

**M.Sc. MICROBIOLOGY (Self Financing Course)**  
**(Two Year) Four Semester Programme under Choice Based Credit System**  
**(Applicable for students admitted in July, 2017 & onwards)**

**Semester I:**

**Max Marks**

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	<u>100</u> (04 credits)
	<b>Total</b>	<u>500</u> (20 credits)

**Semester II:**

Paper V:	Microbial Physiology and Biochemistry	100 (04 credits)
Paper VI:	Molecular Biology and Genetic Engineering	100 (04 credits)
Paper VII:	Plant Virology	100 (04 credits)
Paper VIII:	Medical Microbiology and Immunology	100 (04 credits)
Practical:	Based on Papers V – VIII	<u>100</u> (04 credits)
	<b>Total</b>	<u>500</u> (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	<u>100</u> (04 credits)
	<b>Total</b>	<u>500</u> (20 credits)

**Semester IV:**

Project Dissertation	300 (12 credits)
Project Presentation	100 (04 credits)
Project Viva-Voce	<u>100</u> (04 credits)
	<b>Total</b>
	<u>500</u> (20 credits)

Total Maximum Marks for all 4 Semesters:	2000 (80 credits)
<b>+ 1 Elective Course/ semester: 03 credits - 100 marks</b>	<u>400</u> (12 credits)
<b>Total</b>	<b>2400 (92 credits)</b>

**M.Sc. MICROBIOLOGY (SEMESTER –I)**  
**PAPER I**  
**TECHNIQUES AND TOOLS IN MICROBIOLOGY: 05 Credits**

**Total: 48 Hours**

<b>Unit – I Culture And Visualization Of Microbes: 01 Credit</b>	<b>Hours</b>
Pure cultures, culture media (defined/synthetic, complex, selective, differential, enriched)	2
Aseptic conditions, sterilization techniques, inoculation methods (spread-plate, streak-plate, pour-plate)	2
Culture characteristics, culturing for specific requirements e.g. antibiotic sensitivity	2
Principles of staining, Gram stain, staining for <i>Mycobacterium</i> , endospore, capsule, flagella	2
Principles of microscopy, compound microscope, phase contrast microscope, fluorescence microscope	2
Electron microscope, SEM, TEM, stains in electron microscopy	2
<b>Unit – II Spectroscopy And Tracer Techniques (Principle, Instrumentation, Application) : 01 Credit</b>	
UV and visible light Spectrophotometry	3
Spectrofluorimetry	2
Atomic absorption spectroscopy	2
Electron spin resonance spectroscopy, Nuclear magnetic resonance spectroscopy	3
Tracer techniques (Types of radioactive decay, detection and measurement of radioactivity by Geiger-Muller and scintillation counting, autoradiography)	2
<b>Unit – III Centrifugation And Separation Techniques: 01 Credit</b>	
Ultracentrifugation, density gradient centrifugation	2
Paper and thin layer chromatography	2
Column chromatography – ion-exchange, affinity, hydrophobic interaction, reverse-phase, size-exclusion,	3
Gas chromatography, HPLC,	2
Polyacrylamide gel electrophoresis (native and SDS), 2D electrophoresis, isoelectric focusing	3
<b>Unit – IV Techniques In Virology: 01 Credit</b>	
Bioassay, Purification	3
Test for viral purity, Quantification	3
Serology (Ouchterlony gel diffusion, ELISA, immunoblotting)	2
Serologically specific electron microscopy, RIA	2
Molecular methods of virus identification (Southern blotting, northern blotting, PCR)	2
<b>Practical based on Units I – IV : 01 Credit</b>	

**M.Sc. MICROBIOLOGY (SEMESTER – I)**  
**PAPER II**  
**MICROBIAL DIVERSITY: 05 Credits**

**Total: 48 Hours**

<b>Unit – I Classification, Comparative Structure/Function, Plant Pathogenic Aspects (Including Control) Of Bacteria And Archaea: 01 Credit</b>	<b>Hours</b>
<i>Xanthomonas oryzae, Erwinia carotovora</i>	2
<i>Ralstonia (Pseudomonas) solanacearum</i>	3
<i>Streptomyces scabies, Agrobacterium tumefaciens</i>	2
Archaea (extreme halophiles, methanogens, hyperthermophiles)	2
<i>Phytoplasma, Spiroplasma and Mycoplasma</i>	3
<b>Unit – II Classification, Comparative Structure/Function, Plant Pathogenic Aspects (Including Control) Of Viruses: 01 Credit</b>	
Cucumber mosaic virus	3
Tobacco mosaic virus	3
Tomato leaf curl virus	2
Papaya ringspot virus	2
Yellow vein mosaic virus	2
<b>Unit – III Classification, Comparative Structure/Function, Plant Pathogenic Aspects (Including Control) Of Fungi And Algae: 01 Credit</b>	
Parasexuality in Fungi, <i>Alternaria sp.</i>	2
<i>Penicillium sp., Uromyces sp., Peronospora sp.</i>	2
Yeasts	2
<i>Anabaena sp., Gloeotrichia sp.</i>	2
<i>Cosmarium sp., Prochloron</i>	2
<i>Trentepohlia sp., Padina sp.</i>	2
<b>Unit–IV Classification, Comparative Structure/Function, Plant Pathogenic Aspects (Including Control) Of Protozoa And Nematodes: 01 Credit</b>	
<i>Entamoeba sp.</i>	2
<i>Paramecium sp.</i>	2
<i>Giardia sp.</i>	2
<i>Meloidogyne sp.</i>	3
<i>Ascaris sp.</i>	3
<b>Practical based on Units I – IV : 01 Credit</b>	

**M.Sc. MICROBIOLOGY (SEMESTER – I)**  
**PAPER - III**  
**CELL STRUCTURE: 05 Credits**

**Total: 48 Hours**

<b>Unit – I Cell Structure And Cell Cycle: 01 Credit</b>	<b>Hours</b>
Cell structure and organization in prokaryotes and eukaryotes	3
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	3
<b>Unit – II Cell Organelles - I: 01 Credit</b>	
Cell wall and Plasma membrane	3
Lysosomes and golgi bodies	3
Microtubules, Microfilaments, Intermediate filaments	3
Taxic movements	3
<b>Unit – III Cell Organelles - II: 01 Credit</b>	
Nucleus	2
Arrangement of DNA in prokaryotes and eukaryotes	3
Mitochondria	2
Chloroplast	3
Ribosomes	2
<b>Unit – IV Bacterial Growth: 01 Credit</b>	
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	3
Factors affecting bacterial growth (temperature, oxygen, pH, hydrostatic and atmospheric pressure)	3
<b>Practical based on Units I – IV : 01 Credit</b>	

**M.Sc. MICROBIOLOGY (SEMESTER – I)**  
**PAPER - IV**  
**MICROBIAL GENETICS: 5 Credits**

**Total: 48 Hours**

<b>Unit – I Basic Genetics: 01 Credit</b>	<b>Hours</b>
Mendelian principles	3
Neurospora genetics	3
Cell division (Mitosis, meiosis)	3
Linkage and crossing over (Mechanism, significance)	3
<b>Unit – II Genome Organization: 01 Credit</b>	
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)	3
Plasmids (Purification, organization, F-plasmid, R-plasmid, Ti plasmid, ColE1 plasmid replication control)	2
Genetic recombination in bacteria (General principles, transformation, transduction, conjugation)	3
<b>Unit – III Genetic Code, Mutation &amp; Dna Repair: 01 Credit</b>	
Genetic code (Discovery, significance, degeneracy)	3
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)	3
<b>Unit – IV Bacteriophage Genetics: 01 Credit</b>	
Diversity of phage genomes	4
Life cycle of bacteriophage (lytic, lysogenic)	4
Genetic switch of phage lambda (Biphasic nature, $\lambda$ repressor, induction of switch)	4
<b>Practical based on Units I – IV : 01 Credit</b>	

**M.Sc. MICROBIOLOGY (SEMESTER - II)**  
**PAPER - V**  
**MICROBIAL PHYSIOLOGY & BIOCHEMISTRY: 05 Credits**  
**Total: 48 Hours**

<b>Unit – I Microbial Metabolites: 01 Credit</b>	<b>Hours</b>
Carbohydrates	2
Lipids	2
Amino acids	2
Proteins	3
Nucleic acids	3
<b>Unit – II Bacterial Respiration And Energy Production: 01 Credit</b>	
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	3
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)	3
Fermentative diversity (Lactic acid, mixed-acid, propionic acid and Clostridial fermentations)	2
Pentose phosphate pathway	1
<b>Unit – III Bacterial Photosynthesis: 01 Credit</b>	
Types of bacterial photosynthetic pigments (chlorophyll, bacteriochlorophyll, chlorosomes, carotenoids, phycobilins), reaction centres and antenna pigments, photosynthetic membranes	3
Anoxygenic and oxygenic photosynthesis, Electron flow in purple, green and cyanobacteria, generation of reducing power and ATP	3
Carboxysomes, pathways for CO <sub>2</sub> fixation (Calvin cycle, reverse citric acid cycle, hydroxypropionate pathway, Acetyl-CoA pathway)	3
Asymbiotic and symbiotic nitrogen fixation and nitrogenase complex	3
<b>Unit – IV Enzymes: 01 Credit</b>	
Nomenclature and classification	3
Nature and specificity	2
Modes of action	2
Kinetics and regulation	3
Enzyme inhibition and allosteric control	2
<b>Practical based on Unit I – IV : 01 Credit</b>	

**M.Sc. MICROBIOLOGY (SEMESTER - II)**  
**PAPER - VI**  
**MOLECULAR BIOLOGY AND GENETIC ENGINEERING: 05 Credits**

**Total: 48 Hours**

<b>Unit – I Transcription, Translation, Gene Regulation: 01 Credit</b>	<b>Hours</b>
Structure of bacterial gene (Operon model)	1
Transcription and post-transcriptional processing of mRNA	3
Regulation of gene expression (Operon model)	3
<i>lac</i> Operon, <i>trp</i> Operon (Organization, regulation, repression)	3
Translation and post-translational processing of proteins	2
<b>Unit – II Recombinant DNA Technology – I: 01 Credit</b>	
Introduction to recDNA technology (General concepts, isolation, purification and visualization of genomic and plasmid DNA)	1
Enzymes used in recDNA (Restriction endonuclease, ligase, DNA polyaersase, Reverse transcriptase)	2
General properties of vectors, pBR322, ColE1 origin of replication, $\alpha$ -complementation, pUC vectors, phage lambda DNA as vector, cosmids	3
Expression vectors	2
Cloning strategies (Restriction digestion, ligation, linkers, adapters, homopolymer tails, directional cloning, TA-cloning)	4
<b>Unit – III Recombinant DNA Technology – II: 01 Credit</b>	
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, $\alpha$ -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)	4
<b>Unit – IV Special Techniques: 01 Credit</b>	
PCR (including Real-time PCR)	3
Site-directed mutagenesis (Principles, generation of mutants, significance)	2
RFLP, AFLP, VNTRs	3
DNA microarray	2
<i>E. coli</i> genome	2
<b>Practical based on Unit I – IV : 01 Credit</b>	

**M.Sc. MICROBIOLOGY (SEMESTER - II)**  
**PAPER - VII**  
**PLANT VIROLOGY: 05 Credits**

**Total: 48 Hours**

<b>Unit – I Classification And Structure Of Plant Viruses: 01 Credit</b>	<b>Hours</b>
Development of science of virology	3
Nomenclature and classification (Criteria, International Committee on Taxonomy of Viruses, classification)	3
Structural components	3
Particle morphology (Helical, icosahedral, bacilliform, geminate)	3
<b>Unit – II Genome Organization And Replication Of Plant Viruses: 01 Credit</b>	
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)	3
Replication of Cauliflower mosaic virus (DNA virus)	3
<b>Unit – III Symptomatology And Transmission Of Plant Viruses: 01 Credit</b>	
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)	4
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)	4
<b>Unit – IV Control Of Plant Viruses, And Sub-Viral Pathogens: 01 Credit</b>	
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)	4
Satellite RNA	1
Viroids (Structure, classification, replication, pathogenicity)	2
Prions (General account)	2
Hepatitis delta virus (General account)	1
<b>Practical based on Unit I – IV : 01 Credit</b>	



**M.Sc. MICROBIOLOGY (SEMESTER - II)**  
**PAPER - VIII**  
**MEDICAL MICROBIOLOGY AND IMMUNOLOGY: 05 Credits**

**Total: 48 Hours**

<b>Unit – I General Principles Of Host-Microbe Interaction: 01 Credit</b>	<b>Hours</b>
Host-microbe relationship and infection process	2
Koch's postulates	2
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
<b>Unit – II Microbial Diseases: 01 Credit</b>	
Diseases caused by bacteria (Staphylococcus, Mycobacterium, Salmonella, Shigella)	3
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)	3
<b>Unit – III Types Of Immunity : 01 Credit</b>	
Cell-mediated/innate immunity (macrophages, phagocytosis, Cytotoxic lymphocytes, NK cells, pathogen-associated molecular patterns, toll-like receptors)	3
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)	2
<b>Unit – IV Artificial Immunity, Immunological Tolerance And Hypersensitivity: 01 Credit</b>	
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)	3
Autoimmune disorders	2
Antibiotics and their mode of action	3
<b>Practical based on Unit I – IV : 01 Credit</b>	

**M.Sc. MICROBIOLOGY (SEMESTER - III)**  
**PAPER - I**  
**ENVIRONMENTAL MICROBIOLOGY: 05 Credits**

**Total: 48 Hours**

<b>Unit – I Biosphere &amp; Ecosystem: 01 Credit</b>	<b>Hours</b>
Biosphere	3
Ecosystem (General principles, components)	2
Energy transfer	2
Food chain	3
Microbes in extreme environments	2
<b>Unit – II Microbiology Of Water: 01 Credit</b>	
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)	3
Algal blooms, biofilms.	3
<b>Unit – III Water Pollution &amp; Its Management: 01 Credit</b>	
Sources of water pollution	3
Indicator microorganisms	2
Waste water treatment	2
Solid and liquid-waste treatment	3
Biological waste water management, BOD, COD.	3
<b>Unit – IV Microbiology Of Soil &amp; Air: 01 Credit</b>	
Soil microbes and rhizosphere bacteria (plant growth promoting rhizobacteria)	2
Microbial interactions in soil (mutualism, commensalism, parasitism, predation, competition, amensalism)	3
Mycorrhiza (arbuscular mycorrhiza, ectomycorrhiza, ericaceous, monotropoid, orchitaceous)	2
Nitrogen, carbon and sulphur cycles	3
Sampling of microbes in air (passive monitoring, active monitoring by impingers, impactors)	2
<b>Practical based on Unit I – IV : 01 Credit</b>	

**M.Sc. MICROBIOLOGY (SEMESTER - III)**  
**PAPER - II**  
**INDUSTRIAL & FOOD MICROBIOLOGY: 05 Credits**

**Total: 48 Hours**

<b>Unit – I Introduction To Industrial Microbiology: 01 Credit</b>	<b>Hours</b>
Suitability of microbes in industrial processes and their source	2
Fermentation	3
Recovery and purification of fermentation products	3
Strain improvement	2
Product optimization	2
<b>Unit – II Industrial Fermentation Products: 01 Credit</b>	
Alcohol and alcoholic beverages	2
Organic acids (citric, lactic, acetic)	2
Amino acids (glutamine, lysine, tryptophan)	2
Enzymes (amylase, protease, pectinase)	2
Vitamins (B <sub>12</sub> , riboflavin)	2
Immobilized enzyme technology	2
<b>Unit – III Food Microbiology: 01 Credit</b>	
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	3
Food borne diseases	3
<b>Unit – IV Food Preservation: 01 Credit</b>	
Food preservation by heat (pasteurization, appertization, D value, microbial heat Resistance), preservation by low temperature (chilling, freezing)	3
Preservation by radiation (microwave, UV, ionizing )	3
Preservation by chemical additives and canning	3
Lab testing procedures	3
<b>Practical based on Unit I – IV : 01 Credit</b>	

**M.Sc. MICROBIOLOGY (SEMESTER - III)**  
**PAPER - III**  
**BIostatistics AND COMPUTER APPLICATIONS: 05 Credits**

**Total: 48 Hours**

<b>Unit – I Statistical Concepts: 01 Credit</b>	<b>Hours</b>
Population and sample designs	3
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)	3
<b>Unit – II Distribution Patterns: 01 Credit</b>	
Relationship between curve area and standard deviation	3
Departure from normality	2
Binomial and Poisson distributions and applications	3
Positive and negative correlations, regression	2
Prediction of unknown variables	2
<b>Unit – III Introduction To Computers: 01 Credit</b>	
Computer components and function	3
Concept of data/information	3
Representation of data in binary (binary to decimal, decimal to binary), bits, bytes	3
Introduction to programming language C <sup>++</sup> (Algorithm, flowchart)	3
<b>Unit – IV INTERNET AND BIOINFORMATICS: 01 Credit</b>	
Biological databases (General account)	3
Sequence alignment and database searching	3
Evolutionary concepts based on sequences	3
BLAST, FASTA, EMBOSS	2
Multiple sequence alignment by CLUSTAL W	1
<b>Practical based on Unit I – IV : 01 Credit</b>	

**M.Sc. MICROBIOLOGY (SEMESTER - III)**  
**PAPER - IV**  
**MICROBIAL BIOTECHNOLOGY: 05 Credits**

**Total: 48 Hours**

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

**M.Sc. MICROBIOLOGY (SEMESTER - IV)**

**EXTERNAL PROJECT**

**Duration: 3-4 months**

**No. of Credits: 20**

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).