NIMS UNIVERSITY, JAIPUR

SYLLABUS

MASTER OF SCIENCE (BIOTECHNOLOGY)

Course Structure and Examination Scheme

M. Sc. (Biotechnology) 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. Biotechnology

First Year

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

Second Year

	Distribution of Marks			
	Theory	**Practical**	**Internal**	**Total**
1. Animal Cell Science and Technology	**50**	**30**	**20**	**100**
2. Plant Biotechnology	**50**	**30**	**20**	**100**
3. Bioresources and Environmental Biotechnology	**50**	**30**	**20**	**100**
4. Bioinformatics and Intellectual Property Right	**50**	**30**	**20**	**100**
5. Biostatistics and Intellectual Property Right	**50**	**30**	**20**	**100**
6. Biostatistics and Computer Application	**50**	**30**	**20**	**100**
7. Bioprocess Engineering and Technology	**80**	**-**	**20**	**100**
8. Applied Biotechnology	**50**	**30**	**20**	**100**
9. Dissertation	**80**	**-**	**20**	**100**

CELL BIOLOGY

Unit- I

Cell diversity: Cell theory, cell size, shape. Structure and function of cell organelles in prokaryotic and eukaryotic cells. Cytoskeleton: The self assembly and dynamic structure of cytoskeletal filaments. How cells regulate their cytoskeletal filaments; molecular motors and movements. Cell-cell interactions; cell adhesion proteins, tight and gap junctions, plant cell adhesion and plasmodesmata.

Unit- II

Transport of nutrients, ions and macromolecules across membranes. Signal transduction, cellular response to environmental signals. Cell motility-cilia, flagella of eukaryote and prokaryote.Cells as experimental models *E. coli, Caenorhadbitis, Drosophila, Arabidopsis* and vertebrates.

Unit- III

Energy conversion: Mitochondria and chloroplast, genetic system of mitochondria and plastids, electron transport chain and their protein pumps. The evolution of electron transport chains.

Unit- IV

Biosynthesis of protein in eukaryotic cell. Co and post translational modifications, intracellular protein trafficking. Synthesis of secretory and membrane proteins.

Unit- V

The cell cycle – molecular events in plants and animals. The mechanism of cell division. Programmed cell death. Extra cellular control of cell division, cell growth and apoptosis. Cellular basis of differentiation and development-mitosis, gametogenesis and fertilization. Development in *Drosophila* and *Arabidopsis*; special and temporary regulation of gene expression.

Practicals:

1. Microscopy: demonstration of different types of microscopes
2. Microtomy
3. Sub-cellular fractionation and marker enzymes.
4. Histochemical localization of protein, carbohydrate, fats, starch, lignin, DNA, RNA etc.
5. Mitosis and Meiosis
6. Salivary gland chromosome.

Books:

1. Molecular Biology of cell, Alberts, B *et al.*
2. Molecular Cell Biology, Lodish et al.
3. Reproduction in Eukaryotic cells, D.M. Prescott, Academic Press.
4. Developmental biology, S.F. Gillbert Sinaur Associates Inc.
5. Cell in development and inheritance, E.B. Wilson, Mac Millan, NY
6. The Coiled Spring, Ethan Bler, Cold Spring Harbour Press.
7. Fertilization F.T.: Longo Chapman and Hall.

MOLECULAR BIOLOGY AND MICROBIAL GENETICS

Unit- I

Nucleic acid as genetic information carriers: historical aspects and current concepts, melting of DNA. 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 DNA 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 N2 assimilation.

Unit- III

Maturation and processing of RNA: methylation, cutting and trimming of rRNA; capping, polyadenylation and splicing of mRNA; capping, cutting and modification of tRNA degradation system. Catalytic RNA, group I and group II intro 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 Brujin 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).

GENERAL MICROBIOLOGY

Unit- I

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

Unit- II

Morphology and ultra structure of bacteria: morphological types; cell walls of archeabacteria – Gram negative, Gram positive eubacteria- eukaryotes; L- forms: cell wall synthesis, antigenic properties- capsule type composition and function; structure, function of cell membrane - flagella, cilia, chromosomes, carboxysomes, magnetosomes, phycobolisomes, nucleid: 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 the 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.

Unit- V

Classification and salient features of bacteria according to the Bergey's Manual of Systematic Bacteriology-Archeabacteria; Methanotrophs, Halophiles and Sulphur dependent Archeabacteria - Gram Negative Bacteria; Spirochetes, Aerobic or Microaerophilic rods and cocci. Facultative aerobes, anaerobes, Rickettsia and Chlamydia, anoxygenics 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, Environment, 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, Dessication on bacteria.
5. Cultivation of Anaerobic organisms.
6. Sterlisation 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 (iii) Negative staining (iv)Flagella staining (v)Cell Wall staining

Books

1. Brock TD, Madigan MT, Biology of microorganisms. Prentice Hall Int. Inc.
2. Text of microbiology, R. Ananthanarayanan and C. K. Jayaram Paniker Orient Longman, 1997.
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.

Warrdlaw (Eds) Sourcebook, Source book of Experiments for the Teaching of Microbiology. Academic press, London and New York.

5. Cellular microbiology. 1999. Henderson et al. Wiley.
6. Prokaroyotic Development Brunn, Y.V. and Shimkets, L.J. 2000. ASM Press.
7. Stainer RY, Ingraram JL, Wheelis, ML Painter PR (1986).
8. Topley & Wilson's (1995) Text book on principles of bacteriology, virology & immunology IX ed. Edward Arnold, London.
9. Michael J. Peljar JR et al. Microbiology: Concepts and Applications, Mc Graw- Hill. Inc. 1993 (ISBN. 0- 07- 049258-1).
10. Prescott Harley Klein: Microbiology III ed. 1996 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 vitamims, 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 Toranto.
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 Toranto.
4. Biochemistry: Zubay G.L, W.C. Brown Publishers.

ENZYMOLOGY

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.

Practicals

Isolation, purification, assay and kinetics of some enzymes from plants, animals and microorganisms namely amylase, peroxidase, catalase and phosphatase etc.

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.

GENETIC ENGINEERING

Unit- I

History and development of genetic engineering, its principles, basic methods and scope and milestones. Isolation 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 engineering, *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 Transposones 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/phage mid 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.Glove and B.D. Hames. IRL Press Qxford, 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. Gooddol, 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 (2nd 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-Helnemann, 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, isotachophoresis, 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 2nd 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, 6th edition, Kieth Wilson and John Walker, Camdridge.

MYCOLOGY AND VIROLOGY

Unit- I

Introduction to fungi: history, general characteristic of fungi. Classification of fungi according to Alexopoulous and 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. Homothalism, heterothallism, 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; capsid 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 PI.

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, pathogeneicity, 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 2nd Ed. 2004. Flint, S.J. Enquist, L.W., Racamiello, V.R. and Skalk, A.M., Washington D.C. ASM Press.
2. Mathew's Plant Virology 4th Ed. 2002 Hull, R. San Diego Acad. press.
3. Fields Virology 4th Ed. 2001. Knip, D.M. and Howley, P.M., New York: Lippnicott 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: Elservier 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, hydro carbon 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.(a) to determine BOD (b) to determine COD.

6. Demonstration of waste water treatment plant.
7. Demonstration of composting.
8. Isolation of microorganisms from soil.
9. Isolation of Rhizosphere micro flora.
10. Study of halophiles.
11. Study of thermophiles
12. Isolation of *Rhizobium* from: (a) Root Nodule (b) Soil
13. Isolation of free living nitrogen fixers.
14. Isolation of VAM spore.
15. Study of cyanobacteria.

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. Ronald M. Atlas, Principles of Microbiology
7. Davis, Microbiology,
8. 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).
9. Stainer RY, Ingraram JL, Wheelis, ML Painter PR (1986).General Microbiology

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 effecter 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. Kuby J. Immunology IIed. (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 5th 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.

ANIMAL CELL SCIENCE AND TECHNOLOGY

Unit-I

Structure and organization of animal cell, cell physiology, equipments and materials for animal cell culture technology. Introduction to the balanced salt solution and simple growth medium. Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium, role of carbon dioxide, role of serum and supplements. Serum and protein free defined media and their applications.

Unit-II

Primary and established cell line cultures, biology and characterization of the cultured cells, parameters of growth, basic techniques of mammalian cell culture *in vitro*, disaggregation of tissue and primary culture.

Unit-III

Maintenance of cell culture, measurement of viability and cytotoxicity, cell separation, scaling up of animal cell culture, cell synchronization, cell transformation, measurement of cell death, apoptosis.

Unit-IV

Cell cloning, micromanipulation and types of cloning, somatic cell genetics, stem cell culture, embryonic stem cells and their applications.

Unit-V

Application of animal cell culture, cell culture based vaccines, organ and histotypic cultures, three dimensional culture and tissue engineering, hybridoma technology, monoclonal antibodies production.

Practicals

1. Preparation of tissue culture medium and membrane filtration.
2. Preparation of single cell suspension from spleen and thymus.
3. Cell counting and cell viability.
4. Macrophage monolayer from PEG and measurement of pathogeneicity.
5. Trypsinization of monolayer and subculturing.
6. Cryopreservation and thawing.
7. Measurement of doubling time.
8. Role of serum in cell culture.
9. Preparation of metaphage chromosome from cultured cells.
10. Isolation of DNA and demonstration of apoptosis of DNA laddering.
11. MTT assay for cell viability and growth.
12. Cell fusion with PEG.

Books

1. Culture of Animal Cells, 3rd Edition, R. Freshney, Wiley-Liss.
2. Animal Cell Culture- Practical Approach, Ed. John R.W. Mesters, Oxford.
3. Cell Growth and Cell Division, A Practical Approach. Ed. R. Basega, IRL Press.
4. Cell Culture Lab Fax. Eds. M. Butler & M. Dawson, Bios Sci. Pub. Ltd., Oxford.
5. Animal Cell Culture Technique, Ed. Martin Clynes, Springer.

6. Methods in Cell Biology, Vol. 57, (Animal Cell Culture Methods), Ed. Jenni P. Mather and David Barnes, Academic Press.

PLANT BIOTECHNOLOGY

Unit-I

Introduction and history of cell and plant tissue culture, tissue culture as a technique to produce novel plants and hybrids.Tissue culture media (composition and preparation).Initiation and maintenance of callus and suspension culture, Single cell clones, Organogenesis. Micropropogation : rapid clonal propagation, transfer and establishment of whole plant in soil. Shoot tip culture and production of virus free plants. Somatic embryogenesis, embryo rescue.

Unit-II

Anther culture, pollen culture and ovary culture for production of haploid plants and homozygous lines. Protoplast (isolation, culture and fusion). Somatic hybridization: selection of hybrid cells and regeneration of hybrid cells, symmetric and asymmetric hybrids and cybrids.Cryopreservation, slow growth and DNA banking for germplasm conservation.

Unit-III

Plant transformation technology, basis of tumor formation, hairy root culture, features of Ri and Ti plasmids. Mechanism of DNA transfer, role of virulence gene. Use of Ti and Ri plasmid as vectors, binary vectors, use of 35 S and other promoters, genetic markers, use of reporter genes, reporter gene with introns, use of Scaffold attachment, methods of nuclear transformation, viral vectors and their application,multiple gene transfer. Transgene stability and gene silencing.Gene transfer technique (direct and indirect).

Unit-IV

Application of plant transformation for productivity and performance, herbicide resistance, phosphoinothricin, glyphosphate, sulphonyl urea, atragene, insect resistance, Bt gene, Non Bt like protease inhibitor, alpha amylase inhibitor, virus resistance, coat protein mediated, nucleocapsid gene disease resistance, chitinase, 1-3 betaglucanase, RIP, antifungal protein, thionins, PR proteins, nematode resistance, abiotic stress, post harvest losses, long shelf life of fruits and flowers, use of ACC synthatase, polygalacturanase, ACC oxidase, Male sterile lines and Barnase systems.

Unit-V

Chloroplast transformation, advantages, vectors, success with tobacco and potato. Metabolic engineering and industrial products: plants secondary metabolites, control mechanism and manipulation of phenylpropanoid pathway, alkaloids, polyhydroxy butyrate, therapeutic proteins, lysosomal enzymes, antibodies, edible vaccines, purification strategies, oleosin partitioning technology.

Practicals

1. Preparation of media.
2. Surface sterilization
3. Organ culture
4. Callus propagation, organogenesis, transfer of plant to soil.
5. Protoplast isolation and culture.
6. Anther culture, production of haploids.
7. Cytological examination of regenerated plants.
8. Agrobacterium culture, selection of transformants, reporter gene (GUS) assays.
9. Developing RFLP and RAPD maps.
10. Preparation of suspension culture.

Books

1. Plant Biotechnology,J.Hammond, P. McGarvey and V. Yusibov (Eds.), Springer Verlag, 2000.
2. Plant Cell and Tissue Culture for the Production of Food Ingredients, T.J. Fu, G. Singh and W.R. Curtis (Eds.), Kluwer Academic/ Plenum Press. 1999.
3. Biotechnology in Crop Improvement,H.S. Chawla, International Book
4. Distribution Company, 1998.

5. Practical Application of Plant Molecular Biology,R.J. Henry, Chapman and Hall, 1997.
6. Elements of Biotechnology, P.K. Gupta, Rastogi and Co. Meerut, 1996.

BIORESOURCES AND ENVIRONMENTAL BIOTECHNOLOGY

Unit-I

Environment – basic concept and issues; Water – Natural (scarce) resources and its management. Source of water pollution and its biological control, measurement of water pollution, water supply treatment processes. Preparing potable water. Removal of microbial contaminants. Aerobic treatment processes –activated sludge, oxidation ditches, trickling filter, towers, rotating discs, rotating drums. Oxidation ponds. Anaerobic treatment processes, anaerobic digestion, anaerobic filters.

Unit-II

Microbiology of degradation of xenobiotics in environment (ecological hydrocarbons, oil pollution, surfactants, pesticides. Genetic regulation of xenobiotic degradation. Phytoremediation of disturbed ecosystem. Use and development of GEM for bioremediation. Integrated treatment system with special reference to biodegradation of polychlorinated biphenyls (PCBs). Micro electro mechanical systems (MEMs)

Unit-III

Solid wastes: Sources and management (composting, ensilage, vermiculture and biogas production). Radioactive and other hazardous wastes and their management (sources and safety). Bioscrubbing heavy metals and organic pollutant (bioaccumulation, biosorption). Application of microbes as biofertilizers and biopesticides for productivity improvement and crop protection. Principles of biomonitering and applications of biosensors for detection of environmental pollutants. Biomining: Use of microbes in biohydro-metallurgy and biomineralization.

Unit-IV

Global environmental problem: UV and ozone depletion, Green House Effect and acid rain, their impact and biotechnological approaches, and their limitations. Air pollution and its control through biotechnological approach. Bio diversity and its conservation; Use of GMO in management of environmental pollution. Nitrogen, Phosphorus and Sulphur cycles and their role in environmental pollution.

Unit-V

Classical plant breeding, molecular basis of genetic modification and crop improvement programmes. GM food crops. Biotechnology in controlling crop diseases, weeds, insects and pests. Plant germplasm collection including of wild species, intraspecific variations in crop plants, molecular characterization of variations. Biosafety concerns, issues of intellectual property rights and legal concerns of bioresource.

Practicals

1. Detection of coli forms for determination of purity of potable water.
2. Determination of total dissolved solids of water.
3. Determination of dissolved oxygen concentration of water sample.
4. Determination of Biological Oxygen Demand (B.O.D.) of a sewage sample.
5. Determination of Chemical Oxygen Demand (C.O.D.) of sewage sample.
6. Determine the efficiency of removal of air pollutants using fibrous air filters.
7. Isolation of xenobiotic degrading bacteria by selective enrichment technique.
8. Test for the degradation of aromatic hydrocarbons by bacteria.
9. Survey of degradative plasmids in microbes growing in polluted environment.

10. Effect of sulphur dioxide on crop plants.
11. Estimation of heavy metals in water /soil by atomic absorption spectro-photometery.
12. Estimation of nitrates in drinking water.
13. Study on biogenic methane production in different habitats

Books

1. Plant, Gene and Crop Biotechnology, M.J. Crispeel and D.E. Sadava ASPB 2003.
2. Economic Botany, S. L. Kocher
3. Waste Water Engineering- Treatment, Disposal and Reuse, Metcall and Eddy. Inc., Tata McGraw Hill, Delhi.
4. Comprehensive Biotechnology, Vol. 4. M. Moo-Yound (Edin-chief), Pergamon Press, Oxford.
5. Environmental Chemistry, A.K. De, Willey eastern Ltd., New Delhi.
6. Introductions to Biodeterioration, D. Allsopp and K.J. Seal, ELBS/Edward Arnold.
7. Bioremederation Engineering: Design and Application, J.T.Cookson, McGraw Hill, Inc.
8. Biotechnology for waste and waste water treatment, Cheremisin off Nicholas P.

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, BLAST- 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 treat).

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 Designs.

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). CAL (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. Statistics in Biology, Bliss, C.I.K (167): Vol. 1, McGraw Hill, New York.
6. Statistics for Biologists by Campbell R. C. (1974): Cambridge Uni. Press, Cambridge.
7. Statistical Methods as Applied to Immunological data, app. 1163-1206. In D.M. Weir (Ed/) Hand-book 'Experimental Immunology', Lutz, W. (1967), Blackwell Pub. Ltd., Oxford.
8. Practical Statistics for experimental Biologist, Wardlaw, A.C. (1985), John Wily and Sons., Inc. New York.

BIOPROCESS ENGINEERING AND TECHNOLOGY

Unit-I

Introduction to Bioprocess Engineering, classification of bioreactors type, specialized bioreactors (pulsed, fluidized, photo bioreactors etc.). Bioreactor design parts and functions. Isolation, preservation, improvement and maintenance of industrial microorganisms. Media for industrial fermentation. Air and media sterilization.

Unit-II

Types of fermentation processes. Analysis of batch, fed batch and continuous bioreactors, stability of microbial reactors, analysis of mixed microbial population.

Unit-III

Measurement and control of bioprocess parameters. Downstream processing (introduction, removal of microbial cells and solid matter, foam separation, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, membrane process, drying and crystallization).

Unit-IV

Whole cell immobilization and their industrial applications. Industrial production of chemicals, utilizing wastes for alcohol (ethanol), acids (citric, acetic and gluconic), solvents (glycerol, acetone, butanol) production, antibiotics (penicillin, streptomycin, tetracycline), amino acids (lysine, glutamic acid) and single cell protein production. Use of microbes in mineral beneficiation and oil recovery.

Unit-V

Introduction to Food Technology, principles of food processing, elemental idea of canning and packaging, sterilization and pasteurization of food products, technology of typical food/food products(bread, cheese, idli), food preservation.

Practicals

1. Isolation of industrially important microorganisms for microbial processes.
2. Determination of thermal death point (TDP) and thermal death time (TDT) of microorganism for design of a sterilizer.
3. Comparative studies of ethanol production using different substrates.
4. Microbial production of citric acid using *Aspergillus niger*.
5. Microbial production of antibiotics (Penicillin).
6. Production and estimation of alkaline protease.
7. Use of alginate for cell immobilization.
8. Quantification of ethanol.
9. Single Cell Protein production.

Books

1. Biochemical Engineering, Aiba, S., Humphrey, A.E. and Millis, N.F. Univ. of Tokyo press, Tokyo.
2. Biochemical reactors, Atkinson, B., Pion Ltd. London.
3. Biochemical Engineering Fundamentals, Baily, J.E. and Ollis, D.F., McGraw Hill Book Co., New York.
4. Bioprocess Technology: Fundamentals and Applications, KTH, Stockholm.
5. Process Engineering: in Biotechnology, Jackson, A.T., Prentice Hall, Engelwood Cliffs.
6. Bioprocess Engineering: Basic Concepts, Shuler, M.L. and Kargi. F., Prentice Hall, Engelwood Cliffs.
7. Principles of Fermentation Technology, Stanbury, P.F. and Whitaker, A., Pergamon press, Oxford.
8. Bioreaction Engineering Principles, Nielson, J. and Villadsen, J., Plenum Press.
9. Chemical Engineering Problems in Biotechnology, Shuler, M.L. (Ed.), ALCHE.
10. Bioichemical Engineering, Lee, J.M. Prentice Hall Inc.
11. Bioprocess Engineering-Kinetics, Mass Transport, Reactor and Gene Expression, Vieth, W.F., John V. and Sons. Inc.

APPLIED BIOTECHNOLOGY

Unit-I

Agri-biotechnology: Cloning by tissue culture, Improvement of animal breeds, Improvement of cultivars by plant genetic engineering. Soil biotechnology: Improving soil bioprocesses for plant nutrient conservation, carbon conservation and sequestering. Harnessing more N_2 fixation and biofertilizers. Better understanding of plant- microbe relation including host plant and pathogen. Improving quality of biopesticides.

Unit-II

Biotechnology in medicine: Drug discovery, creating pharmaceuticals through combinatorial chemistry, through peptide and DNA synthesis through protein or antibody engineering, in vitro fertilization & related techniques. Introduction to Pharmaco-genomics.

Unit-III

Making DNA molecule: DNA synthesis products, PCR application. Application bio-technological tools in forensic science. Transcriptome**:** Determining DNA sequences, Whole genome short gun sequencing, Genome annotation, functional genomics, open reading frame (ORF), coding sequences (COS), Para logs, Orthologs. Evaluations of RNA level gene expression, Microarray analysis. Gene chips, motif, spotted arrays expressed sequence tags (ESTs), comparative genomics, horizontal gene transfer (HGT).

Unit-IV

Biotechnology in industry and information technology. Introduction to Nanotechnology. Proteomics**:** Proteome, definition of proteomics, functional proteomics, structural protein two dimensional electrophoresis. Identification of genes with unknown proteins, genomic analysis of pathogens, extremophiles, environmental genomics, metagenomics. Construction of genomic libraries directly from environment, hierarchical cluster analysis of gene expression following exposure to Y radiations.

Unit-V

Environmental biotechnology for improvement of environment and quality of food. Leather processing, Enzymes & microbiological treatment of oil industrial wastes for biogas production. Bioprocessing of solid waste. Biotechnological approach for energy production from municipal waste, composting bioremediation in aquacultures & removal of heavy metals.

Practicals:

1. Isolation of nitrogen fixing bacteria (Rhizobium, Azotobacter, Azospirilum etc)
2. Measurement of Nitrogen fixing ability.
3. Isolation of phosphate solubilising organism
4. Testing for phosphate solubilizers.
5. Transfection of *E. coli* with M 13 Phage DNA.

Books:

1. Introductions to Biodeterioration, D. Allsopp and K.J. Seal, ELBS/Edward Arnold.
2. Bioremederation Engineering: Design and Application, J.T. Cookson, McGraw Hill, Inc.
3. Biotechnology for waste and waste water treatment, Cheremisin off Nicholas P.
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5. Bioinformatics 2000. Higgins & Taylor. OUP.
6. Elements of Biotechnology, P.K. Gupta, Rastogi and Co. Meerut, 1996.
7. Molecular Cloning: a Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
8. DNA Cloning: A Practical approach, D.M.Glove and B.D. Hames. IRL Press Qxford, 1995.
9. Molecular and Cellular Methods in Biology and Medicine, P.D. Kaufman. W Wu.. D. Kim and L.J.: Cseke, CRC Press. Florida. 1995.