SEMESTER I

21BT01 STATISTICAL METHODS FOR BIOLOGICAL RESEARCH

3 1 0 4

INTRODUCTION TO STATISTICAL STUDY DESIGN AND DECISION MAKING: Organization of a statistical survey, data collection methods, representation of data – diagrammatic and graphical representation. Fundamentals of sampling – need for sampling, properties of sample and sampling procedure. Study design: Prospective and case controlled, survival analysis.

(10+3)

DESCRIPTIVE STATISTICS AND HYPOTHESIS TESTING: Measures of central tendency, deviation, correlation and regression. Statistical significance- interpretation of p values, standard errors and confidence intervals. t test, F test, single tail and double tail. Analysis of variance and covariance.

(10+4)

PROBABILITY DISTRIBUTIONS AND NON PARAMETRIC STATISTICS: Probability, binomial, Poisson and normal distributions – applications in biological research. Wilcoxon signed rank test, Mann Whitney test, the Kolmogorov- goodness of fit test, Kruskall Wallis test, Spearman rank correlation and their applications in Biology.

(15+4)

FREQUENCY DISTRIBUTIONS: Chi square distributions, multiple linear regression, factor analysis, Principal Component Analysis (PCA), cluster analysis.

(10+4)

Total L: 45+ T: 15 = 60

REFERENCES:

21BT02 PROTEIN CHEMISTRY AND ENGINEERING

3 0 0 3


(10)

PROTEIN FOLDING: Folding pathways, thermodynamics and kinetics of protein folding, Molecular Chaperones, protein folding diseases; Protein stability, tertiary structure and its determination by X-ray crystallography and protein NMR; post translational modifications, Glycoprotein and phosphoprotein analysis, Protein evolution – In vitro evolution.

(10)

PROTEIN CONJUGATES: Protein modification- group specific reagents for amino acid modifications, Biotinylated enzymes, Liposome conjugates, Fluorescent conjugates, Colloidal gold labeled proteins; Structure and functional relationship of proteins: Enzymes, antibodies, Protease inhibitors, membrane protein, receptors.

(15)

ENGINEERING PROTEINS: Protein engineering methods- Directed and random mutagenesis, High Throughput mutagenesis and functional screening, Engineering thermal stability, specificity and other properties; Antibody engineering; Therapeutic insulin- case study 1, Engineering subtilisin and other industrial enzymes — case study 2 & 3; Engineering with non natural amino acids – case study 4, Protein design — Basic concepts in design and construction of new protein/enzyme molecule.

(10)

LIST OF CASE STUDIES:
Case study 4: Protein engineering with non-natural amino acids – Chapter 11-“Protein Engineering” by Kaumaya P: In Tech 2012.

Total L: 45

REFERENCES:

353
INTRODUCTION: Overview of tools and techniques used in rDNA. Large scale production of heterologous protein in prokaryotic and eukaryotic systems – problems and solutions. Biosafety and regulations concerning genetically modified organisms

RECOMBINANT MICROBIAL PRODUCTS: Recombinant rhizobia, azospirillum, and agrobacterium; Therapeutics — humulin, humira Hepatitis B Vaccine, Human growth hormone; Industrial products- xanthan gum, plastics (Synechocystis), Remediation-oil spill, CO₂ trapping, explosive removal, mercury removal. CASE STUDY 1. Recombinant Fungi — Biocontrol agent, biological insecticide, GM Arbuscular mycorrhizae, -GM fungi that fight against malaria, dengue, CASE STUDY 2, 3

GENETICALLY MODIFIED PLANT: Resistance to biotic stress (pests and diseases)- Bt cotton, corn and Brinjal; ; Resistance to abiotic stress (environmental); Improved nutritional qualities- proteins of high value ,baking quality, oil quality, starch quality. Yield parameters- Short duration, indefinite flowering, high photosynthetic efficiency. CASE STUDY 4, 5, 6, 7


LIST OF CASE STUDIES


REFERENCES:


BIOREACTORS: Submerged fermentation: Operation and application – Stirred tank reactors, reactors in series, reactors with recycle, packed bed reactors, plug flow reactors, airlift reactors, bubble column reactors, membrane reactors, high throughput reactors, disposable reactors. Solid state fermentation: Reactors for SSF, features, advantages and limitations.


Effect of agitation on oxygen transfer in reactors and towers. Mixing time and residence time distribution in aerated tanks. Multiple impeller system. Influence of agitation of microbial, plant animal cells. Scale up and scale down of bioreactors. (13+4)

REFERENCES:

21BT05 Research Methodology and IPR
vide Automotive Engineering 21AE06

21BT72 AUDIT COURSE I
vide Automotive Engineering 21AE72

21BT51 rDNA LABORATORY

The Laboratory course will be conducted in mini-project mode. Students will clone and express a gene in \textit{E.coli}. The experiments would include, isolation of the gene of interest, cloning and creating a recombinant \textit{E.coli}. Confirmation of recombinants by Southern hybridization, followed by analysing the expression of the transgene by RTPCR

Reference

21BT52 DATA MINING AND ANALYSIS LABORATORY

Students will be carrying out two projects. One project will involve the computational analysis of genomics and proteomics data thereby deriving the structural, functional and phylogenetic inferences. Second project will pertain to the modeling and simulation of biochemical engineering problems using numerical methods and MATLAB programming.

REFERENCES:

SEMESTER II

21BT06 BIOSEPARATION TECHNOLOGY

SOLID-LIQUID SEPARATION: Classification of bio-products.; Pretreatment of fermentation broth; Unit operations involved in the development of a bio-product; Cell harvesting techniques, Filtration and centrifugation equipments; Batch and continuous filtration process, biomass separation using rotary drum filter, cake washing, Scale-up of filtration and centrifugation, Case studies 1 & 2 (12 + 4)

MEMBRANE BASED SEPARATION PROCESS: Principles, operation and application of microfiltration; Ultrafiltration; Nanofiltration, Reverse osmosis, Dialysis and Electro-dialysis process. Case study 3. (11+4)

PRODUCT ISOLATION: Adsorption, Equilibrium relationships for adsorption, Performance characteristics of fixed bed adsorber; Concept of breakthrough curve, Engineering analysis of fixed bed adsorber, Aqueous two phase liquid extraction; Examples of ATP systems, Separation of protein and enzymes using ATP systems, Supercritical fluid extraction for separation of biomolecules. Case study 4 (10+3)

PURIFICATION: Chromatography column selection; Packing material selection; Testing procedure for packed columns; Calculation for number of theoretical plates; Asymmetry and design aspects; Theory, practices and application of Affinity chromatography, Gel permeation chromatography, Ion exchange chromatography and Hydrophobic interaction chromatography. Case study 5 (12+4)
LIST OF CASE STUDIES


REFERENCES:

21BT07 TECHNOLOGIES AND STRATEGIES IN OMICS RESEARCH

TECHNOLOGIES IN GENOMIC AND PROTEOMIC ANALYSIS: Genome sequencing technologies – EST, SAGE, MPSS, microarray technologies, Next generation sequencing; Proteomics technologies: 2D-electrophoresis, MALDI-TOF mass spectrometry.

GENOME ANALYSIS: Genome assembly and annotation, Genomic browsers and databases, Comparative genomics- miRNA and target genes identification, metagenomics – analysis and applications, Epigenetic analysis.

TRANSCRIPTOMICS: Expression databases and analysis tools, Examples in transcriptome analysis and applications.

PROTEOMICS: Databases and computational methods for proteome analysis, Protein-protein interactions — yeast two-hybrid system.

REFERENCES:

21BT08 QUALITY ASSURANCE AND BIOSAFETY

QUALITY ASSURANCE: Principles and practices in quality assessment, Methods of QC and QA (drugs and biologicals), Validation of process parameters and finished products

BIOSAFETY: Good Manufacturing Practices, Environment health and safety, GMO- biosafety evaluation, LMO- Risk assessments, Industrial Effluents

REGULATIONS: Regulatory Compliance for Drugs and Biologics (FDA, India), Regulation of genome engineering technologies- India, Convention on Biological Safety, New drugs – clinical trials

CASE STUDIES: Biopharmaceuticals, Agriculture, Food processing

REFERENCES:
6. http://www.dbtindia.nic.in

21BT82 AUDIT COURSE II
vide Automotive Engineering 21AE82

21BT53 INSTRUMENTAL METHODS OF ANALYSIS LABORATORY
0 0 4 2

Students will qualitatively and quantitatively analyze the analytes present in any biological samples using analytical techniques like HP LC, GC, PCR, Flame photometry, Lyophilizer by performing the following steps:

a. Standard Operating Procedures
b. Sample Preparation Techniques
c. Varying Precursors/Operational Parameters.
d. Data collection, analysis and interpretation

Additionally, students will interpret spectral/imaging data collected from high end instruments like SEM, TEM, AFM, FT-IR, Mass Spectrometry

Total P: 60

REFERENCES:

21BT54 BIOPROCESS DEVELOPMENT LABORATORY
0 0 4 2

Students in small groups will develop a process for the manufacturing of bioproducts. The experimentation would include:

a. Optimization of production media by Placket Burman/Response surface methodology
b. Bioreactor experiments - sterilization kinetics, kLa determination by static/dynamic method, growth and substrate utilization kinetics, determination of Monod parameters
c. Downstream processing strategy for product recovery and purification - ultrasonication/filtration/centrifugation/precipitation
d. Analysis of yield, productivity and purity of product.
e. Economical analysis of the process developed.

Total P: 60

REFERENCES:

21BT63 INDUSTRIAL VISIT AND TECHNICAL SEMINAR
vide Automotive Engineering 21AE63

SEMESTER – III

21BT71 PROJECT WORK – I
vide Automotive Engineering 21AE71

SEMESTER – IV

21BT81 PROJECT WORK – II
Vide Automotive Engineering 21AE81
PROFESSIONAL ELECTIVES

21BT21 MOLECULAR PRINCIPLES OF CELLULAR PROPERTIES 3003

THE IMPORTANCE OF MEMBRANES: Transport of small molecules; principles of membrane transport; channels and electrical properties of membranes (9)

CYTOSKELETONS, JUNCTIONS AND MATRIX: Actin and related proteins; myosin; microtubules; cellular polarization and migration; cell-cell junctions; extracellular matrix; plant cell wall (9)

CELL FUNCTION ANALYSES: Regulatory networks and molecular interactions; mathematics of transient behavior; negative feedback and oscillations; cooperative activation; positive feedback and bistability; system robustness (9)

INTRACELLULAR COMMUNICATION: Principles of cellular signaling; G protein coupled signaling; enzyme mediated signals; gene control through alternate signaling; signaling in plants; INTRACELLULAR TRAFICS: Cellular compartmentalization; movement between nucleus and cytosol; proteins into mitochondria. Molecular mechanisms of membrane transport and compartmental diversity; endocytosis and exocytosis (18)

REFERENCES:

21BT22 VACCINES AND THERAPEUTIC PROTEINS 3003

BIOPHARMACEUTICAL PROTEINS: Therapeutic protein production from bacterial, yeast and mammalian systems, recovery of therapeutic proteins from inclusion bodies. Recombinant hormones: insulin, erythropoietin, growth hormone, follicle stimulating hormone – production by recombinant methods and applications. Recombinant cytokines and their receptors: granulocyte colony stimulating factor, interferon β-1 b, TNF α receptors. (12)

RECOMBINANT ENZYMES, ENZYME ACTIVATORS AND INHIBITORS: tPA, coagulation factor VIII, asparaginase, biosimilars. (12)

RECOMBINANT VACCINES: Modern types of vaccines- subunit vaccines, recombinant vaccines, hepatitis B vaccine, yeast, recombinant vector vaccines, DNA vaccines, plantbodies, QC in vaccine production. (10)

MONOCLONAL ANTIBODIES: Therapeutic applications of monoclonal antibodies, clinical overview, human recombinant antibody production, production of anti idiotypic antibodies, expression of antibody fragments, immunotherapy with genetically engineered antibodies. (11)

REFERENCES:

21BT23 METABOLIC ENGINEERING 3003

INTRODUCTION: Regulation of metabolic pathways: Jacob Monod model, catabolite regulation, glucose effect, cAMP deficiency, feedback regulation, regulation in branched pathways, concerted feedback regulation, cumulative feedback regulation, differential regulation by isoenzymes, amino acid regulation of RNA synthesis, energy charge, regulation, permeability control. (11)

METABOLIC FLUX BALANCE ANALYSIS: Comprehensive models of cellular reactions; stoichiometry of cellular reactions, reaction rates, dynamic mass balances, metabolic flux analysis. MFA of determined systems, overdetermined systems, experimental determination of metabolic fluxes by isotope labeling. (9)
METABOLIC CONTROL ANALYSIS AND NETWORK ANALYSIS: Fundamental of Metabolic Control Analysis, control coefficients and the summation theorems, Determination of flux control coefficients, MCA of linear pathways, branched pathways, theory of large deviations. Control of flux distribution at a single branch point, grouping of reactions, optimization of flux amplification (9)


REFERENCES:

21BT24 ADVANCED TOPICS IN PLANT MOLECULAR BIOLOGY

PLANT GENOME AND PHYSIOLOGY: Genome organization and gene expression; organelle genomes, Gene regulation, Protein targeting, Photosynthesis, lipid metabolism, Respiration, Secondary metabolites. CASE STUDY 1 (13)

TRANSGENIC PLANTS: Gene manipulation; genome and Plastid transformation; Plant functional Genomics; activation tagging, RNAi, transposon tagging, molecular pharming Biosafety of transgenic plants. CASE STUDY 2 (12)

STRESS RESPONSE SIGNAL TRANSDUCTION: Biotic, abiotic- salinity, drought, heat, cold, UV radiation, heavy metals, pathogen and pest infestation. CASE STUDY 3 (10)

HORMONES AND GROWTH REGULATION: Plant development, Flowering, Tissue culture. CASE STUDY 4 (10)

REFERENCES:

21BT25 TECHNIQUES IN MOLECULAR SUBTYPING OF PATHOGENS

Overview – Phenotyping methods – Characteristics of Ideal typing methods — limitations of traditional methods (9)

DNA based Techniques: DNA hybridization, PCR based approaches, Electrophoresis based methods, Bead based nucleic acid assay, Plasmid Analysis (12)

DNA Sequencing based Techniques: MLST, SNP, VNTR, MLVA, IS analysis, Pyrosequencing, Ribotyping, Microarray, CRISPR, NGS (12)

Omics based Techniques: Protein based methods, Transcriptome analysis, Proteomic profiling, Microbial Lipid Analysis (12)
REFERENCES:
3. Shariat N and Dudley EG, CRISPRs: Molecular Signatures Used for Pathogen Subtyping, Applied and Environmental Microbiology, 80,4, pp-430–439, 2014

21BT26 BIOMATERIALS AND TISSUE ENGINEERING

INTRODUCTION: tissue architecture, cell organization, ECM molecules, Cell-Cell adhesion, Cell matrix adhesion, Matrix molecules and their ligands, Growth factors and their functions. Repair and regeneration; STEM CELLS: Embryonic and adult, cell lineages, cell determination and differentiation. Induced pluripotent stem cells, application of stem cells in tissue engineering. (16)


BIOMATERIALS: Scaffolds/substrates for tissue regeneration, Metals, Ceramics, synthetic Polymers, biopolymers-Characteristics and applications. Nanomaterials Microscale patterning of cells and environment, Polymer scaffold fabrication, micro and nanoscale fabrication, Surface Modification- Objectives, biological coating (10)

CASE STUDIES: Musculoskeletal, Skin, Hematopoietic system (9)

REFERENCES:

21BT27 MEMBRANE SEPARATIONS

REVERSE OSMOSIS: Theoretical background, Membranes and materials, Membrane selectivity, Membrane modules, Membrane fouling, control and cleaning, Applications (10)

ULTRAFILTRATION AND MICROFILTRATION: Characterization of Ultrafiltration membranes, Concentration polarization and membrane fouling, Membrane cleaning, membrane modules and system design, Applications. Microfiltration: Types and application. (12)


CASE STUDIES: Membrane processes in production of functional whey components, Separation and fractionation of milk fat globules, Fractionation of milk proteins for making cheeses, caseins and whey proteins and for milk protein standardization, Sewage treatment using membrane bioreactors, Membrane separations for removal of microorganisms, Desalination of sea water using RO and Electrodialysis (11)

REFERENCES:
BIOETHANOL AND BIOBUTANOL: Different feedstocks for bioethanol and biobutanol production, Fermentation process, Sugarcane molasses and other sources for fermentation process. Lignocellulosic pretreatment methods, Hydrolysis, Hydration, Lignin upgradation, Simultaneous Saccharification and fermentation (SSF), Co-fermentation and economics of bioethanol production, ABE Fermentation, Recent development in bioethanol and biobutanol commercialization (12)

BISODIESEL: First, second and third generation biofuels, Biorefinery concepts, Transesterification reaction mechanism, Basics and chemistry of fats and oil, oil resources and feedstock, methods for biodiesel production, Different types of catalysts employed, heterogeneous catalysis, tree-borne oil biodiesel, enzyme based biodiesel and microalgae based biodiesel, Physicochemical properties and biodiesel characterization techniques. Case study 1 & 2 (11)

BIOHYDROGEN AND BIOGAS: Thermo-chemical conversion of lignocellulosic biomass, Biohydrogen production process: Chemical method and Biological method, Factors affecting biohydrogen production, Characteristics of biohydrogen, Feedstocks for biogas production, Microbial and biochemical aspects, Operating parameters for biogas production, Digesters for rural application (12)

MICROBIAL FUEL CELLS AND BIOELECTROGENESIS: Mechanism of Bioelectrogenesis, Basics of Bioelectricity generation in Microbial Fuel Cell, Exoelectrogens and electron transfer mechanism, Available architectures, Voltage and power generation, Kinetics and mass transfer in Microbial Fuel Cell, Applications of Microbial Fuel Cell - Desalination cell and Electrolysis cell (10)

LIST OF CASE STUDIES

REFERENCES:

21BT29 BIOLOGICAL TREATMENT OF INDUSTRIAL WASTE

MICROBIAL REACTIONS AND KINETICS: Methods for community characterization; Community dynamics; Bioavailability; Designing and Engineering of microorganisms; Stoichiometry and energetics - donors and acceptors, yield coefficients; Mass balances; Soluble Microbial Products; Input active biomass, Mathematical models (15)

BIOLGICAL TREATMENTS AND REACTORS: Design and operation of activated sludge process, lagoons, trickling filters, rotating biological contactors, reactors for wastewater treatment. Aerobic and Anaerobic reactors for solid waste treatment, Biofilters, Bioscrubbers (12)

BIODEGRADATION AND BIOREMEDIATION: Molecular recapitlance; Mechanism of metabolism of hydrocarbons, halogenated hydrocarbons, xenobiotics, polymers; In-situ and ex-situ remediation; Bioaugmentation; Phytoremediation. (10)

CASE STUDIES (8)
REFERENCES:
3. Mukesh Doble and Anil Kumar, “Bioremediation of Industrial Effluent”, Elsevier, USA, 2005

21BT30 BIOREACTOR DESIGNS


DESIGN OF DIFFERENT BIOREACTORS: Pneumatic agitated bioreactors – bubble column and airlift reactors, Immobilized cell reactors, Photo-bioreactors. Design of reactors for solid state fermentation. Scale up — Fundamental, Semi-fundamental, Dimensional analysis and rule of thumb approaches, Scale up based on mass transfer coefficient, power consumption, shear and mixing.

BIOREACTORS FOR ANIMAL AND PLANT CELLS: Characteristics of animal and plant cells, Types of reactors: reactors for mammalian cells, reactors for hairy root culture. Design considerations – mass transfer, effect of shear, scale up of reactors for animal cells and plant cells.


REFERENCES:

21BT31 FUNDAMENTALS OF CELLULAR MECHANICS

MOLECULAR MECHANICS: Forces in Biology; Molecular motors and force generation, Single molecule mechanics; Biopolymers — Properties of DNA, Protein, Cytoskeletal polymers, Chain Models, functional implications.

CELLULAR MECHANICS: Mechanics of cell and organelle membrane; Cytoskeleton and cortex; Static and dynamic cell processes; Cell motility, adhesion, migration and contraction. Quantitative aspects of cell mechanics — continuum mechanics, models of viscoelasticity, single cell mechanical models.

MECHANOTRANSDUCTION: Mechanical Signals, Mechanosensing, Intracellular signaling initiated by mechanical signals.

EXPERIMENTAL METHODS: Single molecule — optical and magnetic traps, force spectroscopy, AFM; Cellular level — passive and active rheology, motility and adhesion assays. Case Studies — cancer, malaria, and sickle cell anemia.

REFERENCES:

21BT32 TECHNIQUES IN EPIDEMIOLOGICAL DATA ANALYSES

CLINICAL INTERROGATION: Prospective study – relative risk and poisson regression: behavior type and risk of coronary disease. Randomized trial – t-tests and computer intensive approaches: memory loss rates in Alzheimer’s disease patients. (10)

FITTING MODELS: Goodness of fit – Pearson chi-square tests: Mendel’s ornamental flowers. Multivariate linear regression models: pregnancy weight gain and birth weight. CLUSTER ANALYSIS: Graphic cluster analysis, PCA with contour plots: race/ethnicity and gene frequencies. (20)

BIAS AND MISCLASSIFICATION: Simple linear regression and correlation: bias in repeated blood pressure measurement. (6)

REFERENCES:

Total L: 45

21BT33 PHARMACOGENOMICS

PHARMACOGENETICS: Case studies in Polymorphic genes encoding drug metabolizing enzymes, transporters, receptors and other drug targets in man and animals. Effects of genetic polymorphisms on the disposition and metabolism of drugs, environmental, endogenous chemicals and other xenobiotics. Regulation of drug metabolizing enzymes — examples. (15)

PHARMACOGENOMICS IN DRUG DISCOVERY: Drug discovery principle, target identification, screening methodologies and assays, mechanism-based design, structure-based design, in vitro and in vivo testing, chemical analogs and development issues (10)

PHARMACOGENOMICS IN DRUG DEVELOPMENT: Genome wide studies to understand the genetic basis for differences in drug response. Genetic variability in drug receptors, transporters and enzymes as well as regulatory proteins involved in promoting and inhibiting transcription and translation. Toxicogenomics. (10)

REGULATORY AND ETHICAL ASPECTS: Case studies, clinical trials, FDA, Pharmacogenomic Data Submission, Guidance and other regulatory guidelines (10)

Total L: 45

REFERENCES:

21BT34 METAGENOMICS AND EPIGENOMICS

TECHNIQUES AND STRATEGIES FOR METAGENOMIC ANALYSIS: Types of metagenomes — Amplicon, Shotgun and Functional. Tools used for identifying diversity, searching for novel genes and gene products, and investigating relationships among genes, mRNAs, and proteins in microbial communities. NGS for metagenome analysis. Metagenomic bioinformatics tools enabled genome assembly and classification of large-scale sequencing data. (14)

EPIGENETIC AND EPIGENOME REGULATION: Histones and nucleosomes, chromatin organization, Histone modifications and epigenetic information, transcription in chromatin environment, Techniques used in the study of transcription factor binding and DNA methylation, chromatin remodelers, regulation of gene expression – non-coding RNAs, small non-coding RNAs. Molecular regulation of genomic imprinting, genetic control of epigenomes, methylomes, role of environment in epigenome regulation (10)

TECHNIQUES USED IN EPIGENOME ANALYSIS: ChIP, ChIP on chip, ChIP sequence, ChIP- PCR, sequencing, enzyme based methods, NGS based sequencing of the epigenome. Epigenome systems – Human epigenome, epigenomics in plants, fungi (10)

APPLICATIONS OF METAGENOMICS AND EPIGENOMICS: Metagenomic applications in agriculture, environment and health. Plant-microbe interactions, bioremediation, industrial bioproducts. Epigenetic regulation in stem cells, epigenetics of the immune system, epigenetics in neuronal diseases, Cancer epigenomics. (11)

Total L: 45
REFERENCES:

21BT35 SYSTEMS BIOLOGY: THEORY AND APPLICATIONS


Total L: 45

REFERENCES:

21BT36 ANALYTICAL INSTRUMENTATION TECHNIQUES


CHROMATOGRAPHY AND MASS SPECTROMETRY: Concepts on liquid chromatography and its variants (HPLC, Capillary LC, reverse phase LC, 2D-LC), Applications: Food Analysis, Characterization of antibody-drug conjugates, determination of fungicides, TLC-HPLC as an integrated approached for determination of complex molecules from soil/water samples; Integrated Approaches on Mass spectrometry – GC-MS and LC-MS.

ELCTROPHORETIC APPLICATIONS: Concepts on Capillary and Pulsed Field Gel electrophoresis; PFGE Applications: Profiling of Serovars using PFGE, Investigation of Epidemiology; Capillary electrophoresis: Analysis of Vitamins, separation of enantiomers, drug discovery; Electrophoresis-Colorimetry integrated technique


Total L: 45

REFERENCES:
2. Richard F. Venn, "Principles and Practice of Bioanalysis", Taylor and Francis, 2000

21BT37 ALGORITHMS IN BIOINFORMATICS

BIOLICAL DATABASES: Scope and history of Bioinformatics; DNA, Protein and Structural Databases; Secondary databases and their construction with case study
SEQUENCE ALIGNMENT ALGORITHMS: Pairwise sequence alignment: Dot matrix; K-tuple methods: BLAST, FASTA.; Dynamic Programming; Multiple sequence alignment: Progressive methods - Clustal W, Iterative methods – HMM; Scoring matrices: PAM, BLOSSUM, PSSM. (14)

GENE AND PHYLOGENETIC PREDICTION: Gene prediction: Asymmetry statistics, Neural networks; Phylogenetic prediction: Distance methods; (12)

PROTEIN AND RNA STRUCTURE PREDICTION: RNA structure prediction: Minimum free energy methods and co-variation site analysis; Protein structure Prediction: two dimensional structure-Neural networks, three dimensional structure-Rosetta Method, HMMSTR. (12)

REFERENCES:

21BT38 CANCER GENOMICS

3 0 0 3

INTRODUCTION TO CANCER BIOLOGY : Hallmarks of cancer, Concept of clonal evolution and genetic diversity in cancer, Genomics of Cell proliferation and apoptosis. Role of tumour suppressor gene and oncogenes, Genomic instability and genetic pathways involved in cancer, Cell cycle control in cancer. (10)

GENOMICS OF CANCER METASTASIS : Local tumour invasion and intravasation, Circulating tumour cells, micro metastasis and cancer dormancy, Genes involved in epithelial to mesenchymal transition, intrinsic regulation and tumour microenvironment, pre-metastatic niche and organ specific metastasis, tumour heterogeneity and cancer stem cells. (10)

GENOME ANALYSIS IN CANCER : Genome and transcriptome data sets in cancer, Genomic analyses of familial cancer, cancer genomic landscapes, cancer epigenetics, challenges and future direction in cancer research, Genome resource projects like TCGA, COSMIC and EVS, Bioinformatics for cancer genomics – Data types and analysis using bioinformatic tools- specific case studies, miRNAs in cancer and their analyses. (15)

GENOMICS FOR DIAGNOSIS AND THERAPY: Screening and risk assessment factors, Biomarker discovery and validation through genome studies. Treatment options- Surgery, Classes of chemotherapeutic agents and their resistance mechanism, differentially expressed gene set analyses in resistant and susceptible tumor sets. Targeted therapy for personalised medicine using genome tool sets, cancer pharmacogenomics. (10)

REFERENCES:

21BT39 TRANSPORT PHENOMENA IN BIOLOGICAL SYSTEMS

3 0 0 3

Unit I: Introduction
Conservation of Mass; Application of Mass Conservation to a Biological Cell: Metabolic Flux Analysis; Application of Mass Conservation to Macroscopic Systems; Useful Forms of Mass Conservation in Fluid Systems; Primary Driving Force for Mass Flux; A Constitutive Equation; Solution Approaches; Steady State Diffusion; Unsteady State Diffusion; Pseudo Steady State Approximation (PSSA) for Unsteady State Diffusion

Unit II: Momentum&Energy Conservation
Rheology; Types of Flows; Shell Momentum Balances; Equation of Motion; Unsteady State Flow; Pulsatile Flow; Solutions to Equations; Turbulent Flow; Macroscopic Aspects: The Engineering Bernoulli Equation, Modes of Heat Flux; Equation of Energy

Unit III: Charge& Multiple Conservations
Lorentz Force Law; Charge Density and Flux; Maxwell’s Relations; An Expression for Charge Conservation; Maxwell’s Equations in Differential Form; Constitutive Equation; Ions in Solutions. Simultaneous Concentration Gradient and Electrical Potential Gradient; Simultaneous Concentration Gradient and Velocity Gradient; Blood Oxygenators; Simultaneous Temperature Gradient and Velocity Gradient: Heat Transfer to Fluid Flowing in a Long Circular Tube under Laminar Flow Conditions

Total L: 45

365
Unit IV: Applications of mass transport in biological systems
Fluid flow in circulation and tissues; transport in porous media; transport in kidneys; transport in organs and organisms

Books
1. G.K. Suraishkumar; Continuum Analysis of Biological Systems: Conserved Quantities, Fluxes and Forces; Springer Heidelberg New York; 2014
2. G. A Truskey, Fan Yuan, D. F Katz; Transport Phenomena in Biological Systems; Prentice Hall; 2004

References
2. Fournier, Ronald L - Basic Transport Phenomena in Biomedical Engineering, Fourth Edition-Taylor and Francis; 2017

ELECTIVE LABORATORY

21BT55 BIOLOGICAL BIG DATA ANALYSIS LABORATORY

Course Description: Students will design workflow for functional analysis of biological big data with the aid of computational platforms and programming languages and derive statistically significant inferences.

Total P: 90

REFERENCES:

21BT56 ANIMAL CELL CULTURE LABORATORY

Course Description: Students will maintain mammalian cells with good viability recognize and troubleshoot problems common to routine cell culture practices and carryout record keeping. Students will perform preparation, evaluation and optimization of media components, cryopreservation and recovery, assessment of cell growth, cell viability assays, toxicity studies, mammalian cell transfection.

Total P: 90

REFERENCES:

21BT57 PLANT TISSUE CULTURE LABORATORY

Course Description: Students will culture and maintain plant tissues /organs aseptically and perform micro propagation, genetic modification, secondary metabolite production and analyses.

Total P: 90

REFERENCES:

21BT58 PROTEIN PURIFICATION AND ANALYSIS LABORATORY

Course content
1. Induction of recombinant protein in Bacteria/ yeast
2. Assay of enzymes / recombinant protein analysis by western hybridization
3. Protein purification using FPLC - Affinity chromatography/ ion-exchange chromatography
4. Analysis, Fraction pooling and sample concentration
5. Purity analysis by HPLC

Total P: 90
REFERENCES:
2. Rosenberg I M “Protein analysis and purification: benchtop techniques - ED 2, Birkhauser 2007 Boston

21BT59 BIOFUEL LABORATORY

Course content
1. Biomass size reduction and particle size distribution analysis
2. Pretreatment of high FFA content oils
3. Pretreatment of lignocellulosic biomass
4. Lipid extraction using Soxhlet apparatus
5. Biodiesel production in a batch reactor
6. Estimation of biofuel properties
7. Fatty acid profile determination using GC
8. Sugar profile determination using HPLC

REFERENCES:

Total P: 90

21BT60 ENVIRONMENTAL BIOTECHNOLOGY LABORATORY

Experiments:
1. Sampling techniques for water, soil, solid waste
2. Physico-chemical characteristics of water and wastewater
3. Physico chemical analyses of solid waste
4. Biodiversity analysis of microorganisms in soil, water – metagenomic analyses
5. Toxicity and teratogenicity analysis
6. Production of Enriched Microorganisms for any specific remediation -

REFERENCES:

Total P: 90

21BT61 MOLECULAR CLONING AND EXPRESSION LABORATORY

Students will clone and express a heterologous gene in either prokaryotic or eukaryotic system and analyse the recombinant products. The techniques used will include: retrieval of DNA sequence from NCBI, primer designing, DNA isolation, gene amplification, DNA manipulation, transformation, RTPCR, Southern, Northern and/or Western Hybridization analysis of expression.

Reference
Origin of the Elements, the Solar System and the Planets: Planets in the Solar System and Beyond, Planet Formation, Planets and moons, Exoplanets, Hot Jupiters and Planet Migration

Exoplanets: Methods to detect exoplanets – Radial velocity method, transit method, direct imaging, microlensing, planet composition; Diversity of exoplanets; Exoplanet properties;

Origins of Life: Defining life; Schrödinger and life; Essentials for biological life; Origins of life on earth- theories and hypotheses; Chemical evolution - Miller Urey experiments; Primordial soup; the spark of life; Limits of life; Life in the extremes; Co-evolution of life and planet

Search for life outside earth: Habitable zone; factors that influence habitability; Anthropic principle; Biosignatures to detect life; Missions to detect biosignatures. Is the structure of life universal? Search for Extraterrestrial Intelligence

Total: 45

REFERENCES: