

# **Syllabus**

## **For**

# **M.Sc. MICROBIOLOGY**

---



**MANDSAUR**  
**UNIVERSITY**  
MAKING FUTURE READY!

**Faculty of Life Sciences**

---

**Mandsaur University, Mandsaur**  
**M. P., India**

**M.Sc. Microbiology**  
**Semester I**

**MIC080: Microbial Physiology and Biochemistry [Credit: 6(3+1+2)]**

**UNIT I: Carbohydrates**

**12 Hours**

Structure and properties of mono, oligo and polysaccharides. Metabolism and regulation- Glycolysis, TCA cycle, Glyoxylate cycle. Pentose phosphate pathway, Gluconeogenesis, Entner – Doudoroff pathway. Substrate level phosphorylation; Oxidation- Reduction reactions. Redox potential, Electron transport chain, Oxidative phosphorylation and ATP synthesis. Biosynthesis of peptidoglycan.

**UNIT II: Fermentation Pathways & Bioenergetics**

**12 Hours**

Fermentation reactions, Fermentation balances, Homo and Heterolactic fermentation. Laws of thermodynamics, Gibbs free energy, endergonic & exergonic reactions, Standard state free energy changes, High energy compounds. Introduction to Metabolism - Catabolism, anabolism, catabolic, anabolic and amphibolic pathways.

**UNIT III: Lipids**

**12 Hours**

Classification, structure of saturated and unsaturated fatty acids, triacylglycerol, phospholipids, glycolipids and sterols; Oxidation of fatty acids ( $\alpha$ ,  $\beta$ ,  $\omega$  oxidation). Biosynthesis of fatty acids (saturated and unsaturated) and sterol.

**UNIT IV: Amino acids & Proteins**

**12 Hours**

Classification, structure and properties of amino acids. General aspects of amino acid metabolism; amination, transamination, deamination. Decarboxylation, urea cycle. Classification, properties and structural organization of proteins (primary, secondary, tertiary and quaternary).

**UNIT V: Nucleic acids**

**12 Hours**

Structure of bases, nucleosides and nucleotides; Biosynthesis: Purine and pyrimidine, *denovo* and salvage pathway.

**PRACTICAL**

1. Estimation of reducing sugars by DNS Method
2. Estimation of protein by Bradford method
3. Estimation of protein by Lowry method
4. Numerical related to Gibbs free energy change
5. Estimation of DNA by DPA Method
6. Estimation of RNA by Resorcinol Method
7. Extraction and estimation of ergosterol from fungi.
8. Lipid estimation by thin layer chromatography.

**SUGGESTED READINGS**

1. Byung Hong Kim and Geoffrey Michael Gadd. (2008). Bacterial Physiology. Cambridge.
2. Charles Gerday and Nicolas Glansdorff. (2007). Physiology and Biochemistry of Extremophiles. ASM Press.
3. El-Sharoud, Walid (Ed.). (2007). Bacterial Physiology a molecular approach. Springer.
4. Richard J. Simpson. (2005). Proteins and Proteomics: A Laboratory Manual. I.K. International Publishing House Ltd. New Delhi.
5. Voet, D. and Voet, J.G. (2004). Biochemistry, John Wiley and Sons.
1. Palmer, T. (2001). Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, Horwood Publishing Chichester.
2. Brun, Y.V. and Shimkets, L.J. (2000). Prokaryotic Development, ASM Press.
3. Lehninger (2000). Principles of Biochemistry, 3rd edition by Nelson & Cox (Worth) pub.
4. Arora, D.K. and Seema Gupta (1996). Bacterial Physiology. Anmol Publications. New Delhi.
5. Caldwell. D.R. (1995). Microbial Physiology and metabolism, Brown Publishers.

## **M.Sc. Microbiology Semester I**

### **MIC090: Bacteriology and Virology [Credit: 6(3+1+2)]**

#### **UNIT I: Introduction & Classification**

**12 Hours**

Introduction to microbes and prokaryotes. Natural system of classification, binomial nomenclature, international code of nomenclature of prokaryotes. Taxon, species, strain. Criteria used for classification. Three domain classification, classification according to Bergey's manual of systematic bacteriology.

#### **UNIT II: Morphology and Ultrastructure of Bacteria & Cyanobacteria**

**12 Hours**

Bacteria: Different cell morphology, flagella, pili, capsule, cell wall, cell membrane, cytoplasm. Intracytoplasmic inclusions, reserved food materials (different types of granules and globules), endospores and exospores. Cyanobacteria: Ultrastructure, reproduction and significance of *Microcystis*, *Gleocapsa*, *Spirulina*, *Nostoc*, *Anabaena* and *Scytonema*.

#### **UNIT III: Nutrition and Cultivation**

**12 Hours**

Micro and macro nutrients, growth factors. Nutritional types of bacteria. Culture media: classification of media (Simple, complex and special media with example). Growth: Nutritional uptake, Growth kinetics, generation time, growth curve, factors affecting growth. Aerobic, anaerobic, batch, continuous and synchronous cultures. Mechanism of cell cycle and binary fission.

#### **UNIT IV: Acellular entities- viruses, viroids and prions**

**12 Hours**

Brief outline on discovery of viruses, origin of viruses, Nomenclature and classification of viruses: ICTV system of classification, distinctive properties of viruses. Morphology and ultrastructure of viruses: capsids and their arrangements; types of envelopes and their composition- viral genome (RNA, DNA), structure and importance- Viroids, Prions.

#### **UNIT V: Cultivation and assay of viruses**

**12 Hours**

Cultivation of viruses in embryonated eggs, experimental animals and cell cultures (suspension cell cultures and monolayer cell cultures; cell lines and cell strains).

#### **PRACTICAL**

1. Isolation of bacteria: Serial dilution and pure culture techniques.
2. Staining techniques:
  - a. Simple, Differential: Acid-fast, capsule and cell wall
  - b. Cytoplasmic inclusion stains: Flagella, spore and nucleus
3. Biochemical identification for bacterial identification.
4. Bacterial growth measurement: plate count and turbidometry.
5. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data
6. Evaluation of bacterial growth in liquid media and factors affecting growth.
7. Isolation of bacteriophage from sewage.
8. Studying isolation and propagation of animal viruses by chick embryo technique.

#### **SUGGESTED READINGS**

1. Marjorie Cowan, Kathleen Park Talaro (2009). Microbiology: A Systems Approach. 2nd Edition. The McGraw/Hill.
2. Naveen Kango (2009). Textbook of Microbiology. I.K. International Publishing House Ltd. New Delhi.
3. Pelczar, M.J., Chan, E.C.S., kreig N.R. (1986) Microbiology Tata McGraw- Hill Pub.
4. Salle, A.J. (1967). Fundamental principle of Bacteriology. Tata Mc Graw Hill publishing company.
5. Edward, K. Wanger & Martinez, J. Heweltt (2004). Basic virology. Blackwell publishing.
6. Sullia, S.B. & Shantharam S. (1998). General Microbiology, Oxford IBH pub. Co. New Delhi.
7. Falkow, S.; Rosenberg, E; Schleifer, K.-H.; Stackebrandt, E.; Dworkin, M. (Eds.) (2007). The Prokaryotes.3rd ed., Vols. 1-7 (Set). Springer.

**M.Sc. Microbiology  
Semester I**

**MIC100: Microbial Growth, Enzymology and Bioinstrumentation [Credit: 5(3+0+2)]**

**UNIT I: Microbial Growth, Enzymes & Enzyme Kinetics** **9 Hours**

Microbial Growth: Growth measurement & kinetics.

Enzymes: Definition, specificity, active sites, coenzymes, enzyme units, isozymes, enzymes kinetics; Michaelis-Menten equation. Significance of  $K_m$  and  $V_{max}$ , LB plot, Determination of kinetic parameters, multi substrate kinetics.

**UNIT II: Enzyme Action & Inhibition** **9 Hours**

Mechanism of enzyme action- lock and key and induced fit hypothesis. Regulation-Covalent, allosteric and feedback inhibition. Reversible (competitive, noncompetitive and uncompetitive) and irreversible inhibitions. Kinetics analysis of allosteric enzymes. Ribozymes and abzyme.

**UNIT III: Enzyme Technology** **9 Hours**

Industrial uses of enzymes: sources of industrial enzymes, thermophilic enzymes, proteolytic enzymes in meat and leather industry, detergents and cheese production. Clinical applications of enzymology. Immobilization of enzymes and their applications.

**UNIT IV: Chromatography & Spectrophotometer** **10 Hours**

Principle, working and application of:

Chromatography: TLC, Column chromatography, HPLC and gas chromatography.

Spectrophotometer: UV-Vis, atomic absorption spectrophotometer

**UNIT V: Electrophoresis** **8 Hours**

Principle, working and application of Electrophoresis: Native and SDS-PAGE of proteins, Agarose gel electrophoresis of DNA

**PRACTICAL**

1. Enzyme kinetic study of amylase
2. Enzyme assay: protease
3. Enzyme assay: lipase
4. Enzyme purification: ammonium per sulphate method and dialysis
5. Quantitative estimation of enzyme using UV-Vis spectrophotometer
6. To perform enzyme immobilization
7. Separation of analytes using chromatography
8. SDS PAGE

**SUGGESTED READINGS**

1. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14<sup>th</sup>edition. Prentice Hall International Inc.
2. Moat AG and Foster JW. (2002). Microbial Physiology. 4<sup>th</sup>edition. John Wiley & Sons
3. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9<sup>th</sup>edition. McGraw Hill Higher Education.
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company.
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition. W.H. Freeman and Company.
6. Voet, D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons.
7. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed., Cambridge University Press.
8. Nigam A and Ayyagari A. 2007. Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill.

**M.Sc. Microbiology**  
**Semester I**

**MIC110: Pharmaceutical Microbiology [Credit: 5(3+0+2)]**

**UNIT I: Introduction to Pharmaceutical Microbiology** **8 Hours**

The ecology of microorganisms affecting pharmaceutical industry. Types of microorganisms occurring in pharmaceutical products. Introduction to Pharmacokinetics.

**UNIT II: Microbiological spoilage and prevention** **9 Hours**

Microbiological spoilage prevention of pharmaceutical products; antimicrobial agents used as preservatives, evaluation of the microbial stability of formulation. The sterilization in pharmaceutical industry: Heat, radiation, gaseous and filtration sterilization, injectable, sterile fluids.

**UNIT III: Antimicrobial agents** **9 Hours**

Bacteriostatic and bactericidal agents, factors affecting antimicrobial activity, antimicrobial chemicals: sanitizers, disinfectants, antiseptics, phenols and phenolic compounds, alcohols, halogens, heavy metals, dyes, aldehydes, detergents, selective toxicity and target sites of drug action in microbes. Development of synthetic drugs.

**UNIT IV: Chemotherapy & Antibiotics** **10 Hours**

Principles of chemotherapy: Clinical and lab diagnosis, sensitivity testing, choice of drug, dosage, route of administration. Antibiotics :Classification and applications; Mode of action of important drugs: Cell wall inhibitors (Betalactam eg. Penicillin), membrane inhibitors (polymyxins), macromolecular synthesis inhibitors (streptomycin), antifungal antibiotics (nystatin)

**UNIT V: Microbiological Assay** **9 Hours**

The clinical basis of drug resistance, biochemistry and genetics of drug resistance. Microbiological assays: growth promoting and inhibiting substances, nutritional mutants and their importance, vitamin assay, amino acid assay. antimicrobials (Phenol coefficient/RWC), Drug sensitivity testing methods. Assay for antibiotics: MIC, the liquid tube assay, solid agar tube assay, agar plate assay.

**PRACTICAL**

1. Sterility testing methods for pharmaceutical products
2. Testing for sterilization equipment
3. Tests for disinfectants (Phenol coefficient/RWC)
4. Determination of antibacterial spectrum of drugs/antibiotics
5. Chemical assays for antimicrobial drugs
6. Determination of MIC valued for antimicrobial chemicals
7. Microbiological assays for vitamins/amino acids
8. Microbiological assays for antibiotics (Liquid tube assay, agar tube assay, agar plate assays)

**SUGGESTED READINGS**

1. Disinfection, sterilization and preservation. Block, S.S. (ed). Lea and Febigor, Baltimore
2. Pharmaceutical Microbiology. Hüge, W.B. and Russel, AD.Blackwell Scientific, Oxford
3. Principles and methods of sterilization in health sciences. Perkins, JK. Pub: Charles C. Thomos, Springfield.
4. Compendium of methods for the microbiological examination of foods. Vanderzant, C. and Splittstoesser,D. Pub: American Public Health Association, Washington, D.C.
5. Disinfectants: Their use and evaluation of effectiveness. Collins, CH., Allwood, MC., Bloomfield, SF. And Fox, A. (eds). Pub: Academic Press, New York
6. Inhibition and destruction of microbial cell by Hugo, WB. (ed). Pub: Academic Press, NY
7. Manual of Clinical Microbiology. Lennette, EH. (ed).Pub: American Society for Microbiology, Washington.
8. Principles and Practices of disinfection. Russell, AP.,Hugo,WB., and Ayliffe, GAJ.(eds). Publ. Blackwell Science.

**M.Sc. Microbiology**  
**Semester II**

**MIC120: Microbial Genetics [Credit: 6(3+1+2)]**

**UNIT I: Prokaryotic & Eukaryotic Genome**

**12 Hours**

*E. coli* genome: coiled, supercoiled (plectonemic), folded fiber model. Yeast *S. cerevisiae* genome. Eukaryotic genome organization: Nucleosome model, split gene, overlapping genes and Cot curves; histone modifications, DNA methylation, repetitive and non-repetitive DNA sequence. Law of DNA constancy, C value paradox and genome size, karyotype and idiogram, chromosome banding pattern, types of chromosomes. Organelle genome.

**UNIT II: Gene and Mutation**

**12 Hours**

Gene as unit of mutation, molecular basis of spontaneous and induced mutations and their role in evolution; mutagens, types of mutations, transposon mutagenesis, site directed mutagenesis, environmental mutagenesis, Ames and other toxicity testing. Genetics of fungi- alteration of generation, induction of mutation in *Neurospora crassa* and yeast.

**UNIT III: Genetic recombination**

**12 Hours**

Homologous recombination: Holiday model, Meselson -Radding modification; Proteins involve in homologous recombination, Gene conversion, Site specific recombination, Cre-loxP recombinant system, legitimate & illegitimate recombination, Overview of bacterial genetic map.

**UNIT IV: Gene transfer mechanisms**

**12 Hours**

Bacterial transformation; Host cell restriction; Transduction; Complementation; Conjugation and Transfection: mechanisms and applications, genetic analysis of virus, bacteria and yeast genomes.

**UNIT V: Plasmids and Bacteriophages**

**12 Hours**

Plasmids, F-factors - description and their uses in genetic analysis, Colicins and Col Factors, R plasmids. Lysogeny and lytic cycle in bacteriophages, Life cycle and their uses in microbial genetics. Transcriptional switch for lytic and lysogenic in bacteriophage lamda.

**PRACTICAL**

1. Cot curve analysis
2. Study of spontaneous mutation by Gradient plate method.
3. Study for the effect of physical mutagen.
4. Ames test for detecting chemical mutagen.
5. Study of Replica plating technique.
6. Numerical concepts of gene mapping.
7. Preparation of competent cells.
8. Bacterial transformation by CaCl<sub>2</sub> method.

**SUGGESTED READINGS**

1. Jeremy W Dale and Simon F Park. (2010). Molecular Genetics of Bacteria. Fifth Edition. WileyBlackwell.
2. Dale. J.W. (1994). Molecular Genetics of bacteria, John Wiley & Sons.
3. Robert J. Brooker. (2009). Genetics: Analysis and Principles, 3rd Edition. McGraw-Hill.
4. Geaorge Lipps. (2008).Plasmids: Current Research and Future Trends. Academic Press.
5. Madhusudan W Pandit. (2007). Scientoonic Tell-Tale of Genome and DNA. I.K. International Publishing.
6. Oladele Ogunseitán. (2004). Microbial Diversity: Form and Function in Prokaryotes. Wiley-Blackwell.
7. Lewin, B. (2002). Genes VIII. Oxford.
8. Streips & Yasbin (2001). Modern microbial Genetics. Wiley Ltd.
9. Bloom, Freyer, Micklos. (1996). Laboratory DNA Science. The Benjamin/Cummings Pub.
10. Silhavy, T. (1994). Experiments with Gene Fusions, Cold Spring Harbour Lab. Press.
11. Miller, J.H. (1992). Short course in bacterial genetics, CSH Laboratories

**M.Sc. Microbiology**  
**Semester II**

**MIC130: Molecular Biology and Genetic Engg. [Credit: 6(3+1+2)]**

**UNIT I: Central Dogma**

**12 Hours**

DNA replication - prokaryotic and eukaryotic DNA polymerases, initiation, elongation, termination; Transcription: RNA polymerases, initiation, elongation and termination; The genetic code: salient features, RNA and DNA codon tables; Wobble base pair. Translation: Translation: initiation, elongation and termination.

**UNIT II: DNA damage, repair & Regulation of gene expression**

**12 Hours**

DNA damage - sources and types; DNA repair: direct reversal, excision repair, recombinational, SOS repair. Transcriptional regulation-positive and negative; Operon concept-lac, gal, trp, ara operons; Feedback inhibition and allosteric control.

**UNIT III: Enzymes & Vectors of genetic engineering**

**12 Hours**

Restriction enzymes- nomenclature, types, applications; Restriction endonuclease- blunt and sticky ends; DNA Modifying enzymes- alkaline phosphatase, polynucleotide kinase and terminal deoxynucleotidyl transferase. Characteristics of cloning and expression vectors; Plasmids, Ti plasmid; Yeast vectors- plasmids and YAC; Shuttle vectors; Cosmid and phagemid vectors.

**UNIT IV: Gene libraries and Gene delivery**

**12 Hours**

Construction of genomic library; cDNA construction: hairpin loop strategies; Directional and non-directional cDNA synthesis; Screening of libraries. Transcription & gene delivery: Lipofection, Microinjection, Electroporation.

**UNIT V: Techniques and Applications of genetic engineering**

**12 Hours**

Southern and northern blotting, Molecular markers: RAPD, RFLP; DNA Sequencing. Polymerase chain reactions; In-situ hybridization; Genetic engineering in medicine, agriculture and environment.

**PRACTICAL**

1. Isolation of genomic DNA from bacteria.
2. Plasmid DNA isolation
3. Agarose gel electrophoresis
4. Restriction digestion of DNA.
5. Amplification of suitable gene using PCR.
6. Competent cell preparation
7. Purification and ligation of the DNA into vector
8. Transformation and screening.

**SUGGESTED READINGS**

1. Jeremy W Dale and Simon F Park. (2010). Molecular Genetics of Bacteria. Fifth Edition. Wiley-blackwell.
2. Dale. J.W. (1994). Molecular Genetics of bacteria, John Wiley & Sons.
3. Robert J. Brooker. (2009). Genetics: Analysis and Principles, 3rd Edition. McGraw-Hill.
4. Lewin, B. (2002). Genes VIII. Oxford.

## M.Sc. Microbiology Semester II

### MIC140: Environmental Microbiology [Credit: 5(3+0+2)]

#### **UNIT I: Aero Microbiology**

**9 Hours**

Air spora in different layers of atmosphere, bioaerosol, assessment of air quality using principles of sedimentation, impaction, impingement, suction and filtration. Brief account of transmission of airborne microbes; Microbiology of indoor and outdoor. Allergy: Causes and tests for detection of allergy.

#### **UNIT II: Aquatic Microbiology**

**9 Hours**

Fresh and marine ecosystem. Zonation of water ecosystem; upwelling, eutrophication; food chain in aquatic ecosystems. Role of methanotrophs in ecosystem. Potability of water, microbial assessment of water, water purification. Ground water types and their contamination. Biofilm. Waste treatment: sewage and effluent treatment; primary, secondary and tertiary treatment.

#### **UNIT III: Soil Microbiology**

**9 Hours**

Biotic and abiotic interactions, concepts of habitat and niche. Microbial communities; nature, structure and attributes, levels of species diversity, succession and stability, r and K selection, genetic exchange between communities. Biodiversity management and conservation. Role of microbes in organic solid waste treatment matter in various soil types, subterranean microbes.

#### **UNIT IV: Anoxic ecosystem & Extremophiles**

**9 Hours**

Methanogens-reduction of carbon monoxide, reduction of iron, sulphur, manganese, nitrate and oxygen. Microbial transformations of carbon, phosphorus, sulphur, nitrogen and mercury. The domain Archaea, acidophilic, alkalophilic, thermophilic, halophilic, barophilic, osmophilic and radiodurant microbes- mechanisms and adaptation. Application of extremophiles.

#### **UNIT V: Biodegradation and Bioremediation**

**9 Hours**

Role of microbes in degradation, Biodegradation of Xenobiotics hydrocarbons, pesticides and plastics. Biodeterioration of wood, pulp and paper; Biosorption/bioaccumulation of heavy metals. Bioremediation of soil, air and water: various methods, advantages and disadvantages. Bioleaching of iron, copper, gold and uranium.

#### **PRACTICAL**

1. Enumeration of fungal and bacterial aerospora.
2. Study the microbiological quality of water samples from different sources.
3. Detection of coliforms in water by MPN test method.
4. Determination of BOD of water.
5. Biosorption of dyes by *Aspergillus niger* or brewer's yeast
6. Isolation of methanogens from enrichment.
7. Study of bacterial interactions in soil.
8. Study of microbial tolerance/ resistance to heavy metals.

#### **SUGGESTED READINGS**

1. Jagbir Singh. (2010). Solid Waste Management. I.K. International Publishing House Ltd. New Delhi.
2. Volodymyr Ivanov. (2010). Environmental Microbiology for Engineers. CRC Press.US 21.
3. A.L. Bhatia. (2009). Textbook of Environmental Biology. I.K. International Publishing House Ltd. New Delhi.
4. Atlas, R.M., (2005). Handbook of media for environmental microbiology. CRC press.
5. Patrick, K. Jjemba. (2004). Environmental microbiology: principles and applications. Science Publishers.
6. Christon J Hurst, Ronald L Crawford, Guy R Knudsen Michael J McInerney, Linda D Stetzenbach, (2002). Manual of Environmental Microbiology 2nd Edition. ASM press.
7. Francis H Chapelle, (2000), Ground Water Microbiology and Geochemistry. 2<sup>nd</sup> Edition. John Wiley & Sons.
8. Robert L Tate, (2000), Soil Microbiology 2nd Edition. John Wiley & Sons.
9. Gabriel Bitton, (1999), Waste Water Microbiology. 2nd Edition. Wiley-Liss.
10. Robert S. Burlage, Ronald Atlas, David Stahl, Gill Geesey, Gary Saylor (1998) Techniques in Microbial Ecology. Oxford University Press. New York.



**M.Sc. Microbiology**  
**Semester II**

**MIC150: Food and Dairy Microbiology [Credit: 5(3+0+2)]**

**UNIT I: Food Micro flora**

**9 Hours**

Introduction: Importance of food microbiology; types of microorganism in food; source of contamination; factors influencing microbial growth of food (extrinsic and intrinsic).

**UNIT II: Microbes Associated with Milk and Dairy Products**

**10 Hours**

Microorganisms of milk and milk products – factors affecting growth of microorganisms – types of microorganisms in milk and dairy products like Butter, Cheese, Cream, Ice cream, Yogurt, Whey. Examination of microbial load of milk and milk products.

**UNIT III: Food preservation**

**9 Hours**

Principles of food preservation methods of preservation (a) physical (irradiation, drying heat processing, chilling and freezing, high pressure and modification of atmosphere, pasteurization) (b) chemical (sodium benzoate class I & II). Food sanitation: food manufacturing practices; Hazard analysis, critical control points, personnel hygiene.

**UNIT IV: Fermented foods**

**8 Hours**

Concept and application of fermentation; Fermented food: Bread, wine, fermented vegetables, Idli: methods and organisms used, single cell protein, production of food enzymes.

**UNIT V: Spoilage of food, milk and milk Products**

**9 Hours**

Contamination and spoilage: cereals, sugar products, vegetables and fruits, meat products, fish and seafood, poultry; spoilage of canned foods. Types of microbial spoilage of milk and milk products - spoilage of milk, butter, cheese, yogurt, raw milk, dry milk, ice cream, whey.

**PRACTICALS**

1. Microbial Spoilage of fruits & vegetables.
2. Microbial spoilage of canned foods.
3. Isolation and Enumeration of yeast from rice batter (Fermented Foods).
4. Spoilage of Eggs.
5. Effect of salt and sugar on the growth of food microflora.
6. Microbiology of Bread production.
7. MBRT test for milk.
8. Isolation of lactic acid bacteria from curd.

**SUGGESTED READINGS**

1. Adams , M.R. and M.O Moss., 1995. Food Microbiology , the Royal Society of Chemistry, Cambridge.
2. Doyle , M.P. 2001. Food Microbiology . 2nd Edn. Panima Book company Limited. New Delhi.
3. Frazier, W.C and Westhoff D.C 1988. Food Microbiology . TATA McGraw Hill Publishing Company Ltd. New Delhi.
4. Jay, J.M. 2000. Modern Food Microbiology., 4th Edn. CBS Publishers and Distributors , New Delhi.
5. Stanbury, P.F. Whitaker and Hall. S.J 1995. Principles of Fermentation Technology, 2nd edition, Pergaman Press.
6. Thomas E. Barman . 1969, Enzyme Hand Book Vol . 5 Springer – Verlag Berlin

## M.Sc. Microbiology Semester III

### MIC190: Medical Microbiology [Credit: 5(3+2)]

#### **UNIT I: Infection and Transmission**

**9 Hours**

Infection and transmission: Entry of pathogen into human host – portals of entry. Virulence factors and their role in breaching host defense, mechanism of microbial adhesion, colonization and invasion, tissue damage and anti-phagocytic factors, toxigenesis- bacterial toxins and its types, Quorum sensing in *Staphylococcus pyogenes*. Communicable diseases; Nosocomial and community infections and their control.

#### **UNIT II: Bacterial and Protozoan diseases**

**9 Hours**

Study of diseases caused by pathogenic bacteria: pathogenicity, laboratory diagnosis, epidemiology and control measures– *Streptococcus Staphylococcus, Shigella, Salmonella, Corynebacterium, Vibrio, Haemophilus, Mycobacterium. Spirochetes-Treponema*. Protozoan diseases-malaria, leishmaniasis and filariasis.

#### **UNIT III: Fungal diseases**

**9 Hours**

Aetiology, clinical symptoms, laboratory diagnosis and treatment of superficial infections (dermatomycoses): Epidermophyton, Microsporum and Trichophyton; Madura foot; Subcutaneous mycoses: Sporotrichosis and Systemic mycosis: Blastomycosis, Coccidioidomycosis, Candidiasis, Opportunistic mycoses: Aspergillosis.

#### **UNIT IV: Viral diseases**

**9 Hours**

Etiology, clinical symptoms, laboratory diagnosis and treatment: Pox virus, Herpes virus Varicella-zoster, Adenovirus, Picorna virus, Orthomyxoviruses (influenza), Paramyxoviruses (Mumps and Measles), Rhabdoviruses, Hepatitis viruses, H1N1, Oncogenic viruses, HIV, Arboviruses. Prion infection- Mad Cow, CJD, Kuru.

#### **UNIT V: Antimicrobial agents**

**9 Hours**

Classification of antimicrobial agents, Mechanism of drug action – antibacterial (Bacteriostatic and bactericidal) antifungal and antiprotozoans. Methods of testing drug sensitivity (*in vitro* and *in vivo*), antibiotic assay in body fluids. Mechanism of multi drug resistance. Probiotics as therapeutic agents.

#### **PRACTICAL**

1. Study of normal microflora of skin.
2. Study of normal microflora of mouth.
3. Dental caries susceptibility test.
4. WIDAL Test
5. Study of microbial flora of the infected wounds.
6. Primary screening of enteric pathogen from gastro intestinal tract.
7. Microbiological assessment of medicinal importance crude plant extract.
8. Testing for antibiotic/drug sensitivity/resistance.

#### **SUGGESTED READINGS**

1. Connie R Mahon. (2010). Textbook of Diagnostic Microbiology. 3rd edition. Pearson.
2. Fritz H. Kayser. (2005). Medical microbiology. Thieme Verlag.
3. Wadher, and Bhoosreddy. (2005). Manual of Diagnostic Microbiology. Himalaya Publisher.
4. Credric, A. Mims. (2004) Medical microbiology. (3rd Ed.). Mosby Inc.
5. Frank, Steven A. (2002). Immunology and Evolution of Infectious Disease. Princeton University Press.
6. Warren Levinson Ernest Jawetz (2002), Medical Microbiology and Immunology: Examination and Board Review, 7th Edition. McGraw-Hill/Appleton and Laye.
7. Leslic Collier, John Oxford. (2000) Human virology: a text book for students of medicine, dentistry & microbiology (2nd Ed.) Oxford University Press.
8. Nester, Roberts, Pearsall, Anderson. (1998). Microbiology -A Human Perspective, 2nd edition, McGraw-Hill.

**M.Sc. Microbiology**  
**Semester III**

**MIC200: Immunology [Credit: 5(3+2)]**

**UNIT I: Immune System and immunity**

**9 Hours**

History of immunology; Innate and adaptive immunity; Cells: Lymphoid progenitor cells- T-cells, B cells, and Natural Killer cells, Myeloid Progenitor cells- Monocytes, Macrophages, Dendritic cells, Basophils, Eosinophils, Neutrophils, Mast cell; Primary and secondary lymphoid organs; Immune responses – Cell mediated and Humoral, Clonal selection theory.

**UNIT II: Antigen, Antibodies and Complement Pathway**

**9 Hours**

Immunogenicity and Antigenicity; Types, structure and properties of antigens; Haptens; Adjuvant; Immunoglobulins: structure, types and subtypes, properties; Primary and secondary immune responses; Antibody diversity; Antigen-Antibody reaction; Complement system – Structure, components, properties and functions; Complement pathways.

**UNIT III: MHC and Hypersensitivity**

**9 Hours**

Major histocompatibility complex and their classes: Structure and functions; T cell and B cell receptors; Antigen processing and presentation; Chemokines; Cytokines; Hypersensitivity: Types and Mechanisms; Immunological tolerance; Autoimmune Diseases: Grave's disease, Rheumatoid arthritis; Immunodeficiency Diseases: SCID, Chediak-Higashi syndrome, DiGeorge syndrome.

**UNIT IV: Immunization**

**9 Hours**

Active and passive immunization; Vaccine technology- Live, killed, attenuated and sub unit vaccines, Role and properties of adjuvants, conjugate vaccines, recombinant DNA and protein based vaccines; Hybridoma technology for monoclonal antibody production; Antibody engineering; Abzymes. UNIT V: MHC and Tumor immunology

**UNIT V: Immunotechnology**

**9 Hours**

Precipitation reactions: RID, ODD; Agglutination reaction: Coomb's test; Immunoassay: Immunoelectrophoresis, Immunofluorescence, ELISA, RIA and Flow cytometry; Immunological test: Montoux test, WIDAL, VDRL, Complement Fixation test and Western blot.

**PRACTICAL**

1. Ouchterlony Double diffusion.
2. Radial-Immuno diffusion.
3. Enzyme Linked Immunosorbent assay.
4. Latex agglutination.
5. Agglutination for blood group determination.
6. Serum separation from Blood.
7. Staining for blood cell differentiation.
8. Demonstration of Immunoelectrophoresis.

**SUGGESTED READINGS**

1. Madigan, Martinko, Dunlap, Clark. (2009). Brock Biology of Microorganisms, Twelfth Edition. Benjamin Cummings.
2. Tortora, Funke, Case. (2009). Microbiology, Ninth Edition. Benjamin Cummings.
3. Jacquelyn G. Black, Larry M. Lewis. (2005). Microbiology: Principles & Explorations. Edition 6. Wiley, John & Sons.
4. Richard, A., Goldsby, Thomas J., Kindt, Barbara A. & Osborne (2000). Kuby Immunology. 4<sup>th</sup> edition. W. H. Freeman and Company, New York.
5. Kuby, J. (2006). Immunology 6<sup>th</sup> Edition. WH. Freeman and Company, New York

**M.Sc. Microbiology**  
**Semester III**

**MIC210: Soil & Agricultural Microbiology [Credit: 5(3+2)]**

**UNIT I: History Soil Microbiology**

**9 Hours**

Development of soil Microbiology, Distribution of soil Microorganisms in soil; Role of microorganisms in soil fertility; influence of soil environmental factors.

**UNIT II: Microbial Transformation**

**9 Hours**

Organic matter Decomposition and Microbial transformation of minerals, Organic matter decomposition; Microorganisms association with organic matter decomposition; Factors affecting organic matter decomposing; humus.

**UNIT III: Microbial Interaction**

**9 Hours**

Interaction of microbes with plants, rhizosphere concept, quantitative and qualitative studies, R:S ratio, Rhizoplane, Spherosphere, Phyllosphere microorganisms, Plant growth regulators production by microorganisms.

**UNIT IV: Biofertilizers and Biopesticides**

**9 Hours**

Biology of nitrogen fixation: *Rhizobium*, *Azospirillum*, *Azotobacter*, Phosphobacteria, Blue green algae, Mass production of bacterial biofertilizer, BGA, Quality control, Production of mycorrhizal; rhizobacteria *Pseudomonas*. Biopesticides: Bacterial, Fungal and viral insecticides and Entomopathogenic fungi.

**UNIT V: Plant Diseases**

**9 Hours**

A Brief account of the symptoms, ethiology, life cycle and management of bacterial disease (Blight of paddy, citrus canker) fungal disease, (Late blight of potato, stem rust of wheat), viral diseases (Bunchy Top of Banana, Rice Tungro virus, Phyllody of sesame)

**PRACTICALS**

1. Isolation and Enumeration of Soil Bacteria.
2. Estimation of Soil fungi by Dilution plating.
3. Soil Moisture determination.
4. Isolation of rhizospheric microorganisms.
5. Isolation of free living nitrogen fixing microorganisms: *Azospirillum* and *Azotobacter*
6. Isolation of phosphate solubilizing bacteria
7. Isolation of *Rhizobium* from root nodules.
8. Study of different plant disease using photography.

**SUGGESTED READINGS**

1. Mishra, R.R Soil Microbiology. Jagmander Book Agency, New Delhi
2. Subba Rao, N.S. Soil Microbiology. Oxford and IBH Publishing Co. New Delhi.
3. Dubey, R.C. and D.K.Maheswari . A Text Book of Microbiology, S. Chand and Co. Ltd. New Delhi.
4. Rangaswamy . G and D.J. Bagyaraj., 1993, Agricultural Microbiology, Prentice Hall of India Pvt, Ltd. New Delhi.

**M.Sc. Microbiology**  
**Semester III**

**MIC221: Fermentation Technology [Credit: 3(3+0)]**

**UNIT I: Microbial Fermentations**

**9 Hours**

Concept and scope of microbial fermentations, Inoculum, screening and selection, strain improvement, fermentation medium, Fermentation processes, continuous fermentation, batch fermentation. Bioreactors: types, designs and functional characteristics, scale up of fermentation, upstream processing & downstream processing, Fermentation economics.

**UNIT II: Production of Organic Solvents, Organic Acids and Amino Acids**

**9 Hours**

Production of organic solvents: ethyl alcohol glycerol, Acetone butanol.  
Organic acid: Butyric acid propionic acid ;Citric acid Lactic acid acetic acid Gluconic Acid.  
Amino acids: Lysine, glutamic acid.

**UNIT III: Production of Vitamins and Enzymes**

**9 Hours**

Vitamins: vitamin B<sub>2</sub> (Riboflavin), vitamin B<sub>12</sub> (Cobalamide), Vitamin C.  
Enzymes: amylase, cellulase, pectinases, invertase, protease and lipase.

**UNIT IV: Production of Antibiotics, Polysaccharides and Cell Biomass**

**9 Hours**

Antibiotics: Penicillin, streptomycin, tetracyclines chloromphenicol and griseofulvin.  
Microbial polysaccharides, Microbial insecticides, Microbial nematicides.

**UNIT V: Immobilization and Biotransformation**

**9 Hours**

Principles of immobilization, Different kinds of immobilization techniques and their importance, Sources of industrially important microorganism in India and abroad Biotransformation, steroid transformation.

**SUGGESTED READINGS**

1. El-Mans, E.M.T and C.F.A Bryce 2002. Fermentation Technology and Biotechnology. Taylor and Francis, UK
2. Ghose, T.K and P.Ghose 2003. Biotechnology in India, Springer Publishers, India
3. Glazer, A.N and H.Nikaido, 1995 Microbial Biotechnology. W.H. Freeman and Co., New York
4. Mukerji, K.G., V.P.Singh and K.L.Garg, 1987. Frontiers in Applied Microbiology Print House India
5. Prescott and Dunn. 1982. Industrial Microbiology. AVI Publishing Co., west port, Connecticut, U.S.A.
6. Stanbury, P.F., A.Whitaker and S.J.Hall 1995. Principles of fermentation Technology, Pergamon, UK

## M.Sc. Microbiology Semester III

### MIC222: IPR, Biosafety and Bioethics [Credit: 3(3+0)]

#### **UNIT I: Introduction to IPR**

**9 Hours**

Introduction to intellectual property; Types of IP: Patents, Trademarks, Copyright & Related rights, Industrial design, Traditional knowledge, Geographical indications, Protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; Introduction to history of GATT, WTO, WIPO and TRIPS; Concept of 'prior art': invention in context of "prior art"; Patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation.

#### **UNIT II: Basics of Patents**

**9 Hours**

Types of patents; Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and Implications; Role of a Country Patent Office; Procedure for filing a PCT application.

#### **UNIT III: Patent filing and Infringement**

**9 Hours**

Patent application: forms and guidelines, fee structure, time frames; Types of patent applications: provisional and complete specifications; PCT and convention patent applications; International patenting-requirement, procedures and costs; Financial assistance for patenting-introduction to existing schemes; Publication of patents-gazette of India, status in Europe and US; Patenting by research students, lecturers and scientists-University/organizational rules in India and Abroad; Credit sharing by workers; Financial incentives; Patent infringement-meaning, scope, litigation, case studies and examples.

#### **UNIT IV: Biosafety**

**9 Hours**

Introduction; Historical background; Introduction to Biological Safety Cabinets; Primary containment for Biohazards; Biosafety levels; Biosafety Levels of specific microorganisms; Recommended Biosafety Levels for infectious agents and infected animals; Biosafety guidelines, Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk analysis; Risk assessment; Risk management and communication; Overview of national regulations and relevant international agreements including Cartagena protocol.

#### **UNIT V: Bioethics**

**9 Hours**

Introduction, Ethical conflicts in biological sciences - interference with nature, Bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation; Bioethics in research: cloning and stem cell research, Human and animal experimentation, animal rights/welfare; Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion; Sharing benefits and protecting future generations - Protection of environment and biodiversity; Biopiracy

#### **SUGGESTED READINGS**

1. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. New Delhi: Tata McGraw- Hill Pub.
2. Kuhse, H. (2010). Bioethics: an Anthology. Malden, MA: Blackwell.
3. Karen F. Greif and Jon F. Merz, Current Controversies in the Biological Sciences -Case Studies of Policy Challenges from New Technologies, MIT Press
4. Recombinant DNA Safety Guidelines, 1990 Department of Biotechnology, Ministry of Science and Technology, Govt. of India. Retrieved from <http://www.envfor.nic.in/divisions/csurv/geac/annex-5.pdf>
5. Craig, W., Tepfer, M., Degrassi, G., & Ripandelli, D. (2008). An Overview of General Features of Risk Assessments of Genetically Modified Crops. Euphytica, 164(3), 853-880.
6. Guidelines for Safety Assessment of Foods Derived from Genetically Engineered Plants. 2008.

**M.Sc. Microbiology**  
**Semester III**

**MIC230: Mycology [Credit: 4(4+0)]**

**UNIT I: Introduction and Fungal taxonomy** **12 Hours**

Introduction: History and Development of Mycology, scope of mycology. Recent developments in Mycology. Fungal taxonomy: Taxonomic problems associated with variation in fungi, Classification of fungi (Alexopoulos and Mims).

**UNIT II: General characteristics of fungi and reproduction** **12 Hours**

Morphology and somatic structures: The thallus, organization, fungal cell, nuclear components, specialized somatic structures; Aggregation of hyphae, tissues, General aspects of fungal nutrition and reproduction (Asexual, Sexual reproduction, Heterothalism and Parasexuality)

**UNIT III: Fungal major groups (Part I)** **12 Hours**

Chytridiomycota, Zygomycota, Basidiomycota, Ascomycota, Deuteromycota, Oomycota.

**UNIT IV: Fungal major groups (Part II)** **12 Hours**

Hypochytriomycota, Labyrinthulomycota, Plasmodiophoromycota and Myxomycota. Symbiotic fungi-Lichens.

**UNIT V: Economic importance of fungi** **12 Hours**

Fungi as biocontrol agent, Economic importance of Fungi in Agriculture, Industry and medicine. Fungi as SCP, Fungi as parasites of human and plants. Role of fungi in bio deterioration of wood and paper. Fungi as insect symbiont.

**SUGGESTED READINGS**

1. Alexopoulos C J and Mims C W, 1979 Introductory Mycology 3rd edn, Wiley Eastern. New Delhi.
2. Deacon, J W, 1997- Modern Mycology 3rd Edition, Blackwell Science publishers, London.
3. Mehrotra, RS & Aneja, K R, 1998. An Introduction to Mycology. New Age International Pvt. Ltd. New Delhi.
4. Odum, E.P. 1971. Fundamentals of Ecology; Third Edition. Toppan Co. Ltd. Tokyo, Japan.
5. Mercedes S. Foster & Gerald F. Bills (2011) Biodiversity of Fungi: Inventory and Monitoring Methods. Academic Press
6. Michael John Carlile, Sarah C. Watkinson, G. W. Gooday (2007) The fungi. Academic Press. London, U. K
7. Kevin Kavanagh (2011) Fungi: Biology and Applications. John Wiley & Sons, Sussex, U.K.
8. David Moore, Geoffrey D. Robson, Anthony P. J. Trinci (2011) 21st Century Guidebook to Fungi. Cambridge University Press.