

COURSES OF STUDIES

M.Sc. in Biotechnology

(2020-2021)



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 & Bioinformatics	4CH
BT-415	Practical	8CH

2nd Semester

BT- 421	Genetics & Molecular Biology	4CH
BT- 422	Immunology	4CH
BT- 423	Bioprocess Engineering & Technology	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 (Fundamentals of Biotechnology)	4CH
BT- 535	Practical	8CH
	*Non credit course on Fakir Mohan Studies	

4th Semester

BT- 541	Journal paper Discussion and Seminar	8CH
BT- 542	Project Dissertation, Presentation & Grand Viva	16CH

First Semester

CELL BIOLOGY

BT-411

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; intracellular organelles: endoplasmic reticulum and Golgi apparatus, lysosomes and peroxisomes, ribosomes, cellular cytoskeleton; mitochondria, chloroplasts and Cellular energy transactions; 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 oncogenes, tumor suppressor genes: structure, function of action of pRB and tumor suppressor proteins; Programmed Cell Death

Unit-III: Transport of nutrients, ions and macromolecules across membranes, molecular mechanisms of membrane transport; transport across mitochondria and chloroplasts; nuclear transport; intracellular vesicular trafficking from endoplasmic reticulum through Golgi apparatus to lysosomes/cell exterior, intracellular protein trafficking, 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
8. Cell by GM Cooper.

Unit-I: Introductory Microbiology : History, Microbial evolution, modern approaches in taxonomy, ribotyping, ribosomal RNA sequencing; taxonomic nomenclature and Bergey'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 infectious 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 Ltd.
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
7. Prescott's Microbiology

Unit-I: Chemical foundations of Biology: pH and buffers, Principles of thermodynamics, Heterocyclic compounds and secondary metabolites in living systems – nucleotides, pigments and isoprenoids, Analytical techniques in biophysics and biochemistry for small molecules 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. Nucleotides- Structure and conformation of nucleic acids

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 transcarbamylase, 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 BIOINFORMATICS 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 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 different types of blast, submitting DNA sequences to databases, Fasta format for sequence alignment

Unit-III: Sequence analysis, pairwise alignment, dynamic programming algorithms for computing distance. Multiple sequence alignment, algorithms for multiple sequence alignment, generating motifs and profiles, local and global alignment, Needleman and Wunsch algorithm, Smith Waterman algorithm

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. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Andreas D. Baxevanis, B.F. Francis Ouellette (John Wiley and Sons)
6. Introduction to Bioinformatics by Arthur M. Lesk
7. Biostatistics: Basic concepts & methodology for Health Sciences, W.W.Daniel & C L Cross

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. Using NCBI and Introduction and use of various genome databases
21. Sequence information resource: using NCBI, EMBL, GenBank, Entrez, Swiss-Prot/TrEMBL, UniProt
22. Similarity search using tools like BLAST and interpretation of results
23. Multiple sequence alignment using ClustalX2
24. Phylogenetic analysis of protein and nucleotide sequences
25. Use of different protein structure prediction databases (PDB, SCOP, CATH)
26. Homology modelling of proteins
27. Demonstration of apoptosis of DNA laddering

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* & *Drosophila*), 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; DNA repair, Recombination: Homologous Recombination: Holiday Model, RecA and other recombinases, Site specific recombination: FLP / FRT and Cre/Lox combination.

Unit-III: Transcription: Prokaryotic transcription, Eukaryotic transcription, RNA polymerases, General and specific transcription factors, mechanisms of transcription regulations, transcriptional and post-transcriptional modifications, Translation: Prokaryotic and Eukaryotic translation, the translation machinery, mechanisms of initiation, elongation and termination, regulation of translation, co-and post-translational modifications of proteins.

Unit-IV: Signaling in metabolism, development and immunity: Signaling molecules and cell-surface receptors, G-protein coupled receptors, TGF- β and Smads, Cytokine receptors and JAK-STAT pathway, Receptor Tyrosine kinases and Ras, MAP kinase pathways, Toll and IMD pathway in innate immunity, Pathways that involve signal-induced protein cleavage, Phosphoinositides as signal transducers

BOOKS

1. Molecular Biology LabFax, T.A. Brown (ed), Bios Scientific Publishers Ltd., Oxford, 1991.
2. Molecular Biology of the Gene (4th 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 (2nd Edition), J. Darnell, H. Lodish and D. Baltimore, Scientific American Books Inc USA 1994.
4. Molecular Biology of the Cell (2nd edition), B. Alberts, D. Bray, J. Lewis, M. Raff. K. Roberts, and J.D. Watson, Garland Publishing Inc., New York, 1994.
5. Gene VI (6th 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.

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, B-lymphocytes, T-lymphocytes, macrophages, dendritic cells, natural killer and lymphokine activated killer cells, eosinophil, neutrophils and mast cells. Nature and biology of antigens: immunogens, haptens and super antigens.

Unit-II: Immunoglobulins: Basic structure and function, Hybridoma technology and monoclonal antibodies, Antigen-antibody interactions, Major histocompatibility Complex, Antigen processing and presentation, BCR and TCR generation of diversity. Regulation of immune response, generation of humoral and cell mediated immune responses, Activation of B and T – lymphocytes, T-cell regulation, MHC restriction, Immunological tolerance.

Unit-III: Cytokines and their role in immune regulation, Complement System, Cell - mediated cytotoxicity: Mechanism of T cell and NK cell mediated lysis, antibody-dependent cell-mediated cytotoxicity, macrophage mediated cytotoxicity, lymphocyte trafficking, Hypersensitivity.

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

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, Richard Coico, Geoffrey Sunshine (Wiley-Liss).
3. Fundamentals of Immunology, William Paul.
4. Immunology by Roitt and others.

Unit-I: Introduction to bioprocess engineering, Bioreactors, Types of specialized bioreactors (CSTR, Bubble Column, Airlift, Tower, fluidized, Packed Bed, photobioreactors etc.), Measurement and control of bioprocess parameters, stability of microbial reactors, Media for industrial fermentation, Air and media sterilization, Isolation, preservation and maintenance of industrial microorganisms, analysis of mixed microbial populations, Kinetic of microbial growth and death. Types of fermentation processes: Analysis of batch, fed-batch and continuous bioreactions, Solid State fermentation, biotransformation.

Unit-II: 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, Enzymatic Bioconversion, Enzyme and whole cell immobilization and their industrial applications.

Unit-III: 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.

Unit-IV: Metabolic Engineering of Microbes for production of industrial enzymes, Biofuel, Flavanoids, biodegradable plastics; Metabolic engineering of Plant Secondary metabolites (phenylpropanoid pathway, shikimate pathway); Metabolic engineering of Animal cells for production of therapeutic proteins, antibodies and vaccines.

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, Englewood 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.
10. Modern Industrial Microbiology and Biotechnology, Okafor, N, Science Publishers, New Hampshire 03748, USA.

11. Metabolic Engineering: Principles and Methodologies, Stephanopoulos, G.N; Aristidou, A.A and Nielsen,N., Academic Press.

BT-424 BIOTECHNIQUES & 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, biosensors, flow cytometry, fluorescent in situ hybridization (FISH)

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

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

1. Electrophoresis (Agarose & SDS)
2. Chromatography (Paper & TLC)
3. Isolation of genomic DNA
4. Preparation of metaphase chromosomes from cultured cells.
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. Immunodiagnosics (demonstration using commercial kits).
18. Isolation of industrially important microbes
19. Scale up from frozen vial to agar plate to shake flask culture.
20. Estmation of Specific growth rate (μ) from growth curve
21. Measurement of residual substrates.
22. Estimation of BOD
23. Isolation of Industrial enzyme from microbes and plants.

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, Somatic cell genetics, Organ and histotypic cultures, Cell culture based vaccines, Three dimensional culture and tissue engineering

Unit-IV: Animal Reproductive Biotechnology: structure of sperm and ovum; cryopreservation of sperms and ova of livestock, artificial insemination, super ovulation, embryo recovery and in vitro fertilization. Culture of embryos, cryopreservation of embryos, embryo transfer technology, transgenic manipulation of animal embryos, applications of transgenic animal technology,

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.

Unit- I: Scope of Genetic Engineering, Milestones in genetic engineering

Basic techniques in gene analysis: Restriction enzymes, modification enzymes, joining DNA molecules, bacterial transformation, gel electrophoresis, nucleic acid blotting, nucleic acid purification and yield analysis. Polymerase chain reaction: Primer designing, thermostable polymerases, PCR product purification and cloning (TA and T-blunt vector), variants of PCR, RT-PCR, Real-time PCR, Applications of PCR. Gene-cloning vectors: Plasmids, bacteriophages, phagemids, cosmids and Preparation of ordered cosmid libraries, artificial chromosomes. Cloning a gene: Genomic libraries, cDNA libraries, directional cDNA cloning, PCR-based libraries, subtraction libraries, library construction in post-genomics era. Alternative strategies of gene cloning: Cloning interaction genes one– two – and –three hybrid systems, screening for the clones by nucleic acid hybridization, Immunoscreening and function based screening, phage display.

Unit-II: Creating mutations: Primer-extension mutagenesis, strand selection methods, cassette mutagenesis, PCR-based mutagenesis, creating random mutations in specific genes, protein engineering. Expression strategies for heterologous genes: Expression vector design , codon optimization, host engineering, *in vitro* transcription and translation, expression in *E. coli*, expression in yeast, expression in insect cells, expression in higher-eukaryotic cells, Processing of recombinant proteins: Purification and refolding, characterization of recombinant proteins, stabilization of proteins.

Unit-III. Genome sequencing projects: Genomic mapping, genetic mapping, physical mapping, nucleotide sequencing (manual, automated, NGS including sequencing by synthesis and pyrosequencing), human genome project, finding genes in genomes, gene assignment and related bioinformatics.

Post-genome analysis: Global changes in gene expression (Differential display, Microarrays, ChIPs with everything), Transcriptomics, Proteomics, , genome-wide two hybrid screens, protein arrays

Transgenic technologies: Targeted gene replacement, chromosome engineering, antisense and RNA interference, knock-out analysis; Gene therapy: Vector engineering, Strategies of gene delivery, gene replacement / augmentation, gene correction, genome editing by CRISPER-CAS.

Unit-IV: Molecular markers in genome analysis: RFLP, RAPD, AFLP analysis, SSR, CAPS, SCAR, STS, SNP, molecular markers linked to disease resistance genes, Application of markers in forensic, disease prognosis, genetic counseling, pedigree, animal trafficking and poaching, germplasm maintenance, taxonomy and biodiversity. Biosafety regulations: Definition of GMOs and LMOs, role of institutional biosafety Committee, RCGM, GEAC for GMO application in food and agriculture, environmental release of GMOs, risk analysis and assessment, risk management and communication, international agreements and national regulation relating to GMO Intellectual Property Rights

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-Click.

Unit I: 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, Embryo 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, phosphinothricin, glyphosate, sulfonyl urea, atrazine, insect 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 resistance abiotic stress post-harvest losses, long shelf life of fruits and flowers, use of ACC synthase, poly-galacturonase, 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: Introduction to conventional plant breeding, Molecular marker-aided breeding and marker-assisted selection; QTL mapping: Choice of mapping population (Traits, phenotyping, Genetic diversity, population structure), Types of QTL mapping (Biparental and GWAS), linkage analysis and map construction; Fine mapping of QTLs; map-based cloning of QTLs; Application of mapped QTLs in marker-aided breeding programs. Arid and semi-arid plant biotechnology, Green house 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.

UNIT-I

Concept of Biology: Origin of life, cell (Prokaryotic and eukaryotic, unicellular and multi cellular) Cellular organisation, tissue, organ and organ system

UNIT-II

Genetics and Molecular Biology: Gene, Chromosome, DNA, RNA, Central Dogma, Molecules of life (Protein, Carbohydrate and lipids), Genetics-heredity, Mendel and Mendelian principles chromosomal aberration, common hereditary diseases.

UNIT-III

Applied Microbiology and Immunology: Microbial world and diseases caused by them (Plants and Animal), Immune system (Innate and Adaptive). Cells of immune system, Antigen and Antibody, autoimmune diseases, HIV, Vaccines.

UNIT-IV

Recent Advancement in Biosciences and Biotechnology: Genetic engineering, Application of Biotechnology in health and agriculture, Bt. Cotton, stem cells, gene therapy, GMO, synthetic cells, IPR, Bioethics.

BT-535

PRACTICAL

8CH

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, Presentation and Grand Viva	16CH