

DEPARTMENT OF MICROBIOLOGY
GOVT. V. Y. T. P.G. AUTONOMOUS COLLEGE DURG

M.Sc. – MICROBIOLOGY
SEMESTER I
PAPER – I
MMB 101 BACTERIOLOGY AND VIROLOGY

Unit – I

- Morphology and ultra-structure of bacteria: Morphological types, Archaeobacteria, Gram negative and positive Eubacteria, Actinomycetes and L-forms
- Cell wall: synthesis, antigenic properties; Capsule: types, composition and function Cell membranes: structure, composition and properties; Structure and functions of flagella, pili, gas vesicles, chromosomes, carboxysomes, magnetosomes Phycobolosomes, Endospore. Cell division
- Reserve food material, polyhydroxybutyrate, polyphosphate granules, oil droplets, cyanophycin granules and sulphur inclusions.

Unit – II

- Classification of microorganisms: Basis of microbial classification; Haeckel's three kingdoms concept, Whittacker's five kingdom concept, three domain concept of Carl Woese
- Salient feature of bacterial classification according to the Bergey's manual of determinative bacteriology
- Cultivation of bacteria: aerobic, anaerobic, shake & still cultures
- Nutritional types, culture media, Growth curve, Generation time, Growth kinetics, Asynchronous, synchronous, batch, continuous cultures, Measurement of growth, factors affecting growth, Control of bacteria and preservation methods.

Unit – III

- Brief outline on discovery of viruses, Classification and nomenclature of viruses
- Distinctive properties of viruses, morphology and ultra structure, capsids and their arrangements, types of envelopes and their composition, Viral genome, their types and structures
- Virus related agents (viroids, prions).
- Bacteriophages: structural organization, life cycle; one step growth curve, eclipse phase, phage production, burst size, lysogenic cycle, bacteriophage typing; Brief details on MI3, Mu, T3, T4, and Lamda P1.

Unit – IV

- Cultivation of viruses: embryonated eggs, experimental animals; Cell culture: primary and secondary cell cultures, suspension cell cultures and monolayer cell cultures and transgenic system
- Assay of viruses: physical and chemical methods (protein, nucleic acid, radioactive tracers, electron microscopy), infectivity assay (plaque Method, end point method)
- Structural organization, life cycle, pathogenecity, symptoms, control of vector : Plant Viruses (TMV, CMV, and PVX) and Animal Viruses (Pox, Herpes, HIV, Influenza, Polio)

Recommended Books:

1. A Text book of Microbiology – P.Chakraborty , New central book agency(P) Ltd. Kolkata.
2. General Microbiology I &II - C.B. Powar and H. F. Dagainawala , Himalaya Publishing House Bombay.
3. Microbiology – B.D. Davis, R. Dulbecco, H.N. Eisen and H.S. Ginsberg, Harper and Row Publishers Philadelphia.
5. A Text book of Microbiology – R.C. Dubey and D.K. Maheshwari, S. Chand and Company Ltd., New Delhi.
6. Microbiology: Fundamentals and Applications – S.S. Purohit, Students Edition, Jodhpur.
7. Biology of Microorganisms – T.D. Brock and M.T. Madigan, Prentice Hall Int. Inc
8. Fundamental Principles of Bacteriology – A.J. Salle
9. General Microbiology – R.Y. Stainer, J.L. Wheelis and P.R. Painter, Macmillan Educational Ltd. London.
10. Modern Microbiology – E.A. Brige, W.M.C. Brown, Oxford, England
11. Text book on Principles of Bacteriology, Virology and Immunology – Topley and Wilson, Edward Arnold, London
13. An Introduction to Viruses – S.B. Biswas and Amita Biswas, Vikas Publishing house Pvt.Ltd.
14. Virology: Principles and Applications – John Carter and Venetia Saunders, John Wiley and Sons Ltd.

M.Sc. – MICROBIOLOGY
SEMESTER I
PAPER – II
MMB 102 PHYCOLOGY AND MYCOLOGY

Unit – I

- Algae – Distribution, classification, thallus range and nutrition, Pigmentation
- Blue Green Algae: classification, properties, economic importance; Diatoms
- Algal Reproduction
- Algal Ecology
- Algal Biotechnology
- Lichens – General account, classification, structure, reproduction and economic importance.

Unit – II

- General Features of fungi: Structure and cell differentiation, Classification, Reproduction
- Salient features of Division Myxomycotina, Mastigomycotina and Zygomycotina. Life cycle and economic importance of representative members
- Salient features of Division Ascomycotina – Hemiascomycetes, Plectomycetes, Pyrenomycetes, Discomycetes, Labelbeniomyces, Loculoascomycetes. Life cycle and economic importance of representative members

Unit – III

- Salient features of Division Basidiomycotina–Teliomycetes, Hymenomycetes. Life cycle and economic importance of representative members
- Salient features of Division Deuteromycetes –Hypomycetes, Coelomycetes, Blastomycetes. Life cycle and economic importance of representative members
- Evolutionary tendencies in lower fungi and higher fungi.

Unit – IV

- Fungi and Ecosystem – Saprophytes, substrate groups and nutritional strategies, substrate successions
- Fungi and bioremediation
- Industrial importance of Fungi
- Heterothallism in fungi
- Sex hormones in fungi
- Effect of Environment on fungal growth
- Prevention of fungal growth
- Mycorrhiza – Ectomycorrhiza, Endomycorrhiza, Vesicular Arbuscular Mycorrhiza

Recommended Books:

1. An Introduction to Mycology – R.S. Mehrotra, and K.R. Aneja 1990, New Age International publishers.
2. Introduction to Mycology (3rd Ed.) –Alexopoulos, C.J. and C.W. Mims 1979. Wiley Eastern Ltd.,
3. Fundamentals of Mycology – J.H. BurnettmPublisher : Edward , Arnold Crane russak.
4. The Fungi – M.Charlile& S.C. Watkinson, Publisher:Academic Press.
5. Fundamentals of Fungi – E. Moore-Landeekeer, Publisher: Prentice Hall.
6. The Algae: Structure and Reproduction, Vol I and II – F.E. Fritsch, Vikas Publishing house Pvt. Ltd.
7. A text book of Algae – A.V.S.S. Sambamurthy, I.K. International Pub.

M.Sc. – MICROBIOLOGY
SEMESTER I
PAPER – III
MMB 103 BIOCHEMISTRY

Unit – I

- Carbohydrates: Characters and classification; Monosaccharide -classification, structure and physico-chemical properties, glycosides; Derivatives of monosaccharide – aminosugars, sugar acids and phosphorylated sugars
- Disaccharides- sucrose, lactose and maltose
- Structure, occurrence and biological significance of polysaccharides (starch, cellulose, chitin, glycogen and peptidoglycan)

Unit – II

- Amino acids: Standard amino acids, nonstandard amino acids, D-amino acids, beta- and gamma-amino acids, Classification of amino acids, Analysis of mixtures of amino acids, Derivatives of amino acids
- Proteins : Classification, organization and specificity of proteins, assemblies of proteins, purification
- Vitamins: Classification- water and fat soluble vitamins, structure and their biochemical properties
- Hormones : Basic mechanism of hormones action , hormones and diseases

Unit – III

- Lipids: Classification of lipids; fatty acids: physico - chemical properties, separation, distribution in nature, characterization and saponification
- Nomenclature, outline structure, properties and functions of glycerides, neutral lipids(waxes, fats and oils) Membrane lipids: phospholipids, spingophospholipids and glycolipids
- Steroids, Plant sterols, Ergosterol, Stigmasterol and Cholesterol
- Structure of purine and pyrimidine bases, nucleosides and nucleotides and their nomenclature, Types of RNA and DNA and their structures

Unit – IV

- Enzymes: Nomenclature, classification
- Enzyme kinetics, factors affecting enzyme activity: Effect of pH, substrate concentration, temperature and inhibitors
- Mechanism of enzyme action, Competitive and non-competitive inhibition, Regulation of enzyme activity, allosteric enzymes and feedback mechanisms
- Enzyme assay: General considerations and different methods

Recommended Books:

1. Principles of Biochemistry- Albert L. Lehninger , CBS Publishers And Distributors
2. Fundamentals of Biochemistry – Dr. J.L. Jain , Dr. Sanjay Jain, S.Chand Publication
3. Biochemistry- U.Satyanarayana, U.Chakrapani , Books and Allied (p) Ltd.
4. Color Atlas of Biochemistry- J.Koolman And K.H. Roehm , Thieme Stuttgart, New York
5. Biochemistry- Power And Chattwal, Himalaya Publishing House
6. Biochemistry- Christopher K. Mathews, K.E. Van Holde, Kevin G. Ahern, Pearson Education
7. Practical Biochemistry- Principles And Techniques- Keith Wilson And John Walker
8. Biochemistry – Donald Voet and Judith G. Voet

M.Sc. – MICROBIOLOGY
SEMESTER I
PAPER – IV
MMB 104 FUNDAMENTALS OF IMMUNOLOGY

Unit –I

- Immune System and Immunity: History of Immunology
- Structures, composition and functions of cells and organs involved in immune system
- Immune responses: Innate immunity and Acquired immunity
- Antigens: Structure and Properties, types, Iso and allo, haptens, adjuvants, antigen specificity
- Immunoglobulin: structure, heterogeneity, types and subtypes, properties (physico Chemical and biological)

Unit –II

- Complement: structure, components, properties and functions
- In vitro Methods: agglutination, precipitation, complement fixation, immune fluorescence, ELISA, Radio Immunoassays
- In vivo Method: Skin tests & immune complex tissue demonstrations, applications of these methods in diagnosis of microbial diseases
- Immunohaematology: blood groups, blood transfusion and Rh incompatibilities

Unit – III

- Structure and functions of MHC
- Gene regulation and Ir-genes; HL-A and tissue transplantation, Tissue typing methods for organ and tissue transplantations in humans; graft versus host reaction and rejection
- Autoimmunity: Theories, mechanism and diseases with their diagnosis

Unit –IV

- Tumor immunology: Tumor specific antigens, Immune response to tumors, immune diagnosis of tumors, detection of tumor markers, alphafoetal proteins, carcino embryonic antigen
- Hypersensitivity Reactions: Antibody mediated, Type I(Anaphylaxis), TypeII(Antibody dependent cell cytotoxicity), Type III (Immune complex mediated reactions), Type IV (Cell mediated hypersensitivity reaction)
- Cytokines: Properties, classification, biological functions, cytokine receptors and cytokine related diseases

Recommended Books:

1. Essentials of Immunology – I.M. Roitt, ELBS, Blackwell Scientific publishers, London.
2. Kubey Immunology II-Edition– J. Kube, W.H. Freeman and company. New York.
3. Immunology. Understanding of Immune System –Klaus D.Elger Wiley– Liss. NY.
4. Text book on Principles of Bacteriology, Virology and Immunology (IX Edi)–Topley&Wilson's (5 volumes) Edward Arnold, London.
5. Immunology – S.S. Lal and Sanjeev Kumar, Rastogi Pub. Meerut India.
6. Immunology at a glance – J.H.L. Playfair
7. The chain of Immunology – G. Feinberg and M.A. Jackson
8. Lecture notes on immunology – I.R. Todd, Blackwell scientific Publications, Oxford.
9. Fundamental Immunology – W.E. Paul, Raven Press, New York
10. Fundamentals of Immunology – R.M Coleman, M.F. Lombord and R.E. Sicard, 2nd Ed. Brown Publishers

M.Sc. MICROBIOLOGY
SEMESTER –I
LAB COURSE I
MMBP 01 BACTERIOLOGY & VIROLOGY AND PHYCOLOGY & MYCOLOGY
List of Practical Exercises

M.M. – 100

I – Bacteriology and Virology

1. Isolation of bacteria from following sources and study their cultural characteristics.
Air, Water and Soil.
2. Identification of isolated bacteria by Gram staining.
3. Identification of isolated bacteria on the basis of biochemical properties.

IMVic test

TSIA test

H₂S production test

Catalase production test

Amylase production test

4. Determination of bacterial growth by Turbidity measurement (Spectrophotometric method).
5. Isolation and examination of Actinomycetes from soil and study their cultural characteristics.
6. Phage titration.
7. Symptomatology study of Viral Diseases (plants and animals).

II – Phycology & Mycology

1. Isolation of Green Algae and Cyanobacteria from soil and water samples.
2. Study the special features of selected Green Algae, Cyanobacteria and Diatoms.
3. Study the special features of Lichens.
4. Isolation and examination of Rhizospheric fungi by Warcup's method.
5. Isolation and examination of Keratinophilic fungi from soil by Keratin Bait technique.
6. Isolation and examination of Coprophilous fungi from dung by Moist Chamber method.
7. Isolation and examination of Storage fungi from food grains by Blotter technique.
8. Isolation and examination of Zoosporic fungi from water by Seed Bait technique.
9. Isolation and examination of Aeromycoflora by petriplate exposure.
10. Study of Endomycorrhiza colonization and calculation of percent root infection.
11. Study the special features of selected fungal isolated.
12. Micrometry and camera Lucida studies of some microbial structures.

M.Sc. MICROBIOLOGY
SEMESTER –I
LAB COURSE II
MMBP 02 BIOCHEMISTRY AND IMMUNOLOGY
List of Practical Exercises

M.M. – 100

I Biochemistry

1. Preparation of buffer and determination of pH.
2. Extraction and determination of total sugars in the sample by Dubois method.
3. Determination of reducing sugar in the sample by Benedict's reagent.
4. Distinguish between aldose and ketose sugar by Seliwanoff's test.
5. Determination of starch by Iodine test.
6. Detection of free amino acid in the sample by Ninhydrin test.
7. Extraction of protein and estimation by Folin-Lowry and Biuret method.
8. Detection of presence of lipid by Saponification.
9. Isolation of genomic DNA from bacterial cell and estimation by DPA method (Diphenylamine method).
10. Isolation and estimation of RNA from yeast.
11. Enzyme production test by microorganisms (Amylase/Lipase/Gelatinase/Pectinase/ Protease).

II Immunology

1. Study of agglutination reaction with blood grouping and Blood examination for Rh factor.
2. Characterization of Lymphocytes from blood.
3. Antigen antibody reaction by Double Diffusion technique.
4. Separation of Immunogen by immuno electrophoresis technique.
5. Dot ELISA.
6. Determination of concentration of given antigen by RID technique.

M.Sc. – MICROBIOLOGY
SEMESTER II
PAPER – I
MMB 201 MOLECULAR BIOLOGY

Unit – I

- Nucleic acid as genetics information carriers: experimental evidence, melting of DNA
- DNA replication: general principles, various modes of replication, Types and properties of DNA polymerases, Proof reading, Continuous and discontinuous synthesis, Exonuclease activity in eukaryotic DNA polymerases, Superhelicity in DNA, Linking number, Topological properties, Mechanism of action of topoisomerases, Initiation of replication of single stranded DNA, Construction of replication fork in test tube
- Retroviruses and their unique modes of DNA synthesis, Relationship between replication and cell cycle
- Inhibitors of DNA replication: Blocking precursor synthesis, nucleotides polymerization, altering DNA structures

Unit – II

- Transcription: general principles, basic apparatus, steps (initiation, elongation and termination), Types of RNA polymerases, Inhibitors of RNA synthesis
- Polycistronic and monocistronic RNAs, Maturation and processing of RNA: Methylation, Cutting and trimming of rRNA, Capping, Polyadenylation and splicing of mRNA, Cutting and modification of tRNA degradation system, Catalytic RNA, group I and group II intron splicing RNase P

Unit – III

- Basic features of genetic code
- Protein synthesis: steps, details of initiation, elongation, termination, roles of various factors in above steps, Inhibitors of proteins synthesis, Synthesis of exported proteins on membrane bound ribosomes

Unit – IV

- Regulation of genes expression: Operon concept, catabolite repression instability of bacterial RNA,
- Gene regulation: Inducers and co repressors, Negative regulation (E.coli lac operon), Positive regulation (E.coli ara operon, regulation by attenuation – his and trp operons; anti termination – N protein and nut sites in D),
- DNA binding proteins, enhancer sequences and controls of transcription by interaction between RNA polymerases and promoter regions, Use of alternate sigma factors, controlling termination attenuation and anti termination. Identification of protein binding sites on DNA, regulation of rRNA and tRNA synthesis.

Recommended Books:

1. Molecular biology of gene, Watson, Baker, Bell, Gann, Levine, Personal Education LPE
2. Principles and Techniques of Biochemistry and Molecular Biology, K. Wilson and J. Walker, Cambridge low price Edition.
3. Mol Bio- Fundamentals of Molecular Biology, A. Upadhyay, Himalaya Pub.
4. Molecular Biology, A.V.S.S. Sambamurthy, Narosa Pub.
5. Essentials of Molecular Biology, Malacinski, M.George and David Freidfelder, Narosa Pub.
6. Biochemistry, C.B. Powar and Chatwal, Himalaya Pub.
7. Principles of Biochemistry, Nelson and Cox

M.Sc. – MICROBIOLOGY
SEMESTER II
PAPER – II
MMB 202 MICROBIAL GENETICS

Unit – I

- DNA damages: Biological indications of damage to DNA
- Types of DNA damage (deamination, oxidative damage, alkylation, pyrimidindimers)
- Evidences to repair system
- Repair pathways (methyl directed mismatch repair, very short patch repairs, nucleotide excision repairs, base excision repairs, recombination repairs, and SOS system)

Unit – II

- Gene as a unit of Mutation, Types of mutagens and their origin
- Genetic analysis of mutants and Isolation of mutants
- Gene as a unit of recombination
- Molecular nature of recombination

Unit – III

- Gene transfer mechanism: Transformation, Transduction, Conjugation, Transfection
- Lysogeny and their applications
- Genetic analysis of Bacteria and Yeast
- Plasmids, types and their uses in genetic analysis, as vector for gene cloning, Replication of selected plasmids, compatibility
- Transposons and their uses in genetic analysis
- Construction of bacterial strains

Unit – IV

- Genetics of phage: genetic recombination in phages
- Effect of parental ratio, reciprocity
- Genetic mapping of phage T4 and other phages
- RAPD, RFLP
- Features of T4 life cycle and T4 gene organization
- λ phage DNA and its genetic organization, life cycle of λ

Recommended Books:

1. Microbial Genetics – Maloy et al. 1994, Jones and Bartlett publishers.
2. Modern microbial genetics – Streips and Yasbin, 1991, Niley Ltd.
3. Microbial genetics – S.R. Maloy, J.E. Cronan, and David Freifelder, 1st edition 2006, Narosa publishing house, New Delhi.
4. Microbial Genetics – C.B. Powar, Vol I&II, Himalaya Pub.
5. Genetics – P.K. Gupta, Rastogi Pub.
6. Biotechnology and Genetics – R. Shetty
7. Genetics – W. Monroe
8. Genetics – N.W. Strickberger 3rd edition
9. Fundamentals of Genetics – B.D. Singh, Kalyani Pub.
10. Fundamental Principles of Bacteriology – A.J. Salle, TMH Edition, New Delhi

M.Sc. – MICROBIOLOGY
SEMESTER II
PAPER – III
MMB 203 MICROBIAL PHYSIOLOGY

Unit – I

- Basic aspects of bioenergetics: entropy, enthalpy, electrons carrier, artificial electron donors, inhibitors, uncouplers, energy bond, phosphorylation.
- Global regulatory responses: Heat shocks response, stringent response and regulation by small molecules such as ppGpp and cAMP, signal hypothesis
- Brief account of photosynthetic and accessory pigments: chlorophyll, bacteriochlorophyll, rhodopsin, carotenoids, phycobiliproteins

Unit –II

- Autotrophy: Carbohydrate anabolism, Oxygenic and an-oxygenic photosynthesis
- Autotrophic generation of ATP , fixation of CO₂, Calvin cycles, C₃-C₄ pathway,
- Chemolithotrophism, Sulphur, iron, hydrogen, nitrogen oxidation ,
- Methanogenesis,
- Luminescence

Unit – III

- Respiratory metabolism: Embden Mayer Hoff Parnas pathway, Entner Doudroff pathway, Glyoxalate pathway
- Krebs cycle, Reverse TCA cycle, Oxidative and substrate level phosphorylation
- Gluconeogenesis, Pasteur effects
- Fermentation of carbohydrates: homo and heterolactic fermentation

Unit – IV

- Nitrogen metabolism
- Synthesis of major amino acids: polyamines
- Synthesis of polysaccharides: peptidoglycan, biopolymers as cell components.

Recommended Books:

1. A text book of Microbiology – P.Chakraborty , New central book agency(P) Ltd. Kolkata.
2. General Microbiology I & II - C.B. Powar and H. F. Dagainawala , Himalaya Publishing House Bombay.
3. Microbiology – B.D. Davis, R. Dulbecco, H.N. Eisen and H.S. Ginsberg, Harper and Row, Publishers Philadelphia.
4. Biology of Microorganisms – T.D. Brock and M.T. Madigan, Prentice Hall Int. Inc
5. General Microbiology – R.Y. Stainer, J.L. Wheelis and P.R. Painter, Macmillan Educational Ltd. London.
6. Modern Microbiology – E.A. Brige, W.M.C. Brown, Oxford, England
7. Microbial Physiology and Metabolism – D.R. Coldwell, Brown Publisher
8. Microbial Physiology – A.G. Moat and J.W. Foster, Wiley Pub.

M.Sc. MICROBIOLOGY
SEMESTER II
PAPER IV
MMB 204 BIOSTATISTICS

Unit – I

- Introduction: Definition, Basic concepts,
- The sample and population Measurement scales, Statistical inference and parameters
- Classification of Data : Objective of Classification, Types of data
- Presentation of data: Tabulation, Frequency distribution, Graphical presentation of data and interpretation
- Measures of central tendencies (mean, mode, median)

Unit – II

- Measures of dispersion (range, mean deviation, standard deviation and error)
- Probability : Basic Concepts, Types, Applications, Calculation of Probability
- Correlation: Types and Methods, Correlation coefficient and its significance

Unit – III

- Regression analysis: linear regression, regression coefficient, uses of regression analysis, difference between correlation and regression.
- Tests of significance: Chi-Square, characteristics, applications
- Student's t Test: Properties and Applications
- Variance – Ratio test 'F' test

Unit – IV

- Analysis of Variance (ANOVA): Introduction, procedure, multiple comparisons
- Experimental designs: Basic concepts and principles, types, significance.
- Statistical quality control: Introduction, types, advantages.

Recommended books:

1. Statistics in Biology – C.I.K. Bliss, Vol.1, McGraw Hill, New York
2. Statistics for Biologists – R.C. Campbell, Cambridge Uni. Press, Cambridge.
3. Microbiological Assay – W. Hewitt, Academic Press, New York.
4. Hand Book for experimental immunology – D.M. Weir, (W. Lutz), Blackwell Pub.Ltd. Oxford.
5. Practical Statistics for experimental Biologists –A.C. Wardlaw, John wiley and Sons, New York.
6. Biostatistics, A foundation for analysis in the health science, Wayne W. Daniel, Wiley India Edition
7. A text book of Biostatistics, B. Annadurai
8. Research Methodology, Methods and Techniques, C.R. Kothari, New Age International Pub.
9. Biostatistical analysis – J.H. Zar
10. Introduction to Biostatistics – R.R. Sokal and F.J. Rohaf
11. Fundamentals of Biostatistics – Khan and Khanum, Ukaaz Pub. Hyderabad.
12. Biostatistics – P. Ramakrishnan, SarasPbu. Kanyakumari.

M.Sc. MICROBIOLOGY
SEMESTER –II
LAB COURSE: I
MMBL 03 MOLECULAR BIOLOGY AND MICROBIAL GENETICS
List of Practical Exercises

M.M. - 100

I – Molecular Biology

1. Isolation of DNA from plant (Cauliflower/Onion/ Spinach Leaf).
2. Isolation of Genomic DNA from Bacteria (Gram positive/Gram negative).
3. Estimation of total DNA from given sample by DAP method.
4. Estimation of RNA From yeast.
5. Isolation and purification of Plasmid DNA from bacteria.
6. Extraction of total protein and protein profile study.

II –Microbial Genetics

1. Determination of antibiotic sensitivity by Well Diffusion method.
2. Determination of MIC for different antibiotics.
3. Isolation of antibiotic resistant bacterial population by Gradient plate method.
4. Isolation of UV induced Auxotrophic mutants by Replica Plating technique.
5. Study of bacterial Transformation.
6. Study of bacterial Transduction.

M.Sc. MICROBIOLOGY
SEMESTER –II
LAB COURSE: II
MMBL 04 MICROBIAL PHYSIOLOGY AND BIostatISTICS
List of Practical Exercises

M.M. - 100

III – Microbial Physiology

1. Effect of light on growth and sporulation of fungi.
2. Effect of temperature on growth of bacteria and determination TDP & TDT.
3. Effect of pH on growth of microorganism.
4. Study the fermentation of carbohydrates (glucose, sucrose & lactose).
5. Effect of salt concentration on growth of microorganism.
6. Effect of molecular oxygen on growth of microorganism.
7. Effect of heavy metal on growth of microorganism.

IV – Biostatistics

1. Construction of frequency tables by given sample data.
2. Construction of histograms by given sample data.
3. Compare the measures of central tendency from a common data table.
4. Prove that the frequency distributions with equal means have different amount of dispersion.
5. Calculate the standard deviation of the given data mean.
6. Compare the sample mean with the population mean by t Test.
7. Determine whether the observed frequencies are similar to expected frequencies by χ^2 test.
8. Estimate and test the given hypothesis about population mean by ANOVA.
9. Computation of correlation coefficient.

M.Sc. – MICROBIOLOGY

SEMESTER III

PAPER – I

MMB 301 BIOPHYSICAL TECHNIQUES, INSTRUMENTATION AND BIOINFORMATICS

Unit – I

- Microscopy–Phase contrast, Fluorescence microscopy
- Electron microscopy-Transmission and scanning electron microscopes (TEM & SEM)
- Centrifugation techniques: Basic principles of centrifugation, Standard sedimentation coefficient and measurement of sedimentation coefficient, Analytical and preparative centrifugation
- Differential, rate zonal and equilibrium density gradient centrifugation

Unit – II

- Principle & application of Chromatography: General principles. Types- partition, adsorption; paper, thin layer, column chromatography, HPLC, GLC, gel filtration, ion exchange chromatography and affinity chromatography
- Principle & application of Electrophoresis: General principles, Types – paper electrophoresis, cellulose acetate, starch gel electrophoresis, polyacrylamide gel electrophoresis and Agarose gel electrophoresis, Horizontal and vertical electrophoresis, Two dimensional electrophoresis, Immune electrophoresis
- Blotting techniques -Southern, Northern and Western blotting
- PCR – Mechanism of working & types

Unit – III

- Electromagnetic spectrum and Instrumentation: measuring the absorption and application of UV- visible spectrophotometer, Spectroscopic techniques- Principle, simple theory of absorption of light by molecules, Fluorescence spectroscopic, NMR, ESR and Mossbauer spectroscopic method
- Radio isotopic techniques: Principle, Radioactive isotopes, radioactive decay, Detection and measurement of radioactivity, Geiger-Muller counter, scintillation counter, Autoradiography, tracer techniques and applications, commonly used isotopes in biology, Labeling procedures and safety aspects.

Unit– IV

- Concept of Bioinformatics: Aim and branches, Applications, Role of internet
- Basic biomolecular concepts: Protein, Amino acids, DNA, RNA sequences, structure and functions, Forms of biological information
- Bioinformatics resources: NCBI, EBI, ExPASy, RCSB, DDBJ, available tools
- Open access bibliographic resources and literature data bases: PubMed, BioMed Central, Public Library of Science (PloS), CiteXplore

Recommended Books:

1. Biophysical Chemistry, Principles and Techniques – Upadhyay and Upadhyay, Himalaya Pub.
2. Instrumental Analysis – Skoog and Haller
3. Analytical Chemistry – G. Chatwal and Anand, Himalaya Pub.
4. Biotechniques: Theory and Practice – S.V.S. Rana, Rastogi Pub.
5. Practical Biochemistry- Principles And Techniques- Keith Wilson And John Walker
6. Bioinformatics: Databases, Tools and Algorithms, by OrpitaBosu, Simminder Kaur Thukral, OXFORD University Press.
7. Bioinformatics: Sequence and Genome Analysis by D.W. Mount , second edition, Cold Spring Harbor Laboratory Press
8. Bioinformatics : Methods and Application by S.C. Rastogi, N. Mendira, P. Rastogi, Third edition , PHI Learning Private Limited
9. Introduction to Bioinformatics by Teresa. K. Attwood and David J. Parry- Smith, Low Price edition, Pearson Education

M.Sc. – MICROBIOLOGY
SEMESTER III
PAPER – II
MMB 302 MEDICAL MICROBIOLOGY

Unit – I

- Early discovery of pathogenic microorganisms: Development of bacteriology as scientific discipline, Contributions made by eminent scientists
- Normal microbial flora of human body; Role of the resident flora
- Establishment, spreading, tissue damage & anti-phagocytic factors: Mechanism of bacterial adhesion
- Colonization & invasion of mucous membranes of respiratory, enteric & urogenital tracts
- Role of aggressins, Depolymerising enzymes, Organotropisms, Variation & virulence
- Four lines of defense mechanism

Unit – II

- Classification of pathogenic bacteria: Staphylococcus, Streptococcus, Pneumococcus, Neisseria, Cornebacterium, Bacillus, Clostridium, Non-sporing Anaerobes, Organisms belonging to Enterobacteriace, Vibrios
- Non fermenting gram negative bacilli, Yersinia, Haemophilus, Bordetella, Brucella, Mycobacteria, Spirochaetes, Actinomycetes, Rickettsiae, Chlamdiae

Unit – III

- Viruses host interactions: pox viruses, herpes virus, adeno viruses, picarno viruses, orthomyxo viruses, paramyxo viruses, arbo viruses, rhabdo viruses, hepatitis viruses, oncogenic viruses, human immuno deficiency viruses (AIDS)
- Fungal infections: Dermatophytes, dimorphic fungi, opportunistic fungal pathogens, their description, classification and laboratory diagnosis; Fungal Diseases: Mycoses systemic and subcutaneous, Pneumocystis, Blastomycoses, Dermatophytosis, Aspergilosis
- Protozoal diseases: Leishmania, Trypanosoma

Unit –IV

- Laboratory control: antimicrobial therapy, Various methods of drug susceptibility testing, Antibiotic assay in body fluids
- Brief account on available vaccines and schedules, passive prophylactic measures
- Nosocomial infection: common types of hospital infections, their diagnosis and control

Recommended Books:

1. Text book of Microbiology – R. Ananthanarayanan and C. K. Jayaram Panicker, orient Longman, 1997.
2. Medical Microbiology – Mackie and MaCartney,
 1. Microbial Infection Vol. 1:.
 2. Practical Medical Microbiology. Vol 2– Churchill Livingstone, 1996.
 3. Microbiology in clinical Practice – D.C. Shanson, Wright PSG, 1982.
 4. Bailey and Scott's Diagnostic Microbiology – Baron EJ, Peterson LR and Finegold SM Mosby, 1990.

M.Sc. – MICROBIOLOGY
SEMESTER III
PAPER – IIIA (Elective)
MMB 303AFOOD AND DAIRY MICROBIOLOGY

Unit – I

- Food as substrate for microorganisms: Important micro organisms in food microbiology - Molds, Yeasts and Bacteria (General characteristics and importance)
- Principles of food preservation: Asepsis (anaerobic conditions, high temperatures, low temperature, drying)
- Factors influencing microbial growth in food: Extrinsic & intrinsic factors; Chemical preservatives and food additives, Canning, processing for Heat treatment - D, Z, and F values and working out treatment parameters.

Unit – II

- Contamination and Spoilage: Principle, Cereals, sugar products, vegetables, fruits, meat and meat products, Milk and Milk products, Fish & sea foods, poultry-spoilage of canned foods. Detection of spoilage and characterization.
- Food-borne infections and intoxications: Bacterial and nonbacterial with examples of infective and toxic types (Brucella, Bacillus, Clostridium, Escherichia, Salmonella, Shigella, Staphylococcus, Vibrio, Yersinia; Nematodes, Protozoa, algae, fungi and viruses),
- Food borne outbreaks: laboratory testing procedures, Prevention Measures Food sanitation in manufacture and retail trade, Food control agencies and its regulations
- Plant sanitation: Employee's Health standards-waste treatment-disposal-quality control.

Unit –III

- Food fermentations: bread, cheese, vinegar, fermented vegetables, fermented dairy products
- Experimental and industrial production methods of fermented food products
- Spoilage and defects of fermented dairy products
- Oriental Fermented foods, their quality standards and control

Unit – IV

- Food Produced by Microbes: Fermented foods, microbial cells as food (single cell proteins)
- Bioconversions: Production of alcohol, Fermented beverages (beer and wine), Steroid conversions
- Industrial Enzymes productions
- Genetically modified foods
- Mushroom cultivation

Recommended Books:

1. Food and Dairy Microbiology –M.K.Rao, Mangalam Pub.
2. Food Microbiology – M.R. Adams and M.O. Moss, New Age International Pvt. Ltd.
3. Industrial Microbiology – Jr. L.E. Casida New Age International Pvt. Ltd.
4. Food Microbiology – W. C. Frazier and D.C. Westhoff, Tata McGraw Hill Pub.
5. Industrial Microbiology – Prescott and Dunn, CBS Pub. New Delhi
6. Food biotechnology – V. Mehta, Camus books
7. Basic Food Microbiology - Banwart George J.
8. Food Microbiology: Fundamentals and Frontiers -Dolle
9. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2 - Joshi.
10. Fundamentals of Dairy Microbiology - Prajapati.
11. Essentials of Food Microbiology. Edited by John Garbult. Arnold International Students Edition.
12. Microbiology of Fermented Foods. Volume II and I. By Brian J. Wood. Elsevier Applied Science Publication.
13. Microbiology of Foods - John C. Ayres. J. OrwinMundt. William E. Sandinee. W. H. Freeman and Co.

M.Sc. – MICROBIOLOGY
SEMESTER III
PAPER – IIIB (Elective)
MMB 303B AGRICULTURE MICROBIOLOGY

Unit - I

- Microorganisms of soil, rhizosphere and phyllosphere microflora, Brief account of Microbial interactions: antagonism, symbiosis, mutualism, commensalisms, synergism and parasitism.
- Nutrient cycle: Carbon cycle , nitrogen cycle, phosphorous cycle and sulphur cycle.

Unit- II

- Role of enzymes and toxins in pathogenesis.
- Fungal diseases of plants: Rusts of wheat, linseeds; late blight of potato; red rot of sugarcane.
- Bacterial diseases of plants : Citrus canker, blight of rice
- Viral diseases of plants: Leaf curl of Papaya, vein clearing of lady's finger
- Physical, chemical and Biological control of plant diseases (Bacterial control of insect pests: *Bacillus thuringiensis* as bacterial insecticide, Viral control of insect pests: Nuclear polyhedrosis viruses (NPV) and cytoplasmic polyhedrosis viruses (CPV), Fungal control of insect pests: Entomopathogenic fungi : *Metarhiziumanisopliae*, *Beauveria bassiana*, *Verticillium lecani*, *Hirsutiellathompsoni*)

Unit- III

- Storage fungi: Categories of storage fungi, conditions during storage in relation to damage of seeds, harmful effects
- Mycotoxins and their effect on human being.
- General idea about quarantine.
- Production of biogas and alcohol from agricultural wastes.

Unit- IV

- Biofertilizers : Types, production and application.
- Mycorrhizae : Types and their application in agriculture and forestry.
- Vermicomposting.
- Reclamation of waste agricultural land by microorganisms.

Recommended Books:

1. Soil Microbiology by Prof. N.S. Subba Rao, Fourth edition, Oxford and IBH Publishing CO. PVT., LTD., New Delhi
2. Introduction to soil microbiology. Alexander M. (1977) John Wiley & Sons, Inc., New York.
3. Modern Soil Microbiology, Dirk J, Elias V, Trevors JT, Wellington, EMH (1997) Marcel Dekker INC, New York.

M.Sc. MICROBIOLOGY

SEMESTER –III

**MMBP 05 LAB COURSE I: BIOPHYSICAL TECHNIQUE, INSTRUMENTATION AND
BIOINFORMATICS**

List of Practical Exercises

M.M. – 100

I Biophysical Technique, Instrumentation and Bioinformatics

1. Separation of Carbohydrates by Paper Chromatography
2. Separation of Amino acids by Paper Chromatography
3. Separation of Lipids by Thin Layer Chromatography
4. Demonstration Column Chromatography
5. Demonstration HPLC and GC
6. Determination of λ max for different coloured solution
7. Verification of Lambert-Beers Law by UV-VIS Spectrophotometer
8. Separation of Proteins by Electrophoresis
9. Determination of molecular size of DNA by Agarose gel Electrophoresis
10. Confirmation of immune response by Immunoelectrophoresis
11. Demonstration of Differential, rate zonal and equilibrium density gradient centrifugation
12. Assessment of scientific data from Literature data bases (PUBMED, LITDB, Medline)
13. Assessment of nucleic acid databases for retrieval of gene sequence.
14. Protein databases for retrieval of amino acid sequence of target protein.
15. Pair wise sequence alignment using Dot matrix.
16. Demonstration of multiple sequence alignment using BLAST.

M.Sc. MICROBIOLOGY

SEMESTER –III

MMBP 06 LAB COURSE II: MEDICAL, FOOD AND DAIRY MICROBIOLOGY/ AGRICULTURE

MICROBIOLOGY

List of Practical Exercises

M.M. – 100

I – Medical Microbiology

1. Isolation and preliminary identification of Normal microbial flora of the skin.
2. Effect of detergents and soaps on the Normal flora of skin.
3. Isolation and preliminary identification of microbial flora of teeth crevices.
4. Isolation and preliminary identification of microbial flora from saliva.
5. Urine culture and its microbiological analysis.
6. Isolation and preliminary identification of enteric pathogens using TSIA medium.

II – Food and Dairy Microbiology

1. Isolation and preliminary identification of microorganisms from different food (Cereals, sugar products, meat and meat products, milk and milk products, fermented food)
2. Isolation and preliminary identification of microorganisms from different spoiled fruit and vegetables.
3. Study of different chemical preservatives and additives used for preservation of food.
4. Determination of quality of milk samples by Methylene Blue Reductase test.
5. Detection of number of bacteria in milk by SPC method
6. Microbiological examination of fresh and canned foods
7. Detection of Mycotoxins/ Aflatoxin from contaminated grains

III – Agriculture Microbiology

1. Study the bacterial, fungal and viral diseases in plants.
2. Isolation of rhizobia from root nodules of leguminous plants.
3. Inoculation of seeds with rhizobia.
4. Study of pesticidal activity of *Bacillus thuringiensis*.
5. Isolation of VAM spores from soil.
6. Isolation of *Azotobacter* species from soil.
7. Isolation of microorganisms from rhizosphere.

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M.Sc. – MICROBIOLOGY

SEMESTER IV

PAPER – I

MMB 401 ENVIRONMENTAL MICROBIOLOGY

Unit – I

- Aerobiology: Droplet nuclei, aerosol, Assessment of air quality, solid-liquid-impingement methods.
- Brief account of air borne transmission of microbes (viruses, bacteria & Fungi) their diseases and preventive measures.
- Positive and negative roles of microbes in environment: Bioremediation, Biodegradation of recalcitrant compounds, lignin, pesticides, bioaccumulation of metals, biodeterioration of paper, leather, wood, textiles.
- Metal corrosion: mode of deterioration, organisms involved, its disadvantages, mode of prevention.

Unit – II

- Aquatic microbiology: Water ecosystem, fresh water (pond, lakes, streams)-marine habitats (estuaries, mangroves, deep sea, hydrothermal vents, salt pans, coral reefs)
- Zonations of water ecosystems: upwelling, Eutrophication
- Potability of water: microbial Assessment of water quality, Water purification
- Brief account of major water borne disease & their control measures.

Unit – III

- Soil microbiology: Classification of soils, Physical and chemical characteristics
- Brief account of microbial interactions, symbiosis, mutualism, commensalisms, competition, ammensalism, synergism, parasitism, predation
- Biogeochemical cycles and the organisms: carbon, nitrogen, phosphorus and sulphur
- Biofertilisers: biological nitrogen fixation, nitrogenase enzyme, nif genes.
- Symbiotic microbes: Rhizobium and Frankia, Non symbiotic microbes: azotobacterazospirillum
- Mycorrhiza: ecto, endo, ectendomycorrhizae,
- Microbiology of rumen

Unit – IV

- Waste Treatment: -types of wastes (solid, liquid), characterization
- Treatments: physical, chemical, biological (aerobic, anaerobic, primary, secondary and tertiary).
- Solid waste treatment: Saccharification, Gasification, Composting,
- Utilization of solid wastes in food (SCP, mushroom, yeast), fuel (ethanol, methane) fertilizer (composting)
- Liquid waste treatment: Trickling Activated sludge, Oxidation pond, Oxidation ditch.

Recommended Books:

1. Environmental Microbiology – Banwarila, Cybertech. Pub.
2. Introduction to Soil Microbiology – Alexander Martin, Wiley Eastern Press.
3. Agricultural Microbiology – G. Rangaswami and D.J. Bagyaraj, Prentice Hall India Ltd.
4. Environmental Biotechnology – Indu Shekher Thakur, International Pub. House
5. Microbial Ecology fundamental & applications -R.M. Atlas & R. Bartha, Pearson pub.

M.Sc. – MICROBIOLOGY
SEMESTER IV
PAPER – II
MMB 402 INDUSTRIAL MICROBIOLOGY AND FERMENTATION TECHNOLOGY

Unit – I

- Introduction to industrial microbiology. Definition, scope, history, Screening for microbes of industrial importance
- Primary screening and Secondary screening, Fermentation equipment and its use
- Design and Types of fermenter: Batch, fed batch and continuous fermenters
- Agitation, aeration, antifoam, pH and temperature control
- Direct, dual or multiple fermentations, Scale-up of fermentations

Unit – II

- Strain development strategies: Environmental factors and genetic factors for improvement
- Raw materials: Saccharides, starchy and cellulosic materials
- Fermentation media and sterilization
- Types of fermentations processes – Solid state, surface and submerged fermentations.
- Role of computer in fermenter operation
- Downstream Processing

Unit – III

- Production and application of microbial enzymes: Amylases and proteases, uses, microorganisms, inoculum preparation, production medium, fermentation and recovery
- Fermentative production of vitamin B2 and vitamin B12
- Industrial production of organic acid-citric acid, glutamic acid and lactic acid

Unit – IV

- Industrial production of alcohol and alcoholic beverage (beer and wine)
- Commercial production of antibiotics – Penicilline, Tetracycline, Streptomycin
- Fermentative production of amino acids and uses

Recommended Books:

1. Fermentation technology – M.L. Srivastava, Nrosa Pub.
2. Principles of Fermentation technology – P.R. Stanbury
3. Solid State Fermentation in Biotechnology – A. Pandey, S. Rodriguez and Nigam, Asia Tech Pub.
4. Advances in Fermentation Technology – A. Pandey, S. Rodriguez and Nigam, Asia Tech Pub.
5. Biotechnological innovations in chemical synthesis – BOITOLpub., Butterworth,
6. Industrial Microbiology – G. Reed (Editor), CBS publishers, New Delhi.
7. Biology of Industrial Microorganisms – A. L. Demain.
8. Pharmaceutical Biotechnology – S.P. Vyas and V.K. Dixit, Cbs pub. New Delhi.
9. Industrial Biotechnology – S.N. Jogdand, Himalaya Pub. House, Delhi

M.Sc. – MICROBIOLOGY
SEMESTER IV
PAPER – IIIA (Elective)
MMB 403A MICROBIAL BIOTECHNOLOGY

Unit – I

- Genetic Engineering: Scope, Core techniques & essential enzymes used in rDNA technology
- Restriction digestion, ligation & transformation
- Cloning vectors: Plasmids, types & structures , Phages, cosmids vectors, Expression vectors, Promoter probe vectors
- Artificial chromosomes: YAC, and BAC

Unit – II

- Specialized Cloning strategies: cDNA synthesis and cloning, mRNA enrichment, DNA Primers, Linkers, Adaptors and their synthesis
- Genomic libraries, Nucleic acid microArrays
- Site directed mutagenesis and Agrobacterium-mediated transformation
- Particle bombardment, Calcium chloride transformation of bacteria

Unit – III

- Steroid transformations – Substrates, typical structures, microorganisms, inoculums preparation, 11-hydroxylation, process and recovery
- Therapies for genetic diseases (gene therapy)
- Monoclonal antibodies and hybridoma technology, Vaccine development, Immobilized enzyme
- Genetically modified microorganism and their impact

Unit – IV

- PCR: Methods and Applications
- Introduction to Intellectual Property Rights, Patentable subject matter and patent types, Patent requirements: technical specifications, novelty, and non-obviousness
- Rights of patent holder, Patent protection for biological materials
- Regulations for clinical trials, Rules for import and export of biological materials
- Bio-safety and Bioethics

Recommended Books:

1. Principles of gene manipulation – Old and Primrose, Blackwell Publications
2. Molecular Cloning – Sambrose and Russell, CHS press
3. Biotechnology – B. D. Singh, Kalyani Pub.
4. A text book of Biotechnology – R.C. Dubey, S. Chand & Company Ltd.
5. Biotechnology – S.N. Jogdand, Himalaya Pub.
6. Gene Cloning – Sambrook, MacGraw hill Pub.
7. Genomics and Cloning Technology and Application – H.D. Kumar, East-West Press Pvt.Ltd.

M.Sc. – MICROBIOLOGY
SEMESTER IV
PAPER – IIIB (Elective)
MMB 403B MICROBIAL GENOMICS AND PROTEOMICS

Unit - 1

- Whole genome analysis: preparation of ordered cosmid libraries
- Bacterial artificial chromosome libraries, shotgun libraries
- Conventional sequencing (Sanger, Maxam and Gilbert methods), automated sequencing

Unit- 2

- Sequence analysis: computational methods, homology algorithms (BLAST) for proteins and nucleic acids
- Open reading frames, annotations of genes, conserved protein motifs related structure/function (PROSITE, PFAM, ProfileScan)
- DNA analysis for repeats (direct and inverted), palindromes, folding programmes

Unit - 3

- DNA microarray: printing of oligonucleotides and PCR products on glass slides, nitrocellulose paper
- Whole genome analysis for global patterns of gene expression using fluorescently labelled cDNA or end-labelled RNA probes
- Analysis of single nucleotide polymorphisms using DNA chips

Unit - 4

- Proteome analysis: Two-dimensional separation of total cellular proteins, isolation and sequence analysis of individual protein spots by mass spectroscopy.
- Protein microarray
- Advantages and disadvantages of DNA and protein microarrays
- Use of internal, public domain databases for nucleic acid and protein sequences (EMBL, GenBank), database for protein structures (PDB)

Recommended Books:

1. Introduction to Bioinformatics. Lesk M.A. (2008) Oxford Publication, 3rd International Student Edition
2. Bioinformatics: methods and applications, genomics, proteomics and drug discovery, Rastogi S.C., Mendiratta N. and Rastogi P. (2007) 2nd ed. Prentice Hall India Publication
3. Principles of Protein structure- Schultz, G. E., and Schirmer, R. H. Dr. ShaktiSahi Proteomics, Daniel C. Leibler
4. Microbial Proteomic- MarjoPoutanen
5. Proteins: Structures and Molecular Principles (2d ed.), TE Creighton Organic spectroscopy, William Kemp
6. Proteome Research: Two-Dimensional Gel Electrophoresis and Detection Methods (Principles and Practice), T. Rabilloud (Editor), 2000, Springer Verlag
7. Introduction to Protein Architecture: The Structural Biology of Proteins, M.Lesk, 2001, Oxford University Press

M.Sc. MICROBIOLOGY
SEMESTER –IV
MMBP 07 LAB COURSE I : ENVIRONMENTAL MICROBIOLOGY
List of Practical Exercises

M.M. - 100

I -Environmental Microbiology

1. Isolation of pesticide & herbicide degrading microorganisms
2. Study of mycorrhizal root colonization and spore load in soil of different plants
3. Isolation of symbiotic & non-symbiotic biofertilizers from soil
4. Identification of symbiotic bacterioids of Rhizobia.
5. Isolation of phosphate solubilising microorganism from soil
6. Isolation of antibiotic producer from soil and determine the antimicrobial spectrum of isolates.
7. Isolation of nitrate producing microorganism from soil
8. Water analysis for total bacterial population by standard plate count (SPC) method
9. Detection of coliform bacteria in water sample
10. Determination of Biological Oxygen Demand (BOD) of water.

M.Sc. MICROBIOLOGY
SEMESTER –IV
MMBP 08LAB COURSEII : INDUSTRIAL MICROBIOLOGY, FERMENTATION
TECHNOLOGYANDMICROBIAL BIOTECHNOLOGY/ MICROBIAL GENOMICS AND
PROTEOMICS

List of Practical Exercises

M.M. - 100

I-INDUSTRIAL MICROBIOLOGY AND FERMENTATION TECHNOLOGY

1. Lipase production and confirmation.
2. Cellulase production and confirmation.
3. Amylase production and confirmation.
4. Xylanase production and confirmation.
5. Production of antibiotics from Actinomycetes and confirmation of anti microbial activity.
6. Liposome production for immobilization of protein.
7. Demonstration of Alcohol production.

II A- MICROBIAL BIOTECHNOLOGY

1. Isolation and purification of Plasmid DNA from bacteria.
2. Gene Expression study in microorganism.
3. Restriction Mapping of DNA and interpretation.
4. Awareness of Patenting

II B - MICROBIAL GENOMICS AND PROTEOMICS

1. DNA isolation from bacteria and determination of molecular size
2. Sequence analysis of DNA
3. Protein isolation from E coli, Bacillus and Yeast.
4. Sequence analysis of proteins (by BLAST, ClustalW and Phylip).
5. Protein structure prediction by Homology modeling.
6. Overexpression of heterologous protein in E.coli.
7. Purification of cloned protein in E.coli.
8. Protein identification by immunoblotting