Dr. SHYAMA PRASAD MUKHERJEE UNIVERSITY

RANCHI

SYLLABUS FOR MASTER IN SCIENCE

MICROBIOLOGY

SEMESTER SYSTEM

(2018)

SYLLABUS FOR M.Sc. Microbiology

DSPMU, RANCHI

COURSE STRUCTURE OF M.Sc.

Semester	Paper number	Name of the Paper	Mid Sem	End Sem	Full Marks	Pass Marks
Semester I	Paper I	General Microbiology	30	70	100	45
	Paper II	Diversity of Prokaryotic and Eukaryotic Microbes	30	70	100	45
	Paper III	Microbial Physiology and Metabolism	30	70	100	45
	Paper IV	Virology	30	70	100	45
	Paper V	Practical based on Paper I and Paper II	00	00	100	45
	Paper VI	Practical based on Paper III and Paper IV	00	00	100	45
Semester II	Paper VII	Cell Biology and Analytical techniques	30	70	100	45
	Paper VIII	Bio-Molecules and Enzymes	30	70	100	45
	Paper IX	Environmental Microbiology	30	70	100	45
	Paper X	Microbial Genetics	30	70	100	45
	Paper XI	Practical based on Paper VII and Paper VIII	00	00	100	45
	Paper XII	Practical based on Paper IX and Paper X	00	00	100	45

Semester III	Paper XIII	Molecular Biology	30	70	100	45
	Paper XIV	Recombinant DNA Technology	30	70	100	45
	Paper XV	Medical Microbiology	30	70	100	45
	Paper XVI	Agricultural Microbiology	30	70	100	45
	Paper XVII	Practical based on Paper XIII and Paper XIV	00	00	100	45
	Paper XVIII	Practical based on Paper XV and Paper XVI	00	00	100	45
Semester IV	Paper XIX	Industrial Microbiology and Bioprocess Engineering	30	70	100	45
	Paper XX	Bioinformatics	30	70	100	45
	Paper XXI	Immunology	30	70	100	45
	Paper XXII	Food And Dairy Microbiology	30	70	100	45
	Paper XXIII	Practical based XX, Paper XXI and Paper XII	00	00	100	45
	Paper XXIV	DISSERTATION	00	00	100	45
		Total Marks			2400	

M.Sc. Microbiology Semester I
Paper I: General Microbiology

UNIT – I: History and scope of Microbiology. Recent trends and developments in modernmicrobiology. Identification, characterization and classification of microorganisms- Principles of bacterial taxonomy and classification: - Bergey's manual and its importance,Concepts, nomenclature and taxonomic ranks: general properties of bacterialgroups. Major characteristics used in Taxonomy-morphological, physiological andmetabolic, ecological, numerical taxonomy, genetic and molecular classificationsystems; the kingdoms of organisms and phylogenetic trees. Distinguishingcharacteristics between prokaryotic and eukaryotic cells Structure and function of Cellwall of bacteria, cell membranes, flagella, pili, capsule, gas vesicles, carboxysomes,magnetosomes and phycobolisomes.

UNIT- II: Methods of sterilization**:** Physical methods – Dry heat, moist heat, radiationmethods, filtration methods, chemical methods and their application. Concept ofcontainment facility, sterilization at industrial level.Microbial cultures: Concept of pure culture, Methods of pure culture isolation,Enrichment culturing techniques, single cell isolation, and pure culture development.Microscopic identification characteristics, staining methods – simple staining,differential staining, structural staining and special staining methods.

UNIT -III: Microbiological media-Natural and synthetic; autotrophic, heterotrophic and phototropicmedia: basal, defined, complex, enrichment, selective, differential, maintenance andtransport mediaPreservation and Maintenance of Microbial cultures: Repeated sub culturing,preservation at low temperature, sterile soil preservation, mineral oil preservation, deepfreezing and liquid nitrogen preservation, drying, glycerol cultures, freeze-drying(lyophilization).

UNIT -IV: Bacterial nutrition and growth kinetics- synchronous, stock,batch and continuouscultures. Growth measurement methods –Metabolic diversity, measurements of NAD, ATP, DNA, and Protein, CO_2 liberated O_2 consumed, extra cellular enzymes. Cultivationof aerobes and anaerobes.
Reproduction and spore formation in bacteria.Morphology, Ultra structure and chemical composition of bacteria,actinomycetes, spirochetes, rickettsiae, mycoplasma, Chlamydiae.

M.Sc. Microbiology Semester I
Paper II: Diversity of Prokaryotic and Eukaryotic Microbes

UNIT I. Archaea: Systematics, and occurrence, diversity, characteristic features, significance and potential applications(eg. biochips, methane generation, ultrafiltration membranes, production of PHB and PHA, desulphurization ofcoal and crude oil, bioleaching of metals, enzymes, compatible solutes and others) of different groups ofarchaebacteria (Crenarchaeota, Euarchaeota, Korarchaeota, Nanoarchaeota).

UNIT II. Bacteria: Conventional and molecular systematics, and general discussion on the occurrence, diversity,characteristic features, significance and potential applications of various groups of bacteria according toBergey's Manual of Systematic Bacteriology.

UNIT III. Fungal Systematics and diversity: Implications of molecular and biochemical methods including rDNAanalysis, RFLP, RAPD.Endophytic fungi, colonization and adaptationof endophytes.Endophytes as latent pathogens and biocontrol agents.

Mycorrhizal fungi: Diversity of endo and ectomycorrhizal fungi. Biology of arbuscularmycorrhizal fungi:signaling, penetration and colonization inside roots, culturing and benefits, recent advances in the field ofmycorrhiza. **Agriculturally important toxigenic fungi:** Biodiversity, Chemical and biological characterization of toxicmetabolites, toxigenic fungi in sustainable agriculture with special emphasis on biopesticides.

UNIT IV. Biotechnological applications of yeasts: Yeasts as producers of bioactive molecules such as pigments, lipids,organic acids and EPS, yeasts as probiotics, yeasts in bioremediation, yeasts in alcoholic fermentations.

UNIT V. Algal diversity from morphology to molecules: Importance of algae in production of algal pigments, biofuels,hydrogen production, important bioactive molecules, role of algae in sustainable environment.

M.Sc. Microbiology Semester I
Paper III: Microbial Physiology and Metabolism

UNIT I. Growth and cell division: Measurement of growth, growth physiology, cell division, growth yields, growthkinetics, steady state growth and continuous growth.

UNIT II. Solute Transport: Primary and Secondary transport: Introduction, Kinetics,ABC transporters, Phosphotransferase system, Drug export systems, amino acid transport.

UNITIII. Central Metabolic Pathways and Regulation: Glycolysis, PPP, ED pathway, Citric acid cycle: Branched TCA andReverse TCA, glyoxylate cycle.

UNIT IV. Protein and Nitrogen metabolism: Metabolism of amino acids: Amino acid biosynthesis and utilisation. Catabolism of amino acid, transamination, decarboxylation and oxidative deamination.

UNIT V. Metabolism of lipids and hydrocarbons: Lipid composition of microorganisms,biosynthesis and degradation oflipids.

UNIT VI. Metabolism of nucleotides: Purine and pyrimidine biosynthesis, regulation of purine and pyrimidine biosynthesis,inhibitors of nucleotide synthesis.

UNIT VII. Physiological Adaptations and Intercellular signaling: Introduction to two component system, regulatory systemsduring aerobic- anaerobic shifts: Arc, Fnr, Nar, FhlAregulon, response to phosphate supply: The Pho regulon. Quorum sensing: A and C signaling system, sporulation in *Bacillus subtilis*, control of competence in *Bacillussubtilis*.Heat-Shock responses, pH homeostasis, osmotic homeostasis.

M.Sc. Microbiology Semester I
Paper IV: VIROLOGY

UNIT I. Animal Viruses: Classification, Morphology and Chemistry of Viruses: Virus evolution and classification, properties of viruses,virus structure. Techniques for visualisation and enumeration of viral particles, measuring biologicalactivity of viruses, characterization of viral products expressed ininfected cells, Diagnostic virology, Physical and chemical manipulation of viruses.

UNIT II. Virus replication Strategies: Principal events involved in replication: Adsorption, penetration, uncoating nucleicacid and protein synthesis, intracellular trafficking, assembly, maturation and release, viral-host interaction, Hostresponse to viral infection.Replicative strategies employed by animal DNA viruses. Replicativestrategies employed by animal RNA viruses. Identification of virus prototypes associated with different virusreplication schemes; Details on important viruses namely Herpesvirus, Poliovirus, Influenza virus, VSV, SV40 andAdeno Virus, Poxviruses, Hepatitis Viruses, coronaviruses, Retroviruses.**Subviral pathogens:** HDV, Prions, Viroids.

UNIT III. Pathogenesis of viral infectionand control of viral diseases: Stages of infection, Patterns of some viral diseases- epidemiology, transmission,infection, symptoms, risk, transformation and oncogenesis, emerging viruses.Host specific and nonspecific defense mechanismsinvolved in resistance to and recovery from virus infections. Role of interferon in viral infections. Viral Chemotherapy: Nucleoside analogs, reverse transcriptaseinhibitors, protease inhibitors, History of vaccines especially smallpox and polio. New methods: subunit vaccines,anti-idiotype and DNA vaccines.

UNIT IV. Plant and microbial viruses: General methodsof propagation of plant viruses; purification of plant viruses using centrifugation, chromatography andelectrophoresis techniques, their assay and comparison of the sensitivity of assay methods; methods employed inidentification of plant viruses and structural and functional genomics.

UNIT V. Symptoms of plant virus diseases, transmission of plant viruses, viral and viroid diseases and their control: General discussion on symptoms caused by viruses and viroids in diseased economically important trees andagricultural crops, and their control including development of virus disease resistant transgenics.

UNIT VI. Microbial viruses: Diversity, classification, characteristics and applications of bacteriophages, and general accounton algal, fungal and protozoan viruses.

PAPER V: Practical based on Paper I and Paper II

PAPER VI: Practical based on Paper III and Paper IV

M.Sc. Microbiology Semester II
Paper VII: Cell Biology and Analytical techniques

UNIT I. Organellar Biology: structure, function and biogenesis of chloroplast and mitochondria, mesosomes, lysosomes and cytoskeletal system. Photosynthesis in bacteria and plants, oxygenic and anoxygenic photosynthesis, PSI and PSII, electron transport, CO_2 fixation, purple green and halo bacteria photosynthesis. Physiochemical properties of bacteria- intracellular osmotic pressure, permeability of bacterial cell, nutrient transport-simple diffusion, active, passive and facilitated diffusion.

UNIT II. Signal transduction in eukaryotes: Protein kinases, phosphorylation cascades, Ras pathway, MAP kinase pathway, cylic nucleotides, G proteins.

UNIT III. Microscopy- Basic principles and application of light, phase contrast microscopy, fluorescent and electron microscope- scanning and transmission. Microtome and sample preparations- fixing of specimens, preparation of block, staining of biological samples. Principles of cytometry and flow cytometry.

UNIT V. Analytical Techniques: Principles of centrifugation,techniques, preparative and analytical methods, density gradient centrifugation. General principle and application of chromatography-paper, column, thin layer, Gas, Ion Exchange, affinity chromatography, HPLC and Gel filtration.Electrophoresis-moving boundary, zone electrophoresis, immunoelectrophoresis, immunoblotting, isoelectric focussing, 2-D electrophoresis.

UNIT VI. Principles, laws of aborption and radiation. Visible, ultraviolet, infrared and mass spectrophotometry. Absorption spectra, flame photometry, NMR,ESR, principles of colorimetry, turbidometry, viscometry. Determination of size, shape and molecular weight of macromolecule- light scattering, diffusion, sedimentation, optical rotatory dispersion and X ray diffraction.

UNIT VII. Radio isotopic tracers- methodology, radiometric analysis, stable and radioactive isotopes, preparation, labelling, detection and measurement of isotopes. RIA, Kinetics of radioactive disintegration, manometric techniques, freeze drying and its application in biological systems

M.Sc. Microbiology Semester II

Paper VIII: Bio-Molecules and Enzymes

UNIT I. Major Biomolecules: Carbohydrates – Classification, chemistry, properties, and function –. Conjugated polysaccharides– lycoproteins, muriens and lipopolysaccharides.

UNIT II. Lipids – classification, chemistry, properties and function –Conjugated lipids – lipoproteins. Major steroids of biological importance – prostaglandins.

UNIT III. Amino acids and proteins: classification, structure and function. Peptide structure. Ramachandran's plot.. Structural levels of proteins – primary, secondary, tertiary and quaternary, denaturation of proteins. Hydrolysis of proteins, Protein sequencing using various methods.

UNIT IV. Nucleic acids –Structure, function and their properties. Structural polymorphism of DNA, RNA. Structural characteristics of RNA. Sources,.

UNIT V. Enzymology- Introduction, General characteristics of enzymes, Activation energy, Coupled reactions, active site and its importance, Factors influencing catalytic efficiency. Enzyme kinetics, Rapid Equilibrium, Henry-Nucgaekkus-Menten's equations, Steady State approach, significance of Km, Haldane equation, Velocity vital Substrate concentration curves. Methods of plotting enzyme kinetics data-Lineweaver-Burk. Equilibrium dialysis, Effect of pH and temperature on enzyme stability and activity, Arrhenius equation.

UNIT VI. Regulation of enzyme activity: Feedback inhibition, reversible covalent modification, irreversible covalent modification, allosteric concept, Aspartate transcarbamylalse, ligand-protein interaction, scatchard plot, Hill plot, cooperativity index, Models for allostery (MWC, KNF), Half site reactivity. Enzyme Inhibition, Models and types of inhibition.

UNIT VII. Applied enzymology: Application of enzymes in analytical labs. (clinical and industrial), enzymes as industrial catalysts, Immobilized enzymes, enzyme electrodes, assay of enzyme activities for diagnostic purposes, abzymes, recent developments

M.Sc. Microbiology Semester II

PAPER IX: ENVIRONMENTAL MICROBIOLOGY

Unit 1 Brief history and development of environmental microbiology: History and development of microbial ecologyhighlighting significant contributions of microbiologists and emergence of environmental microbiology, andsignificant applications of microbes in solving environmental pollution problems.

Unit – 2 Environment and Ecosystems

Definitions, biotic and abiotic environment. Environmental segments. Composition and structureof environment. Concept of biosphere, communities and ecosystems. Ecosystem characteristics,structure and function. Food chains, food webs and trophic structures. Ecological pyramids.

Unit – 3 Eutrophication

Water pollution and its control,, Eutrophication, causes of eutrophication, effects ofeutrophication on the quality of water environment, factors influencing eutrophication.Qualitative characteristics and properties of eutrophic lakes. Algae in eutrophication, algal blooms, their effects and toxicity, coloured waters,red tides, and cultural eutrophication. Physico-chemical and biological measures to controleutrophication

Unit –4 Effluent treatment techniques

Microbiology of wastewater and solid waste treatment: - Waste-types-solid and liquid waste Characterization, physical, chemical, biological, aerobic, anaerobic, primary, secondary and Tertiary treatments.Anaerobic processes: Anaerobic digestion, anaerobic filters, and up flow anaerobic sludge.Treatment schemes for effluents of dairy, distillery, tannery, sugar and antibiotic industries.Bioconversion of Solid Waste and utilization as fertilizer.Bioaccumulation of heavy metal ions from industrial effluents.

Unit 5 Biodegradation

Factors affecting biodegradation, effects of pesticides, biodegradation of pesticides, mechanism of biodegradation, microorganisms involved, biodegradation of other toxic chemicals. Bioplastics.

Unit – 6 Bioremediation of Xenobiotics

Microbiology of degradation of xenobiotics in the environment, ecological considerations, decaybehaviour, bioaccumulation and bio magnification, oil pollution, surfactants and pesticides. Genetically Modified Organisms released and itsenvironmental impact assessment and ethical issues.Bioremediation of **Petroleum** hydrocarbons.

Unit – 7 Global environmental problems

Ozone depletion, UV-B,global warming and its impact, ozone layer-formation and depletion, greenhouse effect and acid rain, their impact and biotechnological approaches for management. .

M.Sc. Microbiology Semester II

Paper X: MICROBIAL GENETICS

UNIT I. Genetic analysis of bacteria: Importance and uses of mutation analysis. Inheritance in bacteria, types of mutations,spontaneous and induced mutagenesis, isolating mutants, selecting mutants, mutant enrichment. Reversions versussuppression. Complementation tests, recombination tests and gene replacements. Cloning genes bycomplementation. Cloning genes by marker rescue.

UNITII. Gene transfer and mapping by conjugation: Basis of fertility in bacteria. Self-transmissable and mobilizableplasmids. Molecular mechanism of gene transfer by conjugation – genes and proteins involved. Regulation of genetransfer by conjugation. Hfr strains. Mapping bacterial genomes using Hfr strains. Chromosomal DNA transfer byplasmids – by integrated plasmids, by chromosome mobilization and by creation of prime factors. Ti plasmid transfer system and its application in creating transgenics.

UNITIII. Lytic bacteriophages: Lytic development cycle using phages T4 and T7 as models. Regulation of expression ofgenes in phage T4 – transcriptional activators, antitermination, a new sigma factor and replication-coupledtranscription. Regulation of gene expression in phage T7 – a phage-encoded RNA polymerase. Replication of T4versus T7 phages – recent advances. Replication and packaging of filamentous phages M13 and f1 – recentadvances. Genetic analysis of phages – complementation and recombination tests with phages.

UNIT IV.Lysogenic phages: Lambda phage – gene and promoter organization. Lambda lytic cyle – regulation of geneexpression – very early, early and late genes. Establishment and maintenance of lysogeny. Regulation of geneexpression in lysogenic phase - role of cI, cII and cIII proteins. Lambda immunity region and immunity tosuperinfection. Events leading to induction – role of cI and cro repressors in regulating the events. Other lysogenicphages – P2 and P4.

UNIT V. Gene transfer by transformation and transduction: Natural transformation and competence. Molecular basis ofnatural transformation – DNA uptake competence systems in gram positive and gram negative bacteria. Regulationof competence in *B.subtilis*. Importance of natural transformation. Artificially induced competence. Generalizedversus specialized transduction - T4 and lambda phage. Mapping bacterial genes by transduction.

UNIT VI.Transposons: Discovery of transposition. Classes of bacterial transposons. Regulation of transposition activity.Effects of transposition in bacteria. Genetic requirements for transposition. Molecular mechanisms of transposition – genetic evidence supporting themechanisms. Conjugative transposons. Transposon mutagenesis. Cloning out genes by transposon mutagenesis. Mutransposon, Mu*d* transposons and gene fusions, mini-Mu elements and their use in *in vivo* cloning. Yeast Ty-1transposon

UNIT VII.Gene regulation: Control of gene expression. Positive gene regulation, negative gene regulation and attenuation,using the *lac*, *gal*, *trp*,

M.Sc. Microbiology Semester II

PAPER XI: Practical based on Paper VII and PaperVIII

PAPER XII: Practical based on Paper IX and Paper X

M.Sc. Microbiology Semester III
Paper XIII: MOLECULAR BIOLOGY

UNIT I. The nature of Genetic material: The structure of DNA and RNA; Melting of DNA, Superhelicity,Organization of Microbial Genomes, Organization of Eukaryotic Genomes, Chromatin arrangement, nucleosomeformation.

UNIT II.DNA replication: Arrangement of replicons in a genome, Various modes of replication, specific features of replication in Prokaryotes and Eukaryotes, action of topoisomerases, Telomeremaintenance and Chromatin Assembly, Single stranded DNA replication. DNA repair and recombination, DNA Mismatch Repair, Double StrandBreak Repair, Recombination as a molecular biology tool.

UNIT II.Transcription: Transcription machinery of prokaryotes, eukaryotes, various forms of RNApolymerase promoters, enhancers, silencers, activators, effectof chromatin structure, regulation of transcription.

UNIT III.Post-transcriptional processes: RNA processing, splicing, capping and polyadenylation, rRNA and tRNAprocessing, RNA Editing; RNAi and miRNAs, Antisense RNA, Post-transcriptional gene regulation.

UNIT IV.Translation: The genetic code and protein structure, Mechanisms of translation inprokaryotes, Mechanisms oftranslation in eukaryotes, *in vitro*translation systems, polycistronic/ monocistronic synthesis, Regulation of translation, RNA instability, inhibitors oftranslation, stringent response in bacteria. Post-translational processes:Protein modification, folding, chaperones, transportation; The Signal Hypothesis,protein degradation.

UNIT V. Molecular basis of cell physiology: Signals and cascades in organism development Molecular mechanisms of Oncogenesis and cancer,genetic disorders, aging, mitochondrial inheritance. Implications of genome organization, Genes and behavior, Genomeanalysis, DNA typing, Genomics and beyond.

M.Sc. Microbiology Semester III
Paper XIV: RECOMBINANT DNA TECHNOLOGY

UNIT I.Basics of DNA cloning: Simple cloning and cloning using linkers and adaptors. Cloning vectors – plasmids, phages lambda and M13, phagemids, cosmids, P1 phage, PACs, BACs and YACs. Selection andscreening of clones.

UNIT II.Methods of DNA and protein analysis: Isolation and purification of DNA.Agarose, polyacrylamide and pulsed field gel electrophoresis of DNA.Southern and Northern Blotting. Radiolabelling probes. RFLP analysis. DNAfingerprinting and its application. Native PAGE,SDS-PAGE and two-dimensional PAGE analysis of proteins. Western Blotting analysis.

UNIT III Polymerase Chain Reaction: Concept of PCR and various thermophilic enzymes used in PCR. Gradient PCRversus Touchdown PCR. Designing primers. Long PCR, Inverse PCR, RT-PCR, 5' and 3' RACE, qPCR, Real Time PCR using SYBR Green, Scorpion primers and TaqMan probes,MOPAC, Multiplex PCR, Differential Display PCR, RAPD fingerprinting of micro-organisms.

UNIT IV.Construction of cDNA and genomic DNA libraries: Vectors used in the construction of cDNA versus genomicDNA libraries. Screeninglibraries by colony hybridization and colony PCR. Enriching for clones in cDNAlibraries by positive selection and subtractive hybridization.

UNIT V. Genome sequencing: DNA sequencing by Sanger's method – traditional and cycle sequencing. Physical mappingby restriction fragment fingerprinting of BAC clones. Whole genome shotgunsequencing. Clone-by-clone shotgun sequencing of genome – preparation of BAC/YAC library, map construction,random shotgun phase, finishing phase and sequence authentication.Genome annotation at the nucleotide level, protein level and process level. Comparative genome sequencing ofmicro-organisms to identify and categorize SNPs. Array CGH.

UNIT VI.Transcriptional analysis of gene expression and transcriptomics: Gene expression analysis by NorthernBlotting, RT-PCR, EST analysis and the use of reporter genes.Transcriptome analysis by DD-PCR and EST analysis, DNA microarrays (cDNA arrays and oligo arrays), SerialAnalysis of Gene Expresion (SAGE).

UNIT VIIOverexpression of recombinant proteins: Overexpression and tagging of recombinant proteins in *E.coli*, driven bylac, T7 and Tet-regulatable promoters, Expression in *B. subtilis*. Overexpression systems in *S.cerevisiae*,*S.pombe*. Baculovirus overexpression system. Mammalian cell overexpression system.

UNIT VIII.Analysis of protein-DNA and protein-protein interactions: Gel retardation assay, DNA footprinting by DNase Iand chemical methods, yeast one-hybrid assay, ChIP-chips. Yeast two hybrids, three-hybrids, split hybrids and reverse hybrids. Co-immunoprecipitations, pull-downs and Far-Westerns. GFP and FRET. Phage display.

UNIT VIII.Pharmaceutical products of DNA technology: Human protein replacements – insulin, hGH and Factor VIII.Human therapies – TPA, interferon, antisense molecules.

M.Sc. Microbiology Semester III
Paper XV: MEDICAL MICROBIOLOGY

UNIT I.General topics on medical microbiology: History and development, Koch's postulates, classification of medically important bacteria. Infection: source, modes of transmission, portal of entry into susceptible host and prevention. Bacterial pathogenicity, identification of bacteria: staining methods, culture method, biochemical tests and other recent methods. Sterilization and disinfection. Normal microbial flora, antimicrobial agents, drug resistance and drug sensitivity test.

UNIT II.Systematic Microbiology: Diseases caused by Gram positive cocci-sore throat, pneumonia etc., Diseases caused by Gram negative cocci- meningitis, gonorrhoea etc. Diseases caused by Gram positive bacilli- Tuberculosis, Diptheria, Tetanus, Gas gangrene etc, Diseases caused by Gram negative bacilli of Entrobacteriaceae- Enteric fever, Bacillary dysentery, UTI
Diseases caused by Gram negative bacilli- Cholera, plague, Whooping cough, Wound infection, Septicaemia. Sexually transmitted diseases. Disease caused by mycoplasma, Chlamydia, Rickettsia.

UNIT III.Overview of medical Mycology: Important fungal diseases- Superficial, Subcutaneous, Systemic and opportunistic Mycosis. Overview of Medical Parasitology, Important Protozoan Diseases-Ascaris,Ankylostomiasis,Falariasis,Taeniasis, Echinococcosis etc. Overview of Medical Virology, Important Viral Diseases-Herpesvirus,Poliovirus,Rabies Virus,Arboviruses,Hepatitis, HIV etc. Opportunistic Microbial Infection, Water, Milk and Food borne Diseases,Microbial Vaccine.

UNIT IV.QualityControl: Introduction,Total Quality Management,Framework,Laboratory Processes,Assurance and Assessment,Quality control Planning and Improvement.

UNIT V.Haematology: Basic Haematological Disorders- Classifiacation of Anemia,Iron Deficiency anemia,MegaloblasticAnemia, Haemolytic Anemia, Basic Haematological Techniques- Collection of Blood Specimens, Haemolysis of Blood, Separation of Serum and Plasma, Maintenance and Transport of Specimen, Coagulation and Bleeding Disorders (in brief).

M.Sc. Microbiology Semester III
Paper XVI: Agricultural Microbiology

UNIT I.Soil Microorganism in agro ecosystem: Types of microbial communities: soil microbial diversity: significance and conservation; effect of agricultural practices on soil organism..

UNIT II.Biological Nitrogen fixation: The range of nitrogen fixing organisms; mechanism of nitrogen fixation (biochemistry of nitrogenase); genetics of nitrogen fixation.
Rhizobiunm Legume Association; Symplasmids, N2 fixation by non leguminous plants.

UNIT III.Chemical transformation of microbes: Organic matter decomposition, nutrient mineralization and immobilization; transformation of carbon and carbon compounds.

UNIT IV.Biodegradation of herbicides and pesticides

UNIT V.Biofertilizers: Mass cultivation of microbial inoculants; green manuring; algalization; *Azolla*.

UNIT VI.Microbial products and plant health: Plant growth promoting rhizobacteria (PGPR); significance of mycorrhizae, Microbial herbicides, biological control.

PAPER XVII: Practical based on Paper XIIIandPaperXIV

PAPER XVIII: Practical based on Paper XV and Paper XVI

M.Sc. Microbiology Semester IV

PAPER XIX: INDUSTRIAL MICROBIOLOGY AND BIOPROCESS ENGINEERING

UNIT I.Introduction to industrial microbiology: Sources of industrially important microbes, strain development,types of fermentation and fermenters, process optimization, and recent developments in fermentation technology.

UNIT II.Downstream processing of microbial products: Filtration, centrifugation, cell disruption, liquid-liquid extraction,chromatography, membrane processes, drying (lyophilisation and spray drying), and crystallization.

UNIT IIIFermentation economics: Basic objective for successful economically viable fermentation process, cost breakdown for well established fermentation processes, market potential of the products, cost aspects of various stages inthe processes development including effluent treatment.

UNIT IV.Production aspects: Microbial strains, substrates, strain improvement, flow diagrams, product optimization,and applications of industrial alcohol (ethanol and butanol), amino acids (lysine, phenylalanine, tryptophan),antibiotics (cephalosporins, tetracyclines, polyenes), enzymes and immobilized enzymes, SCP, microbial polyesters,biosurfactants, and recombinant products (insulin, somatostatin, thaumatin).

UNIT V.Bioprocessing Technology and Bioengineering: An introduction to fermentation processes- range of fermentation process, microbial biomass. Microbial growth kinetics-batch Culture, continuous culture, industrial application of continuous culture processes, fed-batch culture. The isolation, preservation and improvement of industrially important and useful microorganism.

UNIT VI.Industrial fermentation-typical media, media formulation, water, energy and carbon sources, nitrogen sources, minerals. Vitamin sources, nutrient recycle, buffers, precursors and metabolic regulators, oxygen requirements.Media sterilization, sterilization of fermenter, sterilisation of the feed.Inocula for industrial fermentation-development of inocula for yeast, bacteria,fungi and actinomycetes, the inoculation of fermenters.Design of fermenter, basic functions, construction, aeration and agitation, oxygen requirements of industrial fermentation.

M.Sc. Microbiology Semester III

PAPER XX: BIOINFORMATICS

UNIT I.Introduction to computers and bioinformatics- Types of operating systems, concepts of networking and remotelogin, basic fundamentals of working with unix.

UNIT II.Biological databases- Overview, modes of database search , mode of data storage (Flat file format, db-tables), flatfileformats of GenBank, EMBL, DDBJ, PDB.

UNIT III. Sequence alignment –Concept of local and global sequence alignment, Pairwise sequence alignment, scoring analignment, substitution matrices, multiple sequence alignment.
UNIT IV. Phylogenetic analysis- Basic concepts of phylogenetic analysis, rooted/uprooted trees, approaches for phylogenetictree construction (UPGMA, Neighbour joining, Maximum parsimony, Maximum likelihood).

UNIT VI. Generation and analysis of high throughput sequence data- Assembly pipeline for clustering of HTGS data,format of ".ace" file, quality assessment of genomic assemblies, International norms for sequence data quality,Clustering of EST sequences, concept of Unigene.Annotation procedures for high through-put sequence data- Identification of various genomic elements (proteincoding genes, repeat elements, strategies for annotation of whole genome, functional annotation of EST clusters,gene ontology (GO) consortium.

UNIT VII.Structure predictions for nucleic acids and proteins- Approaches for the prediction of RNA secondary andtertiary predictions, energy minimization and base covariance models, Basic approaches for protein structurepredictions, comparative modeling, fold recognition/"threading"and*ab-initio* prediction.

M.Sc. Microbiology Semester III
PAPER XXI: IMMUNOLOGY

UNIT I.Immune System:Three fundamental concepts : Specificity, discrimination of self from non-self and memory.Lymphocytes, theirsubpopulation, properties and functions, lymphocyte trafficking.

UNIT II.Antigens and Immunoglobulins
Concept of haptens, determinants, conditions of antigenicity, antigens and immunogenecity, superantigen.Immunoglobulins: Structure and properties of immunoglobulin classes. Theories of antibodyformation, hybridoma technology for monoclonal antibodies and designer monoclonal antibodies.Multiplemylomas and structural basis of antibody diversity. Freund's adjuvants and itsSignificance.

UNIT III.Genetic organization: Organization of the genes for B and T cell receptors. Genetic organization of MHC-I andMHC-II complex (both HLA and H-2).Peptide loading and expression of MHC-I and MHC-II molecules.

UNIT IV.Immune response and signaling: Humoral and cell-mediated immune response; Innate immune response andpattern recognition; Recent advances in innate immune response especially NK-DC interactions; Major cytokinesand their role in immune mechanisms: TNF, IFN, IL-1, IL-2, IL-4, 1L-6, 1L-10, 1L-12, IL-17, TGFβ; Cell signalling through MAP kinases and NF-κB.

UNIT V.Immunity and Immunoassays: Defense against bacteria, viruses, fungi and parasites. Immunodiagnostics and immunotherapy invirology – Serological methods for detection and quantitation of viruses including Hepatitis,Influenza, HIV and others.Immuno-assays: ELISA, ELISA-PCR, RIA, Western Blotting, Immunofluroscens andtheir application. Tolerance and autoimmunity:Central and peripheral tolerance, and their mechanism; Mechanisms ofautoimmunity; Autoimmune components of diabetes mellitus (DM), multiple sclerosis (MS), experimentalautoimmune encephalitis (EAE); Infections leading to autoimmune diseases.

UNIT VI. Immunological disorders and hypersensitivity: Deficiencies / defects of T cells, B cells, complement andphagocytic cells;immunodeficiency with special reference to AIDS, Comparative study of Type I-V hypersensitivities with examples.Mechanism and molecular events in mast cell degranulation by IgE,pharmacological mediators of type-1 reactions.

UNIT VII.Transplantation and tumor immunology: Alloreactive response; types of grafts, Graft rejection and GVHD; HLA-matching; mechanismand prevention of graft rejection.Transgenic animals for xenotransplantation; Tumor antigens, immune response to tumors and immunotherapy oftumors.

UNIT VIII.Vaccine: Vaccines – Introduction and History, Effectiveness and Adverse effect of Vaccines,Types of Vaccines, Production of Vaccines, Delivery system of Vaccines, Hepatitis B, AIDS, and DNA vaccines, DIVA Vaccines,Recent Advances in Vaccines,Vaccines for Cancer.

M.Sc. Microbiology Semester III
PAPER XXII: FOOD AND DAIRY MICROBIOLOGY

UNIT I. Microbiology of foods: Vegetables, fruits, milk, fermented and non-fermented milk products, fresh meats,poultry and non-dairy fermented foods.

UNIT II.Industrial Food fermentations: Starter cultures their biochemical activities, production and preservation of the followingfermented foods.
a. Soy sauce fermentation by Moulds
b. Fermented vegetables – Sauerkraut
c. Fermented Meat – Sausages
d. Production and application of Baker's Yeast
e. Application of microbial enzymes in food industry

UNIT III.Quality assurances in foods: Foodborne infections and intoxications; bacterial with examples of infective and toxic types – Clostridium, Salmonella, Shigella, Staphylococcus, Campylobacter, Listeria.Mycotoxins in food with reference to Aspergillus species.

UNIT IVQuality assurance: Microbiological quality standards of food. Government regulatory practicesand policies. FDA, EPA, HACCP, ISI.

UNIT V. Food preservation methods: Radiations - UV, Gamma and microwaveTemperatureChemical and naturally occurring antimicrobialsBiosensors in food industry.

UNIT VI.Microbiology of cheese and beverage fermentation: Microbiology of fermented milk products (acidophilus milk, yoghurt).Role of microorganisms in beverages – tea and coffee fermentations.Vinegar Fermentation.

UNIT VII.Advanced Food Microbiology: Genetically modified foods. Biosensors in food, Applications of microbial enzymes in dairyindustry [Protease, Lipases].Utilization and disposal of dairy by-product - whey.

PAPER XXIII: Practical based XX, Paper XXI and Paper XII

PAPER XXIV: DISSERTATION