Course Structure of

M.Sc. Plant/Animal Biotechnology [from **Batch 2013** onwards]

Course Code	Semester / Course Title	Credits	
	Semester-I		
MCE-503*	Fundamentals of Nanotechnology [Deficiency Course]	3 (3-0-0)	
MAS-511*	Statistical Methods [Deficiency Course]	3 (2-0-1)	
CSIT-701	Computer Orientation	3 (2-0-1)	
MCE-701	Molecular Cell Biology	3 (2-0-1)	
BCBE-701	Biochemistry	3 (2-0-1)	
MCE-704	Environmental Biotechnology	3 (2-0-1)	
MBFT-720	General Microbiology	4 (3-0-1)	
MAS-815**	Experimental Design	3 (2-0-1)	**19**
	Semester-II		
MCE-702	Advanced Molecular Biology Techniques and Instrumentation	3 (2-0-1)	
MCE-703	Molecular Genetics	3 (2-0-1)	
CBBI-801	Bioinformatics	3 (2-0-1)	
MCE-804	Medical Biotechnology	3 (2-0-1)	
BCBT-813	Enzyme Technology	3 (2-0-1)	
MAS-815**	Experimental Design [*only for those who have studied MAS-511 during 1st Sem.*]	3 (2-0-1)	
MCE-780	Seminar-I	1 (0-0-1)	
MCE-899	Dissertation	4 (0-0-4)	**20**
	Semester-III [Specialization -Plant Biotechnology]		
CBBI-708	Biomolecular Modeling	3 (2-0-1)	
TE-801	Plant Tissue Culture Technology	3 (2-0-1)	
MCE-802	Plant Biotechnology	3 (3-0-0)	
MCE-805	Nanobiotechnology	3 (3-0-0)	
MCE-806	Genetic Engineering	3 (2-0-1)	
MBFT-814	Microbial Biotechnology	3 (2-0-1)	
MCE-880	Seminar-II	1 (0-0-1)	
MCE-899	Dissertation	4 (0-0-4)	**23**
	Semester-III [Specialization - Animal Biotechnology]		
CBBI-708	Biomolecular Modeling	3 (2-0-1)	
TE-802	Animal Tissue Culture Technology	3 (2-0-1)	
MCE-803	Animal Biotechnology	3 (3-0-0)	
MCE-805	Nanobiotechnology	3 (3-0-0)	
MCE-806	Genetic Engineering	3 (2-0-1)	
MBFT-814	Microbial Biotechnology	3 (2-0-1)	
MCE-880	Seminar-II	1 (0-0-1)	
MCE-899	Dissertation	4 (0-0-4)	**23**
	Semester-IV		
MCE-899	Dissertation	22 (0-0-22)	
	Total Credits	**84**	

* Deficiency Courses

** **Note**: The students who have not opted any course in Statistics in their UG program will study the deficiency course, MAS-511: Statistical Methods instead of MAS-815: Experimental Design in the 1st Semester and they will Study the advanced course (i.e., MAS-815: Experimental Design) during their 2nd Semester

SEMESTER - I

MCE-503 : Fundamentals of Nanotechnology 3 (3-0-0)

Unit 1: Introduction: Overview, history and background, importance of nanotechnology in modern science.

Unit 2: Analyzing tools: Overview of modern microscopic tools like SEM, TEM, STM, AFM, Confocal Microscopy. Overview of types of Spectroscopies like UV-Vis, IR, Raman spectroscopy. X-Ray Crystallography.

Unit 3: Nanomaterial Synthesis: Basic physics and chemistry of nanomaterials. Types of synthetic routes, Top-down and Bottom-up techniques.

Unit 4: Nanomaterial Applications: Application of nanomaterials in the field of electronics, composites, catalysis, ceramics. Uses in biosensors, drug delivery, gene therapy.

Unit 5: Safety aspects: Nanoparticle related Health and safety issues, ethical, legal and social implications, environmental issues.

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MAS-511 : Statistical Methods 3 (2-0-1)

Definition and Scope of Statistics: Source of Animal Husbandry and Dairy Statistics.
Method of condensation of data, frequency distribution.
Measures of central-tendency, Measures of dispersion, Moments, skewness and kurtosis.
Elementary notions of Probability, laws of addition and multiplication of probability.
Theoretical frequency distributions.
Binomial- frequency distributions and its applications.
Poisson- frequency distributions and its applications.
Normal- frequency distributions and its applications.
Concept of Sampling. Simple Random Sampling (with and without replacement).
Introduction to testing of Hypothesis and tests of significance. Z and t test for one and Two sample problems. Chi square test for independence of attributes and Goodness of fit.
Simple correlation coefficient and its significance. Line-Regression and Rank-Correlation.

Practical:
1. Formation of frequency distribution and Graphical representation.
2. Measures of central-tendency.
3. Measures of dispersion.
4. Applications of Z- test for one and two sample problems.
5. Applications of T-test for one and two sample problems.

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CSIT-701 : Computer Orientation 3 (2-0-1)

1. Information Concepts.
2. Computer Basics: Definition, Characteristics and Application of Computers; Computer Hardware: I/O Devices, Memory, CPU; Software Concepts.
3. Operating System: DOS; Windows.
4. Application Software: MS Word; MS Excel.
5. Computer Programming: Algorithm and Flowchart; Introduction to 'C' Language; History; Input and Output Statements; Variables and Constants; Expressions and

Operators; Control Statements; Branching Statements (if, if- else, Nested if); Looping Statements (while, do-while, for); Functions and Arrays.

6. Internet Concepts and Search Engine.

7. Application of statistical packages.

Reference Books:

J.B. Dixit, "Fundamentals of Computers and Programming in 'C' ",
Laxmi Publications (P) Ltd.

Yashavant Kanetikar, "Let us C", BPH Publications.

E. Balaguruswamy, "ANSI C", TMH.

PRACTICAL LIST

1. Demo session on computer and its components, I/O devices, Memory, CPU.

2. MS DOS:

Internal DOS Commands: md, cd, dir, time, del, type, edit, copy, exit, path, prompt, rem, ren, ver.

External DOS Commands: attrib, backup, chkdsk, diskcomp, diskcopy, doskey, format, label, xcopy, move, tree, undelete.

3. Windows:

Login, Desktop, Icons and Folders, Taskbar, Changing Desktop properties, Mycomputer, My Network places, Recycle bin, My Documents, Control panel.

4. Application Software:

MS Word: Getting familiar with various tool bars, Tables and Columns, Mail merge.

MS Excel: Working with Spreadsheets, Mathematical & Statistical functions, Generating Charts,

Creating Macros.

5. C Programming :

- Programs illustrating use of printf() and scanf() statements.
- Practicing with decision making statements like IF, IF-ELSE, Nested IF, ELSE-IF Ladder, Switch, Goto.
- Working with loops.
- Illustration of Arrays.
- Designing programs to demonstrate concept of functions.

6. Internet: Webpage, website, browser, URL, Surfing, Searching, creating mail accounts.

7. A glance over statistical packages like SPSS, MATLAB etc.

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MCE-701 : Molecular Cell Biology 3 (2-0-1)

Unit 1. Macromolecules: Biochemical and molecular aspects of living cells, Carbohydrates, Proteins and Nucleic acids. Cell fractionation procedure.

Unit 2. Cell organelles: Molecular organization of cell organelles (structure and function), cell wall, plasma membrane (various models), endoplasmic reticulum, mitochondria, chloroplast, nucleus, etc.

Unit 3. Cytoskeleton and Extra Cellular Matrix: Microtubules, intermediate filaments and micro filaments. ECM- definition, significance and biomolecules involved in ECM.

Unit 4. Cell growth and division: Cell cycle, mitosis, meiosis, DNA replication, apoptosis, cancer.

Unit 5. Cell signaling and cell- cell interactions: signal transduction, endocrine, paracrine and autocrine signalling, surface receptor mediated transduction, chemistry and function of signaling molecules.

Practical:
Mitosis of Onion Root Tips.
Tissue Types in Dicot Stem.
Tissue Types in Monocot Stem.
Tissue Types in Dicot Root.
Tissue Types in Monocot Root.
Gram Staining of Bacteria.

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BCBE-701 : Biochemistry 3 (2-0-1)

Bioenergetics: Energy and its transformation in living system, thermodynamic principle, introduction to metabolism, methods to study metabolism, high energy compounds.

Carbohydrate metabolism: Introduction, digestion, absorption, glycolysis, HMP, gluconeogenesis, glyoxalate pathway, glycogenolysis, energy aspects and its regulation. Glycogenesis, starch biosynthesis, citric acid cycle, energy aspects and importance.

Lipid metabolism: Introduction, digestion and absorption, TAG, phospholipids, sphingolipids, glycerolipids, biosynthesis. Fatty acid oxidation: importance and regulation. Fatty acid biosynthesis, importance and regulation. Cholesterol biosynthesis: pathway, importance and regulation.

Aminoacid metabolism: Introduction, digestion and absorption, amino acid degradation reactions, urea cycle, linking to TCA cycle. Biosynthesis of essential and non-essential aminoacids, regulation and importance.

Nucleotide metabolism: Introduction, *de novo* and salvage pathways of pyrimidine and purine. Nucleotide synthesis and catabolism and importance and regulation.

Oxidative phosphorylation: Introduction, ETS, ATP formation, importance and regulation.

Practical:
Estimation of lactic acid from milk.
Determination of protein in milk.
Determination of fat from milk.
Determination of lactose from milk.
Determination of acid number of oil.
Determination of saponification number of oil.
Extraction and estimation of starch from potato.
Estimation of protein from unknown biological sample.

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MCE-704 : Environmental Biotechnology 3 (2-0-1)

Unit 1. Sampling and analysis techniques of waste water, solid waste and their disposal, environmental quality standards and indices.

Unit 2. Measurement of the level of pollution- BOD, COD, suspended solids, ammoniacal nitrogen, phosphates, biological indicators.

Unit 3. The process of aerobic waste water treatment, preliminary treatment, primary, secondary treatment, tertiary treatment, sludge treatment, anaerobic waste water treatment.

Unit 4. Landfill, hazards of landfill, uses of landfill sites, trench method, cell emplacement method.

Unit 5. Biodegradation of xenobiotic compounds, general features, hydrocarbon degradation of halogenated compounds, contribution of biotechnology in waste treatment and environmental management.

Practical:
Determination of dissolved oxygen of sewage water
Determination of biological oxygen demand of sewage water
Determination of chemical oxygen demand of the given water sample
Determination of total dissolved solids of water
Study on the inhibitory effect of various environmental temperature on microbial growth

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MBFT-720 : General Microbiology 4 (3-0-1)

History and scope of Microbiology.

General characteristics, classification, morphology, growth and reproduction of Bacteria, Mycoplasma, Chlamydia, Rickettsiae, and Actinomycetes.

General characteristics, classification, morphology and reproduction of Fungi, Algae, Protozoa

Control of microorganisms by Physical agents and Chemical agents.

Practical:
Familiarity with equipment and apparatus used in Microbiology.
Methods of isolation, purification and maintenance of microorganisms.
Staining techniques (Simple, Differential, Special) in bacteria.
Preparation of media and reagents and their sterilization.
Study of cultural and morphological characteristics of important groups of: Fungi, Algae, Protozoa.
Effect of physical agents (viz., temperature, osmotic pressure, UV radiation etc.) on microorganisms.
Effect of chemicals (viz., alcohol, phenol, halogens, heavy metals etc.) on microorganisms.

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MAS-815: Experimental Design 3 (2-0-1)

Analysis of variance technique: Definition and assumptions, One way classification, Two way classification with more than one observation per cell.

Sampling Techniques: Simple Random Sampling, Stratified Random Sampling and Systematic sampling.

Designs of Experiments: Principles of Experimental Design, Randomized Block Design (R.B.D.), Latin Square Designs (L.S.D.), CRD, Missing Plot Technique in R.B.D. and L.S.D. Critical difference (C.D.), Split plot design, Balanced incomplete Block design.

Factorial Experiments: 2^2, 2^3, 3^2, 3^3, 3^3 factorial-designs (Yates method of Analysis), 2 x3 and 2 x 4 factorials. Durcan's Multiple Range Test. Newman's Kuel's Test.

Practical: Analysis of Variance, Randomised Block Design, Latin Squre Design, Factorial design (2^2, 2^3, 3^2,3^3 factorials).

Books:

1. Fundamentals of Applied Statistics (Volume II:-Gupta and Kapoor).
2. Agricultural Statistics: (S.R.S. Chandel).

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SEMESTER - II

MCE-702 : Advanced Molecular Biology Techniques and Instrumentation 3 (2-0-1)

Unit l. Molecular biology techniques: Isolation and purification of DNA, RNA and Plasmids. DNA fingerprinting, polymerase chain reaction (PCR), Southern blotting, Northern blotting, dot blot and slot blot. DNA sequencing techniques.

Unit 2. Chromatographic techniques: Principles, instrumentation and applications of adsorption, partition, exclusion, ion exchange, affinity, column chromatography, chromatofocussing, TLC, HPLC, FPLC and GLC.

Unit 3. Electrophoretic techniques: Principles, instrumentation and applications of gel electrophoresis (AGE and PAGE), Pulse field gel electrophoresis (PFGE).

Unit 4. Centrifugation techniques: Principles, instrumentation and applications of differential, zonal, density gradient and ultra centrifugations.

Unit 5. Principles, instrumentation and applications- of colorimetry, spectrophotometry, atomic absorption photometry, mass spectroscopy. Detection and measurement of radioactive isotopes (GM counter and Scintillation counter), autoradiography.

Practical:

Estimation of chlorophyll pigments using colorimetry
Separation of cell organelles by centrifugation
Separation of nucleic acids by agarose gel electrophoresis
Qualitative and quantitative determination of DNA by UV spectroscopy.
Study of pipetting techniques.

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MCE-703 : Molecular Genetics 3 (2-0-1)

Unit 1. Gene concept and Gene analysis: The gene and gene concept, cistron as a unit of genetic function. Prokaryotic genome, eukaryotic genome, viral genome, genetic code, central dogma including reverse transcription.

Unit 2. Transcription: Enzymatic synthesis of RNA, classes of RNA molecules, mechanism of transcription in prokaryotes and eukaryotes- RNA polymerases, promoter sequences for RNA polymerases, enhancers and silencers, transcription factors and initiation of transcription, basal transcription apparatus, elongation and termination of transcription. Post transcriptional modifications (mRNA processing reactions- 5′ capping, polyadenylation, splicing).

Unit 3. Translation: Introduction to protein synthesis (ribosomes, codon-anticodon interaction). Protein synthesis in prokaryotes and eukaryotes. Translational factors and their functions. Initiation, elongation and termination phases of translation. Comparison of protein synthesis in prokaryotes and eukaryotes. Post translational modification of

proteins (protein folding and protein trafficking). Antibiotics as inhibitors of protein synthesis.

Unit 4. Gene regulation: Gene regulation in prokaryotes, transcriptional control (lac operon model, catabolite repression, tryptophan operon model). Regulation of gene expression in eukaryotes (transcriptional and translational controls). Gene regulation in plant cells.

Unit 5. Mutation: Study of mutation at molecular level. Types of mutation (gene mutation and chromosomal abberations); Molecular basis of gene mutation, tautomeric shifts and abnormal base pairing (transitions and transversions); Frame shift mutations (deletions or additions); Mutagenesis, physical and chemical mutagenic agents; DNA damage and DNA repair mechanisms.

Practical:
1. Estimation of DNA by Diphenylamine Method
2. Screening of auxotrophic mutants in *E. coli*
3. Study of UV induced mutagenesis in bacteria
4. Quantification of microbial growth
5. Study of thermal death kinetics

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CBBI-801 : Bioinformatics 3 (2-0-1)

Introduction to Bioinformatics, philosophical, directional and application oriented background of bioinformatics.

HGP- influence area in bioinformatics, application in different industries, and its Indian scenario as a business, problem and future aspects.

Information network- Internet, web browser and address (NCBI, EBI etc.)

Databases- information resources for proteins and genomics.

SRS, Algorithms, alignment.

Phylogenetic analysis: Fundamental of phylogenetic model, tree interpretation- paralogues and orthologues, tree building and tree evaluation, phylogenetic software.

Comparative genome analysis: introduction, application, genome analysis and annotation.

Molecular structure prediction and visualization (X-ray crystallography, NMR, Bioinformatics).

Microarray data analysis.

Different analysis packages and other miscellaneous tools etc.

Practical:
1. Understanding Linux Operating System and Commands.
2. Introduction to NCBI.
3. Using Entrez to search Literature Databases.

4. Retrieving DNA sequence from GenBank and analyzing various formats of the data stored.
5. Retrieving Protein sequence from GenPept (NCBI) and Expasy.
6. Analyzing Protein Sequences.
7. Analyzing DNA sequence.
8. Sequence alignment using BLAST (Basic Local Alignment Search Tool).
9. Sequence alignment using FASTA.
10. Multiple sequence alignment using ClustalW.
11. Introduction to the structure database PDB.
12. Visualization of the protein structure using VMD.
13. Secondary structure prediction using GOR algorithm

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MCE-804 : Medical Biotechnology 3 (2-0-1)

Unit 1. Introduction: History and scope of medical biotechnology, current status and future prospects.

Unit 2. Disease diagnostics and Immunotechnology: Detection of genetic diseases. Molecular Diagnosis- genetic markers, DNA diagnostics, PCR based diagnostics, array-based diagnostics and nucleotide polymorphisms. Antigen-antibody interaction-complement fixation, agglutination, immunoelectrophoresis, immunofluorescence, enzyme-linked immunosorbant assay (ELISA) and radioimmunoassay (RIA).

Unit 3. Monoclonal antibodies: Hybridoma technology and monoclonal antibody production, applications of monoclonal antibody.

Unit 4. Drug development and gene therapy: Molecular drug designing- disease targets, methods of drug delivery, designing of drug delivery system for biotechnological products; Mode of action of antibiotics and antivirals; molecular mechanism of drug resistance (MDR). Germ line gene therapy, Somatic gene therapy, cellular targets for somatic gene therapy, gene targeting and delivery.

Unit 5. Animal health care and biotechnology: Methods of immunization, preparation of vaccines, type of vaccines, DNA vaccines, Viral vaccines (conventional: killed/attenuated) peptide vaccines and recombinant proteins.

Unit 6. Applications of gene profiling, microarray techniques and DNA fingerprinting in medical science. Stem cell technology and their potential applications.

Practical:
Determination of Blood groups.
Agglutination Test - The Widal Test.
Determination of Blood Glucose by Hagedorn- Jenson method.
Identification of pathogen using double diffusion method of Antigens and Antobodies
Isolation and characterization of bacterial pathogens from provided samples.
In-silico drug designing; enzyme and inhibitor action and docking protocol.

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BCBT-813 : Enzyme Technology 3 (2-0-1)

Unit 1: Introduction of enzymes: General properties and significance, classification and nomenclature. Terms and definition in enzymology, co-factors, coenzymes, active site concept, isoenzymes, allosteric enzymes, marker enzymes, multienzyme complex, ribozyme, abzyme, synzyme, extremozyme, therapeutic enzymes and immobilized enzymes etc.

Unit 2: Enzyme kinetics:steady rate kinetics, Derivation of Michaelis-menten equation using steady state/equilibrium kinetics, plots of lineweaver- Bruke, Hanes, Eadie- Hofster etc. Mechanism of bisubstrate and multisubstrate enzyme catalyzed reaction, Enzyme inhibitors, mechanism of enzyme action-lysozyme, chymotrypsin, alcohol DH.

Unit 3: Regulation of enzyme activity: Covalent modification, allosteric model concerted and sequential, cooperativity. Feedback inhibition.

Unit 4: Enzyme Technology: Commercial production of enzymes, immobilization of enzymes, example of enzyme engineering, application of enzyme (therapeutic uses, analytical uses, manipulated uses etc.), uses of enzyme reactors.

Unit 5: Isolation, purification and localization of enzymes. Various methods to estimate the enzyme activity.

Practical:

1. Effect of temperature, pH, substrate concentration and enzyme concentration and enzyme concentration on enzyme activity.
2. Action of salivary amylase on starch.
3. Determination of acid posphatase activity in sample.
4. Determination of alkaline phosphatase activity in sample.
5. Determination of SGOTin serum.
6. Determination of SGPT in serum.
7. Determination of urease in plant sample.
8. Assay of protein by lowry method.
9. Assay of catalase in vegetables.
10. Hydrolysis of egg protein by pepsin.

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Semester-III

CBBI-708 : Biomolecular Modeling 3 (2-0-1)

Unit 1. Concepts of Molecular Modeling, Simulation of molecular mechanics and dynamics, Empirical representation of molecular energies, Simulations of Free Energy changes, Force fields, Use of Force Fields. A Energy minimization of small molecules, Local and global energy minima. Molecular Mechanics methods, Techniques in Molecular Dynamics, Monte Carlo Simulation for conformational analysis and semi-empirical methods, Application of molecular graphics.

Unit 2. Methods for Prediction of Secondary and Tertiary structures of Proteins - Knowledge-based structure prediction, Principles of Protein Folding, Fold recognition, Methods for comparison of 3D structures of proteins; Methods to predict three dimensional structures of nucleic acids.

Unit 3. Analysis of structures and correctness of structures, Submission of data to PDB: atomic coordinates and electron density maps; Anatomy of Proteins - Ramachandran plot. Evaluation of stereo-chemical properties of protein structures.

Unit 4. Internal and external co-ordinate system; Generation of co-ordinates of biopolymers in Cartesian and cylindrical polar co-ordinate system; Methods of single crystal X-ray diffraction of macromolecules: molecular replacement method and direct method - Fiber diffraction. Structural data banks - Protein Data Bank, Cambridge small molecular crystal structure data bank.

Practical:

1. Introduction to the structure database PDB.
2. Visualization of the protein structure using VMD.

3. Secondary structure prediction using GOR algorithm.
4. Tertiary structure prediction using SWISS-MODEL, ModWeb and Geno3D.
5. Homology modeling of a protein by using the MODELLER software.
6. Protein Structure validation using SAVS server.
7. Protein active site prediction using CastP and Pocket Finder.
8. Automated docking using PATCH DOCK webserver.
9. Structural alignment using DaliLite and SSAP.

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TE-801 : Plant Tissue Culture Technology 3 (2-0-1)

Unit 1: **Introduction to plant tissue culture:** Historical developments and landmarks in Plant Tissue Culture. Organization of tissue culture laboratory, aseptic techniques, media formulation, clonal propagation vs tissue culture, Totipotency: growth, differentiation and morphogenesis in tissue culture.

Unit 2: Micropropagation: Concept, various stages, organogenesis and somatic embryogenesis. Meristem culture: Meristem culture for mass and clonal propagation, production of pathogen free plants, application in forestry.

Unit 3: **Somatic hybridization**: Isolation, purification and culture of protoplasts, protoplast fusion and somatic hybridization, identification and characterization of somatic hybrids / cybrids, its applications.

Unit 4: Secondary metabolites: Production of secondary metabolites by plant cell culture, hairy root culture, biotransformation.

Unit 5: Cell Lines: Cell line selection for resistance to herbicide, stress, insect and diseases

Unit 6: Haploid culture: Tissue culture methods for haploid production and its applications

Practical:
Media preparation.
Explant selection, sterilization and inoculation.
Callus and cell suspension culture: Induction and growth parameters.
Androgenesis: Anther and Pollen culture.
Plant regeneration from embryo, meristem and callus culture.
Synthetic seed preparation.

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TE-802 : Animal Tissue Culture Technology 3 (2-0-1)

Unit 1. Biology of cells in culture: Origin and characterization of different cell types, Subculture, selection of medium, Chemically defined and serum free media, Development of serum free media Advantages and disadvantages of serum free media

Unit 2. Cultured cells-Biology and characterization: Characteristics of cultured cells, Cell bank, Measurement of growth parameters of cultured cells, Cell adhesion, Cell proliferation and differentiation, Identification of specific cell lines

Unit 3. Genetic engineering of mammalian cells: Mammalian cell lines, Mammalian cell expression system, Gene transfer techniques in mammalian cells, Sexing of embryos, Somatic cell nuclear transfer and transgenic animals.

Unit 4. Hybridomas and cell transformation: The basis of hybridoma technology, Storage of hybridoma cells, Monoclonal antibodies and their commercial production, Commercial production of monoclonal antibodies and their use for mankind.

Practical:
Maintenance of Animal Cell Culture Laboratory.
To develop cell lines from egg embryo.
Maintenance of cell lines and to check their viability by Haemocytometer.
To check percent cell viability by MTT assay.
To check the effect of Pesticides on Cell lines.

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MCE-802 : Plant Biotechnology 3 (2-0-1)

Unit 1. Plant genome, nuclear genome, chloroplast genome and mitochondrial genome.

Unit 2. Genetic engineering in plants: Biology of *agrobacterium tumefaciens*, techniques of transferring agronomically important genes using Ti plasmid, protoplast fusion method; methods of direct gene transfer; transfer and expression of cloned DNA in plant cells.

Unit 3. Improving nutritional value of seed storage protein, application of biotechnology in crop improvement, genetic engineering of plants for delay of fruit ripening, herbicides tolerance, salt resistance; virus and pest resistance, role of monoclonal antibodies in agriculture.

Unit 4. Biofertilizers, classification of biofertilizers and importance of Biofertilizers, nif genes; algal biofertilizer, azolla biofertilizer, vesicular and abruscular mycorrhizae.

Unit 5. Biological control, types of biological control, biocontrol agents, microorganisms, viruses, protozoans, production of microbial insecticides.

Practical:
Study of pipetman use and pipetting techniques
Study of labware used for DNA isolation and PCR
Sterilization of glassware, labware and double distilled water for PCR analysis.
Preparation of buffers, reagents and media required for PCR and analysis and its sterilization.
Isolation of plant Genomic DNA using CTAB method and purification of DNA samples.
Quantitative analysis of purified DNA samples through spectrophotometer.
Amplification of DNA samples using Polymerase Chain Reaction, analysis of amplicons, scoring and data analysis.

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MCE-803 : Animal Biotechnology 3 (2-0-1)

Unit 1. Fundamentals of animal genetics: Chromosomes as vehicles of heredity. Structure of chromosomes, chromosome banding.

Unit 2. Gene mapping and gene cloning: Various methods of gene mapping, human genome project, gene mapping of mouse and other animals, basic strategies and methods of gene cloning. Gene knockout and mice model for human genetic disorders.

Unit 3. Animal transgenesis: Mechanism of transferring genes into specific animal tissues and cell lines. Production of transgenic animals (cattle, mice, sheep, goat, pig and fish) and chimeras. Artificial insemination and embryo transfer.

Unit 4. Application of transgenic animals: Production of useful proteins and other products in transgenic animals (production of regulatory proteins, blood products, vaccines, hormones and other therapeutic proteins).

Practical:
Isolation of Macrophages from allergy induced mice
Effect of different allergens on total lymphocyte count.
Isolation of genomic DNA from Blood samples.
Purification and quantification of isolated DNA samples.
RAPD analysis of genomic DNA isolated from different blood samples.
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MCE-805 : Nanotechnology 3 (3-0-0)

Unit 1. Introduction: Background and basic concepts of Nanotechnology.

Unit 2. Nanomaterial properties: Application of basic physics and chemistry in understanding nanomaterial properties. Property changes due to Crystal structures and Lattice types, Vibrational and electronic states of atoms and molecules. Importance of surface area and particle size on nanomaterial property

Unit 3. Characterization Tools: Microscopic analysis using SEM, STM, AFM, TEM, and Confocal microscopy. Spectroscopic analysis using UV-Vis, FTIR, Raman spectroscopy. X-ray Diffraction crystallography. Analysis of crystallographic data.

Unit 4. Types of Nanomaterials and Fabrication: Top-down and Bottom-up techniques. Lithography techniques, Deposition techniques. Synthesis and properties of carbon nanotubes, quantum dots, polymer nanocomposites, DNA nanowires.

Unit 5. Applications of Nanobiotechnology: Catalysis, biotechnology, electronics and devices, composites, communication technology, space technology. Application in medical field, drug delivery, drug targeting, gene targeting. Construction of Nanobiosensors. Application of Nanotechnology in Food Industry.
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MCE-806 : Genetic Engineering 3 (2-0-1)

Unit 1. Biology of cloning vectors and enzymes used in genetic engineering: Plasmids, cosmids, phagemids, *Agrobacterium tumifaciens* based vectors (binary and cointegrate vector stratergy) and artificial chromosomes (BAC, YAC). Enzymes used in genetic engineering- exonucleases, endonucleases- S1 nucleases, restriction endonucleases, ligases, polymerases, reverse transcriptase, terminal deoxynucleotidyl transferase, kinases and alkaline phosphatases.

Unit 2. Principles of recombinant DNA technology: Construction of recombinant DNA, construction of genomic and cDNA libraries, selection and screening of desired clones by hybridization method, genetic method and immunological method.

Unit 3. Recombinant DNA expression: Requirements of gene expression vectors, transient vs stable expression, expression of heterologous gene in bacteria (*E. coli*), detection of expression of foreign genes, maximizing the expression of recombinant DNA.

Unit 4. Marker genes: Selectable and screenable marker genes (reporter genes)- luciferase, β galactosidase, chloramphenicol acetyl transferase. Transfection methods - electroporation, microinjection, particle gun bombardment.

Practical:
Restriction Digestion of DNA with Restriction Endonuclease
Ligation of Restriction Digested Fragments using Ligase Enzyme
Preparation of Competent Cells
Transformation of Competent Cells
Selection of Recombinants using Blue-White Screening
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MBFT 814 : **Microbial Biotechnology 3 (2-0-1)**

History and scope of Biotechnology. Bioreactors: Types of Bioreactors e.g. packed bed, bubble column, air lift, fluidized bed bioreactor, membrane/hollow fiber, photo-bioreactor etc.

Industrial production of alcohol, glycerol, solvents (acetone, butenol, isopropyl alcohol), vinegar, acids (lactic, citric, gluconic acid), vitamins (Riboflavin, B12), antibiotic (penicillin, streptomycin, tetracycline, griseofulvin) by micro-organisms.

Concept of various types of fermentation: Batch, continuous, semisolid and solid state etc.

Methods of enzyme production, their immobilization and application in therapeutic, analytical manipulation and industrial uses.

Use of microbes in producing SCP, substrates used in producing SCP, their nutritional value.

Biotransformation.

Practical:

Study of fermentor and fermentor operation.
Isolation and purification of important microbial enzymes.
Production of lipase by submerged fermentation.
Production of lipase by semisolid fermentation.
Effect of pH and temperature on enzyme production.
Isolation of yeast from fruit juice and rice flour.
Quantitative estimation of ethanol produced during yeast fermentation.
Production of wine from grapes by using yeast.
Citric acid production by solid state fermentation.
Preparation of fungal spore in large scale by bread culture method.
Immobilization of cell on sodium alginate gel.