

## DEVI AHILYA VISHWAVIDYALAYA, INDORE

## M.Sc. (Microbiology): Four Semester Course

(Duration: Two years)

| M. Sc. Sem. I   |   |               |          |                       |          |
|-----------------|---|---------------|----------|-----------------------|----------|
| Paper           | Subject                                 | Maximum Marks |          | Minimum Passing Marks |          |
|                 |   | Theory        | C. C. E. | Theory                | C. C. E. |
| I               | Bacteriology                            | 85            | 15       | 28                    | 05       |
| II              | Virology, Mycology and Phycology        | 85            | 15       | 28                    | 05       |
| III             | Immunology                              | 85            | 15       | 28                    | 05       |
| IV              | Microbial Biochemistry                  | 85            | 15       | 28                    | 05       |
| Practical       | Lab course – I (Paper I and II)         | 50            |          | 20                    |          |
| Practical       | Lab course – II (Paper III and IV)      | 50            |          | 20                    |          |
|                 | Total Marks                             | 500           |          |                       |          |
| M. Sc. Sem. II  |   |               |          |                       |          |
| Paper           | Subject                                 | Maximum Marks |          | Minimum Passing Marks |          |
|                 |   | Theory        | C. C. E. | Theory                | C. C. E. |
| I               | Microbial Genetics                      | 85            | 15       | 28                    | 05       |
| II              | Microbial Physiology                    | 85            | 15       | 28                    | 05       |
| III             | Instrumentation                         | 85            | 15       | 28                    | 05       |
| IV              | Bioprocess Technology                   | 85            | 15       | 28                    | 05       |
| Practical       | Lab course – I (Paper I and II)         | 50            |          | 20                    |          |
| Practical       | Lab course – II (Paper III and IV)      | 50            |          | 20                    |          |
|                 | Total Marks                             | 500           |          |                       |          |
| M. Sc. Sem. III |   |               |          |                       |          |
| Paper           | Subject                                 | Maximum Marks |          | Minimum Passing Marks |          |
|                 |   | Theory        | C. C. E. | Theory                | C. C. E. |
| I               | Molecular Biology & Genetic Engineering | 85            | 15       | 28                    | 05       |
| II              | Medical Microbiology                    | 85            | 15       | 28                    | 05       |
| III             | Biostatistics and Bioinformatics        | 85            | 15       | 28                    | 05       |
| IV              | Applied Microbiology                    | 85            | 15       | 28                    | 05       |
| Practical       | Lab course – I (Paper I and II)         | 50            |          | 20                    |          |
| Practical       | Lab course – II (Paper III and IV)      | 50            |          | 20                    |          |
|                 | Total Marks                             | 500           |          |                       |          |

| M. Sc. Sem. IV                             |   |               |          |                       |          |
|--|---|---------------|----------|-----------------------|----------|
| Paper                                      | Subject                                       | Maximum Marks |          | Minimum Passing Marks |          |
|  |   | Theory        | C. C. E. | Theory                | C. C. E. |
| I  | Pharmaceutical Microbiology                   | 85            | 15       | 28                    | 05       |
| II   | Food and Dairy Microbiology                   | 85            | 15       | 28                    | 05       |
| III  | Environmental Microbiology and Phytopathology | 85            | 15       | 28                    | 05       |
| IV   | Bio-Nanotechnology and Stem Cell Technology   | 85            | 15       | 28                    | 05       |
|  | Project Work                                  | 100           |          | 40                    |          |
| Practical                                  | Lab course – I (Paper I and II)               | 50            |          | 20                    |          |
| Practical                                  | Lab course – II (Paper III and IV)            | 50            |          | 20                    |          |
|  | Total Marks                                   | 600           |          |                       |          |
|  | <b>Grand Total Marks</b>                      | <b>2100</b>   |          |                       |          |
| Theory-50 lectures/paper (1 lecture = 1hr) |   |               |          |                       |          |

| General Scheme for Practical Examination (Minimum 2 days)          |   |          |
|--|---|----------|
| M.Sc. Microbiology   |   |          |
| <b>Lab Course I</b><br>(Paper I & II)<br><b>Total marks- 50</b>    | Q.1 Major Exercise with options from Paper I        | 12 Marks |
|  | Q.2 Major Exercise with options from Paper II       | 12 Marks |
|  | Q.3 Minor Exercise with options from Paper I & II   | 10 Marks |
|  | Q.4 Viva-Voce                                       | 08 Marks |
|  | Q.5 Journal   | 08 Marks |
| <b>Lab Course II</b><br>(Paper III & IV)<br><b>Total marks- 50</b> | Q.1 Major Exercise with options from Paper III      | 12 Marks |
|  | Q.2 Major Exercise with options from Paper IV       | 12 Marks |
|  | Q.3 Minor Exercise with options from Paper III & IV | 10 Marks |
|  | Q.4 Viva-Voce                                       | 08 Marks |
|  | Q.5 Journal   | 08 Marks |

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**M. Sc. (Microbiology) Semester-I**

**Paper I – Bacteriology**

**UNIT-I**

10 lectures

Contributions made by eminent scientists in Microbiology

Classification of microorganisms – Haeckel's three kingdom concept, Whittaker's five kingdom concept, Three domain concept of Carl Woese

Salient features Bergey's Manual of Determinative Bacteriology, Bergey's Manual of Systematic Bacteriology

Modern trends in prokaryote taxonomy:

- Polyphasic taxonomy- Phenetic classification, phylogenetic classification, genotypic classification
- Techniques for determining microbial taxonomy and phylogeny
- Phylogenetic basis-construction and interpretation of phylogenetic trees
- Numerical taxonomy

**UNIT-II**

10 lectures

Morphology of bacteria-morphological types of bacteria

Ultra structure of bacteria-cell walls of eubacteria (Gram negative and Gram positive) and archaebacteria, L-forms, sphearoplast and protoplast.

Capsule – composition and function.

Cell membrane-structure, composition and properties.

**UNIT-III**

10 lectures

Structure and function of flagella, pili, gas vesicles, chromosomes, carboxysomes, magnetosomes, phycobolismes and nucleoid.

Spores and Cysts.

Reserve food materials-Polyhydroxybutyrate, polyphosphate granules, oil droplets, cyanophycin granules and sulphur inclusions.

**UNIT-IV**

10 lectures

Cultivation of bacteria – Aerobic and anaerobic cultivation

Nutritional types of bacteria.

Bacteriological media and its types.

Bacterial growth-Growth curve, growth kinetics. Generation time and growth rate.

Batch and continuous cultivation, synchronous and diauxic growth.

Measurement of bacterial growth, Factors affecting microbial growth.

**UNIT-V**

10 lectures

Microbial death curve under adverse conditions

Concepts of bioburden, thermal death constant and decimal reduction time.

Control of microbes by physical and chemical agents and mechanisms of their microbicidal activity.

Evaluation of antimicrobial potency of disinfectants and antiseptics-tube dilution method, agar diffusion method, phenol coefficient.

**REFERENCES:**

1. Fundamental Principles of Bacteriology-Salle AJ, 7<sup>th</sup> edition (Tata McGraw-Hill, New Delhi)
2. Prescott, Harley & Klein's Microbiology-Wiley JM, Sheerwood LM & Woolverton CJ, 8<sup>th</sup> edition (McGraw-Hill)
3. Microbiology-Pelczar MJ, Chan ECS & Kreig NR, 5<sup>th</sup> edition (Tata McGraw-Hill, New Delhi)
4. Text Book on Principles of Bacteriology, Virology & Immunology (Vol. IV)-Parker MT & Collier LH, 8<sup>th</sup> edition (Topley and Wilson)
5. Elementary Microbiology -Modi, HA (Vol. I & II), 1<sup>st</sup> edition (Akta Pakashan, Nadiad)
6. A Handbook of Elementary Microbiology-Modi, HA, 1<sup>st</sup> edition (Shanti Pakashan, Rohtak)
7. General Microbiology-Stainer RY, Ingharam JL, 5<sup>th</sup> edition (Macmillan Press Ltd, London)
8. Bergey's Manual of Determinative Bacteriology, Holt JG, 9<sup>th</sup> edition (Lippincott Williams & Wilkins)
9. Bergey's Manual of Systematic Bacteriology (Vol.1 to 5), 2<sup>nd</sup> edition (Springer, New York)
10. General Microbiology-Boyd RF, 2<sup>nd</sup> edition (Times Mirror/Mosby College Publishers)
11. Practical Microbiology- Dubey RC & Maheshwari DK, 1<sup>st</sup> edition (S. Chand & Co. Ltd., New Delhi)
12. Microbiology – A Practical Approach – Patel B and Phanse N, 1st edition (Print Care, Indore)
13. Microbiology- A Laboratory Manual- Cappuccino J & Sherman N, 6th edition (Pearson Education Publication, New Delhi)

M. Sc. (Microbiology) Semester-I

Paper II-Virology, Mycology and Phycology

UNIT-I

10 lectures

Discovery, nomenclature and general characters of viruses.  
Classification of virus – Baltimore, ICTV.  
Morphology and ultra structure, capsids and their arrangements, types of envelopes and their composition.  
Viral genome, their types and structures.  
Virus related agents-Viroids and prions.

UNIT-II

10 lectures

Bacteriophages: Organization and life cycle.  
One step growth curve; Lytic cycle, Lysogenic cycle  
Bacteriophage typing.  
Application in bacterial genetics.  
Brief details on T phages and Lambda phages

UNIT-III

10 lectures

Cultivation of viruses in embryonated eggs, experimental animals and cell cultures.  
Assay of viruses: Physical and chemical methods-Protein, nucleic acid, radioactivity tracers, electron microscopy.  
Infectivity assay-Plaque method and end point method.

UNIT-IV

10 lectures

Mycology-  
General characters of fungi, structure and composition of fungal cells, reproduction of fungi.  
Classification of fungi, Economic significance of fungi.  
Symbiotic associations of fungi- mycorrhiza, lichens.  
Life cycle of *Penicillium* and *Saccharomyces*

UNIT-V

10 lectures

Phycology:  
General characters of algae, algal cell structure, nutrition, reproduction, distribution of algae.  
Classification of algae  
Salient features of green algae, diatoms, euglenoids, brown algae, red algae, microalgae.  
Economic significance of algae

REFERENCES

1. General Virology- Luria SE, 3<sup>rd</sup> edition (John Wiley & Sons)
2. Introduction to Modern Virology- Dimmock NJ, 7<sup>th</sup> edition (John Wiley & Sons)
3. Virology- Levy JA, Conrat HF & Owens RA, 3<sup>rd</sup> edition (Prentice Hall)
4. Microbiology-Pelczar MJ, Chan ECS & Kreig NR, 5<sup>th</sup> edition (Tata McGraw-Hill, New Delhi)
5. Text Book on Principles of Bacteriology, Virology & Immunology (Vol. IV)-Parker MT & Collier LH, 8<sup>th</sup> edition (Topley and Wilson)
6. Introduction to Mycology-Alexopoulos CJ & Mims CW, 4<sup>th</sup> edition (Wiley Eastern Limited)
7. An Introduction to Mycology-Mehrotra RS & Aneja KR, 2<sup>nd</sup> edition (New Age International)
8. Fundamentals of Mycology-Burnett JH, 2<sup>nd</sup> edition (Edward Arnold)
9. The Fungi-Charlile MJ, Watkinson SC & Gooday GW, 2<sup>nd</sup> edition (Academic Press, Elsevier)
10. Fundamentals of the Fungi-Moore-Landeekeer E, 4<sup>th</sup> edition (Benjamin Cummings)
11. The Algae: A Review, Prescott GW, Otto Koeltz Science Publishers
12. Algae-An Introduction to Phycology-Hoek C, Mann D and Jahns HM, 1996 (Cambridge University Press)
13. Textbook of Algae- Sarabhai BP and Arora CK, 2002 (Anmol Publications Pvt. Ltd.)
14. Practical Microbiology by R. C. Dubey and D. K. Maheshwari. S. Chand & Co.



**M. Sc. (Microbiology) Semester-I**

**Paper III-Immunology**

**UNIT-I**

10 lectures

Structure, composition and types of cells and organs involved in immune system.  
Innate and acquired immunity.  
Types, structure and functions of MHC molecules, antigen processing and presentation  
Humoral and cell mediated immune responses.  
Immunization – Modern methods of vaccine production

**UNIT-II**

10 lectures

Antigens – Structure, properties and types. Haptens and adjuvants.  
Immunoglobulins- structure, heterogeneity, types and subtypes.  
Physico-chemical and biological properties of immunoglobulins.  
Theories of antibody production, generation of antibody diversity.  
Complement – Structure, components, properties and functions of complement components,  
Complement pathways and biological consequences of complement activation.

**UNIT-III**

10 lectures

Antigen-Antibody interactions-  
*In vitro* methods - Agglutination, Precipitation, Complement fixation.  
Immunofluorescence, ELISA, Radioimmunoassays, Immuno blotting.  
*In vivo* methods: Skin tests and their applications.  
Hybridoma technology - Production and applications of monoclonal antibodies.

**UNIT-IV**

10 lectures

Transplantation immunology-HLA and tissue transplantation, types of grafts, immunologic basis of graft rejection, clinical aspects of graft rejection, HLA typing methods for organ and tissue transplantations in humans  
Tumor immunology- Cancer: origin and terminology, oncogenes, tumor antigens, immune response to tumors, tumor evasion of the immune system, immunodiagnosis of tumors.  
Immunohaematology-blood group systems, medical importance of blood groups: ABO and Rh incompatibility

**UNIT-V**

10 lectures

Type I IgE – Mediated Hypersensitivity,  
Type II Antibody – Mediated Cytotoxic Hypersensitivity.  
Type III Immune Complex – Mediated Hypersensitivity.  
Type IV Delayed – Type Hypersensitivity.  
Autoimmunity – mechanism and diseases.

**REFERENCES**

1. Essentials of Immunology-Roitt IM, 11<sup>th</sup> edition, (Blackwell Pub, USA)
2. Immunology- Klaus DE, 2<sup>nd</sup> edition (Wiley Blackwell)
3. Text Book on Principles of Bacteriology, Virology & Immunology, 9<sup>th</sup> edition-5 volumes (Topley & Wilson)
4. The Experimental Foundations of Modern Immunology-Clark WR, 4<sup>th</sup> edition (John Willey & Sons)
5. Fundamental Immunology- Paul WE, 7<sup>th</sup> edition (Lippincott Williams & Wilkins, USA)
6. Fundamentals of Immunology-Coleman RM, Lombord MF & Sicard RE, 2<sup>nd</sup> edition (WMC Brown, USA)
7. Immunology- Weir DM & Steward J, 8<sup>th</sup> edition (Churchill Livingstone)
8. Microbiology – A Practical Approach – Patel B and Phanse N, 1<sup>st</sup> edition (Print Care, Indore) Hand book of Handbook of Experimental Immunology-Weir DM, 4<sup>th</sup> edition (Blackwell Scientific Co.)
9. A Hand Book of Practical Immunology (1983) GP Talwar, Vikas Publishing House, India.
10. Lecture Notes in Immunology- Reeves W G & Todd I, 2<sup>nd</sup> edition (Blackwell Scientific Publications Ltd., Oxford)



**M. Sc. (Microbiology) Semester-I**

**Paper IV- Microbial Biochemistry**

**UNIT-I**

**10 lectures**

Carbohydrates-definition and classification of carbohydrates, stereoisomerism and optical isomerism of sugars.  
Structure, properties and chemical reactions of monosaccharides  
Structure, properties and functions of disaccharides oligosaccharides and polysaccharides.  
Structure, occurrence and biological importance of carbohydrate derivatives-peptidoglycan, blood group lipopolysaccharides.

**Unit-II**

**10 lectures**

Definition and classification of lipids.  
Building blocks of lipids- fatty acids, glycerol  
Fatty acids: distribution in nature, classification, physico-chemical properties, separation, characterization  
Saponification and iodine number.  
Phospholipids-Structure, properties and functions.  
Lipoproteins - classification, composition and their importance.  
Sphingosine- Structure and function.  
Role of lipids in cellular architecture and functions.

**UNIT-III**

**10 lectures**

Amino Acids : Structure, classification and properties. Handerson Hasselbach equation for ionization of amino acids.  
Primary, secondary, tertiary and quaternary structures of proteins, structure of myoglobin and hemoglobin.  
Ramachandran Plot.  
Chemical reactions of amino acids.  
Lab synthesis of poly peptides.  
Determination of amino acid sequence in proteins / polypeptides.

**Unit-IV**

**10 lectures**

Enzymes as biocatalysts- Enzyme classification.  
Mechanism of enzyme action - specificity, active site, activity unit and isozymes.  
Factors affecting enzyme efficiency, enzyme activators, coenzymes and cofactors.  
Enzyme kinetics : Michaelis- Menton equation, Determination of kinetic parameters, multi-step reactions.  
Enzyme inhibition- reversible, irreversible, competitive, noncompetitive and uncompetitive  
Allostereism- kinetic analysis of allosteric enzymes, principles of allosteric regulation.

**UNIT-V**

**10 lectures**

Vitamins : Discovery of vitamins  
Properties and functions of fat soluble vitamins-vitamins A, D, E and K.  
Properties and functions water soluble vitamins-Pantothenic acid, niacin, pyridoxine, biotin, riboflavin, cyanocobalamin, folic acid and ascorbic acid.

**REFERENCES**

1. Lehniger-Principles of Biochemistry-Nelson DL & Cox MM, 4<sup>th</sup> edition (CBS Publishers, New Delhi)
2. Biochemistry- Berg JM, Tymoczko JL & Stryer L, 6<sup>th</sup> edition (W. H. Freeman)
3. Harper's Biochemistry- Rodwell VW, Bender D, Botham KM Kennelly PJ & Weil PA 30<sup>th</sup> edition (McGraw-Hill Education)
4. Principles of Biochemistry- Zubey GL, Parson WW & Vance DE, 1995 (McGraw-Hill Education)
5. Introduction to Protein Structure- Branden CI & Tooze J, 2<sup>nd</sup> edition (Garland Science)
6. An Introduction to Practical Biochemistry-Plummer DT, 3<sup>rd</sup> edition (McGraw-Hill Book Company)
7. Experiments in Biotechnology- Nighojkar S & Nighojkar A, 1<sup>st</sup> edition (Satprachar Press, Indore)

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

**LAB COURSE I**

**Paper I-Bacteriology**

**Paper II-Virology Mycology and Phycology**

**Suggested List of Practicals**

1. General instrumentation
2. Preparation of media
3. Staining techniques: differential and structural staining methods
4. Isolation techniques
5. Determination of standard plate count
6. Preparation of McFarland scale
7. Study of bacterial growth-
  - i. Factors affecting bacterial growth
  - ii. Growth curve of bacteria, calculation of growth rate and generation time (Demonstration)
  - iii. Diauxic growth pattern of bacteria (Demonstration)
8. Anaerobic cultivation -
  - i. Anaerobic cultivation methods- GasPak anaerobic jar/Candle jar method
  - ii. Isolation of *Clostridium* from soil and its identification
9. Microbiological study of actinomycetes-
  - i. Isolation and characterization of actinomycetes
  - ii. Cover slip culture study for study of morphological characters of actinomycetes
10. Study of bacterial virus
  - i. Isolation of coliphage from sewage
  - ii. Determination of phage titre
11. Study of fungi
  - i. Isolation and identification of economically important fungi
  - ii. Measurement of fungal growth by biomass (mycelial dry weight) method
12. Study of algae
  - i. Isolation of algae from natural sources
  - ii. Morphological studies of economically important algae (permanent slides)
  - iii. Microscopic observation of lichen symbiosis (permanent slides)

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

**LAB COURSE II**



Paper III-Immunology

Paper IV-Microbial Biochemistry

**Suggested List of Practicals**

1. Differential leucocyte count for morphological characteristics of lymphocytes, neutrophils, monocytes, eosinophils and basophils.
2. Separation of lymphocytes from blood by Ficoll-Hypaque density gradient method
3. Preparation of antigens of *Salmonella typhi*
4. Diagnostic immunological methods-
  - i. Flocculation reaction-serodiagnosis of syphilis by VDRL test (Qualitative & Quantitative)
  - ii. Agglutination reaction-serodiagnosis of enteric fever by Widal test (Qualitative & Quantitative)
  - iii. Latex agglutination for detection of C reactive protein /Rheumatoid factor etc.
5. Determination of ABO and Rh blood group type
6. Immunodiffusion techniques-
  - i. Radial Immuno Diffusion (RID)
  - ii. Ourlony Double Diffusion technique (ODD)
  - iii. Immunoelectrophoresis
7. Enzyme Linked Immuno Sorbent Assay (ELISA)
8. Preparation of buffers and volumetric solutions
9. Analysis of carbohydrates-
  - i. Qualitative tests for carbohydrates
  - ii. Quantitative estimation of carbohydrates
10. Analysis of proteins-
  - i. Qualitative tests for proteins
  - ii. Quantitative estimation of proteins
11. Analysis of lipids-
  - i. Qualitative tests for lipids
  - ii. Determination of saponification value of fat
12. Quantitative estimation of DNA by Diphenyl amine (DPA) method
13. Quantitative estimation of RNA by Orcinol method
14. Study of factors affecting enzyme activity
15. Determination of specific activity of enzymes
16. Study of enzyme kinetics
  - i. Study the effect of substrate concentration on enzyme activity
  - ii. Construction of Lineweaver Burk plot
  - iii. Determination of  $V_{max}$  &  $K_M$  values





M. Sc. (Microbiology) Semester-II

Paper I -Microbial Genetics

UNIT-I

10 lectures

Fine structure of prokaryotic and eukaryotic genome.  
DNA structure and types.  
Experimental proof for DNA as genetic material.  
DNA replication-evidence for semi conservative mode of replication: Meselson-Stahl experiment, enzymes involved in DNA replication, DNA replication mechanism, models of DNA replication.  
Inhibitors of DNA replication.

UNIT-II

10 lectures

Spontaneous and induced mutation.  
Molecular nature of mutation, types of mutations.  
Mutagens: Physical and chemical mutagens.  
DNA damage (Deamination, oxidative damage, alkylation, pyrimidine dimers).  
Repair pathways-Photoreactivation, excision repair, methyl directed mis-match repair, recombination repair, SOS repair.  
Screening chemicals for mutagenicity- Ames test

UNIT-III

10 lectures

Structural features of RNA (rRNA, tRNA and mRNA).  
Transcription-General principles, basic apparatus and types of RNA polymerases. Initiation, elongation and termination steps.  
Polycistronic and monocistronic RNAs.  
Post transcriptional processing of RNAs: Methylation, cutting and trimming of rRNA; capping, polyadenylation and splicing of mRNA; cutting and modification of tRNA degradation system.  
Inhibitors of RNA synthesis.  
Control of transcription by interaction between RNA polymerases and promoter regions: Use of alternative sigma factors.  
Ribozymes and RNAi.

UNIT-IV

10 lectures

Basic features of the genetic code.  
Protein synthesis: details of initiation, elongation and termination, role of various factors in these steps, inhibitors of protein synthesis.  
Regulation of gene expression: Operon concept, catabolite repression, positive and negative regulation; inducers and co-repressors.  
Negative regulation in *E. coli*-lac operon; positive regulation-*E. coli* ara operon; regulation by attenuation of *his* and *trp* operons

UNIT-V

10 lectures

Gene transfer mechanisms-Transformation, conjugation, transduction: mechanisms and their applications.  
Transposons – Insertion sequences and composite transposons. Types of transposons and their properties.  
Mechanism of transposition.  
Gene mapping

REFERENCES

1. Genetics- Russel JP, 2<sup>nd</sup> edition (Scott, Foresman & Company, USA)
2. Principles of Genetics- Gardner JE, Simmons JM and Snustad PD, 8<sup>th</sup> edition (John Wiley & Sons)
3. Concepts of Genetics-Klug and Cummings, 10<sup>th</sup> edition (Benjamin Cummings, USA)
4. Microbial Genetics- Freifelder D, 2<sup>nd</sup> edition (Jones & Bartlett Publishers, Boston)
5. Microbial Genetics- Maloy S, Cronan J & Freifelder D, 2<sup>nd</sup> revised edition (Jones & Bartlett Publishers, Boston)
6. Molecular Genetics of Bacteria- Synder L & Champness W, 4<sup>th</sup> edition (ASM Press, Washington)
7. Modern Microbial Genetics- Streips UN & Yasbin RE, 2<sup>nd</sup> (John Wiley & Sons)
8. Genome-Brown TA, 3<sup>rd</sup> edition (Garland Science)
9. Molecular Biotechnology- Glick BR, Pasternak JJ & Patten CL, 4<sup>th</sup> edition (ASM Press, Wahington)
10. Molecular Biology of the Gene-Watson JD *et al.*, 7<sup>th</sup> edition (Cold Spring Harbor Laboratory Press, New York)
11. Lewin's Genes XI- Krebs JE, Goldstein ES, Kilpatrick ST, 11<sup>th</sup> edition (Jones & Bartlett Publishers)
12. Genetic Engineering-Rastogi S & Pathak N, 2009 (Oxford University Press)
13. Genetic Engineering: Principles and Practice-Mitra S, 2<sup>nd</sup> edition (McGraw Hill Education, New Delhi)

**M. Sc. (Microbiology) Semester-II**

**Paper II-Microbial Physiology**

**UNIT-I**

10 lectures

Photosynthesis: Bacterial photosynthesis: scope, electron carriers.  
Photosynthetic reaction center, cyclic flow of electrons.  
Bacterial photophosphorylation in various groups of phototrophic bacteria.  
Electron donors other than water in anoxygenic photosynthetic bacteria.

**UNIT-II**

10 lectures

Respiratory metabolism: Embden-Mayerhoff pathway, Entner-Duodroff pathway, Glyoxalate pathway, Krebs cycle-oxidative and substrate level phosphorylation, reverse TCA cycle, gluconeogenesis, Pasteur effect, anaerobic respiration.  
Biochemistry of methanogens.

**UNIT-III**

10 lectures

Lipid Metabolism- Fatty acid oxidation- alpha, beta and omega oxidations. Energy yields from fatty acid oxidation. Oxidation of unsaturated fatty acids and fatty acids with odd numbered carbon atoms, Ketogenesis  
Biosynthesis of fatty acid and triacylglycerols.

**UNIT-IV**

10 lectures

Biosynthesis of amino acids.  
Catabolism of amino acids.  
Purine and pyridine biosynthesis- de novo pathway and salvage pathway  
Synthesis of polysaccharides, peptidoglycan and biopolymers as cell components.

**UNIT-V**

10 lectures

Metagenomic studies-Unculturable and culturable bacteria, Conventional and molecular methods for the study of microbial diversity.  
Extremophiles- Adaptation mechanism of acidophilic, alkalophilic, psychrophilic, thermophilic, barophilic, osmophilic and halophilic microorganisms, applications of extremophiles.  
Quorum sensing in microorganisms

**REFERENCES**

1. Microbial Physiology and Metabolism- Caldwell DR, 2<sup>nd</sup> edition (Star Pub Co.)
2. Microbial Physiology -Moat & Foster, 2<sup>nd</sup> edition (John Wiley & Sons)
3. General Microbiology-Stainer RY, Ingharam JL, 5<sup>th</sup> edition (Macmillan Press Ltd, London)
4. Prokaryotic Development-Brun Y & Shimkets LJ, 2000 (ASM Press)
5. Extremophiles Handbook- Horikoshi K *et al.*, 1<sup>st</sup> edition (Springer Japan)
6. Extremophiles- Johri JN, 2000 (Springer Verlag, New York)
7. Biology of Microorganisms-Brock TD, Smith DW & Madigan MT, 1984 (Prentice-Hall International)
8. Microbial life in extreme environments-Kushner DS (Academic Press Inc. New York)

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**M.Sc. (Microbiology) Semester-II**

**Paper III- Instrumentation**

**UNIT-I**

**10 lectures**

Microscopy-Theoretical considerations, instrumentation and applications of Light, Phase-contrast, Interference, Polarization and Fluorescence microscopes. Transmission and Scanning electron microscopy, scanning transmission electron microscope (STEM)

**UNIT-II**

**10 lectures**

Centrifugation-Basic principles of sedimentation, mathematical calculations of centrifugal field, angular velocity, relative centrifugal field and sedimentation coefficient.  
Preparative centrifugation- Principle and working of differential and density gradient centrifugation, Zonal and isopycnic separation. Practical applications of preparative centrifugation.  
Principle and working of analytical centrifugation, determination of the relative weight by sedimentation velocity and sedimentation equilibrium methods.

**UNIT -III**

**10 lectures**

**Chromatography-**

Principles of chromatography

Paper and Thin layer chromatography, Adsorption column chromatography, Ion-exchange chromatography, Gel exclusion chromatography, High performance liquid chromatography. Affinity chromatography and Gas chromatography.

**UNIT-IV**

**10 lectures**

Electrophoresis-

Polyacrylamide gel electrophoresis (PAGE) - native and gradient gels, DNA sequencing gels, SDS-PAGE, isoelectric focusing gels, 2-D PAGE.

Agarose gel electrophoresis- DNA gel electrophoresis, Pulsed field gel electrophoresis, RNA electrophoresis.

Capillary electrophoresis.

Radioisotope techniques-Detection and measurement of radioactivity, Geiger-Muller counter, scintillation counter.

Autoradiography-principle and applications

**UNIT-V**

**10 lectures**

Theory, instrumentation and applications of Spectroscopy-Absorption and Emission spectroscopy

Visible, ultraviolet and infra red spectroscopy, fluorescence spectroscopy, Nuclear Magnetic Resonance (NMR) spectroscopy, Mass Spectroscopy- components , ionization mechanisms, MALDI-TOF and Quadrupole mass spectroscopy.

**REFERENCES**

1. Principles and Techniques of Biochemistry and Molecular Biology-Wilson K, Walker J, 6<sup>th</sup> edition (Cambridge University Press, New York.)
2. Biophysical Chemistry -Principles and Techniques- Upadhyay A, Upadhyay K & Nath N, 8<sup>th</sup> edition (Himalaya Publishing)
3. The Biochemistry of Nucleic Acids-Adams RLP, Knowler JT & Leader DP, 1992 (Springer Netherlands)
4. Principles of Physical Biochemistry- Van Holde KE, Johnson WC & Ho PS, 2<sup>nd</sup> edition (Prentice Hall)

  
A. P. Maurya

Phane  
K. K. Kulkarni

M. S. Golani

**M.Sc. (Microbiology) Semester-II**

**Paper IV-Bioprocess Technology**

|  |                    |
|--|--------------------|
| <b>UNIT-I</b><br>Screening of industrially important microorganisms.<br>Strategies for strain improvement.<br>Maintenance and preservation of industrially important microorganisms.<br>Inoculum development for industrial fermentation.<br>Industrial sterilization process for media, air and equipment.<br>Media for industrial fermentations<br>Microbial growth and death kinetics | <b>10 lectures</b> |
| <b>UNIT-II</b><br>Scale up of fermentation process.<br>Down stream processing-<br>Removal of insolubles: filtration, centrifugation.<br>Cell disruption methods.<br>Product isolation: Extraction and adsorption methods.<br>Product purification: Chromatographic methods, Precipitation, crystallization<br>Drying devices.  | <b>10 lectures</b> |
| <b>UNIT-III</b><br>Concept of submerged, surface and solid state fermentations.<br>Batch and continuous fermentation processes.<br>Basic design of fermentation equipment.<br>Monitoring and controls of fermentation parameters.<br>Fermentor types and their applications-Plug flow reactor, Air lift fermentor, Packed bed reactor, Fluidized bed reactor and Tray reactor.           | <b>10 lectures</b> |
| <b>UNIT-IV</b><br>Microbial production of commercially important products – I<br>Solvent – Ethanol<br>Organic acids - Citric acid, Acetic acid, Lactic acid.<br>Enzymes – Amylase and Protease.<br>Steroid bioconversions  | <b>10 lectures</b> |
| <b>UNIT-V</b><br>Microbial production of commercially important products – II<br>Antibiotics – Penicillin and Streptomycin.<br>Vitamins – Cyanocobalamine and Riboflavin.<br>Amino Acids – Lysine and Glutamic acid.<br>Immobilized enzymes and cells: Methods of immobilization, applications of immobilized enzymes.   | <b>10 lectures</b> |

**REFERENCES**

1. Textbook of Industrial Microbiology-Patel AH, 1<sup>st</sup> edition (Macmillan India Ltd, Madras)
2. Industrial Microbiology-Cassida LE, 4<sup>th</sup> edition (Wiley Eastern Ltd, New Delhi)
3. Principles of Fermentation Technology-Stanbary FP, Whitaker A and Hall JS, 2<sup>nd</sup> edition (Elsevier, Delhi)
4. Fermentation Technology-Modi HA, 1<sup>st</sup> edition (Pointer Publisher, Jaipur)
5. Biotechnology-Industrial Microbiology-Crueger W & Crueger A, 2<sup>nd</sup> edition (Panima Publisher, New Delhi)
6. Industrial Microbiology- Prescott SC & Dunn CG, 4<sup>th</sup> edition (Agrobios India, Jodhpur)
7. Bioprocess Technology-Hodi HA, 1<sup>st</sup> edition (Pointer Pulisher, Jaipur)
8. Biology of Industrial Microorganisms-Demain AL & Solomon NA (Butterworth-Heinemann)
9. Fundamentals of Biotechnology- Prave P, Faust U & Sittig W, 1<sup>st</sup> edition (Wiley-Blackwell)
10. Bioprocess Engineering- Shuler ML & Kargi F, 2<sup>nd</sup> edition (Prentice Hall)



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

**LAB COURSE I**

**Paper I-Microbial Genetics**

**Paper II-Microbial Physiology**

**Suggested List of Practicals**

1. Isolation of genomic DNA from bacterial cells and its analysis
2. Isolation of RNA from yeast cells and its analysis
3. Study of UV absorption spectra of nucleic acids
4. To check purity of DNA by spectrophotometric method
5. Study the lethal action of ultra violet radiation
6. Isolation of lac<sup>-</sup> mutants / auxotrophic mutants using ultra violet radiation as a mutagenic agent
7. Isolation of mutants by Replica Plate Method
8. Isolation of drug resistant mutants by Gradient Plate Method
9. Study the transfer of antibiotic resistance between bacterial species by conjugation process
10. Isolation of photosynthetic bacteria
11. Demonstration of phototrophic bacteria in Winogradsky column
12. Study of metabolic activities of microbial cultures-
  - i. Study of carbohydrate metabolism by oxidation/fermentation of glucose (Hugh Leifson's test)
  - ii. Study of glucose breakdown products: Methyl red test, Voges-Proskauer's test
  - iii. Study of catalase/oxidase activity in bacterial cultures
  - iv. Study of lipid hydrolysis by microbial cultures
  - v. Study of degradation of tryptophan by bacterial culture (Indole test)
  - vi. Study of degradation of sulfur containing amino-acids by bacterial culture (H<sub>2</sub>S production test)
13. Measurement of microbial activity in soil by soil respiration method
14. Study of extremophiles-
  - i. Isolation of alkalophiles/acidophiles /halophiles by enrichment technique
  - ii. Study of alkalophilic/alkalotolerant nature of bacterial isolates

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

**LAB COURSE II**

**Paper III-Instrumentation**

**Paper IV-Bioprocess Technology**

**Suggested List of Practicals**

1. Chromatography
  - i. Paper chromatography
  - ii. Thin Layer Chromatography
  - iii. Gel Filtration Chromatography
  - iv. Ion- Exchange Chromatography
2. Electrophoresis
  - i. Agarose gel electrophoresis
  - ii. SDS-PAGE
3. Separation of cells/cell organelles by density gradient centrifugation
4. Screening of industrially important microbes-
  - i. Antibiotic Producers (Crowded Plate , Wilkins Method)
  - ii. Enzyme producers
  - iii. Organic acid producers
5. Determination of antimicrobial spectrum of antibiotic producing isolates by agar ditch method
6. Production of ethanol by yeast using suitable substrates
7. Production of antibiotics/enzymes by submerged fermentation technology
8. Production of enzymes/organic acids by solid state fermentation technology
9. Downstream processing for microbial enzymes/antibiotics/organic acids
10. Immobilization techniques of cells/enzymes
11. Determination of Thermal Death Time (TDT) of microorganisms
12. Determination of Thermal Death Point (TDP) of microorganisms

*A. P. Pradeep*

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*M. Phane*

*A. Rathore*

*M. S. Mehlani*



**M.Sc. (Microbiology) Semester-III**

**Paper I-Molecular Biology and Genetic Engineering**

**UNIT-I**

10 lectures

Essential enzymes used in r-DNA technology.  
Restriction digestion, ligation and transformation.  
Cloning vectors- Plasmids, phages and cosmids.  
Animal virus derived vectors (SV 40, Vaccinia), plant based vectors (Ti, Ri vectors)  
Artificial chromosomes as vectors (YAC and BAC vectors)  
Cloning strategies-Cloning and selection of individual genes, gene libraries - cDNA and genomic libraries.

**UNIT-II**

10 lectures

Specialized cloning strategies –  
Expression vectors: basic features of expression vectors, promoters used in expression vectors, pMal, GST, pET based vectors  
Cassettes and gene fusions  
Fusion vectors-Translational and transcriptional fusion vectors  
Recombinants protein purification-advantages of fusion proteins, fusion proteins tags-His-tag, GST-tag, MBP-tag, methods involved in recombinants protein purification

**UNIT-III**

10 lectures

DNA sequencing methods-Sanger method, Maxam and Gilbert method, Thermal cycle sequencing, Pyrosequencing, Automated DNA sequencing. Assembly of contiguous DNA sequence  
Gene amplification - PCR-principle, types and applications.  
DNA microarray technique.

**UNIT-IV**

10 lectures

Expression of cloned DNA – Expression in heterologous system.  
Study of the transcript of a cloned gene.  
Hybridization techniques-Colony hybridization, plaque hybridization, Southern, Northern, Western and Southwestern blotting, in situ hybridizations.  
Modification of cloned DNA – Site directed mutagenesis, transposon mutagenesis.

**UNIT-V**

10 lectures

Applications of r-DNA technology-Requirement and production of recombinant molecules in pharmaceutical, health, agricultural and industrial sectors and research laboratories.  
Transgenic animals, *Agrobacterium* mediated transformation, Bt cotton, Gene Therapy.  
Ethical and safety issues associated with recombinant DNA technology, IPR and patenting.

**REFERENCES**

1. Genomes- Brown TA, 2<sup>nd</sup> edition ( Oxford: Wiley-Liss)
2. Principles of Gene Manipulation - Old RW & Primrose SB, 5<sup>th</sup> edition (Blackwell Scientific Publications)
3. Gene Cloning & DNA Analysis – Brown TA, 6<sup>th</sup> edition (Wiley Blackwell)
4. Molecular Biotechnology- Glick BR, Pasternak JJ & Patten CL, 4<sup>th</sup> edition (ASM Press, Washington)
5. Principles of Gene Manipulation and Genomics-Primrose SB & Tyman RM, 7<sup>th</sup> edition (Blackwell Publishing)
6. Genetic Engineering-Rastogi S & Pathak N, 2009 (Oxford University Press)
7. Genetic Engineering: Principles and Practice-Mitra S, 2<sup>nd</sup> edition (McGraw Hill Education, New Delhi)
8. Molecular Biology of the Gene-Watson JD, Gann A et al., 7<sup>th</sup> edition (Cold Spring Harbor Laboratory Press, New York)
9. Current Protocols in Molecular Biology- Ausbel FM *et. al.*, 2003 (John Wiley & Sons)
10. Molecular Cloning Vol. I-III - Sambrook and Russel, 2001 (CSH press)
11. Genome analysis (Four Volumes)- Paterson AH, Brubaker CL, Wendel JF, 1993 (Springer, CSH Press)
12. DNA Microarrays: A Practical Approach-Schena M (Oxford University Press)

M. Sc. (Microbiology) Semester-III

Paper II-Medical Microbiology

UNIT-I

10 lectures

Epidemiological studies of infectious diseases-  
Reservoirs and sources of diseases.  
Infection and its types, transmission of infections.  
Types of diseases-epidemic, endemic, pandemic, sporadic  
Preventive and control measures for diseases, Hospital acquired infections and their prevention  
Epidemiological Methods – Descriptive, Analytical and Experimental Epidemiology.  
Introduction to Centers for Disease Control and Prevention (CDC) & National Centre for Disease Control (NCDC)

UNIT-II

10 lectures

Normal microbial flora of human body  
Classification and identification of medically important microorganisms  
Opportunistic pathogens and true pathogens  
Attributes predisposing to microbial pathogenicity- virulence: attenuation and exhalation, infecting dose  
Microbial pathogenicity - Mechanism and factors involved in establishment and spreading of infection, adhesion, invasiveness, toxigenicity.

UNIT-III

10 lectures

Recent advances in medical microbiology-  
Multidrug resistance: Antibiotics-types & mode of action. Types, biochemical mechanisms and development of multidrug resistance. Guidelines for rational use of antibiotics. Multidrug-resistant organisms- Methicillin-Resistant *Staphylococcus aureus* (MRSA), Extended Spectrum  $\beta$ -lactamase (ESBL) producing Gram-negative bacteria, MDR & XDR tuberculosis, Carbapenem resistant *Enterobacteriaceae* (CRE).  
Introduction to emerging diseases- Dengue hemorrhagic fever, Swine flu, Chicken guinea, Ebola, SARS.  
Overview and current status of anti HIV, anti malaria and anti tuberculosis treatment.

UNIT IV

10 lectures

Etiology, clinical features, pathogenesis, laboratory diagnosis, transmission, prevention & control of diseases caused by-  
Gram positive cocci - *Staphylococcus aureus*, *Streptococcus* species.  
Gram positive bacilli - *Clostridium* species.  
Gram negative cocci- *Neisseria* species  
Gram negative bacilli - *E.coli*, *Salmonella* species  
Acid Fast Bacteria – *Mycobacterium tuberculosis*

UNIT-V

10 lectures

Etiology, clinical features, pathogenesis, laboratory diagnosis, transmission, prevention & control of diseases caused by-  
Actinomycetes- *Actinomyces israelii*.  
Spirochaetes- *Treponema pallidum*.  
Rickettsiae- *Rickettsia* species  
Chlamydiae- *Chlamydia* species.  
Fungi: *Microsporium*, *Trichophyton*, *Candida albicans*.  
Virus- Hepatitis virus, HIV, Polio virus  
Protozoa- *Plasmodium* species, *Entamoeba histolytica*.

REFERENCES

1. Medical Microbiology - Mackie TJ & McCartney JE (Vol. 1-Microbial Infection & Vol. 2-Practical Medical Microbiology), 13<sup>th</sup> edition (Churchill Livingstone, London)
2. Text book of Microbiology-Ananthnarayan R & Panikar CKJ, 8<sup>th</sup> edition, (University Press Pvt Ltd, Hyderabad)
3. Basic Medical Microbiology-Boyd RF, 5<sup>th</sup> edition (Little Brown, Boston)
4. Bailey and Scott's Diagnostic Microbiology-Forbes BA, Sahm DF & Weissfeld AS, 12<sup>th</sup> edition (Mosby, Elsevier)
5. Microbiology in Clinical Practice – Shanson DC, 1<sup>st</sup> edition (Wright, London)
6. Biochemistry of Antimicrobial Action – Franklin TJ, Snow GA & Hall, 4<sup>th</sup> edition (Chapman and Hall Ltd.)
7. Epidemiology and Infections – Smith CEG, 1<sup>st</sup> Edition (Meadowfield Press Ltd, England)
8. Bacterial Disease Mechanism-An Introduction to Cellular Microbiology - Wilson M, McNab R & Henderson B, 2002 (Cambridge University Press)



**M. Sc. (Microbiology) Semester- III**

**Paper III-Biostatistics and Bioinformatics**

**UNIT-I**

**10 lectures**

Basic definitions and applications of statistics in biological research.

Sampling: Representative sample, sample size, sampling bias and sampling techniques.

Data collection and representation: Types of data, methods of collection of primary and secondary data. Methods of data representation: tabular, diagrammatic graphical representation by bar diagram, histogram, polygon and pie diagram.

Measures of central tendency: Mean, Median, Mode.

Measures of variability: Standard deviation, standard error, range, mean deviation and coefficient of variation.

**UNIT-II**

**10 lectures**

Test for significance: Small sample tests (Chi-square t test, F test), large sample test (Z test)

Analysis of variance (ANOVA): analysis of variance in one-way and two way classification.

Correlation and Regression: Positive and negative correlation and calculation of Karl-Pearson's co-efficient of correlation. Linear regression and regression equation.

Introduction to probability theory and distributions (concept without deviation).

**UNIT-III**

**10 lectures**

Introduction to bioinformatics-History, aim and scope of bioinformatics.

Database concept, DBMS.

Classification of biological databases and their functions-

Nucleotide sequence database: EMBL, GenBank, DDBJ

Protein sequence database: SWISS-PROT, PIR

Nucleic acid and Protein structure databases – NDB, PDB

Protein structure classification databases (SCOP, CATH)

Genome databases and composite database (NCBI)

Specialized databases (ESTs, EXPASY, Prosite, Pfam)

**UNIT-IV**

**10 lectures**

Basic concepts of sequence comparison, sequence identity, similarity and homology.

Scoring/substitution matrices (PAM, BLOSUM).

Sequence database searching tools (BLAST, FASTA)-basic knowledge of their variants and statistical significance.

Pair wise Local and Global sequence alignment algorithms (Needleman & Wunsch, Smith & Waterman).

Multiple sequence alignment.

**UNIT - V**

**10 lectures**

Studying Open reading frames (ORFs), Motifs, Domains, Patterns, Profiles and their importance.

Phylogenetic analysis-Basic concepts of phylogenetic analysis, rooted/uprooted trees, approaches for phylogenetic tree construction (UPGMA, Neighbour joining methods). Introduction to Operational taxonomic units (OTU).

**REFERENCES**

1. Primer of Biostatistics, Glantz S, 7<sup>th</sup> edition (McCraw Hill Companies)
2. Statistics for Biology-Bishop ON, 3<sup>rd</sup> edition (Longman Publishing Group)
3. Statistics in Biology-Bliss CI, (McGraw Hill Companies)
4. Practical Statistics for Experimental Biologists-Wardlaw AC, 2<sup>nd</sup> edition (John Wiley & Sons)
5. Statistical Methods in Biology-Bailey NTJ, 1<sup>st</sup> edition (English Universities Press)
6. Statistics for Biologists-Campbell RC, 3<sup>rd</sup> edition (Cambridge University Press, UK)
7. Fundamentals of Biostatistics- Irfan AK & Khanum A, 2014 (Ukaaz Publications, Hyderabad)
8. Biostatistics – Arora PN, Malhan PK, 1<sup>st</sup> edition (Himalaya Publishing House, Mumbai)
9. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (Methods of Biochemical Analysis)-Baxevanis AD, Ouellette BFF, 1<sup>st</sup> edition (John Wiley & Sons)
10. Bioinformatics: Sequence, Structure, and Databanks : A Practical Approach-Higgins D, Taylor W, 1<sup>st</sup> edition (Oxford University Press)
11. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins-Baxevanis AD, Ouellette BFF, Volume 43, 2<sup>nd</sup> edition (John Wiley & Sons)
12. Bioinformatics Methods & Protocols (Methods in Molecular Biology)-Misener S, Krawetz SA, 1999<sup>th</sup> edition (Humana Press) N, Malhan PK, 1<sup>st</sup> edition (Himalaya Publishing House, Mumbai)

**M. Sc. (Microbiology) Semester- III**

**Paper IV-Applied Microbiology**

**Unit I**

**10 lectures**

Production of biofertilizers and bioinsecticides-

Production and methods of application of: *Rhizobium* biofertilizer, *Azotobacter* biofertilizer, *Azospirillum* biofertilizer, *Azolla* & Blue-Green Algae biofertilizer, phosphate solubilizing biofertilizer.

Quality control of biofertilizers as per FCO (Fertilizer Control Order)-method of analysis, standards of biofertilizers.

Production of Bioinsecticides : Candidate microorganisms, production, safety, advantages and disadvantages of bioinsecticides.

**Unit II**

**10 lectures**

Biofuel Production-

Biogas-The substrate digester and the microorganisms in the process of biogas production (biomethanation).

Bioethanol-Production of bioethanol from sugar, molasses, starch and cellulosic materials. Ethanol recovery.

Biohydrogen-Microbial production of hydrogen gas.

Microbial production of biodiesel from hydrocarbons.

Algae as biofuel.

**Unit III**

**10 lectures**

Bioremediation and Biosensors-

Microbiology of degradation of xenobiotics in the environment.

Strategies and techniques of bioremediation: *in situ* and *ex situ*.

Approaches to bioremediation- intrinsic bioremediation, biostimulation, bioaugmentation.

Bioremediation of oil spills, metals, lignins and hazardous wastes. Application of GMO in bioremediation.

Biosensors- definition, components of biosensors, principle of operation.

Methods of biomaterial and sensor coupling.

Types of biosensors. Applications of biosensors.

**Unit IV**

**10 lectures**

Bioleaching and Petroleum Microbiology-

Microbes and mineral recovery: General methods of bioleaching, bioleaching of copper, gold and uranium from low grade ores.

Petroleum microbiology-Microbial Enhanced Oil Recovery (MEOR), detrimental activity of microbes in petroleum industry.

**Unit V**

**10 lectures**

Bioplastics and Biosurfactants-

Definition of bioplastics, types of bioplastics, genetically modified bioplastics.

PHA-properties, types, chemical structure, PHA producing microbes.

Modern trends in microbial production of bioplastics.

Applications of bioplastics, biodegradability of bioplastics, advantages and disadvantages of bioplastics.

Biosurfactants- microbial production and applications.

**REFERENCES**

1. Microbial Biotechnology: Fundamentals of Applied Microbiology -Glazer AN and Nikaido H, 2nd edition, Cambridge University Press.
2. A Textbook of Basic and Applied Microbiology-Aneja KR, New Age International.
3. Biofertilizers- Somani LL ,Bhandari SC , Saxena SN , Vyas KK, Scientific Publishers , Jodhpur.
4. Biofertilizers in agriculture and forestry- Subba Rao NS (Oxford and IBH, Publishing Co. New Delhi)
5. Bioremediation- Baker KH and Herson DS, Mc Graw Hill, New York
6. Biodegradation and Bioremediation-Alexander, M, 2nd edition, Academic Press.
7. Textbook of Environmental Biotechnology-Mohapatra PK,I K International Publishing House Pvt. Ltd
8. Microbial Mineral Recovery-Ehrlich HL & Bierley CL , McGraw-Hill



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

**LAB COURSE I**

**Paper I-Molecular Biology and Genetic Engineering**

**Paper II-Medical Microbiology**

**Suggested List of Practicals**

1. Extraction of plasmid DNA and its analysis using agarose gel electrophoresis
2. Preparation of competent cells and transformation of DNA by using  $\text{CaCl}_2$
3. Determination of molecular size of DNA fragments
4. Restriction digestion of DNA samples using restriction endonucleases
5. DNA fingerprinting technique- Restriction Fragment Length Polymorphism-RFLP
6. To perform ligation of DNA fragments
7. DNA purification from electrophoresed agarose gel (electro elution/silica based technique , etc.)
8. DNA amplification by Polymerase Chain Reaction (Demonstration)
9. DNA fingerprinting technique- Random Amplified Polymorphic DNA -RAPD (Demonstration)
10. Blotting techniques (Demonstration)
11. Isolation, biochemical characterization and identification of medically important bacteria-
  - *E. coli*, *Klebsiella pneumoniae*, *Salmonella typhi*, *Proteus mirabilis*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Streptococcus sp.*
12. Determination of antibiotic susceptibility pattern of pathogenic microbes
13. Study of synergistic and additive effect of antibiotics
14. Isolation and identification of resident normal flora from skin/throat
15. Effect of disinfectants on microflora of skin
16. Haematology : RBC Count, Total WBC Count, Differential WBC Count, Haemoglobin estimation
17. Laboratory analysis of urine-physical, chemical, microscopic and bacteriological analysis



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

**LAB COURSE II**

**Paper III-Biostatistics and Bioinformatics**

**Paper IV-Applied Microbiology**

**Suggested List of Practicals**

1. Diagrammatic and graphical presentation of statistical data using MS Excel
2. Use of in-built statistical functions of MS Excel for computations of statistical averages, central tendency and standard deviation
3. Calculation of standard deviation
4. Calculation of standard error
5. Application of tests of significance
6. Introduction to NCBI and its database
7. Variants of BLAST and FASTA
8. Sequence manipulation suite
9. Pairwise sequence alignment
  - i. Global pairwise alignment using Needleman-Wunsch Algorithm based ALIGN EMBOSS tool
  - ii. Local pairwise alignment using Smith Waterman Algorithm based ALIGN EMBOSS tool
10. Multiple sequence alignment
11. Isolation of *Rhizobium* from root nodules
12. Isolation of *Azotobacter* from soil
13. Isolation of *Azospirillum* from soil
14. Isolation and characterization of phosphate solubilisers from soil
15. Isolation and characterization of PHA producing bacteria
16. Isolation and characterization of biosurfactant producing bacteria
17. Isolation and characterization of lignin degrading microorganisms
18. Isolation and characterization of dye degrading microorganisms from industrial effluents



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**M. Sc. (Microbiology) Semester- IV**

**Paper I-Pharmaceutical Microbiology**

**UNIT-I**

**10 lectures**

Introduction to pharmaceutical industry: Role of a microbiologist in a pharma industry (Active Pharmaceutical Ingredient Production units, Formulation units, Research and Development, Quality Assurance and Regulatory Aspects).

Introduction to pharmacopoeia with special reference to Indian, British, United States.

Regulatory authorities for introduction of medicines in market – Role of Food and Drug Administration, FDA guidelines for drugs / biologicals.

Quality assurance and quality management in pharmaceuticals: ISO, WHO and US certification.

Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry.

**UNIT-II**

**10 lectures**

Design and layout of sterile product manufacturing unit. (Designing of microbiology laboratory).

Safety in microbiology laboratory.

Microbiological analysis for pharmaceutical industries: Standard operating procedures for microbiological assay of antibiotics, vitamins and amino acids, water analysis, Microbial limit test, Sterility test, Pyrogen test (BET), Area monitoring, Growth promotion test.

Calibration and validation of equipments

Microbial contamination and spoilage of pharmaceutical products (sterile injectibles, non injectibles, ophthalmic preparations and implants) and their sterilization.

Chemical disinfectants, antiseptics and preservatives.

**UNIT-III**

**10 lectures**

Antibiotics and synthetic antimicrobial agents – Structure, types and modes of action.

Beta lactams and non beta lactams.

Aminoglycosides, Tetracyclines, Chloramphenicol, Macrolides, Fluroquinilones.

Chemosynthetic drugs-Sulphonamides, Trimethoprim, Nitrofurans and Isoniazid.

Antifungal and antiviral drugs.

**UNIT – IV**

**10 lectures**

Molecular principles of drug targeting, Drug delivery system in gene therapy, Micro-encapsulation. Nanoparticles, Liposomes, Antibodies for drug delivery.

Penetrating defenses – How the antimicrobial agents reach the targets (cellular permeability barrier, cellular transport system and drug diffusion).

**UNIT-V**

**10 lectures**

Drug development in pharmaceutical process:

Preclinical and Clinical studies: Phase I, phase II, phase III and phase IV of clinical trials – Objectives, Conduct of trials, Outcome of trials

Production of biopharmaceuticals by genetically engineered cells: Hormones (Humulin, Humatrope), Interferons (Intron A, Referon-A), t-Plasminogen activator (Activase), Monoclonal antibodies and hybridoma technology (Monoclone, Orthoclone OKT3).

Other pharmaceuticals produced by microbial fermentations (Streptokinase, Streptodornase).

New vaccine technology- DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines. Application of microbial enzymes in pharmaceutical industry.

**REFERENCES**

1. Hugo & Russell's Pharmaceutical Microbiology- Denyer SP, Hodges NA & Gorman SP, 7<sup>th</sup> edition (Wiley-Blackwell)
2. Analytical Microbiology (Volume I & II)-Kavanagh F (Academic Press, New York)
3. Quality Control in the Pharmaceutical Industry (Vol.2)-Cooper MS (Academic Press, New York)
4. Biotechnology (Vol 4: Microbial Products)- Rehm HJ, Reed G & Pape H (VCH Publications)
5. Pharmaceutical Biotechnology-Vyas SP & Dixit VK, 1<sup>st</sup> edition (CBS Publishers, New Delhi)
6. Good Manufacturing Practices for Pharmaceuticals: A Plan for total quality control-Willing SH, Tuckerman MM & Hitchings W, 3<sup>rd</sup> edition (Bhalani Publishing House, Mumbai)
7. Advances in Applied Biotechnology (Vol 10): Biopharmaceuticals in transition. Industrial Biotechnology Association-Webber P (Gulf Publishing Company Houston. )
8. Targetting of Drugs- Gregoriadis G & Trouet A, 1<sup>st</sup> edition (Plenum Publishing Corporation, Springer).

**M. Sc. (Microbiology) Semester- IV**  
**Paper II-Food and Dairy Microbiology**

|  |                    |
|--|--------------------|
| <b>UNIT-I</b><br>Food fermentations – Bread and Vinegar.<br>Fermented beverages-Beer and Wine.<br>Microbial cells as food (Single Cell Proteins, Single Cell Oil),<br>Probiotics and Prebiotics.<br>Mushroom cultivation, genetically modified foods.  | <b>10 lectures</b> |
| <b>UNIT-II</b><br>Food infections – Gastroenteritis, Salmonellosis, Shigellosis.<br>Bacterial food intoxications –Botulism and Staphylococcal intoxication.<br>Mycotoxins – Aflatoxins.<br>Microbiological examination of food.<br>Quality assurance: Microbiological quality standards of food, Government regulatory practices and policies.<br>FDA, EPA, HACCP and ISI. | <b>10 lectures</b> |
| <b>UNIT –III</b><br>General principles of food preservation.<br>Preservation by using high and low temperature.<br>Chemical preservatives and food additives.<br>Use of irradiation for preservation.<br>Spoilage of food – fresh food, canned food, milk products.  | <b>10 lectures</b> |
| <b>UNIT - IV</b><br>Composition of milk.<br>Normal flora of milk, changes produced by microorganisms in milk.<br>Pasteurization – basis of pasteurization, methods of pasteurization<br>Milk borne diseases.<br>Microbiological analysis of milk-Standard plate count, direct count, reduction tests, phosphatase test<br>Grades of milk                                   | <b>10 lectures</b> |
| <b>UNIT-V</b><br>Milk starter cultures, Microbiology of cheese – types of cheese, cheese manufacture,<br>Fermented milk products-yoghurt, cultured buttermilk, acidophilus milk, kefir, kumiss<br>Applications of microbial enzymes in dairy industry (proteases and lipases).<br>Utilization and disposal of dairy by-product - Whey                                      | <b>10 lectures</b> |

**REFERENCES**

1. Food Microbiology-Frazier CW & Westhoff CD, 4<sup>th</sup> edition (Tata McGrawhill, NewDelhi)
2. Food Microbiology-Adams RM & Moss OM, 3<sup>rd</sup> edition (RSC publisher)
3. Introductory Food Microbiology-Modi HA, 1<sup>st</sup> edition, (Aavishkar Publishers, Jaipur)
4. Modern Food Microbiology-Jay JM Loessner, MJ & Golden DA, 7<sup>th</sup> edition (Springer)
5. Basic Food Microbiology-Banwart G, 2<sup>nd</sup> edition (Chapman & Hall)
6. Fundamental Principles of Bacteriology-Salle AJ, 7<sup>th</sup> edition (Tata McGrawhill, NewDelhi)
7. Food-borne Infections and Intoxications-Riemann H & Bryan FL, 2<sup>nd</sup> edition (Academic Press, New York)
8. Food Microbiology: Fundamentals and Frontiers - Doyle MP, Buchanan RL, 4<sup>th</sup> edition (ASM Press, Washington)
9. Fundamentals of Dairy Microbiology – Prajapati JP, 1<sup>st</sup> edition (Ekta Prakashan, Nadiad)
10. Microbiology of Fermented Foods – Wood, Brian JB, 1<sup>st</sup> edition (Elsevier Publication)
11. Practical Food Microbiology-Roberts D & Greenwood M, 3<sup>rd</sup> edition (Blackwell Publishing Ltd)
12. Food Microbiology: Fundamentals and Frontiers - Doyle MP & Buchanan RL, 4<sup>th</sup> edition (ASM Press, Washington)
13. Essentials of Food Microbiology-Garbult J, 2<sup>nd</sup> edition (Taylor & Francis)



**M.Sc. (Microbiology) Semester-IV**

**Paper III-Environmental Microbiology and Phytopathology**

|   |                    |
|---|--------------------|
| <b>UNIT-I</b><br>Aerobiology: Droplet nuclei, aerosol.<br>Assessment of air quality.<br>Bacterial, fungal and viral diseases transmitted through air and their preventive measures.   | <b>10 lectures</b> |
| <b>UNIT-II</b><br>Soil Microbiology: Physical and chemical characteristics of soil.<br>Micro flora of various soil types, rhizosphere and phyllosphere.<br>Positive and negative microbial interactions.<br>Biogeochemical cycles: carbon, nitrogen, phosphorus cycle.<br>Symbiotic and non-symbiotic nitrogen fixation, Mycorrhiza, Phosphate Solubilizing Bacteria.   | <b>10 lectures</b> |
| <b>UNIT - III</b><br>Aquatic Microbiology: Potability of water: microbial assessment of water quality.<br>Purification of water.<br>Major water borne diseases and their control measures.<br>Waste Water treatment: Types and characterization of waste water.<br>Physical, chemical and biological waste treatments, Solid waste treatment.   | <b>10 lectures</b> |
| <b>UNIT-IV</b><br>Plant pathology-<br>Definition, causes of plant diseases-inanimate & animate causes.<br>Symptoms of plant diseases, transmission of plant diseases.<br>Plant diseases and their etiological studies: Bacterial plant diseases - Canker & gummoses, Crown galls, Fire blight, Soft rots, Wilts.<br>Viral plant diseases - Cucumber mosaic disease, Potato spindle disease, Tobacco mosaic disease.<br>Fungal plant diseases - Apple scab, Downy mildew of grapes, Late blight of potatoes, Wheat rust. | <b>10 lectures</b> |
| <b>UNIT-V</b><br>Plant disease control-<br>Principles of plant disease control, physical and chemical methods of disease control.<br>Microbial control of plant diseases-Biocontrol as an alternative to chemical pesticides.<br>Microbial biocontrol agents – Bacteria, Fungi.<br>Mechanisms involved in biocontrol – Mycoparasitism, Antibiosis, Competition.<br>Integrated Control – Chemical-Biological control, Physical-Biological control.   | <b>10 lectures</b> |

**REFERENCES**

1. Introduction to soil microbiology-Alexander M, 2<sup>nd</sup> edition (John Wiley and Sons New York)
2. Soil Microbiology- Subba Rao NS, 4<sup>th</sup> edition (Oxford and IBH, Publishing Co. New Delhi)
3. Fundamental Principles of Bacteriology-Salle AJ, 7<sup>th</sup> edition (Tata McGrawhill, New Delhi)
4. Microbiology- Pelczar MJ, Chan ECS & Kreig NR, 5<sup>th</sup> edition (Tata McGraw-Hill, New Delhi)
5. A Textbook of Microbiology- Dubey RC & Maheshwari DK, 2<sup>nd</sup> edition (S Chand & Co. New Delhi)
6. Introduction to Environmental Microbiology- Michael R, 1<sup>st</sup> edition (Prentice Hall)
7. Fundamentals of Microbiology- Frobisher M, Hinsdill RD, Crabtree KT & Goodheart CR, 9<sup>th</sup> edition (W.B. Saunder & Co.)
8. Plant Pathology- Agrios GN, Academic Press.
9. Fundamentals of Plant Pathology-Mehrotra RS, Ashok Aggarwal A, Tata McGraw-Hill Education
10. Principles of Plant Pathology- Manners JG, 2<sup>nd</sup> edition (Cambridge University Press)



**M. Sc. (Microbiology) Semester- IV**

**Paper IV-Bio-Nanotechnology and Stem Cell Technology**

**UNIT-I**

**10 lectures**

Nanotechnology: definition, history of nanotechnology  
Potential uses of nanomaterials in electronics, robotics, computers, sensors, sports equipment, mobile electronic devices, vehicles and transportation.  
Amalgamation of biology and nanotechnology, scope of bio-nanotechnology  
Criteria for suitability of nanostructures for biological applications

**Unit - II**

**10 lectures**

Nanoparticles: Gold, Silver and Magnetic nanoparticles and their applications.  
Nanomaterials: Carbon Nanotubes (CNT), fullerenes, diamondoid, nanoshells.  
Synthesis of Nanomaterials: Concept of top down process and bottom up processes to synthesis of nanomaterials.  
Chemical Methods: metal nanocrystals by reduction, solvothermal synthesis, photochemical synthesis, sonochemical routes, Chemical Vapor Deposition (CVD), Metal Oxide Chemical Vapor Deposition (MOCVD).  
Physical Methods: ball milling, electrodeposition, spray pyrolysis, flame pyrolysis, DC/RF magnetron sputtering, Molecular Beam Epitaxy (MBE).  
Biological synthesis of nanoparticles using plant extracts and microorganisms.

**UNIT-III**

**10 lectures**

Drug delivery devices: Micro-electromechanical systems (MEMS), Nanoelectromechanical systems (NEMS).  
Drug delivery system: microcapsules, PEG-protein conjugates, micelles, liposomes, dendrimers, hydrogels.  
Quantum dots: synthesis and their applications in cancer diagnosis and treatment.  
Nanobiosensors, Nano DNA Technology, Concept of Nanorobots and Nubots

**Unit - IV**

**10 lectures**

Stem cells: Unique properties of stem cells, formation of differentiated blood cells from hematopoietic stem cells, types of stem cells, properties and sources of adult and embryonic stem cells, advantages and disadvantages of adult and embryonic stem cells.

**Unit - V**

Production and harvesting of stem cells, assay of stem cells.  
Stem cell therapy, application of stem cells in drug development, stem cell banking.  
Importance of stem cell research, ethical issues of stem cell research, guidelines for stem cell research in India.

**REFERENCES**

1. Nano: The Essentials: Understanding Nanoscience and Nanotechnology-Pradeep T, 1<sup>st</sup> edition (Tata McGraw-Hill Publishing Company Limited, New Delhi)
2. Nanobiotechnology-Balaji S, 1<sup>st</sup> edition (MJP Publishers)
3. The University Textbook of Nanotechnology-Heller KH, Mehmud CH & Tumbull WH, 1<sup>st</sup> edition (Dominant Publishers)
4. Nanotechnology and Human Health-Malsch I & Emond C, 2013 (CRC Press)
5. Multilayer Thin Films: Sequential Assembly of Nanocomposite Materials- Decher G & Schlenoff JB, 2003 (Wiley-VCH)
6. Biomedical Nanotechnology- Malsch NH, 2005 (CRC Press)
7. Nanotechnology- A Fundamental Approach- Kumar U, 2010 (Agrobios, India)
8. Nanotechnology-Shanmugam S, 2010 (MJP Publishers)
9. Understanding Nanotechnology-Hachette UK, 2002 (Grand Central Publishing)
10. Nanocosm: Nanotechnology and the Big Changes Coming from the Inconceivably Small-Atkinson WI, 2007 (Jaico Publishing House)
11. Molecular cell Biology-Lodish, Berk and Zipursky, 4<sup>th</sup> Edition 2000 (Scientific American book)
12. Molecular Biology of the cell- Alberts et al, 4<sup>th</sup> Edition 2002 (Garland)



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


**LAB COURSE I**

**Paper I-Pharmaceutical Microbiology**

**Paper II-Food & Dairy Microbiology**

**Suggested List of Practicals**

1. Validation of autoclave, hot air oven for sterilization efficiency
2. Calibration of laboratory equipments
3. Physico-chemical analysis of pharmaceutical products
4. Growth Promotion Test (GPT) and Growth Inhibition Test (GIT)
5. Environment and personnel monitoring
4. Bioassay of antibiotics/vitamins/aminoacids
5. Determination of Minimal Inhibitory Concentration (MIC) of antimicrobial pharmaceutical products
6. Disinfectant efficacy testing
7. Sterility testing for sterile pharmaceutical preparations
8. Microbial Limits Tests for pharmaceutical preparations
9. Bioburden estimation
10. Preservative Efficacy Testing for pharmaceutical preparations (PET)
11. Bacteriological analysis of food-
  - i. Bacterial count of food products
  - ii. Enumeration and confirmation of coliforms in food
  - iii. Detection of faecal coliforms
- 12) Bacteriological analysis of milk and milk products-
  - i. Standard plate count
  - ii. Enumeration and confirmation of coliforms
  - iii. Detection of faecal coliforms
  - iv. Detection of acid fast bacteria
- 13) Grading of milk-Methylene blue reduction time (MBRT) test / Resazurin test
- 14) To determine efficiency of pasteurisation of milk by phosphatase test
- 15) Production of fermented food products-bread, yoghurt, wine (Demonstration)



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M. Sc. (MICROBIOLOGY) - SEMESTER IV

LAB COURSE II

Paper III-Environmental Microbiology and Phytopathology

Paper IV-Bio-Nanotechnology and Stem Cell Technology

Suggested List of Practicals

1. Microbiological analysis of air
2. Quantitative analysis of microorganisms present in soil
3. Evaluating the soil health of agricultural soil (Demonstration)
  - pH, organic carbon, phosphorus, potassium, ammoniacal-nitrogen, nitrate-nitrogen
4. Bacteriological analysis of water: Qualitative and Quantitative methods-
  - i. Standard plate count (SPC)
  - ii. Most Probable Number (MPN) of coliforms
  - iii. Routine coliform tests – Presumptive, Confirmed, Completed Test
  - iv. IMViC tests
  - v. Eijkman Test
  - vi. Membrane filtration technique
5. Sewage analysis
  - i. Bacteriological analysis of sewage-Qualitative and Quantitative methods
  - ii. Physical analysis of sewage/industrial effluent by measuring total solids, total dissolved solids and total suspended solids
  - iii. Determination of indices of pollution by measuring BOD/COD of different effluents
6. Isolation and characterization of *Xanthomonas citri* from citrus canker.
7. Isolation and identification of fungal pathogens from diseased plants
8. Preparation of silver nanoparticles by chemical methods
9. Green synthesis of silver nanoparticles using plant extracts/microbial cells
10. Determination of antimicrobial activity of silver nanoparticles
11. Comparative analysis of antimicrobial activity of ionic silver and silver nano particles
12. Spectrophotometric analysis of silver nano particles
13. Study of nano-silver coated gauze/textiles/nanoparticle containing products for antimicrobial activity

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