SYLLABUS PRESCRIBED FOR THE DEGREE OF THE MASTER OF SCIENCE
(From 2013-14 onwards)
M. Sc. in Biotechnology
**FIRST – SEMESTER**

**Course No. I: Cell Biology**

Unit -1

Diversity of cell size and shape, cell theory, structure of prokaryotic and eukaryotic cells, isolation of cells, microscopic techniques for study of cells. Cell motility – cilia & flagella of eukaryotes & prokaryotes

Unit-II

Sub cellular fractionation and criteria of function integrity, cellular organelles, plasma membrane, mitochondria, chloroplast, nucleus and other organelles and their structural organization; transport of nutrients, ions and macromolecules across membranes.

Unit-III

Cellular energy transactions- role of mitochondria and chloroplast; cell cycle-molecular events and model systems; cellular responses to environmental signals in plants and animals-mechanisms of signal transduction.

Unit-IV

Biology of cancer, metabolic pathway and their regulation.; Glycolysis; TCA cycle; Pentose phosphate pathway; Entner Duodoroff pathway; catabolism of lipids: α and β-oxidation; Glyoxylate cycle; catabolism of proteins.

Unit-V

Biosynthesis of proteins in eukaryotic cell; co and post-translational modifications, intracellular protein traffic; cellular basis of differentiation and development, mitosis, gametogenesis and fertilization; development in Drosophila and Arabidopsis; spatial and temporal regulation of gene expression; brief introduction to the life cycle and molecular biology of some important pathogen of AIDS, malaria, hepatitis, tuberculosis, filaria, kalazar,swine flue.

Practicals

1. Microscopy: bright field, phase contrast fluorescence.
2. Microtomy.
3. Instrumental methods for cell biology
4. Isolation of chloroplast and chlorophyll A & B from spinach leaves
5. Study of cell motility.
6. Measurement of cell mass by turbidity method.
7. Sub-cellular fractionation and marker enzymes.
8. Histochemical techniques.
9. Mitosis & meiosis.

Books

1. Molecular Biology of Cell, Alberts, B. et al.
2. Molecular Cell Biology, Lodish et al.
3. Reproduction in Eukaryotic cells, DM Prescott, Academic Press.
4. Developmental Biology, SF Gilbert, Sinauer Associates Inc.
5. Cell in Development and Inheritance, EB Wilson, MacMilan NewYork.

6. The Coiled Spring, Ethan Bier, Cold Spring Harbor Press.

**Course No. II: Biomolecules**

UNIT-I

Structure of water and its solvent properties, acids, bases, pH and buffer (mono, bi, polyprotic buffer)
Free energy and spontaneity of reactions.
ATP and other phosphorylated compound with their free energy of hydrolysis, Phosphoryl group transfer.
Biological oxidation-reductions reactions, coupled reactions and oxidative phosphorylation, inhibitors and uncouplers of oxidative phosphorylation.

UNIT-II

Enzymes- nomenclature, classification,specificity, active sites.
Enzyme kinetics- Michealis-Menton equation, determination of kinetic parameters.
Bi-substrate reaction and their kinetics, enzyme inhibition and kinetics, allosteric enzyme, kinetics, and allosteric regulation of phosphofructokinase.

UNIT-III

Structure and chemistry of macromolecules: proteins, carbohydrates and lipids,
structure and chemistry of biomolecules such as antibiotics, pigments. vitamins as coenzymes.
Analysis of macromolecules- lipid analysis by GLC and mass spectrometry, oligosaccharide and polysaccharide analysis.

UNIT-IV

Biosignaling- Molecular mechanism of signal transduction, G-proteins and cyclic AMP, Gated ion channels, the nicotinic-acetylcholine receptor, receptor enzyme-the insulin receptor.

Membrane transport: biomembrane, nutrient transport across membranes, active and passive diffusion, symport, antiport and uniport, $Na^+$-$K^+$ pumps and their metabolic significance.

UNIT-V

Separation techniques- centrifugation,Chromatographic technique: paper and TLC, gel filtration, ion-exchange, affinity, HPLC.
Electrophoresis-SDS-PAGE, isoelectric focusing, Western blotting, protein sequencing, mass-spectrometry, MALDI-TOF-MS.

Practicals

1. Titration of amino acids.
2. Qualitative and quantitative analysis of amino acids and proteins.
3. Quantitation of DNA and RNA.
4. Qualitative and quantitative analysis of carbohydrates.
5. Analysis of fatty acids- iodine number, saponification value, acid number.
6. UV, visible, fluorescence and IR spectroscopy, absorption spectra.

Books

1. Biochemical Calculations, Irwin H. Segal, John Wiley and Sons Inc.
2. General Chemistry. Linus Pauing, W.H. Freeman & Company
3. Organic Chemistry. DJ Cram and GS Hammond, McGraw Hill.
4. Biochemistry. D Voc and JG Voe, J Wiley and Sons.

5. Physical Biochemistry. D. Freitilder, W.H. Freeman & Company.
6. Laboratory Techniques in Biochemistry and Molecular Biology. Work and Work.
7. Understanding Chemistry CNR Rao, Universities. Press Hyderabad (1999).
8. A Biologist's Guide to Principals and Techniques of Practical Biochemistry. K Wilson & KH Goulding, ELBS Edition, 1986.
9. Tools of Biochemistry by T.O. Cooper.

## Course No. III: Microbial Physiology

UNIT-I

The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; synchronous growth; growth as affected by environmental factors like temperature, acidity, water availability and oxygen; storage and maintenance of cultures, continuous culture.

UNIT-II

Metabolic diversity among microorganisms, photosynthesis in microorganisms; role of chlorophylls, carotenoids and phycobilins: Calvin cycle; chemolithotrophy; hydrogen-iron-nitrite oxidizing bacteria; nitrate and sulfate reduction; Methane fermentation-diversity, syntrophy, role of anoxic decomposition, methanogenesis and acetogenesis; nitrogen fixation; hydrocarbon transformation.

UNIT-III

Structural diversity of bacteria: purple and green bacteria, cyanobacteria, homoacotogenic bacteria, acetic acid bacteria, budding and appendaged bacteria, spirilla, spriochaetes, gliding and sheathed bacteria, pseudomonads, lactic and propionic acid bacteria, endospore forming rods and cocci, mycobacteria, rickettsias, chlamydias and mycoplasms methanogens;

Prokaryotic cells structure and functions: cell walls of eubacteria; peptidoglycan and related molecules; outer-membrane of gram negative bacteria; cell membrane synthesis; cell inclusions like endospores, gas vesicles etc.

UNIT-IV

Host-parasite relationship: entry of pathogens into the host; colonization types of toxins: exo-endo- and entero-toxins and their structures, mode of action, Chemotherapy/antibiotics: antimicrobial agents, sulfa drugs, antibiotics, penicillins and cephalosporins, broad spectrum antibiotics, mode of action, resistance to antibiotics.

UNIT-V

Structural diversity of viruses: bacterial, plant, animal examples of herpes, pox, adenoviruses, retroviruses, viroids and prions and tumor viruses.

Practicals

1. Preparation of liquid and solid media for growth of micro – organisms.
2. Isolation and maintenance of micro-organisms by plating, streaking and serial dilution methods of slants and stab cultures, storage of microorganisms
3. Isolation of pure cultures from soil and water.
4. Growth curve; measurement of bacterial population by turbidometry and serial dilution methods; effects of temperature, pH, carbon and nitrogen sources on growth.
5. Microscopic examination of bacteria and yeast study of micro – organisms by gram staining, acid fast staining and staining for spores.

6. Assay of antibiotics and demonstration of antibiotic resistance.
7. Analysis of water for portability and determination of MPN.
8. Biochemical characterization of selected microbes.

Books

1. General Microbiology, Stanier, R.Y. Ingraham, J.L. Wheelis, M.L. and Painter, P.R. The Macmillan press Ltd.
2. Brock Biology of Microogranisms, Madigan M.T. Martinko, J.M. and Parker, J. Prentice- Hall.
3. Microbiology, Pelczar, M.J. Jr. Chan E.C.S. and Kreig , N.R. Tata McGraw Hill.
4. Microbial Genetics Maloy, S.R.C Cronan , J.E.Jr. and Frelfelder ,D. Johnos Bartlett Publishers.
5. Microbiology- A Laboratory Manual, Cappuccino, J.G. and Sherman N. Addison Wesley.
6. Microbiological Application: A Laboratory Manual in General Microbiology Benson, H.J, WCB: Wm C. Brown publisher

## Course No. IV: Animal Cell Science and Techniques

UNIT-I

Structure and organization of animal cell; equipments and materials for animal cell culture technology; primary and established cell lines cultures, introduction to the balanced salt solutions and simple growth medium; brief account of chemical, physical and metabolic functions of different constituents of culture medium; role of carbon dioxide, serum and supplements.

UNIT-II

Serum and protein free defined media and their application, cell lines, measurement of viability and cytotoxicity; biology and characterization of the cultured cells, measuring parameters of growth; basic techniques of mammalian cell culture in vitro; disaggregation of tissue and primary culture, maintenance of cell culture; cell separation.

UNIT-III

Scaling up of animal cell culture- scale up in monolayer and suspension culture ,Stirred tank reactor, microcarriers , process control in scale up, cell synchronization-physical and chemical methods, cell cloning and micro-manipulation, cell transformation.

UNIT-IV

Application of animal cell cultures, stem cell cultures, embryonic stem cells and their applications, cell culture based vaccines, somatic cell genetics.

UNIT-V

Organ and histotypic culture, organotypic culture measurement of cell death, apoptosis, three dimensional culture and tissue engineering and its application in disease treatment.

Practicals

1. Preparation of tissue culture medium, and membrane filtration.
2. Demonstration and working of instruments in Animal biotechnology.
3. Cell counting and cell viability.
4. Trypsinization of monolayer and sub-culturing.
5. Cryopreservation and thawing.
6. Measurement of doubling time.
7. Role of serum in cell culture.
8. Isolation of DNA and demonstration of apoptosis of DNA laddering.
9. MTT assay for cell viability and growth.
10. Cell fusion with PEG.

Books

1. Culture of Animal Cells (3rd Edition), R. lan Freshmney. Wiley-Liss.
2. Animal Cell Culture-Practical Approach, (Ed) John R.W. Masters, Oxford.
3. Cell Growth and Division' A Practical Approach. (Ed.) R. Basega, IRL Press.
4. Cell Culture Lab Fax. (Eds). M. Buller & M. Dawson, Bios Scientific Publication Ltd. Oxford.
5. Animal Cell Culture Techniques. (Ed.) Martin Clynes, Springer.

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

## SECOND – SEMESTER

### Course No.V:Molecular Biology

UNIT-I

DNA Replication

DNA- structure and chemistry, DNA as a genetic material, DNA replication: prokaryotic and eukaryotic DNA replication, mechanics of DNA replication enzymes and accessory proteins involved in DNA replication.

UNIT-II

DNA Mutation and Repair

Mutation- physical and chemical mutagens, DNA repair – methyl directed mismatch repair, very short patch repair nucleotide and base excision repair, SOS system. DNA Recombination; holiday junction, FLP/FRT, Crelox recombination, Rec A and other recombination, Gene targetting and gene knockout.

UNIT-III

Transcription and modification in RNA/ protein; prokaryotic and eukaryotic transcription, RNA polymerases, general and specific transcription factors, regulatory elements and mechanisms of transcription regulation, 5- Cap formation transcription termination, 3' – end processing and polyadenylation, splicing, editing, stability and nuclear export of mRNA; post- transcriptional gene silencing. Translation; Protein localization; synthesis of secretary and membrane proteins.

UNIT-IV

Oncogenes and tumor suppressor genes: viral and cellular oncogenes, tumor suppressor genes from humans; structure function and mechanism of action of pRB and p53 tumor suppressor proteins. Antisense and ribozyme technology, molecular mechanism of anti-sense molecules, disruption of RNA structure. Biochemistry of ribozyme; hammerhead, hairpin and other ribozymes, strategies for designing ribozymes, applications of antisense and ribozyme technologies.

UNIT-V

Molecular mapping of genome: genetic and physical maps, physical mapping and map-based cloning. Southern and fluorescence in situ hybridization for genome analysis; chromosome micro-cloning; molecular markers in genome analysis: RFLP and RAPD analysis, application of RFLP in forensic, disease prognosis, genetic counseling, pedigree, varietal and germplasm maintenance. Genome sequencing and genomic libraries, YAC, BAC libraries, strategies for sequencing genome, packaging, transfection and recovery of clones.

Practicals

1. Instruments in Molecular biology.
2. Isolation of genomic & plasmid DNA.

3. Southern blotting
4. RFLP analysis
5. Isolation of RNA
6. Isolation of poly A+ RNA
7. Northern blotting
8. Preparation of probes
9. In vitro transcription
10. In vitro translation
11. Metabolic labeling of protein and immunoprecipitation

BOOKS

1. Molecular cloning : A Laboratory Manual , J. Sambrook ; Fritsch and T. Maniatis Cold Spring Harbor Laboratory Press, New York, 2000
2. Introduction to practical molecular biology P.D. Dabre, John Wiley & sons Ltd. New York 1988
3. Molecular Biology LabFax, T.A. Brown (Ed) Bios Scientific Publishers Ltd. Oxford,
4. Molecular Biology of the Gene ($4^{th}$ edition ), J.D. Watson N.H. Hopkins, J.W. Roberts J.A. Steitz and A.M. Weiner, The Benjamin/ Cummlngs Publ Co. Inc. California, 1987.
5. Molecular Cell Biology ($2^{nd}$ Edition) J. Darnell, H. Lodish and D. Baltimore, Scientist American Books, Inc., USA, 1994.
6. Molecular Biology of the Cell ($2^{nd}$ Edition) B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J. D. Watson, Garland Publishing, Inc., New York, 1994.
7. Gene VI ($6^{th}$ Edition) Benjamin Lewin, Oxford University press, U.K., 1998.
8. Molecular Biology and biotechnology; a comprehensive desk reference, R.A. Meyers (Ed.) VCH Publishers, Inc, New York, 1995
9. Genomes, T.S. Brown----

**Course No.VI:Macromolecules & Basic Enzymology**

UNIT-I

Physical techniques in protein, nucleic acids and polysaccharide's structural analysis - UV,IR, NMR, LASER Mass spectroscopy, fluorescence spectroscopy; differential colorimetry, X-ray crystallography, ultra centrifugation, electron cryo-microscopy; scanning and tunneling electron microscopy.

UNIT-II

Sequencing of proteins and nucleic acids, protein-protein and protein-ligand interactions (physical and chemical methods for their study); conformational properties of polynucleotides and polysaccharides-secondary and tertiary structural features and their analysis(theoretical and experimental); protein folding-biophysical and cellular aspects.

UNIT-III

Protein and nucleic acid databases: structural comparison at secondary and tertiary levels; enzyme catalysis in solution: kinetic and thermodynamic analysis, effects of organic solvents on enzyme catalysis and structural consequences; physical and chemical methods for immobilization of small and macromolecules.

UNIT-IV

Glyco and lipoproteins: structure and function; organization of macromolecular complexes: chromatin and ribosomes; protein denaturation. Macromolecules and supra molecular assemblies: types of macromolecules in biological systems, molecular assemblies like membranes, extra-cellular matrix.

UNIT-V

Nucleic acid hybridization: structural analysis and biological studies; ribozymes and catalytic antibodies; functional proteins: structure and drug targets (enzymes and receptors). Computer aided drug designing, computational techniques in structural analysis, nanoparticles.

PRACTICALS

1. Use of alginate for cell immobilization.
2. SDS-PAGE
3. Estimation of enzyme activity: Protease assay
4. Estimation of enzyme activity :Amylase assay.

5. Precieptation of enzymes by (PEG/Acetone )

**Course No. - VII: Biology of the Immune System**

UNIT-I

Introduction: phylogeny of immune system, innate and acquired immunity, clonal nature of immune response; organization and structure of lymphoid organs, nature and biology of antigens and super antigens.

UNIT-II

Antibody structure and function; antigen-antibody interactions; serological ractions like neutralization, precipitation, agglutination, complement fixation, immunodiffusion etc. Major histocompatibility complex, BCR & TCR, generation of diversity, complement system.

UNIT-III

Cells of the immune system; hematopoiesis and differentiation, lymphocyte trafficking. B-lymphocytes, T-lymphocytes, macrophages, dendritic cells, natural killer and lymphokine activated killer cells, eosinophils, neutrophils and mast cells.

Regulation of immune response: antigen processing and presentation, generation of humoral and cell mediated immune responses, activation of B-and T-lymphocytes, cytokines and their role in immune regulation; T-cell regulation, MHC restriction, immunological tolerance.

UNIT-IV

Cell- mediated cytotoxicity; mechanism of T cell and NK cell mediated lysis; antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity; hypersensitivity autoimmunity, transplantation.

UNIT- V

Immunity to infectious agents (intracellular parasites, helminthes & viruses); tumor immunology; AIDS and other immunodeficiences, hybridoma technology and monoclonal antibodies.

Practicals

1. Blood film preparation and identification of cells.
2. Lymphoid organs and their microscopic organization.
3. Immunization, collection of serum.
4. Double diffusion and immuno-electrophoresis.
5. Radial immuno-electrophoresis.

6. Purification of IgG from serum.
7. Western-blotting.
8. ELISA
9. Hapten conjugation and quantitation.
10. immunodiagnostics (demonstration using commercial kits).

Books

1. Kuby immunology, 4th Edition, R.A. Goldsby, Thomas J.Kindt, Barbara, A. Osbarne. (Freedom)
2. Immunology-A short Course, 4th Edition- Ell Benjamin, Richard Coico, Geoffrey Sunshine (Wiley-Liss).
3. Fundamentals of immunology, William Paul.
4. Immunology, Roitt and others.

**Course No.-VIII: Biostatistics & Computer Applications**

UNIT-I

Importance and scope of statistics in biochemical experimentation; Elements of Probability-Mathematical and Statistical definitions; Addition and Multiplication theorems; Probability Distribution Functions – Binomial, Poisson and Normal; Area under normal distribution curve.

UNIT-II

Measures of central tendency: Arithmetic, geometric & harmonic means; Measures of dispersion: range, quartile deviation, variance, standard deviation, coefficient of variation, confidence limits of population mean. Tests of significance hypotheses and errors; student t statistics- population mean equals a specified value; equality of 2 independent means ( equal & unequal variance), equality of 2 means ( paired samples).

UNIT-III

Analysis of variance: one-way analysis (sample sizes equal and unequal), completely randomized design; two-way analysis (one observation per cell), randomized block design; multiple comparisons: least significant difference, Duncan's new multiple range test.

UNIT-IV

Linear regression: regression diagram and equation, regression coefficient, standard error, significant tests, prediction of dependent variable from the independent variable; linear correlation- scatter diagram, correlation coefficient, standard error, significance tests; relationship between regression and correlation coefficients; Non parametric tests: Chi-square statistics, test of goodness of fit, test of independence of attributes; standard line interpolation.

UNIT-V

Introduction to Computers: Basic architecture, generations of computer hardware and software; operating systems-WINDOWS and UNIX; system and application software; introduction to internet-LAN, MAN, WAN, Concept of bioinformatics; application of bioinformatics in microbiology.

## THIRD SEMESTER

### Course No.-IX:Environmental Biotechnology

UNIT-I

Environment: Basic concepts and issues; environmental pollution: types and methods for the measurement; methodology of environmental management-problem solving approach, its limitations; air pollution and its control through biotechnology, air sampling techniques; biodiversity: conservation and management.

UNIT-II

Water pollution and its control: Water as a scarce natural resource, need for water management, sources and measurement of water pollution, waste water treatment-physical, chemical and biological treatment processes; algal blooms and human health.

UNIT-III

Microbiology of waste water treatment: Aerobic process-activated sludge, oxidation ditches, trickling filter, towers, rotating discs, rotating drums, oxidation ponds; anaerobic processes-anaerobic digestion, anaerobic filters, upflow anaerobic sludge blanket reactors; treatment schemes for waste waters of dairy, distillery, tannery industries; biotechnological application of microbes form extreme environment.

UNIT-IV

Microbial degradation of xenobiotics in the environment- ecological considerations, decay behaviour & degradative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides; bioaccumulation of metals and radio-nucleids and detoxification; bioremediation.

UNIT-V

Biological $N_2$ fixation, $H_2$ production, biofertilizers and biopesticides; solid wastes; sources and management (composting, vermiculture and methane production). Single cell protein (Spirulina, yeast, mushroom); global environmental problems-ozone depletion, UV-B green house effect and acid rain, their impact and biotechnology approaches for management.

Practicals

1. Detection of coliforms for determination of the purity of potable water.
2. Determination of dissolved oxygen concentration of water sample.
3. Determination of biological oxygen demand (BOD) of a sewage sample.
4. Determination of the efficiency of removal of air pollutant by using fibrous air filter/Air sampler.
5. Isolation of xenobiotic degrading bacteria by selective enrichment technique.
6. Test for the degradation of aromatic hydrocarbons by bacteria.
7. Survey of degradative of aromatic hydrocarbons by bacteria.
8. Estimation of nitrate, nitrite, and ammonium in drinking water.
9. To study the impact of heavy metals on growth & survival of microbes.
10. To study the impact of pesticides on the growth and survival of microbes.
11. To study the impact of salt and osmotic stress on the growth survival of microbes.
12. To study the biology of $N_2$- fixing microbes/SCP producing microbes.

Books

1. Wastewater Engineering- Treatment, disposal and Reuse. Metcalf and Eddy, Inc,.
2. Tata McGraw Hill, New Delhi.
3. Comprehensive Biotechnology. Vol. 4, M. Moo-young (Ed-in-chief), Pergamon Press, Oxford.
4. Environmental Chemistry, A.K. De. Wiley Eastern Ltd. New Delhi.
5. Introduction to Biodeterioration. D. Allsopp and K.J. Seal, ELBS/Edward Arnold

**Course No.-X: Genetic Engineering**

UNIT-I

Scope of genetic engineering, milestones in genetic engineering; isolation of enzymes, DNA sequencing, DNA mutations: detection and separations; cloning, gene expression; cloning and patenting of life forms; genetic engineering guidelines; molecular tools and their applications; restriction enzymes, modification enzymes, DNA and RNA markers; nucleic acid isolation and purification, yield analysis.

UNIT-II

Nucleic acid amplification and its applications; gene cloning vectors: plasmids, bacteriophages, phagemids, cosmids, artificial chromosomes; restriction mapping of DNA fragments and map construction; nucleic acid sequencing; cDNA synthesis and cloning; mRNA enrichment, reverse transcription, DNA primers, linkers, adaptors and their chemical synthesis; library construction and screening.

UNIT-III

Alternative strategies of gene cloning; cloning of interacting genes:two-and three hybrid systems, cloning of differentially expressed genes ;nucleic acid micro array; site-directed mutagenesis and protein engineering; gene regulation:DNA transfection; Northern blot; primer extension; S1 mapping; RNase protection assay; reporter assays.

UNIT-IV

Expression strategies for heterologous genes; vector engineering and codon optimization, host engineering; in vitro transcription and translation, expression of proteins in bacteria, yeast, insects, mammalian, and plant cells; processing of recombinant proteins: purification and refolding, characterization of recombinant proteins, stabilization of proteins; phage display.

UNIT-V

T-DNA and transposon tagging; role of gene tagging in gene analysis, identification and isolation of genes through T-DNA or transposon; transgenic and gene knockout technologies: targeted gene replacement, chromosome engineering; gene therapy; vector

engineering, strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing.

Practicals

1. Bacterial culture and antibiotic selection media.
2. Preparation of competent cells.
3. Isolation of plasmid DNA.
4. Isolation of Lambda Phage DNA.
5. Quantitation of nucleic acids.
6. Restriction mapping of DNA.
7. Construction of restriction map of plasmid DNA.
8. Cloning in plasmid/ phagemid vectors.
9. Preparation of helper phage and its titration.
10. Preparation of single stranded DNA template.
11. Gene expression in E.Coli and analysis of gene product.
12. PCR
13. 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, IRLPress, Oxford, 1995
Molecular and Cellular Methods in Biology and Medicine, P.B. Kaufman, W. Wu. D. Kim and L.J. Cseke, CRC Press, Florida, 1995.
3. Methods in Enzymology Vol. 152, Guide to Molecular Cloning Techniques, S.L. Berger and A.R. Kimmel, Academic Press, Inc. San Diego,1998.
4. Methods in Enzymology Vol.185 Gene Expression Technology, D.V. Goeddel, Academic Press, Inc. San Diego, 1990.
5. DNA Science. A First Course In Recombinant Technology, D.A. Mickloss and G.A. Freyer, Cold Spring Harbor Laboratory Press, New York,1990.
6. Molecular Biotechnology ($2^{nd}$ Edn.) S.B. Primrose, Blackwell Scientific Publishers, Oxford, 1994.
7. Milestones in Biotechnology, Classic Papers in Genetic Engineering, J.A. Davies and W.S. Reznikoff, Butterworth-Heinemann, Boston, 1992.
8. Route Maps in Gene Technology, M.R. Walker and R. Rapley, Blackwell Science Ltd. Oxford, 1997.
9. Genetic Engineering; An Introduction to gene analysis and exploitation in eukaryotes, S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford, 1998.
10. Molecular Biotechnology-Glick

**Course No. XI: Plant Biotechnology**

UNIT-I

Introduction to plant cell and tissue culture: tissue culture media (composition and preparation), initiation and maintenance of callus and suspension culture. Regeneration through organogenesis and somatic embryo genesis; transfer and establishment of whole plant in soil; embryo culture and embryo rescue; anther, pollen and ovary culture for production of haploid plants and homozygous diploid lines; cryopreservation for germplasm conservation; protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plant; symmetric and asymmetric cybrids; germplasm conservation, virus free plants.

UNIT-II

Cloning vector for higher plant transformation: Agrobacterium tumefaciens Ti and Ri plasmids, basis of tumor formation, hairy root, mechanisms of DNA transfer, role of virulence genes. Viral vectors and their application: direct gene transfer: particle bombardment, electro oration, microinjection: transformation of monocots; transgene stability and gene silencing, selection of clones. Expression of cloned genes: genetic markers, reporter genes, Gus assay.

UNIT-III

Application of plant transformation for productivity and performance: herbicide resistance (phosphnoinothricin, glyphosate, sulfonylurea, atrazine), insect resistance (Bt. endotoxin genes, Non-Bt like proteinase inhibitors alpha amylase inhibitor), virus resistance (Coat protein mediated protection (CPMP), nucleocapsid gene), disease resistance (anti fungal proteins chitinase, 1-3 beta glucanase, ribosome inactivating proteins (RIP), thionins, pathogenesis related (PR) proteins, nematode resistance, abiotic stress (salt tolerance); post harvest losses, long shelf life of fruits and flowers, use of ACC synthase. polygalacturanase. ACC oxidase, carbohydrate composition and concentration during storage. ADP glucose pyrophosphatase.

UNIT-IV

Chloroplast transformation: advantages, vectors, success with tobacco and potato; metabolic engineering and industrial products; plant secondary metabolites, control mechanism and manipulation of phenyl propanoid pathway, Shikimate pathway, alkaloids, industrial enzymes; biodegradable plastics. Polyhydroxybutyrate,

therapeutic proteins; lysosomal enzymes, antibodies, edible vaccines purification strategies, oleosin partitioning technology.

UNIT-V

Molecular marker- aided breeding RFLP maps. Linkage analysis. RAPD markers. STS, microsatellites, SCAR (sequence characterized amplified region), AFLP, QTL. Molecular assisted selection; arid and semi- arid plant biotechnology, green house and green- home 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.

BOOKS

1. J. Hammond, P. McGarvey and V. Yusibov (Eds.): Plant Biotechnology. Springer
Verlag, 2000
T, J. Fu, G. Singh and W.R. Curtis (Eds): Plant Cell and Tissue Culture for the Production of Food Ingredients. Kluwer Academic/Plenum Press. 1999.

2. H.S. Chawla: Biotechnology in Group Improvement, International Book Distributing Company. 1998.

3. R.J. Henry: Practical Application of Plant Molecular Biotechnology. Chapman and Hall. 1997.

4. P.K. Gupta Elements of Biotechnology. Rastogi and Co. Meerut. 1996.

**Course No. XII: Bioprocess Engineering and Technology**

UNIT-I

Biofermentation: designing and application, principles of biofermentation, monitoring and control of parameters (pH, oxygen, agitation, temperature, foam etc.), batch & continuous; production medium, raw materials, isolations; maintenance, preservation & improvement of industrial strains, computer control of fermentation processes.

UNIT-II

Downstream processing: Filtration of fermentation broths, ultra-centrifugation, recovery of biological products by distillation, superficial fluid extraction.

UNIT-III

Industrial production of solvents: Ethyl alcohol, citric and acetic acids; enzymes; amylases, proteases, cellulases; vitamins: vitamin $B_{12}$, vitamin C, antibiotics (penicillin, streptomycin, tetracycline and griseofulvin). Microbes in petroleum industry (oil recovery); immobilized cells & enzymes.

UNIT-IV

Microbiology of food: sources and types of microorganisms in food, food borne pathogens, microbiological examination of food, spoilage of food, food preservation, fermented foods, microbial proteins.

UNIT-V

Dairy microbiology: sources and types of microorganisms in milk, microbial examination of milk, pasteurization and phosphatase test, sterilization of milk, grades of milk, dairy products, fermented milk, butter & cheese.

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. Determination of growth curve of a supplied microorganism.
4. Comparative studies of ethanol production using different substrates.
5. Production and estimation of alkaline protease.
6. Use of alginate for cell immobilization.
7. Microbial production of Citric Acid using *Aspergillus niger.*
8. Microbial production of antibiotic (penicillin)
9. Sauer-Kraut fermentation

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: Fundamental and Application, 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 Billadsen, J. Plenum Press.
9. Chemical Engineering Problems is Biotechnology, Shuler, M.L. (Ed.) AICHE.
10. Biochemical Engineering, Lee, J.M. Prentice Hall Inc.
11. Bioprocess Engineering-kinetics, Mass Transport, Reactors and Gene Expression, Viet; W.F., John Wiley & Sons, Inc.