

# DEPARTMENT OF MICROBIOLOGY

**Syllabus for Two Years Master Degree Course  
(Implemented from the Academic Year 2020  
onwards)**

**CHOICE BASED CREDIT SYSTEM (CBCS)  
SYLLABUS FOR MASTER IN SCIENCE  
IN  
MICROBIOLOGY**



# **YBN**UNIVERSITY

**Established by the Act of Government of Jharkhand Act 15, 2017**

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**As per Section 2(f) of UGC Act. 1956**

# SYLLABUS FOR M.Sc. Microbiology

## YBNU, RANCHI

### COURSE STRUCTURE

Semester	Paper number	Name of the Paper	Mid Sem	End Sem	Full Marks	Pass Marks
Semester I	FCMB1101	General Microbiology	30	70	100	45
	CCMB1102	Diversity of Prokaryotic and Eukaryotic Microbes	30	70	100	45
	CCMB1103	Microbial Physiology and Metabolism	30	70	100	45
	CCMB1104	Virology	30	70	100	45
	CPMB1105	Practical based on Paper I and Paper II	00	00	100	45
	CPMB1106	Practical based on Paper III and Paper IV	00	00	100	45
Semester II	CCMB1201	Cell Biology and Analytical techniques	30	70	100	45
	CCMB1202	Bio-Molecules and Enzymes	30	70	100	45
	CCMB1203	Environmental Microbiology	30	70	100	45
	CCMB1204	Microbial Genetics	30	70	100	45
	CPMB1205	Practical based on Paper VII and Paper VIII	00	00	100	45
	CPMB1206	Practical based on Paper IX and Paper X	00	00	100	45

Semester III	ECMB2301	Molecular Biology	30	70	100	45
	CCMB2302	Recombinant DNA Technology	30	70	100	45
	CCMB2303	Medical Microbiology	30	70	100	45
	CCMB2304	Agricultural Microbiology	30	70	100	45
	CPMB2305	Practical based on Paper XIII and Paper XIV	00	00	100	45
	CPMB2304	Practical based on Paper XV and Paper XVI	00	00	100	45
Semester IV	ECMB2401	Industrial Microbiology and Bioprocess Engineering	30	70	100	45
	CCMB2402	Bioinformatics	30	70	100	45
	CCMB2403	Immunology	30	70	100	45
	CCMB2404	Food And Dairy Microbiology	30	70	100	45
	CPMB2405	Practical based XX, Paper XXI and Paper XII	00	00	100	45
	CPMB2404	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 modern microbiology. 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 bacterial groups. Major characteristics used in Taxonomy- morphological, physiological and metabolic, ecological, numerical taxonomy, genetic and molecular classification systems; the kingdoms of organisms and phylogenetic trees. Distinguishing characteristics between prokaryotic and eukaryotic cells Structure and function of Cell-wall of bacteria, cell membranes, flagella, pili, capsule, gas vesicles, carboxysomes, magnetosomes and phycobolismes.

**UNIT- II:** Methods of sterilization: Physical methods – Dry heat, moist heat, radiation methods, filtration methods, chemical methods and their application. Concept of containment 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 Phototropic media: basal, defined, complex, enrichment, selective, differential, maintenance and transport media Preservation 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<sub>2</sub> liberated O<sub>2</sub> consumed, extra cellular enzymes. Cultivation of 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 of coal and crude oil, bioleaching of metals, enzymes, compatible solutes and others) of different groups of archaeobacteria (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 to Bergey's Manual of Systematic Bacteriology.

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

**Mycorrhizal fungi:** Diversity of endo and ectomycorrhizal fungi. Biology of arbuscular mycorrhizal fungi: signaling, penetration and colonization inside roots, culturing and benefits, recent advances in the field of mycorrhiza. **Agriculturally important toxigenic fungi:** Biodiversity, Chemical and biological characterization of toxic metabolites, 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, growth kinetics, 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.

**UNIT III. Central Metabolic Pathways and Regulation:** Glycolysis, PPP, ED pathway, Citric acid cycle: Branched TCA and Reverse 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 of lipids.

**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 systems during aerobic- anaerobic shifts: Arc, Fnr, Nar, FhlA regulon, response to phosphate supply: The Pho regulon. Quorum sensing: A and C signaling system, sporulation in *Bacillus subtilis*, control of competence in *Bacillus subtilis*. 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 biological activity of viruses, characterization of viral products expressed in infected cells, Diagnostic virology, Physical and chemical manipulation of viruses.

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

**UNIT III. Pathogenesis of viral infection and 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 mechanisms involved in resistance to and recovery from virus infections. Role of interferon in viral infections. Viral Chemotherapy: Nucleoside analogs, reverse transcriptase inhibitors, protease inhibitors, History of vaccines especially smallpox and polio. New methods: subunit vaccines, anti- idiotypic and DNA vaccines.

**UNIT IV. Plant and microbial viruses:** General methods of propagation of plant viruses; purification of plant viruses using centrifugation, chromatography and electrophoresis techniques, their assay and comparison of the sensitivity of assay methods; methods employed in identification 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 and agricultural crops, and their control including development of virus disease resistant transgenics.

**UNIT VI. Microbial viruses:** Diversity, classification, characteristics and applications of bacteriophages, and general account on 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<sub>2</sub> fixation, purple green and halo bacteria photosynthesis. Physicochemical 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, cyclic 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 absorption 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 transcarbamylase, 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 ecology highlighting significant contributions of microbiologists and emergence of environmental microbiology, and significant applications of microbes in solving environmental pollution problems.

#### **Unit – 2 Environment and Ecosystems**

Definitions, biotic and abiotic environment. Environmental segments. Composition and structure of 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 of eutrophication 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 control eutrophication

#### **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, decay behaviour, bioaccumulation and bio magnification, oil pollution, surfactants and pesticides. Genetically Modified Organisms released and its environmental 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 versus suppression. Complementation tests, recombination tests and gene replacements. Cloning genes by complementation. Cloning genes by marker rescue.

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

**UNIT III. Lytic bacteriophages:** Lytic development cycle using phages T4 and T7 as models. Regulation of expression of genes in phage T4 – transcriptional activators, antitermination, a new sigma factor and replication-coupled transcription. Regulation of gene expression in phage T7 – a phage-encoded RNA polymerase. Replication of T4 versus T7 phages – recent advances. Replication and packaging of filamentous phages M13 and f1 – recent advances. Genetic analysis of phages – complementation and recombination tests with phages.

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

**UNIT V. Gene transfer by transformation and transduction:** Natural transformation and competence. Molecular basis of natural transformation – DNA uptake competence systems in gram positive and gram negative bacteria. Regulation of competence in *B. subtilis*. Importance of natural transformation. Artificially induced competence. Generalized versus 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 the mechanisms. Conjugative transposons. Transposon mutagenesis. Cloning out genes by transposon mutagenesis. Mutator transposon, Mud transposons and gene fusions, mini-Mu elements and their use in *in vivo* cloning. Yeast Ty-1 transposon

**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 Paper VIII

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, nucleosome formation.

**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, Telomere maintenance and Chromatin Assembly, Single stranded DNA replication. DNA repair and recombination, DNA Mismatch Repair, Double Strand Break Repair, Recombination as a molecular biology tool.

**UNIT II. Transcription:** Transcription machinery of prokaryotes, eukaryotes, various forms of RNA polymerase promoters, enhancers, silencers, activators, effect of chromatin structure, regulation of transcription.

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

**UNIT IV. Translation:** The genetic code and protein structure, Mechanisms of translation in prokaryotes, Mechanisms of translation in eukaryotes, *in vitro* translation systems, polycistronic/ monocistronic synthesis, Regulation of translation, RNA instability, inhibitors of translation, 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, Genome analysis, 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 and screening 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. DNA fingerprinting 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 PCR versus 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 genomic DNA libraries. Screening libraries by colony hybridization and colony PCR. Enriching for clones in Cdna libraries by positive selection and subtractive hybridization.

**UNIT V. Genome sequencing:** DNA sequencing by Sanger's method – traditional and cycle sequencing. Physical mapping by restriction fragment fingerprinting of BAC clones. Whole genome shotgun sequencing. 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 of micro-organisms to identify and categorize SNPs. Array CGH.

**UNIT VI. Transcriptional analysis of gene expression and transcriptomics:** Gene expression analysis by Northern Blotting, 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), Serial Analysis of Gene Expression (SAGE).

**UNIT VII. Overexpression of recombinant proteins:** Overexpression and tagging of recombinant proteins in *E.coli*, driven by lac, 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 DNaseI and 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, Diphtheria, Tetanus, Gas gangrene etc, Diseases caused by Gram negative bacilli of Enterobacteriaceae- 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, Filariasis, 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. Quality Control:** Introduction, Total Quality Management, Framework, Laboratory Processes, Assurance and Assessment, Quality control Planning and Improvement.

**UNIT V. Haematology:** Basic Haematological Disorders- Classification of Anemia, Iron Deficiency anemia, Megaloblastic Anemia, 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..

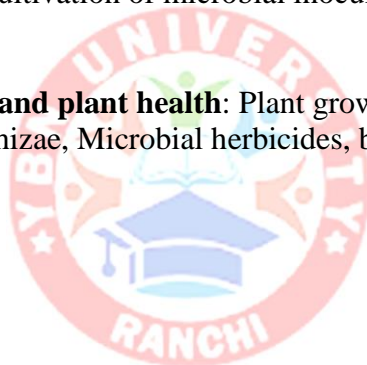
**UNIT II. Biological Nitrogen fixation:** The range of nitrogen fixing organisms; mechanism of nitrogen fixation (biochemistry of nitrogenase); genetics of nitrogen fixation. Rhizobium Legume Association; Symbioses, N<sub>2</sub> fixation by non leguminous plants.

**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 XIII and Paper XIV

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 III. Fermentation 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 in the 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 remote login, basic fundamentals of working with unix.

**UNIT II. Biological databases-** Overview, modes of database search , mode of data storage (Flat file format, db-tables), flat file formats 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 phylogenetic tree 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 (protein coding 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 and tertiary predictions, energy minimization and base covariance models, Basic approaches for protein structure predictions, 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, their subpopulation, properties and functions, lymphocyte trafficking.

#### **UNIT II. Antigens and Immunoglobulins**

Concept of haptens, determinants, conditions of antigenicity, antigens and immunogenicity, superantigen. Immunoglobulins: Structure and properties of immunoglobulin classes. Theories of antibody formation, hybridoma technology for monoclonal antibodies and designer monoclonal antibodies. Multiple myelomas and structural basis of antibody diversity. Freund's adjuvants and its significance.

**UNIT III. Genetic organization:** Organization of the genes for B and T cell receptors. Genetic organization of MHC-I and MHC-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 and pattern recognition; Recent advances in innate immune response especially NK-DC interactions; Major cytokines and their role in immune mechanisms: TNF, IFN, IL-1, IL-2, IL-4, IL-6, IL-10, IL-12, IL-17, TGF $\beta$ ; Cell signalling through MAP kinases and NF- $\kappa$ B.

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

**UNIT VI. Immunological disorders and hypersensitivity:** Deficiencies / defects of T cells, B cells, complement and phagocytic cells; immune deficiency 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-I reactions.

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

**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 following fermented 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 IV. Quality assurance:** Microbiological quality standards of food. Government regulatory practices and policies. FDA, EPA, HACCP, ISI.

**UNIT V. Food preservation methods:** Radiations - UV, Gamma and microwave Temperature Chemical and naturally occurring antimicrobials Biosensors 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 dairy industry [Protease, Lipases]. Utilization and disposal of dairy by-product - whey.

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

**PAPER XXIV: DISSERTATION**