

M.Sc. Microbiology (Self-Financing Course)
Two Year (Four Semesters) Programme
Applicable for students admitted in July 2018 onwards

Semester I: Max Marks (Credits)

Paper I:	Techniques and Tools in Microbiology	100 (04 Credits)
Paper II:	Microbial Diversity	100 (04 Credits)
Paper III:	Cell Structure	100 (04 Credits)
Paper IV:	Microbial Genetics	100 (04 Credits)
Practical:	Based on Papers I-IV	100 (04 Credits)

Total 500 (20 Credits)

Semester II:

Paper I:	Microbial Physiology and Biochemistry	100 (04 Credits)
Paper II:	Molecular Biology and Genetic Engineering	100 (04 Credits)
Paper III:	Plant Virology	100 (04 Credits)
Paper IV:	Medical Microbiology and Immunology	100 (04 Credits)
Practical:	Based on Papers I-IV	100 (04 Credits)

Total 500 (20 Credits)

Semester III:

Paper I:	Environmental Microbiology	100 (04 Credits)
Paper II:	Industrial and Food Microbiology	100 (04 Credits)
Paper III:	Biostatistics and Computer Applications	100 (04 Credits)
Paper IV:	Microbial Biotechnology	100 (04 Credits)
Practical:	Based on Papers I-IV	100

Total 500 (20 Credits)

Semester IV:

Project Dissertation	300 (12 Credits)
Project Presentation	100 (04 Credits)
Project Viva-Voce	100 (04 Credits)

Total 500 (20 Credits)

Total Subject Maximum Marks for all 4 semesters 2000 (80 Credits)

Elective Course for all 4 Semesters 400 (12 Credits)

Grand Total for Course 2400 (92 Credits)

M.Sc. MICROBIOLOGY (SEMESTER –I)
PAPER I
TECHNIQUES AND TOOLS IN MICROBIOLOGY: 05 Credits
(w.e.f. July 2018)
Total: 40 Hours

Unit – I Culture And Visualization Of Microbes: 01 Credit	Hrs
Pure cultures, culture media (defined/synthetic, complex, selective, differential, enriched)	2
Aseptic conditions, sterilization techniques, inoculation methods (spread-plate, streak-plate, pour-plate)	1
Culture characteristics, culturing for specific requirements e.g. antibiotic sensitivity	2
Principles of staining, Gram stain, staining for <i>Mycobacterium</i> , endospore, capsule, flagella	1
Principles of microscopy, compound microscope, phase contrast microscope, fluorescence microscope	2
Electron microscope, SEM, TEM, stains in electron microscopy	2
Unit – II Spectroscopy And Tracer Techniques (Principle, Instrumentation, Application) : 01 Credit	
UV and visible light Spectrophotometry	2
Spectrofluorimetry	2
Atomic absorption spectroscopy	2
Electron spin resonance spectroscopy, Nuclear magnetic resonance spectroscopy	2
Tracer techniques (Types of radioactive decay, detection and measurement of radioactivity by Geiger-Muller and scintillation counting, autoradiography)	2
Unit – III Centrifugation And Separation Techniques: 01 Credit	
Ultracentrifugation, density gradient centrifugation	2
Paper and thin layer chromatography	2
Column chromatography – ion-exchange, affinity, hydrophobic interaction, reverse-phase, size-exclusion,	2
Gas chromatography, HPLC,	2
Polyacrylamide gel electrophoresis (native and SDS), 2D electrophoresis, isoelectric focusing	2
Unit – IV Techniques In Plant Virology: 01 Credit	
Bioassay, Purification	2
Test for viral purity, Quantification	2
Serology (Ouchterlony gel diffusion, ELISA, immunoblotting)	2
Serologically specific electron microscopy, RIA	2
Molecular methods of virus identification (Southern blotting, northern blotting, PCR)	2
Practical based on Units I – IV : 01 Credit	

M.Sc. MICROBIOLOGY (SEMESTER – I)
PAPER II
MICROBIAL DIVERSITY: 05 Credits
(w.e.f. July 2018)

Total: 40 Hours

Unit – I Classification, Comparative Structure/Function, Plant Pathogenic Aspects (Including Control) Of Bacteria And Archaea: 01 Credit	Hrs
<i>Xanthomonas oryzae, Erwinia carotovora</i>	2
<i>Ralstonia (Pseudomonas) solanacearum</i>	2
<i>Streptomyces scabies, Agrobacterium tumefaciens</i>	2
Archaea (extreme halophiles, methanogens, hyperthermophiles)	2
<i>Phytoplasma, Spiroplasma and Mycoplasma</i>	2
Unit – II Classification, Comparative Structure/Function, Plant Pathogenic Aspects (Including Control) Of Viruses: 01 Credit	
Cucumber mosaic virus	2
Tobacco mosaic virus	2
Tomato leaf curl virus	2
Papaya ringspot virus	2
Yellow vein mosaic virus	2
Unit – III Classification, Comparative Structure/Function, Plant Pathogenic Aspects (Including Control) Of Fungi And Algae: 01 Credit	
Parasexuality in Fungi, <i>Alternaria sp.</i>	2
<i>Penicillium sp., Uromyces sp., Peronospora sp.</i>	2
Yeasts	1
<i>Anabaena sp., Gloeotrichia sp.</i>	1
<i>Cosmarium sp., Prochloron</i>	2
<i>Trentepohlia sp., Padina sp.</i>	2
Unit–IV Classification, Comparative Structure/Function, Plant Pathogenic Aspects (Including Control) Of Protozoa And Nematodes: 01 Credit	
<i>Entamoeba sp.</i>	2
<i>Paramecium sp.</i>	2
<i>Giardia sp.</i>	2
<i>Meloidogyne sp.</i>	2
<i>Ascaris sp.</i>	2
Practical based on Units I – IV : 01 Credit	

M.Sc. MICROBIOLOGY (SEMESTER – I)
PAPER - III
CELL STRUCTURE: 05 Credits
(w.e.f. July 2018)

Total : 40 Hours

Unit – I Cell Structure And Cell Cycle: 01 Credit	Hrs
Cell structure and organization in prokaryotes and eukaryotes	2
General structure of a bacterial cell and mycoplasma	2
General structure of Viruses, Algae	2
General structure of Fungi , Protozoa	2
Cell cycle and cell synchrony	2
Unit – II Cell Organelles - I: 01 Credit	
Cell wall and Plasma membrane	3
Lysosomes and golgi bodies	2
Microtubules, Microfilaments, Intermediate filaments	3
Taxic movements	2
Unit – III Cell Organelles - II: 01 Credit	
Nucleus	2
Arrangement of DNA in prokaryotes and eukaryotes	2
Mitochondria	2
Chloroplast	2
Ribosomes	2
Unit – IV Bacterial Growth: 01 Credit	
Bacterial growth principles (binary fission and growth curve)	3
Measurement of microbial growth (Standard plate count/viable count, direct Microscopic count using Petroff-Hausser counting chamber, turbidity measurement)	3
Continuous and synchronous cultures	2
Factors affecting bacterial growth (temperature, oxygen, pH, hydrostatic and atmospheric pressure)	2
Practical based on Units I – IV : 01 Credit	

M.Sc. MICROBIOLOGY (SEMESTER – I)
PAPER - IV
MICROBIAL GENETICS: 05 Credits
(w.e.f. July 2018)

Total: 40 Hours

Unit – I Basic Genetics: 01 Credit	Hrs
Mendelian principles	2
Neurospora genetics	2
Cell division (Mitosis, meiosis)	3
Linkage and crossing over (Mechanism, significance)	3
Unit – II Genome Organization: 01 Credit	
Genome organization in bacteria and eukaryotes (DNA packaging, general aspects of organization of genes in bacteria and eukaryotes, C-value paradox)	2
Types of genomes in viruses, genome organization of tobacco mosaic virus	2
DNA replication (DNA polymerase holoenzyme, mechanism, clamp loading, proof-reading)	2
Plasmids (Purification, organization, F-plasmid, R-plasmid, Ti plasmid, ColE1 plasmid replication control)	2
Genetic recombination in bacteria (General principles, transformation, transduction, conjugation)	2
Unit – III Genetic Code, Mutation & Dna Repair: 01 Credit	
Genetic code (Discovery, significance, degeneracy)	2
Types of mutations (Point mutations [substitution, addition, deletion], frameshift, silent)	3
Molecular mechanisms of mutations (Induction, reversions)	3
DNA repair mechanisms (Base excision, mismatch, double strand break, SOS)	2
Unit – IV Bacteriophage Genetics: 01 Credit	
Diversity of phage genomes	4
Life cycle of bacteriophage (lytic, lysogenic)	4
Genetic switch of phage lambda (Biphasic nature, λ repressor, induction of switch)	2
Practical based on Units I – IV : 01 Credit	

M.Sc. MICROBIOLOGY (SEMESTER - II)
PAPER - I
MICROBIAL PHYSIOLOGY & BIOCHEMISTRY: 05 Credits
(w.e.f. July 2018)

Total: 40 Hours

Unit – I Microbial Metabolites: 01 Credit	Hrs
Carbohydrates	2
Lipids	2
Amino acids	2
Proteins	2
Nucleic acids	2
Unit – II Bacterial Respiration And Energy Production: 01 Credit	
Oxidation-reduction reactions, redox tower, Electron carriers, Energy-rich compounds (ATP, Coenzyme A)	1
Electron transport system, Generation of the PMF, ATP generation, oxidative phosphorylation, substrate-level phosphorylation	2
Chemolithotrophy (oxidation of hydrogen, iron, and reduced sulphur and inorganic nitrogen compounds by bacteria), Anammox	2
Glycolysis and TCA cycle, anaerobic respiration (Denitrification, sulphate and sulphur reduction)	2
Fermentative diversity (Lactic acid, mixed-acid, propionic acid and Clostridial fermentations)	2
Pentose phosphate pathway	1
Unit – III Bacterial Photosynthesis: 01 Credit	
Types of bacterial photosynthetic pigments (chlorophyll, bacteriochlorophyll, chlorosomes, carotenoids, phycobilins), reaction centres and antenna pigments, photosynthetic membranes	2
Anoxygenic and oxygenic photosynthesis, Electron flow in purple, green and cyanobacteria, generation of reducing power and ATP	3
Carboxysomes, pathways for CO ₂ fixation (Calvin cycle, reverse citric acid cycle, hydroxypropionate pathway, Acetyl-CoA pathway)	3
Asymbiotic and symbiotic nitrogen fixation and nitrogenase complex	2
Unit – IV Enzymes: 01 Credit	
Nomenclature and classification	2
Nature and specificity	2
Modes of action	2
Kinetics and regulation	2
Enzyme inhibition and allosteric control	2
Practical based on Unit I – IV : 01 Credit	

M.Sc. MICROBIOLOGY (SEMESTER - II)
PAPER - II
MOLECULAR BIOLOGY AND GENETIC ENGINEERING: 05 Credits
(w.e.f. July 2018)

Total: 40 Hours

Unit – I Transcription, Translation, Gene Regulation: 01 Credit	Hrs
Structure of bacterial gene (Operon model)	1
Transcription and post-transcriptional processing of mRNA	2
Regulation of gene expression (Operon model)	2
<i>lac</i> Operon, <i>trp</i> Operon (Organization, regulation, repression)	3
Translation and post-translational processing of proteins	2
Unit – II Recombinant DNA Technology – I: 01 Credit	
Introduction to recDNA technology (General concepts, isolation, purification and visualization of genomic and plasmid DNA)	2
Enzymes used in recDNA (Restriction endonuclease, ligase, DNA polyaersase, Reverse transcriptase)	2
General properties of vectors, pBR322, ColE1 origin of replication, α -complementation, pUC vectors, phage lambda DNA as vector, cosmids	3
Expression vectors	1
Cloning strategies (Restriction digestion, ligation, linkers, adapters, homopolymer tails, directional cloning, TA-cloning)	2
Unit – III Recombinant DNA Technology – II: 01 Credit	
DNA sequencing	2
cDNA and genomic libraries (Generation of cDNA, RT-PCR, CAPture method for full length cDNA, generation of genomic library)	3
Screening methods and characterization of cloned inserts (Insertional inactivation, α -complementation, hybridization, immunological screening, bait-prey two hybrid system)	3
Bacterial transformation methods (Preparation of competent cells, transformation by heat shock, electroporation, microprojectile bombardment, <i>Agrobacterium</i> mediated using co-integrate or binary vector systems)	2
Unit – IV Special Techniques: 01 Credit	
PCR (including Real-time PCR)	2
Site-directed mutagenesis (Principles, generation of mutants, significance)	2
RFLP, AFLP, VNTRs	2
DNA microarray	2
<i>E. coli</i> genome	2
Practical based on Unit I – IV : 01 Credit	

M.Sc. MICROBIOLOGY (SEMESTER - II)
PAPER - III
PLANT VIROLOGY: 05 Credits
(w.e.f. July 2018)

Total: 40 Hours

Unit – I Classification And Structure Of Plant Viruses: 01 Credit	Hrs
Development of science of virology	2
Nomenclature and classification (Criteria, International Committee on Taxonomy of Viruses, classification)	2
Structural components	3
Particle morphology (Helical, icosahedral, bacilliform, geminate)	3
Unit – II Genome Organization And Replication Of Plant Viruses: 01 Credit	
Genome diversity (Variety, resource conservation, genome organization in TMV, BMV, CaMV, SYNV, TSWV, geminivirus)	3
Genome expression strategies	3
Replication of Tobacco mosaic virus (RNA virus)	2
Replication of Cauliflower mosaic virus (DNA virus)	2
Unit – III Symptomatology And Transmission Of Plant Viruses: 01 Credit	
Epidemiology of virus infection (Gene for gene hypothesis, host responses, hypersensitivity, sensitivity, disease cycles of TMV, CMV, PRSV, geminivirus)	2
Symptoms of virus-infected plants (Morphological, anatomical, physiological)	3
Modes of transmission (Mechanical, vegetative, graft, dodder, seed and pollen, nematodes, insect)	2
Molecular mechanisms of insect vector transmission (Externally borne, internally borne, examples potyvirus, caulimovirus, luteovirus, rhabdovirus)	3
Unit – IV Control Of Plant Viruses, And Sub-Viral Pathogens: 01 Credit	
Conventional methods of plant virus control	2
Modern methods of plant virus control (Cross protection, satRNA mediated, pathogen-derived resistance, R-gene mediated, PGPR mediated, IPM)	3
Satellite RNA	1
Viroids (Structure, classification, replication, pathogenicity)	2
Prions (General account)	1
Hepatitis delta virus (General account)	1
Practical based on Unit I – IV : 01 Credit	

M.Sc. MICROBIOLOGY (SEMESTER - II)
PAPER - IV
MEDICAL MICROBIOLOGY AND IMMUNOLOGY: 05 Credits
(w.e.f. July 2018)

Total: 40 Hours

Unit – I General Principles Of Host-Microbe Interaction: 01 Credit	Hrs
Host-microbe relationship and infection process	1
Koch's postulates	1
Kinds of disease, disease syndrome	2
Transmission of disease	2
Nature of virulence: Toxins (cholera, diphtheria, tetanus)	2
Nature of virulence: antiphagocytic factors, extracellular enzymes	2
Unit – II Microbial Diseases: 01 Credit	
Diseases caused by bacteria (Staphylococcus, Mycobacterium, Salmonella, Shigella)	2
Diseases caused by viruses (influenza virus, HIV)	2
Oncogenic viruses	2
Diseases caused by fungi (Candida albicans, Trichophyton, Aspergillus),	2
Diseases caused by protozoa (Amoeba, Plasmodium, Trypanosoma, Balantidium)	2
Unit – III Types Of Immunity : 01 Credit	
Cell-mediated/innate immunity (macrophages, phagocytosis, Cytotoxic lymphocytes, NK cells, pathogen-associated molecular patterns, toll-like receptors)	2
Inflammation, neutrophils, cytokines	1
Humoral/adaptive immunity (B and T-cells, T-cell receptors, MHC molecules and antigen processing and presentation, B-cell differentiation and antibody production)	2
Antibody-antigen reactions (Interaction, precipitation reactions, agglutination reactions, ELISA, immunoblot, immunoelectron microscopy)	2
Antibodies and complement (Basic structure, effector functions, complement and its activation (classical, alternative, lectin pathways), major classes of antibodies, generation of antibody diversity)	2
Monoclonal antibodies (Clonal selection theory, MAB technology, applications)	1
Unit – IV Artificial Immunity, Immunological Tolerance And Hypersensitivity: 01 Credit	
Hypersensitivity	2
Allergy and allergens	2
Artificial immunity to infectious diseases through active and passive immunization, classification of common vaccines (antigenic preparations, live attenuated, killed vaccines, toxin-based vaccines, conjugate vaccines, DNA vaccines, recombinant vector vaccines)	2
Autoimmune disorders	2
Antibiotics and their mode of action	2
Practical based on Unit I – IV : 01 Credit	

M.Sc. MICROBIOLOGY (SEMESTER - III)
PAPER - I
ENVIRONMENTAL MICROBIOLOGY: 05 Credits
(w.e.f. July 2018)

Total: 40 Hours

Unit – I Biosphere & Ecosystem: 01 Credit	Hrs
Biosphere	2
Ecosystem (General principles, components)	2
Energy transfer	2
Food chain	2
Microbes in extreme environments	2
Unit – II Microbiology Of Water: 01 Credit	
Microbial populations in natural water (marine and fresh-water)	2
Factors affecting growth in aquatic environments (temperature, salinity, light, pH, hydrostatic pressure, dissolved oxygen, inorganic nutrients, organic matter)	2
Purification of drinking water	2
Water borne diseases (Hepatitis A, poliomyelitis, cholera, gastroenteritis)	2
Algal blooms, biofilms.	2
Unit – III Water Pollution & Its Management: 01 Credit	
Sources of water pollution	2
Indicator microorganisms	2
Waste water treatment	2
Solid and liquid-waste treatment	2
Biological waste water management, BOD, COD.	2
Unit – IV Microbiology Of Soil & Air: 01 Credit	
Soil microbes and rhizosphere bacteria (plant growth promoting rhizobacteria)	2
Microbial interactions in soil (mutualism, commensalism, parasitism, predation, competition, amensalism)	2
Mycorrhiza (arbuscular mycorrhiza, ectomycorrhiza, ericaceous, monotropoid, orchitaceous)	2
Nitrogen, carbon and sulphur cycles	2
Sampling of microbes in air (passive monitoring, active monitoring by impingers, impactors)	2
Practical based on Unit I – IV : 01 Credit	

M.Sc. MICROBIOLOGY (SEMESTER - III)
PAPER - II
INDUSTRIAL & FOOD MICROBIOLOGY: 05 Credits
(w.e.f. July 2018)

Total: 40 Hours

Unit – I Introduction To Industrial Microbiology: 01 Credit	Hrs
Suitability of microbes in industrial processes and their source	2
Fermentation	2
Recovery and purification of fermentation products	2
Strain improvement	2
Product optimization	2
Unit – II Industrial Fermentation Products: 01 Credit	
Alcohol and alcoholic beverages	1
Organic acids (citric, lactic, acetic)	1
Amino acids (glutamine, lysine, tryptophan)	2
Enzymes (amylase, protease, pectinase)	2
Vitamins (B ₁₂ , riboflavin)	2
Immobilized enzyme technology	2
Unit – III Food Microbiology: 01 Credit	
Diversity of microbes in food (contamination with airborne bacteria, fungi, contamination with microorganisms present in soil, water, plants, skin, etc.)	3
Factors affecting growth of microorganisms in food (intrinsic factors such as pH, nutrient content, antimicrobial constituents, water activities and extrinsic factors such as temperature, relative humidity, atmospheric gases, etc.)	3
Spoilage of food products	2
Food borne diseases	2
Unit – IV Food Preservation: 01 Credit	
Food preservation by heat (pasteurization, appertization, D value, microbial heat Resistance), preservation by low temperature (chilling, freezing)	3
Preservation by radiation (microwave, UV, ionizing)	2
Preservation by chemical additives and canning	2
Lab testing procedures	3
Practical based on Unit I – IV : 01 Credit	

M.Sc. MICROBIOLOGY (SEMESTER - III)
PAPER - III
BIOSTATISTICS AND COMPUTER APPLICATIONS: 05 Credits
(w.e.f. July 2018)

Total: 40 Hours

Unit – I Statistical Concepts: 01 Credit	Hrs
Population and sample designs	2
Sampling methods (Random, non-random)	2
Frequency distribution (Qualitative, quantitative)	2
Tests of significance (General account, types of hypothesis, importance)	2
Tests of significance (Chi-square test, Students t-test, F-test)	2
Unit – II Distribution Patterns: 01 Credit	
Relationship between curve area and standard deviation	2
Departure from normality	2
Binomial and Poisson distributions and applications	2
Positive and negative correlations, regression	2
Prediction of unknown variables	2
Unit – III Introduction To Computers: 01 Credit	
Computer components and function	3
Concept of data/information	3
Representation of data in binary (binary to decimal, decimal to binary), bits, bytes	2
Introduction to programming language C ⁺⁺ (Algorithm, flowchart)	2
Unit – IV INTERNET AND BIOINFORMATICS: 01 Credit	
Biological databases (General account)	2
Sequence alignment and database searching	3
Evolutionary concepts based on sequences	2
BLAST, FASTA, EMBOSS	2
Multiple sequence alignment by CLUSTAL W	1
Practicals based on Unit I – IV : 01 Credit	

M.Sc. MICROBIOLOGY (SEMESTER - III)
PAPER - IV
MICROBIAL BIOTECHNOLOGY: 05 Credits
(w.e.f. July 2018)

Total: 40 Hours

Unit – I Pharmaceutical Biotechnology: 01 Credit	Hrs
Production of vaccines (including recombinant)	3
Production of insulin (including recombinant)	2
Production of antibiotics (Penicillin, streptomycin)	3
Production of recombinant interferon	2
Unit – II Food And Agricultural Biotechnology: 01 Credit	
Single cell protein	2
Beverages (tea, coffee, beer, wine)	2
Concerns about use of GM food and GM technology	2
Microbes as Biofertilizer	1
Microbes as Biopesticides	1
Microbes in Bioremediation	2
Unit – III Environmental And Industrial Biotechnology – I: 01 Credit	
Biodegradation of xenobiotics and toxic waste	2
Bioaccumulation and metal scavenging by microbes	2
Microbes in relation to Biofuels	2
Microbial Biosensors	2
Biopolymers	2
Unit – IV Environmental And Industrial Biotechnology – II: 01 Credit	
BT cotton (Technology, concerns)	3
Genetically modified microbes for environmental cleanup	3
Environmental cleanup of Petrol, diesel and by-products	2
Microbial utilization in mining and textile	2
Practical based on Unit I – IV : 01 Credit	

M.Sc. MICROBIOLOGY (SEMESTER - IV)

EXTERNAL PROJECT

Duration: 3-4 months

No. of Credits: 20 (w.e.f. July 2018)

Project work for Semester IV will be carried out by the students in various recognized/established labs of Other Universities, of Institutes under CSIR, ICMR, IIT, ICAR, DST, DBT, and of Industry etc. (to be arranged by the students themselves, including whatever expenses become due in this regard).