	30	70	100
Practical							
1	MCR - 561	Practical III	-	8	30	70	100
2	MCR - 562	Practical IV	-	8	30	70	100
Total							**700**

SECOND YEAR THIRD SEMESTER

S. No.	Course Code	Subject Name	Periods (Hours)		Sessional Exam.	End Term Examination	Total
			L	P			
Theory							
1	MCR - 611	Medical Microbiology	4	-	30	70	100
2	MCR - 612	Cellular Microbiology	4	-	30	70	100
3	MCR - 613	Genetic Engineering	4	-	30	70	100
4	MCR - 614	Microbial Biotechnology	4	-	30	70	100
5	MCR - 615	Microbial Ecology and Environment	4	-	30	70	100
Practical							
1	MCR - 651	Practical V	-	8	30	70	100
2	MCR - 652	Practical VI	-	8	30	70	100
Total							**700**

FOURTH SEMESTER

Project Work – All students will work on a research project in the field of microbiology under the supervision of a teacher and submit a report in the form of dissertation. The student will present a seminar on his / her work which shall be evaluated by the internal and external examiners.

Dissertation writing	:	150
Presentation	:	150
Viva voce	:	100
Total	**:**	**400**
Grand Total	**:**	**2500**

Detailed Syllabus

FIRST SEMESTER

MCR – 511 Principles of Bacteriology

Unit-I

Microbiology - Scope and relevance; Antonie van Leewenhoek and discovery of microorganisms; Theory of spontaneous generation – Experiments of Francisco Reddi, John Needham, Lazzaro Spallanzani, Schulz, Schroeder; Role of microorganisms in fermentation and causation of disease - contributions of Louis Pasteur, Robert Koch and Tyndall in the development of microbiology; Lister - antiseptic surgery; Microorganisms and transformation of inorganic matter – contributions of Beijerinck and Winogradsky; Development of microbiology in 20th and **21st century.**

Unit-II

Microscopy – Theoretical principles of microscopy, Types of microscopes – Dark field, Phase contrast, UV and Electron microscopes (transmission and scanning); Differential interference microscopy; preparation and staining of specimen for electron microscopy, Three dimensional imaging.

Unit-III

Morphology, structure and functions of prokaryotic and eukaryotic cells and their components; Prokaryotic cell size, shape and arrangement; Specialized prokaryotic structures – Endospore. Exospore, Cysts, Akenete and Heterocysts; Plasmids – structure and functions; Genetic transfers – Conjugation, Transformation, Transduction.

Nutrition and Cultivation of bacteria- Nutritional requirement and sources- requirement of energy, carbon, nitrogen, oxygen, sulpher, phosphorous and growth facters; Anaerobiosis; Construction of culture media, selective and differential media; Enrichment culture.

Unit-IV

Microbial growth- Definition, measurement of growth, growth curve, kinetics of growth generation time, specific growth rate constant; Effect of environmental factors on growth (oxygen, temperature, pH etc.); Growth of microorganisms under extremes of conditions (Temperature, hydrostatic pressure, pH, osmotic pressure, radiation); Synchronous growth; Batch and continuous cultures.

Control of bacteria- Sterilization -Physical (heat, filtration and radiation) and chemical agents; Monitoring effectiveness of antimicrobial methods.

Unit-V

Microbial evolution; classification of microorganisms- Haeckel's three kingdom, Whittaker's Five Kingdom and eight kingdom conceps of classification; Three domain concept of Carl Woese; Basic principles and techniques used in bacterial classification and identification; General relatedness (DNA-DNA hybridization, DNA and 16S rRNA sequencing). Phylogenetic and numerical taxonomy; Construction of phylogenetic tree; Bergey's Mannual of Systematic bacteriology; General features of important groups of bacteria - Proteobacteria (Enterobacteria, Rhizobiales, Pseudomonadales, Bdellovibrionales), Firmicutes (Clostridia, Mycoplasma, Bacilli, Lactobacilli), Actinobacteria, Spirochaetes, Rickettisia and Archaebacteria.

MCR - 512 Virology

Unit-I

General Virology: brief outline on discovery of viruses, nomenclature and classification of viruses, morphology and ultra structure, capsids and their arrangements, types of envelopes and their compositions, viral genome, their types and structures; Virus related agents (viroids, virusoids and prions).

Unit-II

Isolation and cultivation of viruses –animal inoculation, embryonated hen's egg and tissue culture (Cell monolayers, primary and secondary cell cultures, cell strains and cell lines); Viral assay- electron microscopy, plaque method and endpoint methods, Serological methods – hemagglutination, HAI, compliment fixation, immunofluorescence, ELISA, RIA.

Unit-III

Microbial Viruses: Bacteriophage structural organization, life cycle (Lytic and Lysogenic); One step growth curve, transcription, DNA replication, eclipse phase, phage production, burst size,;Bacteriophage typing; Application in bacterial genetics; Brief account of phage M13, Mu, T_4, Lambda; Mycoviruses, Phycoviruses and Protozoan viruses

Unit-IV

Plant Viruses: Classification and nomenclature, viral structure, symptoms, effects of viruses on plants, appearance of plants, histology, physiology and cytology of plants; Type species of plant viruses like TMV, cauliflower mosaic virus and potato virus X; Gemini viruses; Transmission of plant viruses with vectors (insects, nematodes, fungi) and without vectors (contact, seed dodder, and pollens). Prevention of crop loss due to virus infection, virus free planting material, vector control.

Unit-V

Animal viruses: Classification and nomenclature of animal viruses, epidemiology, pathogenecity, diagnosis, prevention and control of RNA viruses- Picorna, Orthomyxo, Retroviruses, toga and other arthropods viruses, rhabdo, HIV ; DNA viruses- pox, herpes, hepatitis, Interferon and antiviral drugs.

MCR - 513 General Biochemistry

Unit-I

Water- properties and biological role, pH, buffers; Structural features and chemistry of biomolecules; Amino acids- structure, classification, properties and functions.

Unit-II

Proteins- classification, functions and structures (primary, secondary, tertiary and quaternary); Forces stabilizing higher order structures of biomolecules; Carbohydrates- structure, functions properties and classification; (Monosaccharides, Disaccharides, Polysaccharides and Mucopolysaccharides).

Unit-III

Lipids- structure, functions, properties and classification; (Phospholipids, Glycolipids, Lipoproteins and cholestrol); Nucleic acids- structure, functions and properties of RNA and DNA.

Unit-IV

Enzymes as biocatalysts, enzyme classification, specificity, native site, activity unit, isozymes. Enzyme kinetics: Michaelis – Menton equation for simple enzymes, determination of kinetic parameters, multistep reactions and rate limiting steps. Effects of pH and temperature on enzyme action, enzyme inhibition, allosterism, kinetic analysis of allostearic enzymes, Principles of allosteric regulation. (Simple sequential model and concerted model). Vitamins and their role as coenzymes. Artificial enzymes (β- benzyme), Ribozymes.

Unit-V

Bioenergetics: High energy compounds, free energy and spontaneity of reaction, G, G^0, G' and equilibrium. Strategy of energy production in the cell, oxidation- reduction reactions, coupled reactions and group transfer, ATP production, structural features of biomembranes, Biological transport- uniport and co-transport, antiport, symport, group translocases.

MCR - 514 Fungal Biology

Unit-I

Historical introduction to Mycology, Classification, general features, mycelial organization; Cell structure and cell differentiation, nutrition and reproduction in fungi. Salient features of divisions- Myxomycota- Acrasiomycetes, Hydromyxomycetes, Myxomycetes, Plasmodiophoromycetes;

Unit-II

Emycota: Mastigomycotina (Zoosporic fungi) - Chytridiomycetes, Hypochytridiomycetes, Oomycetes; Zygomycotina- (zygomycetes, trichomycetes), Evolutionary tendencies in lower fungi; Heterothallism, sex hormones in fungi. Physiological specialization and phylogeny of fungil.

Unit-III

Salient features of: Ascomycotina- hemiascomycetes, plectomycetes. Discomycetes- laboulbeniomycetes; Loculoascomycetes; Basidiomycotina- teliomycetes, hymenomyctes), Deuteromycotina- (hypomyctes, coelomycetes, blasomycetes.

Unit-IV

Fungi and ecosystem: saprophytes, substrate groups and nutritional strategies, substrate successions, fungi and bioremediation; Economic importance of fungi; Plant diseases- *Pythium* seed rot, grapes-downy mildew, potato-early and late blights, tomato fusarial wilt, wheat-smut and rust.

Unit-V

Attack on fungi by other microorganisms; Mycoses- superficial (Yeast like organisms), cutaneous (Dermatophytes), subcutaneous (*Sporothrix schenckii*) and systemic (*Candida, Cryptococcus, Histoplasma, Blastomyces*)

MCR - 515 Basics of Biostatistics & Computer Applications

Unit-I

Introduction: Definition of Statistics: population and universe, the sample and population, statistical inference; parameter and statistics.

Interval Data: Construction of a histogram; interpretation of histogram, the normal distribution, the quartiles, the mean, mode, median and standard deviation, representing the normal curve, uncertainties in estimation of a mean, comparison of means and variances, coefficient of variance.

Unit-II

Proportion data: examples of proportion data; (MPN, sterility testing of medicines, animal toxicity, therapeutic trial of drugs and vaccines, animal toxicity, infection and immunization studies) statistical treatment to proportion data. Chi-square test, goodness of fit. F – test, t – test, Z – test.

Unit-III

Analysis of variance: Analysis of co- variance; Introduction, procedure and tests, multiple comparisons, Correlation and regression and line fitting through graph points: curves; correlation, linear regression (fitting the best straight line through n series of points) MLR, multi-collinearity, Standard curves and interpolation of unknown Y- values.

Unit-IV

Application of biostatistics in microbiology: Count data - examples of count data (bacterial cell count, radioactivity count, colony and plaque counts), statistical treatment to count data: Poisson distribution, standard error, confidence limits of counts.

Statistical basis of biological assays: Response-Dose metameter. Delusion Assays, Direct and indirect Assays. Quantal Responses Probit, logit, LD_{50}, ED_{50}, PD_{50} – Standard line interpolation assay, parallel line assay (4oint, 6point assays), slope ratio assay.

Unit-V

Basics of Computer: Operating Systems: Windows and Unix; Hardware, Software, Disk operating system, Multimedia network concepts; C- Programming; object oriented programming; Internet and local area network, wide area network.

Bioinformatics – Biological data storage and analysis.

MCR – 551 Practical I
MCR – 552 Practical II

SECOND SEMESTER

MCR – 521 Bacterial and Viral Genetics

Unit-I

Nucleic acids as genetic information carrier: experimental evidences, DNA structure: historical aspects and current concepts, melting of DNA. DNA replication: general principals, various modes of replication, isolation and properties of DNA polymerases, proof reading, continuous and discontiuous synthesis. Inhibitors of DNA replication (blocking precursor synthesis, nucleotide polymerization, altering DNA structure). Asymmetric and dimeric nature of DNA polymerase III and simultaneous synthesis leading and lagging stands, exonuclease activity in eukaryotic DNA polymerases.

Unit-II

Gene as a unit of mutation and recombination. Molecular nature of mutations. Mutagens, Spontaneous mutations-origin. Gene conversion, site specific recombination, Transposable elements, Nomenclature, insertion sequences, Transposons (Structure, Mechanism and Genetics of Transposition). DNA damage and repair; types of DNA damage (deamination, oxidative damage, alkylation, pyrimidine dimers). Repair pathways-methyl directed mismatch repair, very short patch repair, nucleotide excision repair, base excision repair, recombination repair, SOS system.

Unit-III

Structural features of RNA (rRNA, tRNA and mRNA) and relation of function, Initiator and elongator class of tRNA, cutting and modification of tRNA, ribosome binding site on mRNA and corresponding site on rRNA, maturation and processing of rRNA: methylation, cutting and trimming of rRNA, capping, polyadenylation and splicing of mRNA, peptidyltransferase activity of 23S rRNA. Catalytic RNA group I and group II splicing, RNase P.

Unit-IV

Transcription: general principles, Basic apparatus, types of RNA polymerases, steps: initiation, elongation and termination. Inhibitors of RNA synthesis. Polycistronic and monocistronic RNAs. Basic features of Genetic code. Translation and its steps-initiation, elongation and termination, role of various factors in above steps, inhibitors of protein synthesis.

Unit-V

E. coli- model organism to study bacterial genetics; Gene: structure, expression and regulation. Concept of operon (lac and trp operons), catabolic repression, negative and positive regulation, inducers and co-repressors; Plasmids and F factor, Replication of plasmids and plasmid compatibility. Bacteriophages: lytic phages and lysogenic phages, genetics of T 4 and lambda phages, their use in microbial genetics.

MCR - 522 Microbial Physiology and Metabolism

Unit-I

Microbial physiology and metabolism – introduction, Structure, functions and biosynthesis (assembly) of Capsule, Cell walls, Outer membrane, Flagella, Pili, Cytoplasmic membrane, Nuclear material, Ribosomes and Cytoplasmic inclusions; Cellular differentiation - sporulation and morphogenesis; Cell cycle and cell division; Life at extremes of tenvironment.

Unit-II

Basic aspects of bioenergetics- Principles of thermodynamic reactions, entropy, enthalpy, electron carriers, artificial electron donors, Inhibitors, uncouplers, energy bond and phosphorylation; Methods of cell disruption and cell fractionation. Bioluminiscence.

Unit-III

Metabolic precursors and fuelling reactions; Central, peripheral and anapleurotic pathways; Metabolism of carbohydrates – EMP, ED, HMP and Phosphoketolase pathways; Krebs cycle, glyoxalate pathway, oxidative and substrate level phosphorylation. Reverse TCA cycle- gluconeogenesis;

Unit-IV

Bacterial fermentations – Ethanol, Lactic acid, Acetone , Butanol and Mixed acid fermentations; Fermentation balances; Microbial degradation of starch, glycogen, pectin and cellulose; Assimilation of Nitrogen- ammonia, nitrate nitrogen assimilation, dinitrogen fixation; Synthesis and regulation of major amino acids.

Unit-V

Brief account of Bacterial photosynthesis, - Autotrophy, Oxygenic and anoxygenic photosynthetis and their mechanism, Photosynthetic electron transport system, photo-phosphorylation, Dark reaction, C_3, C_4 Pathways; Chemolithotrophy- sulphur, iron, hydrogen, nitrogen oxidations; Methanogenesis.

MCR - 523 Immunology

Unit-I

Immune system and immunity: History of Immunology, composition and functions of cells and organs involved in immune system. Immune responses- innate immunity, acquired immunity. Determinants of innate immunity: species and strains, individual differences, influences of age, hormonal influence, nutritional factors, and mechanical barriers and surface secretions. Non specific immune mechanisms: surface defenses, tissue defenses, opsonization, inflammatory reactions, hormone balance

Unit-II

Antigens and antibodies: Antigens-structure and properties, types - iso and allo – antigens, haptens, adjuvant, antigen specificity. Immunoglobins- Structure, heterogeneity, types and sub types, properties (Physiological and biological). Theories of the antibody production complement- structure, components, properties and functions of different component. complement pathways and biological consequences of the complement activation. Antigen-antibody reactions: *in vitro* methods- agglutination, precipitation. complement fixation, immunofluroscence, ELISA, radioimmuno assay.

Unit-III

Lymphocytes, their sub-population, their properties and functions. Membrane bound receptors of lymph cells. Helper T cells in immune response. T-cell suppression in immune response. Development and differentiation of B and T cells. Mechanism of the cell mediated immunity, immune tolerance to self antigens. Synthesis of antibodies and antibody diversity. Hybridoma technology.

Unit-IV

Major Histocompatability complex and Transplantation: structure and functions of MHC and HL-A system. Gene regulation and *Ir* genes. HLA and tissue transplantation: graft verses host reaction and rejection, immune suppression- specific and non specific autoimmunity.

Unit-V

Hypersensitivity reactions: Antibody mediated- Type I (Anaphylaxis), Type- II, Type-III and Type IV; Defects in immune system: Primary and secondary defects, defects in complement, phagocytes.

MCR - 524 Food and Dairy Microbiology

Unit-I

Food as substrate for microorganisms: Microorganisms important in food microbiology- Molds, Yeasts and Bacteria- general characteristics, classification and importance. Principles of food preservation. Asepsis- removal of microorganisms, anaerobic conditions, high temperatures, low temperatures, drying; Factors influencing microbial growth- Extrinsic and intrinsic factors, Chemical preservatives and food additives. Heat processing ; D, Z and F values and working out treatment parameters for canned foods; Canning,

Unit-II

Microbiology of milk and milk products: Initial microflora of raw milk; Types of microorganisms present in raw milk and spolage caused by these organisms; Sources of contamination of milk; Fermented dairy foods – cheeses, acidophilus milk,kefir and yoghurt; Nutritional and therapeutic benefits of fermented milk products; Probiotic foods; Spoilage of fermented dairy products; Quality control in dairy industry.

Unit-III

Food borne infections and intoxifications: Bacterial diseases with examples of infective and toxic types- *Brucella, Bacillus, Clostridium, Escherichia, Salmonella, Shigella, Staphylococcus,Vibrio, Yersinia,* fungi and viruses; Aflatoxins- structures and functions; Foodborne outbreaks- laboratory testing procedures; Preventive measures- Sanitation in manufacture; Food control agencies and its regulations, HACCP, ISO standaeds.

Unit-IV

Food fermentations: bread, vinegar, fermented vegetables; Spoilage and prevention of spoilage of cereals, vegetables, fruits, meat and meat products, fish and sea products;

Unit-V

Foods produced by Microbes - Fermented foods, microbial cells as food (single cell proteins); Mushroom cultivation; Bioconversions- fermented beverages- beer and wine; Industrial enzymes and their uses in food industry- amylases, proteases, cellulases; Oriental foods- Mycoprotein, Tempeh, Soya sauce; Traditional foods.

MCR - 525 Soil Microbiology

Unit-I

Soil as a habitat for microorganisms: soil genesis, factors involved in soil genesis, soil profile, physicochemical properties of soil (mechanical composition of soil, organic matter and air). Soil microbes- algae, bacteria, actinomycetes, fungi, protozoa and nematodes. Microbial balance in soil. Molecular markers for ecological studies of soil microorganisms.

Unit-II

Rhizosphere and rhizoplane microorganisms: reasons for increased microbial activity in rhizosphere. Composition of root exudates, factors affecting exudation, rhizosphere microorganisms, rhizosphere effect. Effect of microflora on host plants. Factors affecting microbial community in soil- soil moisture, organic and inorganic chemicals, soil organic matter, types of vegetation and its growth stages, different seasons.

Unit-III

Biogeochemical cycle: C, N, P, S cycles. Nitrogen fixation- symbiotic and asymbiotic, significance of nitrogenase and *nif* genes, phosphate solubilization and its mechanism..

Unit-IV

Organic matter decomposition: composition of litter (cellulose, hemicelluloses, lignin) water soluble components-ether and alcohol soluble components and proteins. Organic matter dynamics in soil- microbial decomposition of cellulose, hemi cellulose, lignin. Microbial succession on decomposing litter. Factors affecting organic matter decomposition (litter quality, temperature, aeration, soil pH, inorganic chemicals, moisture); Pesticide degradation in soil, effects of pesticides on soil microflora, soil microbial biomass as an index of soil fertility

Unit-V

Microbial interactions: negative interactions- amensalism, competition, parasitism and predation (mycoparsitism, mycophagy, nematophagy-predaceous fungi), commensalisms, positive interactions- mutualism, synergism, associative symbiosis- symbiosis, cyanobacterial, bacterial (*Rhizobium* legume symbiosis), actinomycetes (actinorrhiza- *Frankia* non root legume symbiosis) and fungal symbiosis- mycorrhiza types and significane of mycorrhiza. Bioinoculants- biopesticides and bioinsecticides. Concept of beneficial microorganisms.

MCR – 561 Practical III
MCR – 562 Practical IV

THIRD SEMESTER

MCR - 611 Medical Microbiology

Unit-I

Early discovery of pathogenic microorganisms, development of bacteriology as scientific discipline. Contributions made by eminent scientists. Normal microflora of human body, role of resident flora and the human host; Epidemiology: epidemic, endemic, pandemic; Transmission of pathogens, route of infection. Treatment and prevention of diseases – antibiotics and drug resistance; Brief account of vaccines and passive prophylactic measures.

Unit-II

Establishment, spreading, tissue damage and antiphagocytic factors. Mechanism of bacterial adhesion, colonization and invasion of mucus membranes of respiratory, enteric and urogenital tracts. Role of aggresins, depolymerizing enzymes, organotropsims, variation and virulence. Organs and cells involved in the immune system and immune response.

Unit-III

Classification of pathogenic bacteria, infections caused by *Staphylococcus*, *Streptococcus*, *Pneumococcus*, *Neisseria*, *Corynebacterium*, *Bacillus*, *Clostridium*, organisms belonging to Enterobacteriaceae- *E. coli, Salmonella, Shigella, Vibrio*, *Yersinia*, *Haemophillus*, *Mycobacterium*, Spirochaetes, *Rickettsia*, *Chlamydia*.

Unit-IV

General properties of viruses. Properties and important infections caused by Pox viruses, Herpes viruses, Picoma viruses, Orthomyxo viruses, Paramyxo viruses, Arbo viruses, Rhabdo viruses, Hepatitis viruses, Retroviruses- HIV.

Unit-V

Fungal diseases: Dermatophytes, Dimorphic fungi: opportunistic fungal pathogens- Candidiasis, Pneumocystis, Blastomycosis and Histoplasmosis. Protozoal infections: *Plasmodium*, *Trypanosoma, Entamoeba, Balatidium, Pneumocystis*.

MCR – 612 Cellular Microbiology

Unit-I

Introduction: bacterial disease. Emergence of cellular microbiology. Cellular biology underlying prokaryotic and eukaryotic interactions: structure of eukaryotic cell membrane - receptors and signal transduction, Cytoskelton-regulation of assembly and disassembly. Secretion systems in prokaryotes. Pathogenicity islands.

Unit-II

Prokaryotic and eukaryotic signaling mechanisms: eukaryotic cell-to-cell signaling, cytokines. Prokaryotic signaling: quorum sensing and bacterial pheromones, Intracellular signaling. Signaling pathways.

Unit-III

Infection and cell-cell interactions; bacterial adherence: basic principles, effect of adhesion on bacteria, effect of adhesion on host cells. Bacterial invasions of host cells; mechanism, consequence of invasion, survival after invasion. Protein toxins: classification of toxins, agents of diseases. Toxins as tools in cell biology and medicine.

Unit-IV

Immune response to bacterial infections: innate response-complement, acute phase proteins, macrophages, cytokines and interferon. Acquired immune response, cell mediated immune response and humoral response.

Unit-V

Cellular microbiology future directions: Virulence genes, tools for identifying virulence gene-by mutation, differential expression, and by use of comparative genomics. Genomic processes in bacterial pathogen evolution, role of horizontal gene transfer in prokaryotic genome evolution. Future approach for discovery of novel therapeutics.

MCR - 613 Genetic Engineering

Unit-I

Techniques in GE: Basic concepts of Southern, Northern and Western blotting. PCR methods and applications. DNA sequencing methods- Sanger's and Maxam-Gilbert method. Sequence assembly. Automated sequencing. Restriction mapping (RFLP, AFLP), RAPD, REP-PCR and their use in DNA fingerprinting. Site directed mutagenesis and protein engineering.

Unit-II

Strategies in gene cloning (cutting and joining of DNA): Isolation of chromosomal and plasmid DNA from bacteria and yeast. Bacterial restriction and modification systems. Restriction endonucleases and their types. Reconition sequence for type II endonucleases. DNA Ligation-reaction mechanism of DNA ligases. Joining of DNA fragments using linkers, adaptors and homopolymer tails.

Unit-III

Strategies in gene cloning (Molecular cloning): Cloning vectors-plasmids, phages, cosmids and shuttle vectors, expression vectors, promoter probe vectors. Cloning strategies: introduction of recombinant vectors in to bacterial cells-transformation and other methods. Selection of clones-colony hybridization, detection of translation products and immunological methods. Probes-types of probes, strategies for construction of probes, use of ESTs and cDNA as probes.

Unit-IV

Whole genome analysis-DNA libraries and genomics: Genomic library, cDNA library, Use of artificial chromosomes (BAC, YAC) for library construction. Genomics - sequence assembly, contigs and genome construction, annotation. Functional genomics- transcriptomics, proteomics. Comparative genomics.

Unit-V

Application of RDT in pharmaceutics and medicines- recombinant human growth hormone- insulin, recombinant vaccines, food and agriculture and production of useful industrial products. Metagenomics and its applications.

MCR - 614 Microbial Biotechnology

Unit-I

General considerations**:** Metabolic pathways and metabolic control mechanisms, primary and secondary metabolites. Biotechnological innovations in the chemical industry, biocatalyst in organic chemical synthesis, efficiency of growth and product formation, growth stoichiometry, maintenance of energy requirement and maximum biomass yield. P/O quotients, metabolite over production and growth afficiency.

Unit-II

Shake flask cultures. Fermentation by batch , fed batch and continuous cultures; Microbial growth and kinetics; Growth and product formation, heat evolution, effect of environment (pH, temperature, D O_2, high nutrient concentration). Media formulation, kinetics of thermal death of microorganisms, batch and continuous sterilization.

Unit-III

Fermentor design - stirred tank, airlift fermentor, hollow fiber bioreactor and immobilized cell reactors; Instrumentation and control; Large scale production; Aeration and agitation - oxygen transfer kinetics; Rheology of fermentation broths - concepts of Newtonian and Non-Newtonian fluids. Plastic fluids, apparent viscosity, foam and antifoam.

Unit-III

Industrial production of antibiotics (β-lactam and rifamcyin), citric acid, acetic acid, lactic acid, ethanol, enzymes (pectinases, amylases, lipases, proteases, cellulases). Amino acids (glutamic acid and lysine), vitamins (riboflavin and cynocobalmine), steroids transformation, biopesticides, fermented food beverages, biopolymers.

Unit-IV

Industrial strains. Strategies for selection and improvement, preservation and maintenance. Aseptic operation and containment of recombinant organisms. Scale up, large scale production using recombinant microorganisms. Product recovery (down streaming).

MCR - 615 Applied and Environmental Microbiology

Unit-I

Microorganisms in the natural environments: Microbes in terrestrial, aquatic, air and biological environments, microbes in the extreme environments and their adaptations; dispersal of microorganism, and methods for the determination of microbial numbers, biomass and activities. Assessment of air quality, solid, liquid impingement methods. Brief account of air borne transmission of microbes- viruses, bacteria and fungi.

Unit-II

Water ecosystem- types- fresh water (ponds, lakes, streams)-Marine habitats (estuaries, mangroves, deep sea, hydrothermal vents, saltpans, coral reefs). Zonations of water ecosystem-upwelling- eutrophication- food chain. Potability of water-microbial assessment of water quality-water purification; Heavy metal tolerance in microbes.

Unit-III

Waste treatment: Waste types- solid and liquid wastes characterization, solid—liquid treatments physical, chemical, biological-aerobic-anaerobic-primary- secondary- tertiary solid treatments- Saccharification- gasification- composting, utilization of solid wastes–Food production (SCP, mushroom, yeasts), Production of fuel (ethanol, methane); Liquid waste treatment-trickling-activated sludge- oxidation pond- oxidation ditch.

Unit-IV

Significance of microbial activities in the environment, Role of microorganisms in the cycling of bio-elements (carbon, nitrogen, phosphorus, sulphur); bioremediation, microbial degradation of pesticides and other recalcitrant chemicals xenobiotics). Global warming and possible control measures.

Unit-V

Microorganism in mineral leaching and recovery; Microbial degradation of petroleum and hydrocarbons; Bio-deterioration of paper-leather-wood- textiles-cosmetics; Metal corrosion and control. Microbial inoculants in agriculture; GMO and their impact; Microbial plastics.

MCR – 651 Practical V
MCR – 652 Practical VI

MCR – 700 Research Project

List of Recommended Practicals

SEM I

MCR – 551 Practical I (Bacteriology and Virology)

1. Study of equipments used in a microbiological laboratory.
2. Microscopy components, principle and use of a compound microscope.
3. Stains, types of stains and principles of staining. Preparation of stains.
4. Examination of living microorganisms - Wet mount technique.
5. Examination of microorganisms by simple staining and negative staining- use of high power objective.
6. Differential staining- Gram staining and Endospore staining of a given bacterial culture.
7. Differential staining- capsule staining (using negative and Anthony staining method).
8. Examination of bacterial motility using hanging drop method.
9. Preparation and sterilization of basic medium (solid and liquid) for cultivation of bacteria. Preparation of agar slants and deep tubes for cultivation of microorganisms.
10. Isolation and enumeration of microorganisms by serial dilution agar plating methods (streak plate, pour plate and spread plate method).
11. Study of colony characteristics of different bacteria.
12. Isolation of microorganisms by enrichment culture technique (Azotobacter, Endospore forming aerobic bacteria).
13. Isolation of Rhizobia from root nodules.
14. Enumeration of microorganisms in soil by serial dilution technique.
15. Study of cultural and physiological characteristics.
16. Study of viral diseases of plants – Host and host tissue and symptom of some important diseases
17. Isolation of bacteriophages from soil.
18. One step growth curve.

SEM I

MCR – 552 Practical II (Mycology and Biochemistry)

1. Examination of different fungi by Lactophenol cotton blue staining
2. Preparation of Fungal media (PDA, SDA) for cultivation of fungi and Isolation of saprophytic fungi from soil
3. Identification of Molds and Yeasts by colony and cell morphological characteristics
4. The effects of Light and Temperature on Growth and sporulation of fungi
5. Isolation and identification of yeasts from sugar rich fruits
6. Microscopic observation of different asexual fungal spores
7. *In vitro* identification of Amylase producer fungi
8. Isolation and identification of antibiotic producer fungi
9. Microscopic observation of fungal fruiting bodies
10. Microscopic observation of Dermatophytes
11. Isolation and identification of plant pathogens from infected plants
12. To observe morphological characteristics of Foliose, Crustose & Fruticose Lichens
13. Spectrophotometry – Principle and applications
14. Estimation of total sugars by phenol sulphuric acid method
15. Estimation of protein by Folins Ceocalchu method
16. Separation of mixture of amino acids by circular paper chromatography
17. Separation of mixture of amino acids by Thin layer chromatography
18. GLC and HPLC – Principle and applications

SEM II

MCR – 561 Practical I (Bacterial Genetics and Microbial Physiology)

1. Total cell/ spore counting using Neubauer / Rosenthal counting chamber.
2. Micrometry – Measurement of size of microorganisms by use of stage and ocular micrometers.
3. Centrifugations –principle, types of centrifuges, handling and care.
4. Growth curve and exponential growth rate constant.
5. Effect of pH, temperature, oxygen , salt concentration and water on growth of microorganisms.
6. To set up Winogradsky column for enrichment of photosynthetic bacteria.
7. Methods of cell breakage.
8. Morphological changes during sporulation in bacteria.
9. Isolation of bacterial and fungal genomic DNA.
10. Isolation of plasmid DNA.
11. Agarose gel electrophoresis.
12. Isolation of RNA from bacteria.
13. Isolation of antibiotic resistant bacterial population by gradient plate technique.
14. Isolation of auxotrophic mutants of bacteria by replica plate technique.
15. Mutagenesis in bacteria by use of chemicals.
16. Genetic transfer by conjugation.
17. Curing of plasmid by use of Acriflavine/ Ethidium bromide.
18. Estimation of nucleic acids by spectrophotometric method.

SEM II

MCR – 562 Practical II (Immunology, Food Microbiology and Soil Microbiology)

1. Determine the number of bacteria in milk by SPC and correlate the quality of milk by MBRT test.
2. Isolation and identification of *Lactobacillus* spp. from fermented food.
3. Isolation of bacterial and fungal population from spoiled food sample.
4. Isolation and identification of bread molds.
5. Soil sampling for microbial analysis and Enumeration of rhizoshere and rhizoplane microbes.
6. Determination of R:S ratio.
7. Determination of soil pH and water holding capacity.
8. Isolation of phosphate solubilizing bacteria from soil.
9. Isolation of siderophore producing bacteria from soil.
10. Isolation of indole acetic acid producing bacteria from soil and Quantitative assessment of IAA.
11. Determination of nitrogenase activity of root nodules.
12. Determination of total carbon and organic matter in a soil sample.
13. Determination of soil microbial biomass carbon, nitrogen and phosphorus
14. Determination of soil phosphatase activity.
15. Isolation of HCN producing bacteria from soil.
16. Evaluation of antifungal activity of soil bacteria by dual culture method.
17. Evaluation of antibacterial activity of soil bacteria by ribbon growth technique and agar-well method.
18. Gel diffusion
19. Immunoelectrophoresis
20. Rocket immunoelectrophoresis

SEM III

MCR – 651 Practical I (Medical and Cellular Microbiology)

1. To study the normal bacterial flora of human body
2. Antibiotic sensitivity test by disc diffusion method – Kiry Bauer method
3. Antibiotic sensitivity test by disc diffusion method – Stoke's method
4. Determination of MIC value by tube/ agar dilution method
5. Isolation of *Salmonella* and *Shigella* species from sewage and stool
6. IMViC test for identification of enteric bacteria
7. Isolation of Mycobacteria spp. on Lowenstein Jensen's medium
8. Identification of *Candida albicans* by germ tube production
9. Isolation of *Staphyllococcus aureus* from nasal swab on mannitol salt agar
10. Coagulase and phosphatase tests for identification of *Staphyllococcus aureus*
11. Isolation and identification of *Pseudomonas aeruginosa* from various body sites
12. To study the pigment production by *Pseudomonas aeruginosa*
13. To test a given organism for oxidative/ fermentative capabilities (O/ F Test)
14. To isolate *Candida albicans* from oral cavity
15. To study the morphology of common pathogenic fungi.
16. Demonstration of cytolysin production by bacteria
17. To demonstrate the antibacterial activity of human serum.
18. Induction of morphological changes in root hair cell of legume by inoculation of rhizobia.
19. Effect co-culture on enteric bacterial growth rate.
20. Sequence similarity search using BLAST

SEM III

MCR – 652 Practical II (Genetic engineering, Microbial technology and Environmental Microbiology)

1. SDS-PAGE electrophoresis.
2. Isolation of total RNA from bacteria.
3. Isolation of total protein from bacterial cells.
4. To perform DNA restriction analysis.
5. To perform DNA ligation.
6. Preparation of competent cells of given bacterial strain.
7. Genetic transfer by transformation and screening of bacterial transformants using replica plate technique.
8. Determine the dissolved oxygen (DO) of given water sample.
9. Determine the biochemical oxygen demand (BOD) of given water sample.
10. Determine the chemical oxygen demand (COD) of given water sample.
11. Perform bacteriological analysis of water by multiple tube test.
12. Enumerate bacterial and fungal population of water sample.
13. Determine total dissolved solids (TDS) in the given water sample.
14. Perform bacteriological analysis of water by membrane filtration method.
15. Isolation of aquatic fungi by baiting method.
16. Isolation of antagonistic actinomycetes from soil and detection of antibacterial activity
17. Alcoholic fermentation by *Saccharomyces cerevisiae* using molasses as substrate and detection of ethanol at various time intervals by spectrophotometric method
18. Production of citric acid by *Asp[ergillus niger*.
19. Lactic acid fermentation
20. Study of laboratory fermentor – demonstration

BOOKS RECOMMENDED
Brock's Biology of Microorganisms – Madigan, Martiko, Parker
Microbiology– An Introduction- Tortora (Pearson Publication)
Presscott's Microbiology – Linda Sherwood *et al.*
Fungal Biology By Jim Deacon 4th Ed. (Blackwell Publication)
The Filamentous Fungi- Fungal Technology By Smith, Berry & Kristansen
Food Microbiology – James Jay
Food microbiology – W. C. Frazier
Food Microbiology By Adams & Moss, 3rd Ed. (RSC Publication)
Plant Viruses By Nyudu (Mc Graw Hill)
Microbial Physiology By Moat & Foster 5th (Wiley & Foster)
Immunology & Immunotechnology By Ashim K. Chkravarty (Oxford Univ. Press)
Understanding Immunology By Peterwood (Pearson Education)
Roitt's Essential Immunology(Series - Essentials) By Peter J. Delves (Author), Ivan M. Roitt (Author), Seamus J. Martin (AuthorBlackwell Publishers
Biochemical Methods By S Sadasivam(Author), A Manickam(Author)New Age International (Publisher)
Cellular Microbiology By Henderson (Willey Publication)
Cellular Microbiology By Corsel *et al* (ASM Publication)
Diagnostic Microbiology By Bailey, Scot , 10th Ed. (Mosby Publisher)
Medical Microbiology By Levison & Jervetz (McGraw Publisher)
Biology of Industrial Microorganisms By A. L. Demain (Butterworth Heinemann)
Biotechnological Innovations in Chemical Synthesis (Biotol Publication)
Soil Microbiology, Ecology & Biochemistry III Ed. By Eldor A. Paul
Manual of Environmental Microbiology, 3rd Edition By Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, Linda D. Stetzenbach (AS M Publication)
Molecular Biology of Gene By Watson, Baker, Bell *et al* (Pearson Publication)
Molecular Genetics of Bacteria By Lary Snyder & Wendy Champrees (ASM Press)
Introduction to Molecular Genetics By Hearch (Elsevier)
Environmental Microbiology, Second Edition By Maier and Pepper (Eds) Elsevier (Publisher)
Microbial Ecology – Atlas and Bartha
Gene coloning – T. A. Brown
Experimental Microbiology – F C Garg
Soil Microbiology – N. S. Subba Rao