COURSES OF STUDIES

M.Sc. in Biotechnology

(2018-2020)

FAKIR MOHAN UNIVERSITY

Vyasa Vihar, Balasore-756020, Odisha

Department of Bioscience and Biotechnology

M. Sc. Biotechnology

1st Semester

BT-411	Cell Biology	4CH
BT-412	Microbiology	4CH
BT-413	Biomolecules & Enzymology	4CH
BT-414	Biostatistics & Computer Application	4CH
BT-415	Practical	8CH

2nd Semester

BT- 421	Genetics & Molecular Biology	4CH
BT- 422	Immunology	4CH
BT- 423	Environmental Biology & Biodiversity	4CH
BT- 424	Bio techniques & Instrumentation	4CH
BT- 425	Practical	8CH

3rd Semester

BT- 531	Animal Biotechnology	4CH
BT- 532	Genetic Engineering	4CH
BT- 533	Plant Biotechnology	4CH
BT- 534	Choice Base Credit Paper	4CH
BT- 535	Bioprocess Engineering & Technology	4CH
BT-536	Practical	4CH

*Non credit course on Fakir Mohan Studies

4th Semester

BT- 541	Journal paper Discussion and Seminar	8CH
BT- 542	Project Dissertation	8CH
BT- 543	Project Presentation & Grand Viva	8CH

First Semester

BT-411 **CELL BIOLOGY**
4CH

Unit-I: Diversity of cell, sizes & shapes, Cell theory, Structure of prokaryotic and eukaryotic cells, internal organization of the cell – Cell Wall, cell membranes: structure of cell membranes and concepts related to compartmentalization in eukaryotic cells; Transport of nutrients, ions and macromolecules across membranes, intracellular organelles: endoplasmic reticulum and Golgi apparatus, lysosomes and peroxisomes, ribosomes, cellular cytoskeleton, mitochondria, chloroplasts and cell energetics; nuclear compartment: nucleus, nucleolus and chromosomes, Cell motility – cilia, flagella of eukaryotes and prokaryotes.

Unit-II:Organization of genes and chromosomes, Chromatin organization, heterochromatin, euchromatin Operon, unique and repetitive DNA, Cell cycle-molecular events and model systems, Mitosis & Meiosis, Cellular energy transactions – role of mitochondria and chloroplasts, cell receptors and trans- membrane signalling, Cellular responses to environmental signals in plants and animals – mechanism of signal transduction,

Unit-III: Molecular mechanisms of membrane transport, nuclear transport, transport across mitochondria and chloroplasts; intracellular vesicular tra cking from endoplasmic reticulum through Golgi apparatus to lysosomes/cell exterior, intracellular protein traffic, Protein localization, synthesis of secretory and membrane protein, receptor mediated endocytosis.

Unit-IV: cell differentiation: stem cells, their differentiation into different cell types and organization into specialized tissues; Cellular basis of differentiation and development – gametogenesis and fertilization, Development in Drosophila and Arabidopsis.

Books

1. Cell Biology by De-Robertis Saunders, Singapore.
2. Reproduction in eukaryotic cells, Prescott DM, Academic Press.
3. Developmental Biology, Gilbert SF, Sinauer Assoc. Inc.
4. Cell in Development and Inheritance, Wilson EB, McMillan, New York.
5. Molecular Biology of Cells, Alberts B et al.
6. Molecular Cell Biology, Lodisch et al.
7. Fertilisation, Longo FT, Chapman Hall, London.

BT-412 MICROBIOLOGY 4 CH

Unit-I: Introductory Microbiology : History, Microbial evolution, modern approaches in taxonomy, ribotyping, ribosomal RNA sequencing; taxonomic nomenclature and Bergen's manual role of micro-organisms; sterilization techniques; principles of microbial nutrition; culture media for different micro organisms, culture collection and maintenance of cultures.

Unit-II: Microbial growth: mathematical expression of growth, growth curve, factors affecting growth, microbial nutrition. Metabolic diversity among micro-organisms, photosynthesis in micro-organisms, fermentations, nitrogen metabolism, nitrogen fixation, Chemotherapy/ Antibiotics: mode of action, resistance to antibiotics.

Unit-III: Diversity of Bacteria, mycoplasma, Archea as the earliest life forms, Eukarya, viruses, Microbial Diseases caused by bacteria and viruses and pathogenic fungi, emerging and resurgent infecticious diseases. Host-parasite relationship: microflora of skin; oral cavity; gastrointestinal tract; entry of pathogens into the host; genesis. Brief introduction to the life cycle and molecular biology of some important pathogens of AIDS, Malaria, Hepatitis and Tuberculosis.Microbial communication system; bacterial quorum sensing; microbial fuel cells; prebiotics and probiotics.

Unit-IV: Mutation and mutagenesis, Ames test; Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, Viruses and their genetic system: Phage and its life cycle, RNA phages, DNA viruses, RNA viruses, Replication of viruses, retro-viruses, prions and viroids, Genetic systems of yeast and Neurospora, Extrachromosomal inheritance.

Books

1. General Microbiology, Stainer, R.Y., Ingraham, J.L., Wheelis, M.L., and Painter, P.R. The McMillan Press Lte.
2. Brock Biology of Microorganisms, 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., Cronan, J.E.Jr., and Friefelder, D. Jones and Bartlett Publishers.
5. Microbiology, A Laboratory Manual, Cappuccion, J.G., and Sherman, N., Addison Wesley.
6. Microbiological Applications (A Laboratory Manual in General Microbiology), Benson, H.J., W.C.B., Wim C. Brown Publishers

BT-413 BIOMOLECULES AND ENZYMOLOGY 4CH

Unit-I: Chemical foundations of Biology: pH and buffers, Principles of thermodynamics, Heterocylcic compounds and secondary metabolites in living systems – nucleotides, pigments and isoprenoids, Analytical techniques in biophysics and biochemistry for small moleculaes and macromolecules for quantification.

Unit-II: Amino acids and peptides, Proteins – classification and separation, purification and criteria of homogeneity, end group analysis, hierarchy in structure and Ramchandran map, Lipids – classification, structure and functions. Sugars – classification and reactions. Polysaccharides – types, structural features, methods for compositional analysis.

Unit-III: Enzyme: Chemical nature, Nomenclature, Classification, Mechanism of enzyme catalysis, Activation energy, Enzyme specificity, Enzyme substrate interaction, factors affecting enzyme activity, Enzyme kinetics, Michaelis – Menton's Equation, Lineweaver – Burk plot, kinetics of multi-substrate reaction, Different types of enzyme inhibitions.

Unit-IV: Regulatory enzyme, covalent modulation and non-covalent modulation of regulatory enzyme, Aspartate transcarbmylase, glycogen phosphorylase, Models of enzyme catalysis, chymotrypsin, hexokinase, carbonic anhydrase, restriction enzyme, ribozymes, biochemistry of ribozyme; hammerhead, hairpin and other ribozymes, strategies for designing ribozymes, applications of ribozyme, isozymes.

Books

1. Essentials of Molecular Biology, David Friefilder, Jones and Bartlett Publications. Proteins – Structure and Molecular Properties, TE Creighton, WH Freeman and Company.
2. Genes VH, B. Lewin, Oxford University Press.
3. Introduction to Protein Structure, C. Branden and J. Tooze, Garland Publishing, New York.
4. Encyclopedia of Molecular Biology, J. Kendrew, Blackwell Scientific Publications, Oxford.
5. Physical Chemistry of Macromolecules, Tanford, C., John Wiley and Sons.
6. Introduction to Biophysical Chemistry, R.B. Martin, McGraw Hill, New York.
7. Biophysical Chemistry, Cantor, W.H. Freeman.
8. Protein Structure, Max Peruz.

BT- 414 BIOSTATISTICS AND COMPUTER APPLICATIONS 4CH

Unit-I: Brief description and tabulation of data and its graphical representation. Measure of central tendency and dispersion; mean, median, mode, range, standard deviation, variance. Idea of two types of errors and level of significance, tests of significance (F, Z and t-test); chi-square tests, Simple linear regression and correlation.

Unit-II: Introduction of digital computers; organizations; low-level and high level languages, the binary number system. Flow charts and programming techniques. Microsoft software (presentation software, word, excel).

Unit-III: Introduction to Bio-informatics and different tools, World Wide Web, Introduction to data structures and database concepts, NCBI, PubMed, Entrez databases, UniProt, SwissProt, database sequence searching from Nucleotide and protein databases-Blast and differnet types of blast, submitting DNA sequences to databases, Fasta format for sequence alignment, pair wise and multiple sequence alignment.

Unit-IV: application of Bioinformatics in phylogenetic relationships, protein structure prediction & engineering, Homology modelling and docking, Protein structure prediction, protein expression analysis and mapping, Data mining.

Books

1. Fundamentals of Biostatistics by Veer Bala Rastogi
2. Basic Biostatistics by G B N Chainy, P. K. Mohanty and G. Mishra
3. Fundamentals of Biostatistics by Bernard Roser
4. Misra, B.N. and M.K. Misra. 1983. Introductory Practical Biostatistics
5. Computer Fundamentals by Anita Goel
6. The C^{++} Programming language by Bjarne Stroustrup

BT-415 Practical 8CH

1. Microscopy
2. Microtomy.
3. Mitosis and meiosis.
4. Preparation of liquid and solid media for the growth of micro-organisms.
5. Isolation and maintenance of organisms by plating, streaking, and serial dilution methods, slants and stab cultures, storage of microorganisms.
6. Isolation of pure cultures of bacteria from soil and water.
7. Cryopreservation and thawing.
8. Growth; growth curve, measurement of bacterial populations by turbidometry and serial dilution methods. Effects of temperature, pH, carbon and nitrogen sources on growth.
9. Measurement of doubling time.
10. Microscopic examination of bacteria, yeast and moulds and study of organisms by Gram stain, acid fast stain and staining for spores.
11. Assay of antibiotics and demonstration of antibiotic resistance.
12. Biochemical characterization of selected microbes.
13. Determination of absorption maxima of bromophenol blue, potassium dichromate solution.
14. Validation of Beer-Lambert Law.
15. Quantitative estimation of Protein, Sugars, Lipids by spectrophotometer.
16. Quantitative estimation of Amino acids.
17. Determination of activity of different enzymes.
18. Preparation of Buffers.
19. Karyotyping
20. Practical related to Biostatistics and computer application.

Second Semester

BT- 421 GENETICS & MOLECULAR BIOLOGY

4CH

Unit-I: Introduction to Genetics. An overview on Mendelian & Non-Mendelian inheritance, Linkage & crossing over, sex linked inheritance, gene mapping (in *E.Coli* & *Drosophilae*), Mutation- types and significance, Structure & numerical variation in chromosomes, meiotic behaviour and genetic consequences in structural heterozygotes, Polygenic inheritance, multiple alleles, evidences of DNA as genetic material, Gene concept, and one gene-one polypeptide hypothesis.

Unit-II: Introduction to Molecular Biology, DNA Replication: Prokaryotic and Eukaryotic DNA replication, Transcription: Prokaryotic transcription, Eukaryotic transcription, RNA polymerase, General and specific transcription factors, mechanisms of transcription regulations, transcriptional and post-transcriptional modifications, gene silencing, Translation: Prokaryotic and Eukaryotic translation, the translation machinery, mechanisms of initiation, elongation and termination, regulation of translation, co-and post-translation modifications of proteins.

Unit-III: DNA repair and recombination, Homologous Recombination: Holiday junction, gene targeting, gene disruption, FLP / FRT and Cre/Lox combination, RecA and other recombinases, Oncogenes and Tumour Suppressor Genes: Viral and cellular oncognes, tumour suppressor genes humans, structure, function and mechanism of action of pRB and p53 tumour suppressor proteins.

Unit-IV: Antisense Technology, Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, applications of antisense, small non-coding RNAs (miRNAs and siRNAs).

Books

1. Molecular Biology LabFax, T.A. Brown (ed), Bios Scientific Publishers Ltd., Oxford, 1991.
2. 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 / Cummings Pub. Co. Inc., California, 1987.
3. Molecular Cell Biology (2^{nd} Edition), J. Darnell, H. Lodish and D. Baltimore, Scientific American Books Inc USA 1994.
4. 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.
5. Gene VI (6^{th} edition), Benjamin Lewin, Oxford University Press, U.K., 1988.
6. Molecular Biology and Biotechnology, A Comprehensive Desk Reference, R.A. Meyeres (ed.), VCH Publishers Inc., New York, 1995.
7. Genomes, T.S. Brown.

BT- 422 IMMUNOLOGY

4CH

Unit-I: Introduction, Phylogeny of immune system, Innate and acquired immunity, Clonal nature of immune response, Organization and structure of lymphoid organs, Cells of the immune system : Hematopoiesis and differentiation, lymphocyte trafficking, B-lymphocytes, T-lymphocytes, macrophages, dendritic cells, natural killer and lymphokine activated killer cells, eosinophil, neutrophils and mast cells.

Unit-II: Nature and biology of antigens and super antigens, Antibody structure and function, Antigen-antibody interactions, Major histocompatibility complex, BCR and TCR generation of diversity, Complement system. 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-III: Cell – mediated cytotoxicity: Mechnism of T cell and NK cell mediated lysis, antibody-dependent cell-mediated cytotoxicity, macrophage mediated cytotoxicity, Hypersensitivity, Autoimmunity.

Unit-IV: Transplantation, Immunity to infectious agents (intracellular parasites, helminthes and viruses), Tumour immunology, AIDS and other immune-deficiencies, Hybridoma technology and monoclonal antibodies.

Books

1. Kuby Immunology, 4th edition, R.A. Goldsby, Thomas J. Kindt, Barbara A. Osborne (Freeman).
2. Immunology, A Short Course, 4th Edition, Eli Benjamin, Rcchard Coico, Geoffrey Sunshine (Wiley-Liss).
3. Fundamentals of Immunology, William Paul.
4. Immunology by Roist and others.

BT- 423 ENVIRONMENTAL BIOLOGY & BIODIVERSITY 4CH

Unit-I: Ecology and Ecosystems: Ecological factors; temperature, Light, water, components of an ecosystem, Classification of ecosystems, Concept of limiting factor, Law of minimum, Functional attributes: Food chain, Trophic levels & Ecological pyramid concept: Pyramid of number, biomass & energy. Bio-geo-chemical cycles: Carbon cycle, nitrogen cycle, sulphur cycle, phosphorous cycle, Concept of Hydrosphere, Lithosphere and Atmosphere, Concept of stress and strain, Biological stress and strain.

Unit-II: Primary Production: Concept, Factors and methods for measuring primary production, Relationship between GPP & NPP, Primary productivity of different world sites. Secondary Production: Concept of secondary production and secondary productivity, maintenance cost, production-assimilation efficiency and secondary productivity. Relationship of secondary production to net primary production, Energy flow in Ecosystems :Concept of Energy, Energy source in Ecosystem, Laws governing energy transformation, concept of free energy, Enthalpy and Entropy, Energy flow in producers and consumers, Lindeman's Trophic-Dynamic concept, Ecological efficiencies, Energy flow models.

Unit-III: Concept of population and population attributes: Biotic potentiality and natality, mortality, survivorship curves, life table, age structure, population growth forms, concept of carrying capacity and environmental resistance, Life history strategies, r and k selection. Population fluctuation and population interaction: Extrinsic and intrinsic factors associated with population fluctuation, abiotic, biotic, density dependent and independent factors. Community: Concept of habitat and niche, types of niches; spatial, trophic and hypervolume niche; ecological equivalents, community organization, types of communities, community structure (analytical and synthetic), qualitative features of community (Composition, stratification, Physiognomy, dispersion, sociability,vitality etc), quantitative characteristics of community(frequency, density, cover dominance and diversity, important value index), Ecotone and edge effect. Community dynamics and succession: Ecological succession (Hydrosere, Lithosere and Xerosere)

Unit-IV: Biodiversity- Concept of Biodiversity (α, β, γ) Significant of biodiversity, Status of Biodiversity at global and National level. Biodiversity hot spots and megadiversity countries. Assessment of Biodiversity (Species Richness,dominance and Diversity Indices, Similarity index etc.). Principle of conservation of Biodiversity (*Ex Situ* and *In Situ*). Strategies for Biodiversity conservation and salient features of biodiversity Act.

BOOKS

1. Fundamentals of ecology by Prof. M.C. Dash
2. Concept of ecology by.Kormundy, 3. Ecology by O.P. Odum

BT- 424 BIO TECHNIQUES & INSTRUMENTATION 4CH

Unit-I pH measurements by method of pH indicators and potentiometric methods, Centrifugation Techniques: Principle and application of High speed centrifuges, Continuous flow centrifuge, Density gradient centrifuge, Analytical ultracentrifugation.

Unit-II Spectroscopic methods: The principle, instrumentation and application of the ultraviolet and visible spectrometry, Fluorescence Photometry, Infra-red-spectroscopy. Atomic Absorption Spectroscopy (AAS): The principle, differences, instrumentation and application of Flame emission spectroscopy and Absorption spectroscopy, Mass spectrometry for proteins & peptide analysis. MS data with specific protein sequences.

Unit-III Chromatography Techniques*:* The principle, experimental techniques, qualitative and quantitative analysis, applications of Adsorption Chromatography, Ion exchange chromatography, Paper chromatography, Thin layer chromatography (TLC), Gas liquid chromatography (GLC), High performance liquid chromatography (HPLC).

Unit-IV Electrophoresis Techniques*:* Principle, methods of measurement and applications of paper and cellulose Acetate electrophoresis, Thin layer Electrophoresis, Polyacrylamide Gel Electrophoresis (PAGE), Two dimensional gel electrophoresis for separation of total cellular proteins, and Agarose Gel Electrophoresis. Bomb Calorimetry: Principle, experimental arrangement and its application. Radioactivity and instruments for measurement of radiation such as Geiger–Müller counter & Liquid Scintillating counter.

BOOKS

i. Instrumental methods of analysis by Willard *et al*.
ii. Practical Biochemistry: Principles and Techniques by Wilson and Walker
iii. Principles and Techniques of Biochemistry and Molecular Biology By Wilson and Walker
iv. Laboratory Manual of Biotechnology by S. K. Bhatnagar and Deepika Abrol, S. Chand & Co.

BT- 425 **Practical** **8CH**

1. Isolation of genomic DNA
2. Preparation of metaphage chromosomes from cultured cells.
3. Demonstration of apoptosis of DNA laddering.
4. RFLP analysis
5. Isolation of RNA
6. Metabolic labeling of proteins and immunoprecipitation
7. Blood film preparation and identification of cells.
8. Lymphoid organs and their microscopic organization.
9. Immunization and collection of serum.
10. Double diffusion and immuno-electrophoresis.
11. Radial immuno diffusion
12. Purification of IgG from serum.
13. Separation of mononuclear cells by Ficoll-Hypaque.
14. Western-blotting
15. ELISA
16. Hapten conjugation and quantization.
17. Immunodiagnostics (demonstration using commercial kits).
18. Calculation of Important Value Index (IVI) of grassland ecosystem.
19. Determination of primary productivity
20. Homozygote and heterozygote determination by Hardy-Weinberg's equation.

Third Semester

BT-531 ANIMAL BIOTECHNOLOGY 4CH

Unit-I: Equipments and materials for animal cell culture technology, Primary and established cell line cultures, Introduction to the balanced salt solutions and simple growth medium, A 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, Measurement of viability and cytotoxicity, Biology and characterization of cultured cells, measuring parameters of growth.

Unit-II: Basic techniques of mammalian cell culture *in vitro*; disaggregation of tissue and primary culture; maintenance of cell culture; cell separation, Scaling-up of animal cell culture, Cell synchronization, Cell cloning and micromanipulation, Cell transformation.

Unit-III: Application of animal cell culture, Stem cell cultures, embryonic stem cells and their applications, Cell culture based vaccines.

Unit-IV: Somatic cell genetics, Organ and histotypic cultures, Measurement of cell death, Apoptosis, Three dimensional culture and tissue engineering.

Books

1. Culture of Animals Cells 3rd Edition, R. Ian Freshney, 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. Butler and M. Dawson, Bios Scientific Publications Ltd., Oxford.
5. Animal Cell Culture Techniques, eds, Martin Clynes, Springer.
6. Methods in Cell Biology, Vol.57, Animal Cell Culture Methods, eds., Jenni P. Mather and David Barnes, Academic Press.

BT – 532 GENETIC ENGINEERING
4CH

Unit- I: Scope of Genetic Engineering, Milestones in genetic engineering: patenting of life forms, genetic engineering guidelines, Molecular tools and their applications: Restriction enzymes, modification enzymes, DNA and RNA markers, Nucleic acid purification, yield analysis, Nucleic acid amplification and its applications, Gene-cloning vectors: Plasmids, bacteriophages, phagemids, cosmids and Preparation of ordered cosmid libraries, 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, Alternative strategies of gene cloning: Cloning interaction genes – two – and –three hybrid systems, cloning differentially expressed genes, DNA microarray, Protein microarrays. Advantage and disadvantage of DNA and protein microarrays.

Unit-II: Mapping of Genome: Genetic and physical maps, physical mapping and map-based cloning, choice of mapping population, simple sequence repeat loci, southern and fluorescence in situ hybridization for genome analysis, chromosome microdissection and microcloning, molecular markers in genome analysis: RFLP, RAPD and AFLP analysis, molecular markers linked to disease resistance genes, Application of RFLP in forensic, disease prognosis, genetic counseling, pedigree, varietal etc. Genome Sequencing: Genome sizes, organelle genomes, genomic libraries, YAC, BAC libraries, shotgun libraries and strategies for sequencing genome, packaging, transactions and recovery of clones, application of sequence information for identification of defective genes.

Unit-III: Site-directed mutagenesis and protein engineering, How to study gene regulation? DNA transactions, northern blot, primer extension, S1 mapping, Rnase protection assay, Reporter assay, Expression strategies for heterologous genes: Vector engineering and codon optimization, host engineering, *in vitro* transcription and translation, expression in bacteria, expression in yeast, expression in plants. Processing of recombinant proteins: Purification and refolding, characterization of recombinant proteins, stabilization of proteins, Phage display, T-DNA and Transposon tagging: Role of gene tagging in gene analysis, T-DNA and transposon tagging, identification and isolation of genes through T-DNA or transposon. Genome analysis for global patterns of gene expression using fluorescent-labelled cDNA or end-labelled RNA probes, Analysis of single nucleotide polymorphism using DNA chips.

Unit-IV: 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.

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.B. Kaufman, W.Wu.D. Kim and L.J. Cseke, CRC Press, Florida, 1995.

4. Methods in Enzymology, Guide to Molecular Cloning Techniques, Vol.152, S.L. Berger and A.R. Kimmel, Academic Press Inc., San Diego, 1996.

5. Methods in Enzymology, Vol.185.

6. Gene Expression Technology. D.V. Goeddel, Academic Press Inc. San Diego, 1990.

7. DNA Science : A First Course in Recombinant Technology, D.A. Mickloss and G.A. Freyer, Cold Spring Harbor Laboratory Pres, New York, 1990.

8. Molecular Biotechnology, 2nd edition, S.B. Primrose, Blackwell Scientific Publishers, Oxford, 1994.

9. Milestones in Biotechnology, Classic Papers on Genetic Engineering, J.A. Davies and W.S. Reznikoff, Butterworth-Heinemann, Boston, 1992.

10. Route Maps in Gene Technology, M.R. Walker and R. Rapley, Blackwell Science Ltd., Oxford, 1997.

11. Genetic Engineering : An Introduction to Gene Analysis and Exploitation in Eukaryotes, S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford, 1998.

12. Molecular Biotechnology-Glick.

BT-533 PLANT BIOTECHNOLOGY 4CH

Unit I: Conventional plant breeding, Introduction to cell and 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; somatic embryogenesis; transfer and establishment of whole plants in soil, Shoot-tip culture; Rapid clonal propagation and production of virus-free plants, Embyro culture and embryo rescue, Protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids, hybrids Biotransformation, Anther, pollen and ovary culture for production of haploid plants and homozygous lines, Cryopreservation, slow growth and DNA banking for germ plasm conservation.

Unit-II: Plant Transformation technology: The basis of tumour formation, hairy root, features of T1 and R1 plasmids, mechanisms of DNA transfer, role of virulence genes, use of T1 and R1 as vectors, binary vectors, use of 35S and other promoters, genetic markers, use of reporter genes, reporter gene with introns, use of scaffold attachment regions, methods of nuclear transformation, viral vector and their applications, multiple gene transfer, vectorless or direct DNA transfer, particle bombardment, electroporation, microinjection transformation of monocots, Transgene stability and

gene silencing, In planta transformation, Application of plant transformation for productivity and performance promoter trapping, activation tagging.

Unit-III: Herbicide resistance, phosphoinothricin, glyphosate, sufonyl urea, atrazine, isect resistance, Bt. Genes, non-Bt like protease inhibitors, alpha amylase inhibitor, virus resistance, coat protein mediated, nucleocapsid gene, disease resistance, chitinase, 1-3 beta glucanase, RIP antifungal proteins, thionines, PR proteins, nematode resistence abiotic stress post-harvest losses, long shelf life of fruits and flowers, use of ACC synthase, poly-galactrunase, ACC oxidase, male sterile lines, bar and barnase systems, carbohydrate composition and storage, ADP glucose pyrophosphatase, terminator gene technology, chloroplast transformation: Advantages, vectors, success with tobacco and potato.

Unit-IV: Metabolic engineering and industrial products : Plant secondary metabolities, control mechanisms and manipulation of phenylpropanoid pathway, shikimate pathway; alkaloids, industrial enzymes, biodegradable plastics, polyhydroxybutyrate, therapeutic proteins, lysosomal enzymes, antibodies, edible vaccines, purification strate-gies, oleosin partitioning technology, Molecular marker-aided breeding : RFLP maps, linkage analysis, RAPD markers, STS, microsatellites, SCAR (sequencie characterized amplified regions), SSCP (single strand conformational polymorphism), AFLP, QTL, map-based cloning, molecular marker-assisted selection, Arid and semi-arid plant biotechnology, Green house and Green-home technology.

Books

1. J. Hammound, P. McGarvey and V. Yusibov, eds, Plant Biotechnology; Springer Verlag, 2000.
2. 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.
3. H.S. Chawla, Biotechnology in Crop Improvement, International Book Distributing Company, 1998.
4. R.J. Henry, Practical Application of Plant Molecular Biology, Chanman and Hall, 1997.
5. P.K. Gupta, Elements of Biotechnology, Rastogi and Co., Meerut, 1996.

BT-535 BIOPROCESS ENGINEERING AND TECHNOLOGY 4CH

Unit-I: Introduction to bioprocess engineering, Bioreactors, Isolation, preservation and maintenance of industrial microorganisms, Kinetic of microbial growth and death.

Unit-II: Media for industrial fermentation, Air and media sterilization, Types of fermentation processes : Analysis of batch, fed-batch and continuous bioreactions, biotransformation, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photobioreactors etc.), Measurement and control of bioprocess parameters.

Unit-III: 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, effluent treatment: DOC and COD treatments and disposal of effluents, Enzyme and whole cell immobilization and their industrial applications.

Unit-IV: Industrial production of chemicals. Alcohol (ethanol), acids (citric, acetic and gluconic), solvents (glycerol, acetone, butanol), antibiotics (Penicillin, streptomycin, tetracycline), aminoacids (lysine, glutamic acid), single cell protein, Use of microbes in mineral beneficiation and oil recovery, Introduction of food technology, Elementary idea of canning and packing, Sterilization and pasteurization of food products, Technology of typical food/food products (bread, cheese, idli), Food preservation.

Books

1. Biochemical Engineering, Aiba, S., Humphrey, A.E. and Millis, N.F., University 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, Englewood Cliffs.
7. Principles of Fermentation Technology, Stanbury, P.F., Whitaker, A., Pergamon Press, Oxford.
8. Bioreaction Engineering Principles, Nielson, J. and Villadsen, J., Plenum Press.
9. Biochemical Engineering, Lee, J.M., Prentice Hall Inc.

BT-536 PRACTICAL 4CH

1. Preparation of tissue culture medium and membrane filtration,
2. Surface sterilization,
3. Organ culture

4. Callus propagation, organogenesis, transfer of plants 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. Cell fusion with PEG
10. Bacterial culture and antibiotic selection media.
11. Preparation of competent cells and Bacterial transformation.
12. Isolation of plasmid DNA.
13. Quantization of nucleic acids.
14. Agarose gel electrophoresis and restriction mapping of DNA.
15. Construction of restriction map of plasmic DNA.
16. PCR
17. Cloning in plasmid vectors.
18. Gene expression of *E. coli* and analysis of gene product.
19. Reporter gene assay (Gus/CAT/β-GAL)
20. Isolation of industrially important microorganisms for microbial processes.

Fourth Semester

BT- 541	Journal paper Discussion and Seminar	8CH
BT- 542	Project Dissertation	8CH
BT- 543	Project Presentation & Grand Viva	8CH