

# NIMS UNIVERSITY, JAIPUR



## SYLLABUS

**MASTER OF SCIENCE  
(MICROBIOLOGY)**

## COURSE STRUCTURE AND EXAMINATION SCHEME

M. Sc. (Microbiology) degree program will comprise of four semesters. Candidates will be evaluated after each semester. Final theory examination of 50 marks, assessment of 20 marks and practical of 30 marks in each paper will be conducted at the end of the semester. Each theory paper will have six questions and the candidate will have to attempt five questions. However, each question except question No.1 will have two choices. Question No.1 will be compulsory and will have objective type questions from all the units. Sessional of 20 marks will be the total of two sessional examinations each of theory. One seminar carrying 50 marks will be delivered each year by the student.

**Dissertation:** The project work will involve indepth practical work on a problem suggested by the supervisor of the student. The student will submit the results of the work done in the form of dissertation to the head of the department in the fourth semester. The dissertation will carry 200 marks. The dissertation submitted by the student will be evaluated by one external expert, head of the department and supervisor of the student. The dissertation examination will be held in the department and the dissertation will not be mailed to the external examiner.

Minimum pass marks will be 40% in theory and 40% in practical and 50% in aggregate.

### M. Sc. Microbiology

#### First Year

	Distribution of Marks			
	Theory	Practical	Internal	Total
<b>1. General Microbiology</b>	50	30	20	100
<b>2. General Biochemistry</b>	50	30	20	100
<b>3. Microbial Growth and Physiology</b>	50	30	20	100
<b>4. Molecular Biology and Microbial Genetics</b>	50	30	20	100
<b>5. Enzymology</b>	80	-	20	100
<b>6. Mycology and Virology</b>	50	30	20	100
<b>7. Microbial Diversity and Ecosystems</b>	50	30	20	100
<b>8. Genetic Engineering</b>	50	30	20	100
<b>9. Instrumentation and Techniques</b>	80	-	20	100
<b>10. Immunology</b>	50	30	20	100

## Second Year

	Distribution of Marks			
	Theory	Practical	Internal	Total
<b>1. Medical Microbiology and Public Health</b>	50	30	20	100
<b>2. Food and Dairy Microbiology</b>	50	30	20	100
<b>3. Agricultural Microbiology</b>	50	30	20	100
<b>4. Biostatistics and Intellectual Property Right</b>	80	-	20	100
<b>5. Biostatistics and Computer Application</b>	80	-	20	100
<b>6. Environmental Microbiology</b>	50	30	20	100
<b>7. Industrial Microbiology</b>	50	30	20	100
<b>8. Dissertation</b>	-	-	-	200

## GENERAL MICROBIOLOGY

### Unit-I

History, development and scope of Microbiology. Distinctive characters of major groups: Prions, Viruses, Bacteria, Fungi, Algae and Protozoa. Microscopy

### Unit-II

Morphology and ultra structure of bacteria: morphological types, cell walls of archeobacteria, Gram negative, Gram positive eubacteria. Eukaryotes, L- forms: cell wall synthesis, antigenic properties- capsule type, composition and function. Structure and function of cell membrane. Flagella, cilia, chromosomes, carboxysomes, magnetosomes, phycobolism, nucleoid. Endospore-morphology, physiology and formation. Reserve food material, cytoplasmic inclusions.

### Unit-III

Cultivation of bacteria-aerobic, anaerobic culture techniques, culture media. Growth curve-generation time, growth kinetics, batch and continuous culture, growth measurements, factors affecting growth; maintenance and preservation of microbial culture. Control of microbes-physical and chemical methods. Types of bacteria on basis of energy and nutritional requirement.

### Unit-IV

Classification of microorganisms: Haeckel's three kingdoms concept- Whittaker's five kingdoms concept, three domain concept of Carl Woese, Modern trends in classification. Ribotyping, nucleic acid hybridization, RNA fingerprinting, molecular chromometer. Classification and salient features of bacteria according to the Bergey's manual of systematic bacteriology.

### Unit-V

Archeabacteria: Methanotrophs, halophiles and sulphur dependent archeabacteria - Gram negative bacteria; spirochetes, aerobic or micro-aerophilic rods and cocci. Facultative aerobes, anaerobes, Rickettsia and Chlamydiae, Anaerobes and oxygenic phototrophs, gliding bacteria, sheathed bacteria, budding and appendaged bacteria chemolithotrophs- Gram positive cocci and rods, endospore forming rods, mycobacteria and actinomycetes.

### Practicals

1. Preparation of culture media – Liquid & Solid media, Enrichment, Selective & Differential media. Preparation of slant & deep tube culture.
2. Isolation of pure culture by Pour plate, Serial dilution and Streak plate method.
3. Study of growth curve.
4. Effect of pH, temperature, osmolarity & oxygen, UV, Desiccation on bacteria.
5. Cultivation of anaerobic organisms.
6. Sterilization methods.
7. Methods of quantitative estimation of micro-organisms (a) Total Count- Haemocytometer (b) Viable Count- Plate Count.
8. Methods of staining bacteria (i) Simple staining (ii) Gram staining (iii) Endospore staining (iv) Negative staining (v) Flagella staining (vi) Cell Wall staining

### Books

1. Brock TD, Madigan MT, (1993) Biology of microorganisms. Prentice Hall Int. Inc.
2. Ananthanarayanan R. and C. K. Jayaram Paniker (1997) Text of Microbiology, Orient Longman.
3. Hewitt, W. (1974): Microbiological Assay. Academic Press, New York.
4. Wardlaw, A. C. (1982): (I) Four Point parallel line assay Penicillin pp. 370-379. (II) Microbiological assay of a Vitamin- nicotinic acid. pp. 214-233. In. S. B. Primrose and A. C. Wardlaw (Eds) Sourcebook, Source book of Experiments for the Teaching of Microbiology. Academic press, London and New York.
5. Henderson et al. (1999) Cellular Microbiology. Wiley.
6. Brunn, Y. V. and Shimkets, L. J. (2000) Prokaryotic Development. ASM Press.
7. Stanier RY, Ingraham JL, Wheelis, ML Painter PR (1986). General Microbiology
8. Topley & Wilson's (1995) Text book on Principles of bacteriology, virology & immunology IX ed. Edward Arnold, London.
9. Michael J. Pelczar JR et al. (1993) Microbiology: Concepts and Applications, Mc Graw- Hill. Inc. (ISBN. 0- 07- 049258-1).
10. Prescott Harley Klein: (1996) Microbiology III ed. ECB Pub.

## GENERAL BIOCHEMISTRY

### UNIT-I

Biophysical properties of molecules, cell, sub-cellular organelles, transport across cell membrane, biological oxidation-reduction, bioenergetics and oxidative phosphorylation.

### UNIT-II

Enzyme, coenzyme and inhibitors, fat and water-soluble vitamins, structure and properties of amino acids, properties and biological significance of proteins.

### UNIT-III

Biological role of lipids, saturated and unsaturated fatty acids, plant growth substances, biological membranes, plant and animal pigments.

### UNIT-IV

Replication, transcription and translation. Introduction to recombinant DNA technology, major metabolic pathways of Carbohydrates, Proteins And Lipids, Biological Nitrogen Fixation.

### UNIT-V

Photo synthesis and photo respiration . Nutritional aspects of carbohydrate, proteins Fats, Minerals and Vitamins.

### Practical:

1. Color reactions of carbohydrates, proteins and fats. Determination of reducing, non-reducing and total sugars.
2. Protein estimation by Lowry method, amylase assay in human saliva.

### Books:

1. Outlines of Biochemistry: Conn, E.E, Stumpf, P.K Bruening, G and Doi, R.H. John Wiley and sons Inc, New York and Toronto.
2. Biochemistry: Styer, L. Freeman WH and company, New York.
3. Fundamentals of Biochemistry: Voet &Voet, PraH, CW John Wiley and Sons Inc, New York and Toronto.
4. Biochemistry: Zubay G.L, W.C. Brown Publishers.

## MICROBIAL GROWTH AND PHYSIOLOGY

### Unit-I

Thermodynamics in relation with biological reactions. Free energy, oxidation- reduction reactions in relation with free energy. Conservation of energy of oxidation of ATP. Physiological buffers and pH.

### Unit-II

Enzymes: Definition, role and classification. Co- enzyme: Hydrogen transferring co-enzymes (NAD, FAD). Electron transferring co-enzymes, non haeme iron electron transferring proteins. Group transferring co-enzymes.

### Unit-III

Microbial photosynthesis and accessory pigments: Bacteriochlorophyll, rhodopsin, carotenoids, phycobiliproteins, carbohydrate anabolism, autotrophic oxygenic and anoxygenic photosynthesis, autotrophic generation of ATP, fixation of CO<sub>2</sub> - Calvin cycle and C 3-C4 pathway. Chemolithotrophy – sulphur, iron, hydrogen, nitrogen oxidation, methanogenesis, luminescence.

### Unit-IV

Bacterial growth: Definition, requirements of growth, microbial nutrition. Mechanisms of nutrient uptake. Prokaryotic cell cycle, growth curve and kinetics of bacterial growth. Measurement of bacterial growth. Environmental factors for growth continuous culture.

### Unit-V

Respiratory metabolism: Embedden Mayer Hoff pathway, Entner Daudroff pathway, glyoxalate pathway, Krebs cycle, oxidative and substrate level phosphorylation. Reverse of TCA cycle, gluconeogenesis, Pasteur effect. Fermentation of carbohydrates – homo and heterolytic fermentation. Assimilation of Nitrogen, dinitrogen, nitrogen, ammonia. Synthesis of major amino acids and polyamines.

### Practicals:

1. Preparation of growth curve of bacteria.
2. Determination of generation time.
3. Determination of nutrient requirement of microbes.
4. To study effect of physical growth.
5. To study oligotrophic or copiotrophy of the bacterial culture.
6. Extracellular enzymatic activity of microorganisms.
7. Different biochemical activities of microorganisms: Carbohydrate fermentation, IMVic test, Indol production, Methyl red test, Voges- Proskauer Test. Citrate production, H<sub>2</sub>S production, NO<sub>3</sub> reductase, Catalase.
8. Antibiotic Sensitivity test.
9. Production of decarboxylase enzyme.
10. Nitrogen fixation on N free medium.

### Books:

1. Microbial ecology: Fundamental and application 4<sup>th</sup> ed. Atlas, R. M. and Bartha, R. , Menlo Park, C. A. : Benzanin/ Cummings
2. Encyclopedia of Microbiology 2<sup>nd</sup> ed. 2000, J. Lederberg (editor in chief). San Diego: Acad. Press.
3. Biochemistry: The molecular basis of life 2003. 3<sup>rd</sup> ed. New York: Mc Graw-Hill.
4. Lehninger Principles of biochemistry, 2005 4<sup>th</sup> ed. New York: W. H. Freeman.
5. Bacterial metabolism 1986, 2<sup>nd</sup> ed. Gottschalk, G. New York: Springer Verlag.
6. Bioenergetics, Nicholls, D. G. and Ferguson, S. J. , San Diego: Academic Press.

## MOLECULAR BIOLOGY AND MICROBIAL GENETICS

### Unit-I

Nucleic acid as genetic information carriers: historical aspects and current concepts. DNA replication: modes of replications, isolation and properties of DNA polymerases, proof reading, continuous and discontinuous synthesis. Asymmetric and dimeric nature of DNA polymerase III and simultaneous synthesis of leading and lagging strands, DNA polymerase, exonuclease activity in eukaryotes. Superhelicity in DNA, topological properties, mechanism of action of topoisomerases. Replication of single stranded DNA. Construction of replication form in test tube. Retroviruses and their unique mode of DNA synthesis. Relationship between cell cycle and replication. Inhibitors of DNS replication. DNA damage and repair: types of DNA damage (delamination, oxidative damage, alkylation, pyrimidine dimers). Repair pathways: methyl directed mismatch pair, very short patch repair, nucleotide excision repair, base excision repair, recombination repair and SOS repair.

### Unit-II

Structural features of RNA (r RNA, tRNA and mRNA) and relation to function. Initiator and corresponding site on rRNA, peptidyl transferase activity of 23S rRNA. Transcription: general principles, types of RNA Polymerases, steps: initiation, elongation and termination, inhibitors of RNA synthesis. Polycistronic and monocistronic RNAs. Control of transcription by interaction between RNA polymerases and promoter regions, use of alternate sigma factors, controlled termination: attenuation and antitermination. Regulation of gene expression: operon concept, catabolite repression, instability of bacterial RNA, positive and negative regulation, lac operon, positive and negative regulation. DNA binding proteins, enhancer sequences and control of transcription. Identification of protein, binding sites on DNA. Global regulatory responses: heat shock response, stringent response and regulation by ppGpp and cAMP, regulation of rRNA and tRNA synthesis. Regulation of nitrogen assimilation.

### Unit-III

Maturation and processing of RNA: methylation, cutting and trimming of rRNA; capping, polyadenylation and splicing of mRNA; cutting and modification of tRNA capping, cutting and modification of tRNA degradation system. Catalytic RNA, group I and group II intron splicing, RNase P. , Genetic code, Protein synthesis: initiation, elongation and termination, role of various factors, inhibitors of protein synthesis. Synthesis of exported proteins on membrane bound ribosomes, signal hypothesis. *In vitro* transcription and translation systems.

### Unit-IV

Gene as unit of mutation and recombination. Molecular nature of mutations and mutagens. Spontaneous and induced mutation. Gene transfer mechanism – transformation, transduction, conjugation and transfection. Mechanisms and applications. Genetic analysis of microbes, bacteria and yeast.

### Unit-V

Plasmids, F-factors description and their uses in genetic analysis. Colicins and col factors. Plasmids as vectors for gene cloning. Replication of selected plasmids: compatibility. Jumping genes and their uses in genetic analysis

### Practicals

1. To study spontaneous mutations by replica plating.
2. To study induced mutation in bacteria.
3. Isolation of antibiotic resistant mutants by gradient plate technique.
4. Isolation of antibiotic resistant mutants by antibiotic disc method.
5. To study bacterial variations.

6. Ames test.

**Books**

1. Bacterial Genomes 1998. De Bruijn et al. Chapman & Hall.
2. Genetics of Bacterial Virulence Dorman C. J. 1994. Blackwell.
3. Genome Analysis. Four volumes 2000. CSH publications.
4. Molecular cloning. 3 volumes. Ambrose And Russell. 2000. CSH press.
5. Principles of Gene Manipulation. 1994 Old & Blackwell Scientific Pulication.
6. Gene VII. Lewin (Oxford University press) 2000.
7. Microbial Genetics. Maloy et al. 1994. Jones & Bertiett Publishers.
8. Modern microbial genetics. 1991 & Yasbin, Niley Ltd.
9. Molecular Genetics of Bacteria. J. W. Dale. 1994. John Wiley& Sones.
10. Molecular Genetics of Bacteria- Larry Synder & Wendy Champness.
11. Molecular Cell Biology, W. H. Freeman by Lodish, Berk, Zippursky.

## ENZYMOLGY

### Unit-I

Enzyme, nomenclature and classification, enzyme compartmentalization in cell organelles, isolation and purification of enzymes, measurement of enzyme activity.

### Unit-II

Enzyme structure, cofactors, coenzymes- their structures and role, active site, enzymespecificity, mechanism of enzyme catalysis

### Unit-III

Enzyme kinetics, enzyme inhibition, and activation, multienzyme complexes.

### Unit-IV

Ribozymes, abozymes, allosteric enzymes and their kinetics, regulation of enzyme activity, active site mapping.

### Unit-V

Enzyme immobilization, application of enzymes in chemical and food industry, biosensors and clinical application of enzymes, enzyme therapy, demulsifying enzyme.

### Books:

1. Enzymes- Dixon, Weble, E. C Throne, K. F Langman, London.
2. Fundamentals of Enzymology- Price, NC and Sterens L, Oxford University Press, Oxford.
3. Methods of Enzymatic Analysis- Bergmeyer, H. U Vol-II Verlag Chemic, Weinhem, Academic Press, New York and London.
4. Biochemical Calculations- Irwin M. Segel, John Wiley and Sons.

## MYCOLOGY AND VIROLOGY

### Unit- I

Introduction to fungi: history, general characteristic of fungi. Classification of fungi according to Alexopoulos & Mims with the general aspects of major divisions of fungi. Fungi and ecosystem: nutrition of Fungi, vitamin requirement, saprophytism, parasitism, mutualism. Symbiotic association of fungi: the mycorrhizae and lichens. Homothallicism, heterothallicism, heterokaryosis, the parasexual cycle, sex hormones in fungi. Fungi as insect symbiont. Mycotoxins and mycotoxicoses. Attack on fungi by other microbes. Fungal disease of plants. Economic importance of fungi.

### Unit-II

General virology: discovery of viruses, nomenclature and classification of viruses; distinctive properties of viruses; morphology and ultra structure; capsids and their arrangements; types of envelopes and their composition, viral genome, their structure ; virus related agents (viroids, prions).

General methods of diagnostic and serology: cultivation of viruses in embryonated eggs, experimental animals, and cell cultures; primary and secondary cell cultures; suspension cell culture and monolayer cell cultures; cell strains, cell lines. Assay of viruses- physical and chemical methods (protein, nucleic acid, radioactive tracers, and electron microscopy).

### Unit-III

Bacterial viruses: bacteriophage structural organization, life cycle, one step growth curve, transcription, DNA replication, eclipse phase, phage production, burst size. Lysogenic cycle, bacteriophage typing, application in bacterial genetics. Brief detail on M13, Mu, T3, T4 and Lambda phages.

### Unit- IV

Plant viruses: classification and nomenclature: effects of viruses on plants, histology, physiology and cytology of plants as affected with virus. Common viral diseases of plants (rice, cotton, tomato and sugarcane), viruses of cyanobacteria, algae, fungi. Life cycle species type of plant viruses like TMV, Cauliflower mosaic virus and potato virus X transmission of plant viruses with vector and without vectors.

### Unit- V

Animal virus: classification and nomenclature of animal and human viruses, epidemiology, life cycle, pathogenicity, diagnosis. Prevention and treatment of RNA viruses, Picorna, Rhabdo, Rota, HIV and other Oncogenic viruses. DNA viruses; Pox, Herpes, Adeno, SV 40, Hepatitis Viruses. Viral vaccines (Genetic recombinant vaccines used in national immunization programmes, interferons and antiviral drugs).

### Practicals

1. Identification & Classification of common fungi.
2. Mounting & staining VAM spores & preparation of diagnostic slides.
3. Study of antagonism by dual culture technique.
4. Recovery and quantitative estimation of VAM spores from the soil.
5. Identification and Classification of common algae.
6. Study of viral infection in plants.
7. Study of viral infection in animals.
8. Bacteriophage production: Single step growth.

### Books

1. Principles of virology 2<sup>nd</sup> Ed. 2004. Flint, S. J. Enquist, L. W. , Racaniello, V. R. and Skalk, A. M. , Washington D. C. ASM Press.
2. Mathew's Plant Virology 4<sup>th</sup> Ed. 2002 Hull, R. San Diego Acad. press.
3. Fields Virology 4<sup>th</sup> Ed. 2001. Knip, D. M. and Howley, P. M. , New York: Lippincott Williams.

4. Virus Taxonomy VIII report of the International committee on Taxonomy of Viruses. Mayo, M. A. Maniloff, J. Desselberger, U. , Ball, L. A. and Fanquest, C. M. 2005. Sandiego: Elsevier Acad. Press.

## MICROBIAL DIVERSITY AND ECOSYSTEMS

### Unit-I

History and development of microbiology, microbial evolution (systemic and taxonomy-evolution of earth and earliest life forms, primitive organisms, their metabolic strategies and molecular coding), bacterial identification, nomenclature and classification (Bergey's Manual), new approaches to bacterial taxonomy classification including ribotyping and ribosomal RNA sequencing. Characteristics of the primary domains.

### Unit-II

Isolation, pure culture techniques, methods of sterilization (physical and chemical), enrichment culture techniques, microbial growth (definition of growth, growth curve, measurement of growth and growth yields, synchronous growth, continuous, batch and fed batch cultures, factors affecting growth), culture collection, maintenance and preservation.

### Unit-III

General structure and feature: Prokaryotic and Eukaryotic cells (functions and composition of cell wall of Gram +ve, Gram -ve bacteria, cell wall and cell membrane synthesis, flagella and motility, cell inclusions like endospores, gas vesicles). Brief account of all groups of bacteria (purple and green, cyanobacteria, budding bacteria, spirochetes, sheathed bacteria, endospore formers and non endospore formers, rods and cocci, rickettsia, Chlamydia, mycoplasma, mycobacteria), Archae: (halophiles, methanogens, extreme thermophiles, thermoplasma), Eukaryotes: (fungi, algae, slime molds and protozoa).

### Unit-IV

Physiology and metabolic diversity among microorganisms. Nutritional classification of microorganisms: (chemoautotrophs, chemoheterotrophs and photosynthetic microbes, photosynthesis in microorganisms), role of chlorophyll, carotenoids, phycobilins, chemolithotrophy, hydrogen, iron, nitrate and oxidizing bacteria, nitrate and sulphate reduction, syntrophy, role of anoxic decomposition, nitrogen metabolism, nitrogen fixation, hydrocarbon transformation. Gene mutation and mutagenesis (mutagens-radiation and chemical). Types of mutation and their repair mechanism, Ames test for mutagenesis, method of genetic analysis, bacterial genetic system (transformation, conjugation, plasmids, transposons). Bacterial genetic map with reference to *E. coli*. Genetic systems of yeast and *Neurospora*. Extra chromosomal inheritance.

### Unit-V

Microbial diseases: Disease reservoir, epidemiological terminologies, infectious diseases transmission modes, respiratory infections caused by bacteria, virus. Sexually transmitted diseases. Diseases transmitted by animals. Food and water born diseases. Pathogenic fungi, emerging and resurgent infectious diseases, nosocomial infections. Host -parasite relationship- normal microbial flora of skin, oral cavity, gastrointestinal tract, entry of pathogen into the host, types of toxins (endotoxin and exotoxin), their structure, mode of action, virulence and pathogenesis. Chemotherapy (antibiotic, antimicrobial agents: sulpha drugs, antibiotics like, penicillin, cephalosporin, broad spectrum antibiotics, super infections, antifungal, mode of action and resistance to them, antibiotics from prokaryotes). Probiotics.

### Practical:

1. Isolation of microorganisms from air.
2. Isolation of microorganisms from water.
3. Bacteriological examination of water by Multiple Tube Technique.
4. Isolation and identification of pathogens.

5. To determine dissolved oxygen of water. (i)to determine BOD(ii)to determine COD.
6. Demonstration of waste water treatment plant.
7. Demonstration of composting.
8. Isolation of microorganisms soil.
9. Isolation of Rhizosphere micro flora.
10. Study of halophiles.
11. Study of thermophiles
12. Isolation of *Rhizobium* from (i)Root Nodule (ii) Soil
13. Isolation of free living nitrogen fixers.
14. Isolation of VAM spore.
15. Study of cyanobacteria.
16. Study of phylloplane microflora by leaf impression method.

**Books:**

1. Ananthanarayan, R and C. K. Jayaram Panicker (1997). Text book of Microbiology, Orient Longman, .
2. Mackie and McCartney, (1996). Medical Microbiology, Vol. I: Microbial Infection. Vol. 2: Practical Medical Microbiology, Churchill Livingstone,
3. Shanson D. C. , Wright PSG, (1982). Microbiology in Clinical Practice.
4. Colwd, D. (1999). Microbial Diversity. Academic Press.
5. Prescott Harley Klein: Microbiology (1996) ECB Pub. (III ed).
6. Pelczar, M. J. Jr. , Chan, E. C. S, and Kreig, N. R. (1993). Microbiology: Concepts and Applications, Mc Graw- Hill. Inc. (ISBN. 0- 07- 049258-1).
7. Stainer RY, Ingraram JL, Wheelis, ML Painter PR (1986). General Microbiology

# GENETIC ENGINEERING

## Unit-I

History and development of genetic engineering, its principles, basic methods, scope and milestones. Isolations of enzymes. DNA synthesis and mutation, detection and separation, cloning and gene expression. Cloning and patenting of life forms. Genetic Engineering Guidelines.

## Unit-II

Introduction to Recombinant DNA Technology (RDT): Core techniques and essential enzymes used in RDT, Restriction Endonucleases (types and classification and application), enzymes for digestion, ligation, transformation and modification. Nucleic acid purification, yield analysis, its amplification and application. Gene cloning vectors: Plasmids, Bacteriophages, Phagemids, Cosmids. Restriction modification systems in Bacteria, F factor and conjugation, transduction, transformation. Artificial chromosomes, specialized cloning strategies, expression vectors. Promoter probe vectors, vectors for library construction.

## Unit-III

Restriction mapping of DNA fragments and mapping construction. Nucleic acid sequencing (dideoxy and chemical methods, sequence assembly automated and genome sequencing) PCR methods and its application. Molecular cloning: construction of cDNA and genomic library, mRNA enrichment, reverse transcription, DNA primers, linkers, adapters and their chemical synthesis. Transformation, Transfection, Gene transfer technique (micro injection, electroporation etc. ). Screening of recombinants. Alternative strategies of Gene cloning –cloning interacting genes. Two and three hybrid system, cloning deferentially expressed genes. Nucleic acid micro array.

## Unit-IV

Principles and practice of nucleic acid hybridization, Southern, Northern, Western Hybridization and Gel retardation technique, DNA Fingerprinting technique, Site Directed Mutagenesis, Gene Replacement, Gene Targeting and Protein Targeting, SI Mapping, RNAase protection assay, Reporter assay. Expression strategies for heterologus genes –vector engineering- rationale for the design of the vectors for the overexpression of recombinant proteins, selection of suitable promoter sequences, ribosome binding sites, transcription terminator, protease cleavage sites and codon optimization, host eng-ineering, *in vitro* transcription and translation (expression in different systems bacteria, yeast, insect cells, mammalian cells and plant cells). Production of inclusion bodies.

## Unit-V

Processing of Recombinant Proteins- Purification and refolding characterization of recombinant proteins, stabilization of proteins. Phage display, T-DNA and Transposomes Tagging- Role of Gene Tagging in Gene Analysis. Identification and isolation of gene through T-DNA and transposomes. Transgenic and Gene knockout Technologies. Targeted gene replacement. (strategies of gene delivery, gene replacement/ augmentation, gene correction, gene editing, gene regulation and gene silencing).

## Practicals

1. Bacterial culture and antibiotic selection media selection media. Preparation of competent cells.
2. Isolation of plasmid DNA
3. Isolation of Lambda phage DNA.
4. Quantitation of nucleic acid.
5. Construction of restriction map of plasmid DNA.
6. Cloning in plasmid/phagemid vectors.
7. Preparation of helper phage and its titration

8. Preparation of single stranded DNA template.
9. DNA sequencing.
10. Gene expression in *E. coli* and analysis of gene product.
11. PCR
12. Reporter gene assay (Gus/CAT/b-GAL )

**Books**

1. Molecular Cloning: a Laboratory Manual, J. Sambrook, E. F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
2. DNA Cloning: A Practical approach, D. M. Glover and B. D. Hames. IRL Press Oxford, 1995.
3. Molecular and Cellular Methods in Biology and Medicine, P. D. Kaufman, W Wu. . D. Kim and L. J. : Cseke, CRC Press. Florida. 1995.
4. Methods of Enzymology Vol. 152. Guide to Molecular Cloning Techniques, S. L. Berger and A. R. Kimmel, Academic Press. Inc. San Diego, . 1998.
5. Methods in Enzymology Vol. 185, Gene – Expression Technology, D. V. Goeddel, Academic Press. Inc. San Diego, 1990.
6. DNA Science. A First course in Recombinant Technology, D. A. Mick loss and G. A. Greyer, Cold Spring Harbor Laboratory Press, New York. 1990.
7. Molecular Biotechnology (2<sup>nd</sup> Edn. ), S. Primorso, Blackwell Scientific Publishers. Oxford, 1994.
8. Milestone in Biotechnology. Classic papers on Genetic Engineering, J. A. Davies and W. S. Roznikolf, Butterworth-Helmemann, Boston, 1992.
9. Route Maps in Gene Technology, M. R. Walker and R. Repley, Blackwell Science Ltd. , Oxford, 1997.
10. Genetic Engineering. An Introduction to gene analysis and exploitation in eukaryotes. S. M. Kingsman, Blackwell Scientific Publication, Oxford, 1998.
11. Molecular Biotechnology - Glick

## INSTRUMENTATION AND TECHNIQUES

### Unit-I

Spectroscopy: interaction of radiation with matter, adsorption of radiation, emission of radiation, Beer-Lambert relationship, components of a spectrophotometer, type of detectors; UV and Vis spectrophotometry. Fluorimetric methods, atomic absorption spectroscopy techniques, flame emission photometry, magnetic resonance spectroscopy. Application of different spectroscopic techniques.

### Unit-II

Chromatography – Principle of adsorption and partition. Mode of Chromatographic methods based on polarity (absorption chromatography, liquid chromatography, gas-liquid chromatography), method based on ionic nature (ion exchange chromatography), methods based on shape (affinity chromatography), HPLC. Application of chromatographic techniques in biology.

### Unit-III

Membrane filtration and dialysis, electrophoresis, zonal techniques, supporting medium, vertical, submarine and gradient electrophoresis. Isoelectric focusing, isotachopheresis, capillary electrophoresis, elution parameters, immunoelectrophoresis. Application of electrophoresis in biology.

### Unit-IV

Centrifugation: Preparative and analytical centrifuges, sedimentation analysis, RCF, zonal and equilibrium density gradients, Ultracentrifuge. Microscopy: light, phase contrast, fluorescence and electron microscopy.

### Unit-V

Radioisotopes: nature of radioactivity, types of radioactivity, radioactive decay, unit of radioactivity. Detection and measurement of radioactivity, (Geiger counters, scintillation counters) autoradiography. Biochemical use of isotopes (tracers, radio immunoassay).

### Books:

1. A Biologist's Guide to Principles and Techniques of Practical Biochemistry, K. Wilson and K. H. Goulding, ELBS Edition, 1986.
2. Tools of Biochemistry, T. G. Cooper.
3. Biomedical Instrumentation and Measurements 2<sup>nd</sup> Edition, Leslie Cromwell, Ered J. Weibell and Erich A. Pfeiffer. Prentice-Hall of India Pvt. Ltd. , New Delhi.
4. Spectroscopy (Atomic and Molecular), Gurdeep Chatwal, Sham K. Anand, Himalaya Publishing House.
5. Principles and techniques of Biochemistry and Molecular Biology, 6<sup>th</sup> edition, Kieth Wilson and John Walker, Cambridge.

# IMMUNOLOGY

## Unit-I

Historical background: Humoral and cellular immunity. Innate immunity: skin and mucosal surface, Physiological barriers, Phagocytic barriers, inflammation and adaptive immunity. Immune dysfunction and its consequences; allergy and asthma. Cells and organs of immune system: Lymphoid cells, stem cells, B and T Lymphocytes, Natural Killer cells, mononuclear phagocytes, granulocytic cells. Organs: Thymus, Bone marrow, Lymphatic system, Lymph nodes, spleen.

## Unit-II

Antigens and antibodies: Antigens; Structure, properties, types, epitopes, haptens. Antibodies; structure and function, antibody mediated functions. Antibody classes and biological activities. Monoclonal antibody.

Antigen antibody interactions: Precipitation reaction, agglutination, radioimmunoassay, ELISA, Immuno blotting, western blotting. Major histocompatibility Complex: General structure and function of MHC, MHC molecules and genes, antigen processing and presentation, T cell receptors, T cell maturation and differentiation, B cell generation, activation and differentiation .

## Unit-III

Immune effector mechanism: Cytokinesis (Properties, receptors, antagonists and secretion). The complement system (Functions, components, activation, regulation and deficiencies). Cell mediated effector responses: cytotoxic T cells, Natural killer cells, and Antibody dependent cell mediated cytotoxicity. Inflammation. Hypersensitive reactions (Type I, II, III and delayed type {DTH}).

## Unit-IV

Immunology in health and disease: Immune responses to infectious diseases: Viral, bacterial and protozoan. AIDS and other Immuno deficiencies. Vaccines, Genetically designed vaccines, BCG, TB, Leprosy, DNA vaccines.

## Unit-V

Transplantation and auto immunity: Organ specific autoimmune diseases, Systemic auto immune diseases. Graft rejection, evidence and mechanism of graft rejection, prevention of graft rejection, immunosuppressive drugs, HLA and disease, mechanism of immunity to tumor antigens. Autoantibodies in human pathogenic mechanism, experimental models of autoimmune disease treatment of autoimmune disorders.

### Practicals:

1. Radio-immunodiffusion.
2. Immuno-electrophoresis
3. Dot ELISA.
4. Ouchterlony Double diffusion.
5. Quantitative precipitin Assay.
6. Widal test.
7. Sandwich ELISA
8. Latex Agglutination.

### Books:

1. Immunology A Short course, Benjamin E and Leskowitz S. , Wiley Liss NY to 1991.
2. Immunology- Understanding of Immune System Klans D. Elgret (1996). Wiley- Liss, NY.
3. Kubly J. Immunology Iled. (1994) W. H. Freeman & Co. NY.
4. Pravesh C. Sen Gupta, Clinical Immunology, Oxford India, 2003(II Vol).
5. Richard A. Goldshy et al. Immunology 5<sup>th</sup> ed. W. H. Freeman & Co. NY 2003.
6. Roitt I, Essential Immunology, Blackwell Se Pub. Oxford. III ed.
7. Topley & wilson's (1995) Text book on principles of bacteriology, Virology & Immunology IX ed. Edward Arnold, London.

## MEDICAL MICROBIOLOGY AND PUBLIC HEALTH

### Unit-I

Discovery of pathogenic microorganisms, development of bacteriology as scientific discipline, contributions made by eminent scientists. Classification of medically important microorganisms, Normal microbial flora of human body, role of resident flora and the human host.

### Unit-II

Establishment, spreading, tissue damage and anti-phagocytic factors; mechanism of bacterial adhesion, (basic principles, effects of adhesion on bacteria and on host cell) colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts. Role of aggressions, depolymerising enzymes, organotropisms, variation and virulence. Organs and cells involved immune system and immune response.

Prokaryotic and eukaryotic signaling mechanisms: eukaryotic cell to cell signaling, endocrine signaling, Ajlikins, prokaryotic signaling, quoreem sensing and bacterial pheromones, intracellullar signaling, signaling pathways.

Injection and cell – cell interactions, bacterial adherence, basic principles, effects of adhesion on bacteria, effects of adhesion on host cells, mechanism, consequence of invasion and survival after invasion. Protein toxins: agents of diseases.

### Unit-III

Classification of pathogenic bacteria. Staphylococcus, Streptococcus, Pneumococcus, Neisseria, Corynbacterium, Bacillus Clostridium, non spore forming anaerobes, Organism belonging to Enterobacteriaceae, Vibrio, Non fermenting Gram negative bacilli Yersinia, Haemophilus, Bordetella, Brucella, Mycobacteria, Spirochetes, Ricekettsiae and Chlamydiae.

### Unit-IV

General properties of Viruses; viruses host interactions; Pox viruses; Herpes viruses, Adeno viruses; Picarno viruses; Orthomyxo viruses; Paramyxo viruses; Arboviruses, Rhabdo viruses, Hepatitis viruses; Oncogenic viruses; Human Immuno Defeciency Viruses(AIDS). Dermophytes, Dimorphic Fungi, Opportunistic fungal pathogens. Description and classification of pathogenic fungi and their laboratory diagnosis.

### Unit-V

Laboratory control of antimicrobial therapy; various methods of drug susceptibility testing, antibiotic assay in body fluids. Brief account if on available vaccines and schedules; passive prophylactic measures; Noscomical infection, common types of hospital infection and their diagnosis and control. Nutrition and health, environment and health, water and waste management and health planning. Communication for health education.

### Practicals

1. Sterilization and disinfections.
2. Collection of samples and containers used for collecting samples.
3. Preparation of culture mediums for growing pathogenic microorganisms.
4. Ziel-Nelson staining method for AFB.
5. Giemsa staining.
6. Study of slides of important pathogens.
7. Study of slides from stool and blood.
8. Identification of pathogens on the basis of cultural characteristics.
9. Conventional and rapid methods of isolation and identification of pathogenic microorganisms.

10. Demonstration of automated methods of diagnostic microbiology.

**Books**

1. *E. coli* and *Salmonella*, Cellular and Molecular Biology, 2<sup>nd</sup> edition.
2. Topley & Wilson's (1995) Text book on principles of bacteriology, Virology & Immunology IX ed. Edward Arnold, London.
3. Text of Microbiology, R. Ananthanarayanan and C. K. Jayaram Panicker, Orient Longman, 1997.
4. Mackie and McCartney, Medical Microbiology, Churchill Livingstone, 1996.
5. Microbiology in Clinical Practice. D. C. Shanson, Wright PSG, 1982.
6. Bailey and Scott's Diagnostic Microbiology Baron EJ, Peterson LR and Tenover FC. Mosby, 1990.

## FOOD AND DAIRY MICROBIOLOGY

### Unit-I

Microorganisms important in food microbiology: Molds, Yeasts and Bacteria-General characteristics, classification and importance. Principles of food preservation. Asepsis – Removal of microorganisms (aerobic conditions, high temperatures, low temperatures, drying). Factors influencing microbial growth in food- Extrinsic and intrinsic factors; Chemical preservatives and food additives. Canning, processing for heat treatment-D, Z and F values.

### Unit-II

Food spoilage; Cereals, sugar products, vegetables, fruits, meat and meat products, milk products, fish and sea foods- poultry-spoilage of canned food. Detection of spoilage and characterization. Food born infections and intoxication: Bacterial and nonbacterial types- *Brucella*, *Bacillus*, *Clostridium*, *Escherichia*, *Salmonella*, *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

Fermented foods: Bread, cheese, vinegar, fermented vegetables, fermented dairy products, oriental fermented foods, their quality standards and control; Experimental and induction methods, microbial cells as food and mushroom cultivation. Fermented beverages: Beer and wine. Genetically modified foods and their acceptability.

### Unit-IV

Composition and constituents of milk and its microorganisms. Source of contamination at farm, transit and manufacturing level. Principles of milk sterilization (pasteurization), methods of sterilization. Fermented milk/dairy products. Spoilage of milk and milk products. (Cheese, yogurt, curd whey, ice cream, butter, ghee).

### Unit-V

Food in relation to disease: Food borne illness, Food poisoning, bacterial and non bacterial infections, intoxication. Food sanitation and microbiology. Food borne diseases outbreak.

#### Practicals:

1. Isolation and identification of common microorganisms spoiling food (fungi and bacteria).
2. Study of general methods of food preservation: (i) Temperature (ii) Salt (iii) Moisture.
3. Preparation of fermented foods (koji, Saukeraut) and fermented beverages (soya sauce, alcohol).
4. Determination of number of bacteria in milk by (i) Standard plate count (ii) Direct microscopic count.
5. Testing of milk by MBRT.
6. Turbidity Test for milk.
7. Test for pasteurization of milk.
8. Coliform Test for milk.
9. Demonstration of food sanitation & hygiene in industries.

#### Books:

1. Adams M. R. and Moss M. O. (1995) Food Microbiology. Royal Society of Chemistry Publication, Cambridge.
2. Frazier WC and Westhoff Dc (1998). Food Microbiology. Tata McGraw Hill Publishing Company Ltd, New Delhi.
3. Publishing Company Ltd, New Delhi.

4. Stanbury, P. F. , Whitaker, A and Hall, S. J. (1995). Principles of Fermentation
5. Technology. 2<sup>nd</sup> Ed. Pergamon Press.
5. Banwart, GJ (1993). Basis Food Microbiology. CBS Publishers and Distributors, Delhi.
6. Hobbs BC and Roberts D. (1993) Food poisoning and Food Hygiene. Edward Arnold
6. (A division of Hodder and Stoughton) London.
7. Robinson RK. , (1990). Dairy Microbiology. Elsevier Applied Sciences, London.
8. Stanbory P. F. A. Whitaker & Hall. 1995. Principles of Fermentation technology.
9. Pergaman. McNeul & Harvey. 1990.
7. Fermentation. A. Practical Approach. IRL.

## AGRICULTURAL MICROBIOLOGY

### Unit-I

Introduction, History and Scope: Soil properties and their effect on growth of microorganisms. Soil as growth medium for microbes. Types of microorganisms found in soil and on plant surfaces (Viruses, Bacteria, Fungi, Algae & Protozoa). Role of soil microorganism in decomposition of organic matter in soil and plant nutrient release (N, P, S Cycles). Interaction of different microbial types (Viruses, Bacteria, Fungi, Algae & Protozoa) among themselves and with soil types.

### Unit-II

Plant Microbe Interaction: Rhizosphere and microbes found in rhizosphere. Rhizobacteria and their role. Phyllosphere and microbes. Role of phyllospheric bacteria in plant growth. Endophytes and their role. Plant microbe symbiosis, Legume – Rhizobial symbiosis, Non legume – Actinorrhiza symbiosis, *Azolla – Anabaena* symbiosis. Biochemistry, Genetics and biological nitrogen fixation. Phosphate solubilisation. Biofertilizers and Biopesticides. Micorrhiza: Ecto&Endo mycorrhiza and their role in biological nitrogen fixation, phosphate solubilisation. Interaction of transgenic plants and microbes.

### Unit-III

Soil pollutants and microbes: Pesticides and herbicides as soil pollutants. Degradation of pesticides and herbicides. Bioaccumulation of metal pollutants. Detoxification of abnoxious soil pollutants. Ground water pollution with nitrites. Bioremediation of oil spilt soils, mine spilt soils.

### Unit-IV

Soil microbial diversity: Genetic as well as functional. Culturable and non culturable forms of bacteria. Human pathogens in soil. Conventional, non-conventional & molecular methods of studying the fate of inoculated strains. Rumen microbiology. Silage & its microbiology.

### Unit-v

Plant diseases and their pathogens. Host pathogen interaction. Synthesis of different elicitors (exogenous and endogenous) and their release. Receptor site for different elicitors. Systemic signal transduction. Different defense mechanisms: PR proteins, Phytoalexins and Phytoanticipins. Suppression of defense mechanisms by pathogen.

### Practicals

1. Viable count of microorganism in soil.
2. Viable count in rhizosphere.
3. Viable count in phyllosphere.
4. Isolation of N<sub>2</sub> fixing bacteria.
5. Isolation of phosphate solubilising bacteria.
6. Isolation of *Rhizobium* from legume nodule.
7. Sterilization of soil and growing plant in small pot.
8. To study effect of *Azotobacter* inoculation on wheat seed germination and plant growth.
9. Examination of VAM spore in mycorrhizal plant roots.
10. Cellulase production by soil microbes.
11. Isolation of endophytic microorganisms.
12. To study decomposition of organic matter and CO<sub>2</sub> production.

## BIOINFORMATICS AND INTELLECTUAL PROPERTY RIGHT

### Unit-I

Introduction to database: Flat file data base: relational database: object oriented databases.

### Unit-II

Sequence analysis and phylogeny: Internet sequence on the net- sequence DNA, RNA and protein, determination of protein structure, gene and protein expression data- protein interaction data. File formats-sequences databases- genome and organism specific database- retrieval, entrez, SRS; similarity searches- amino acid substitution matrices- FASTA, BLASTA- various types of BLAST. Multiple sequence alignment, protein families- protein domain families. Building trees- evolution of macro molecular sequences-genome annotation.

### Unit-III

C-language: introduction, operators, expressions, variables, input, output statements, control statement, function, arrays, pointers, structures, unions, file handling and case studies. Introduction to PERL, variables, strings and numbers, lists analysis, hashes, conditional loops, pattern matching and application.

### Unit-IV

Introduction to structural database- models of protein structure- structure, function and relationship, structural alignment- classification of 3D structure. CATH and SCOP- concepts in protein prediction. Microarray data and analysis: tools and resources, proteomics data analysis, Bioinformatics in drug discovery.

### Unit-V

Fundamental of IPR, Basic principles, copyright, trademark, design, geographical indication, acquisition of rights and remedies for infringement of these IPRs- patent law history, development of patent law, basic principles, criteria novelty. Utility and no obviousness, subject matter in US. UK. Drafting patent specifications. International institutions and international instrument (WTO, WIPD, TRIPS, CBT, PARIS convention, Budapest treats).

### Books:

1. Programming in C- E. Balaguru Swamy.
2. C++ from Scratch. J. Liberty.
3. How computers work. 2000. ron White. Techmedia.
4. How the Internet work. 2000. Preston Gralla. Techmedia.
5. Bioinformatics 1998. Baxevanis.
6. Bioinformatics 2000. Higgins & Taylor. OUP.
7. Nucleic Acids Research. 2001. Jan. Genome Database issue.

## BIOSTATISTICS AND COMPUTER APPLICATION

### Unit-I

Importance and scope in biological experiments. Brief description of tabulation of data and their graphical representation. Measures of central tendency. Arithmetic, Geometric and Harmonic Means, Median, Mode. Measures of dispersion: Range, Quartile- deviation, Variance. Elementary idea of Probability: Mathematical, Axiomatic and Statistical definitions, addition and multiplication. Probability distribution, definition and application: Binomial, Poisson, Normal distributions definitions and its application.

### Unit-II

Simple linear regression and correlation, Relation between two variables. Linear Regression: diagrams and equation, significance test, prediction of dependent variable from independent one. Linear Correlation: scatter diagrams, correlation coefficient, standard error. Relationship between correlation and regression coefficient.

### Unit-III

Elementary idea of random sampling, selection of simple random samples from a finite population. Methods of sampling, definition of sampling distribution, sampling variance and standard error. Test of significance: Normal deviate tests (Z Test), Students T test, Chi square test, F test. Analysis of Variance: One way classification with equal and unequal sample sizes, two way classification with one observation per cell. Completely Randomized Design, Multiple Comparisons Isd and Duncan's New Multiple Range test. Introduction to 2 Factorial Design.

### Unit-IV

Computer Application: Introduction to computer science. Computers and their organizations, hardware, software, operating system (Command and WIMP). Introductions to Windows: Windows application (Microsoft Word, Excel, PowerPoint and Multimedia).

### Unit-V

Introduction to Internet (LAN, MAN, WAN) and use of electronic mail. Elementary idea about programming and presentation (Spread Sheet and Statistical Analysis). Computer Aided Learning in Biotechnology.

### Books

1. Programming in C, E. Balaguru Swamy.
2. C++ from scratch, J. Liberty. s
3. How computer work, 2000, Ron White, Techmedia.
4. How internet works, 2000, Preston Gralla, Techmedia.
5. Bioinformatics 1998, Baxevanis.
6. Bioinformatics 2000, Higgins and Taylor, OUP.
7. Nucleic Acids Research, 2001, Jan. Genome Database issue.
8. Statistics in Biology, Bliss, C. I. K (1967): Vol. 1, McGraw Hill, New York.
9. Statistics for Biologists by Campbell R. C. (1974): Cambridge University Press, Cambridge.
10. Statistical Methods as Applied to Immunological data, app. 1163-1206. In D. M. Weir (Ed/) Hand-book 'Experimental Immunology', Lutz, W. (1967), Blackwell Publication. Ltd. , Oxford.
11. Practical Statistics for experimental Biologist, Wardlaw, A. C. (1985), John Wily and Sons. , Inc. New York.

## 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 and fungi, diseases caused and preventive measures.

### Unit-II

Methanogenesis, reduction of carbon monoxide, reduction of iron, sulphur, manganese, nitrate and oxygen. Microbial transformation of carbon, phosphorus, sulphur, nitrogen and mercury. Extremophiles: acidophilic, alkalophilic, thermophilic and oxamophilic microbes, mechanism and adoption. Halophiles: membrane variation, electron transport, application of halophiles and extremophiles.

### Unit-III

Water ecosystem: fresh water habitats(ponds, lakes, streams), marine habitats (estuaries, mangroves, deep seas, hydrothermal vents, salt pans, coral reefs). Zonation of water ecosystem, upwelling, eutrophication. Potability of water, microbial assessment of water quality, water purification, brief account of major water borne diseases and their control.

### Unit-IV

Soil microbiology: classification of soils, physical and chemical characteristics, micro flora of various soil types: rhizosphere and phyllosphere: brief account of microbial interactions; symbiosis, mutualism, commensalisms, competition, amensalism, synergism, predation: biogeochemical cycles and the organisms: carbon, nitrogen, phosphorus and sulphur: biofertilizers-biological nitrogen fixation, nitrogenase, nif genes: asymbiotic microbes (*Azotobacter*, *Azospirillum*): vesicular arbuscular mycorrhizae

### Unit-V

Microbiology of Sewage and sludge and their treatment. Microbiological disposal of wastes. Heavy metal pollution and Microbial strain improvement for scavenging heavy metals. Metagenomics in Environmental Microbiology.

### Practicals:

1. Isolation of microorganisms from air.
2. Isolation of microorganisms from water.
3. Isolation of microorganism from soil.
4. Isolation of pathogen microorganisms from sewage.
5. Determination of dissolved O<sub>2</sub> in water. (i)To determine BOD (ii)To determine COD.
6. Microbiological degradation of aromatic hydrocarbons.
7. Degradation of herbicides and pesticides.
8. Estimation of nitrates in drinking water.

### Books:

1. Alexander, M. (1977). Introduction to soil microbiology. John Wiley & Sons, Inc. , New York.
2. Ec Eldowney, S. Hardman, D. J. and waite, S. 1993. pollution: Ecology and biotreatment- Longman scientific Technical.
3. W. C. Erneasst, (1982) The environment of the deep sea, Vol. II, J. G. Morin Rubey.
4. K. C. Marshall, (1985) Advances in microbial ecology. Vol- 8 Plenum Press.
5. Martin Alexander Wiley. 1961. Introduction to soil Microbiology Internationals; Edn. New York.
6. Burns R. G. , and Slater J. H. (1982). Experimental Microbial Ecology, Blackwell Scientific Publications, Oxford, London.

# INDUSTRIAL MICROBIOLOGY

## Unit-I

Introduction, history and scope of industrial microbiology. Major types of microorganism used in fermentation. Primary and secondary screening. Industrial strain improvement: strategies, selection and improvement using different methods. Development of recombinant strains.

## Unit-II

Media preparation, sterilization. Kinetics of thermal death of microorganisms. Batch, continuous and fed batch process, aeration and agitation, foam and antifoam. Microbial growth kinetics, measurement of growth, effect of pH, temperature and nutrient concentration on growth. Design and operation of various types of bioreactors, main components, peripheral parts and accessories, various control systems.

## Unit-III

Downstream processing, filtration of fermentation broths, ultra centrifugation, recovery of biological products by distillation, superficial fluid extraction, electrokinetic's dialysis, flotation. Enzyme immobilization: Techniques, production and application of free and immobilized enzymes in food, feed and fodder, detergents, textiles, tannery, pulp and paper, pharmaceuticals and diagnosis.

## Unit-IV

Industrial production of alcohol, citric acid, solvents, amino acids, enzymes (amylase, proteases, celluloses), antibiotics, steroids and large scale production of recombinant molecules- interferon, human proteins, vaccines.

## Unit-V

Production of single cell products. Production of microbial insecticides, fungicides, herbicides, biofertilizers, sewage and sludge disposal and fruit preservation.

### Practicals:

1. Visit to industry/ Breweries.
2. Study of growth medium and production medium.
3. To study industrial production of beer / wine.
4. Measurement of citric acid production.
5. Demonstration of amino acid production by *E. coli* mutant.
6. To test the production of enzymes; Amylases, Proteinases, Lipases and Cellulases by microorganisms.

### Books:

1. Patel, A. H. 1985. Industrial Microbiology. McMillan, India Ltd.
2. Crueger, W. and Crueger, A. 1990. Biotechnology. A Text Book of Industrial Microbiology. Ed. T. D. Brock. Sunderland Mass.
3. Godfrey, T and West, S. 1996. Industrial Enzymology: The application of enzymes in industry. Stockholm New York.
4. Biocatalysts: Fundamentals and Application. Bommarious et al.