ख्वाजा मुईनुद्दीन चिश्ती भाषा विश्वविद्यालय, लखनऊ, उत्तर प्रदेश (भारत)
Khwaja Moinuddin Chishti Language University, Lucknow, U.P. (India)
U.P. STATE GOVERNMENT UNIVERSITY,
(Recognised Under Section 2(f) & 12(B) of the UGC Act, 1956 & B.Tech. Approved by (AICTE)

FACULTY OF ENGINEERING & TECHNOLOGY

KHWAJA MOINUDDIN CHISHTI LANGUAGE UNIVERSITY, LUCKNOW, UTTAR PRADESH

B.TECH. BIOTECHNOLOGY

Curriculum Structure

THIRD YEAR
(V & VI Semesters)

SEMESTER- V

Subject – Bioinformatics-I

Course Outcome (CO); -	
CO 1:	students will be able to understand concepts and application of Bioinformatics, types of databases, sequence similarity, sequence patterns and profiles.
CO 2:	students will be able to use sequence alignment techniques, database searching, pairwise and multiple sequence alignment using various tools.
CO 3:	students will be able to understand scoring matrices and its types including PAM , BLOSUM series and matrices for nucleic acid and protein sequences.
CO 4:	students will be able to understand and apply the protein structure prediction and application of bioinformatics in drug designing.

Course Content

Unit I: Introduction to Bioinformatics; Biological databases: Nucleotide databases, Protein databases, Specialized databases; Laboratory data submission and data retrieval; Various file formats for biomolecular sequences: Genbank, EMBL, FASTA, GCG, msf, nbrf-pir etc.; Basic concepts of sequence similarity: identity and homology, definitions of homologues, orthologues, paralogues; Sequence patterns and profiles.

Unit II: Sequence Alignment And Database Searching: Introduction, Evolutionary Basis of Sequence Alignment, Optimal alignment method, Statistical Significance of Alignment. Database searching Artifacts; Database similarity searching: FASTA, BLAST, Various versions of basic BLAST and FASTA, Advance version of BLAST: PHI-BLAST and profile-based database searches using PSI-BLAST; Multiple sequence alignment: progressive method and Iterative method; Applications of pairwise and multiple sequence alignment; Tools for multiple sequence alignment: CLUSTALW and Pileup (Algorithmic concepts).

Unit III: Scoring Matrices: Basic concept of a scoring matrix, Similarity and distance matrix, Substitution matrices: Matrices for nucleic acid and proteins sequences, PAM and BLOSUM series, Principles based on which these matrices are derived and Gap Penalty; Predictive Method using Nucleotide Sequence: Introduction, marking repetitive DNA, Database search, Codon bias detection, detecting functional site in DNA.

Unit IV: Phylogenetics: Phylogeny and concepts in molecular evolution; nature of data used in taxonomy and phylogeny; definition and description of Phylogenetic trees and various types of trees; Different methods of Phylogenetic tree construction: UPGMA and Fitch-Margoliash Algorithm; case studies in phylogenetic sequence analysis.

Unit V: Protein identification based on composition, Physical properties based on sequence, Motif and pattern, Secondary structure (Statistical method: Chou Fasman and GOR method, Neural Network and Nearest neighbor method) and folding classes, specialized structure or features, Tertiary structures (Homology Modeling); Structure visualization methods (RASMOL, CHIME etc.); Protein Structure alignment and analysis. Application of bioinformatics in drug discovery and drug designing.

Practical

1. Retrieving sequence data from Entrez
2. Locating the chromosome of a Gene
3. Retrieve gene expression data from GEO
4. Retrieving articles using PubMed
5. Finding ORF of a Given Sequence
6. Retrieving structural data of a protein using PDB database
7. Retrieving Motif Information of a Protein Using Prosite
8. Retrieving Gene Information from TAIR database

Text Books / Reference:

1. D.W.Mount; Bioinformatics-Sequence and genome analysis; Cold Spring
1. HarbourLab press.2001
2. B.N.Mishra; Bioinformatics: Concept and application, Pearson Education
3. (in press)2020
4. O' Reilly; Developing Bioinformatics computer skills-1stIndian edition,
5. SPD publication.2001
6. 4. Anthony J.F. Griffiths et al; An introduction to genetic analysis, 1stEd 1976
7. 5. Michael Starkey and Ramnath Elaswarapu; Genomics protocols, Humana press, 2001

Subject – Bioprocess Engineering II

Course Outcome (CO): -	
CO 1:	Analyze microbial growth kinetics, substrate utilization, and enzyme kinetics to optimize product formation and enzyme catalysis in bioprocesses.
CO 2:	Design and operate various bioreactors, including batch, fed-batch, and continuous systems, and manage immobilized cell systems and solid-state fermentations for efficient bioprocessing.
CO 3:	Apply bioprocesses for producing antibiotics, proteins, polysaccharides, and other biochemicals, integrating principles of energy balance, mass transfer, and fermentation technology.

CO 4:	Utilize instrumentation and process modeling for monitoring and controlling bioprocesses, including sterilization, downstream processing, and the operation of plant and mammalian cell culture reactors.

Course Content:

Unit 1: Microbial growth kinetics, substrate utilization, and product formation kinetics, stoichiometry, principles of enzyme catalysis, enzyme kinetics, immobilized enzymes.

Unit 2: Bioreactors- batch, fed-batch or continuous bioreactors, Immobilized cell systems, solid-state fermentations, energy balance and mass transfer, operation and control of bioreactors (aeration, agitation, heat transfer, scale-up and scale-down).

Unit 3: Bioprocesses for the production of antibiotics, proteins, polysaccharides, aroma etc.

Unit 4: Instrumentation and monitoring, sterilization, process modeling, downstream processing, plant/mammalian cell culture reactors, examples of industrial bioprocesses.

Unit 5: Case studies on production of antibiotics, enzymes, insulin, bio-ethanol.

Practical

1. Microbial growth kinetics and estimation of cell mass
2. Growth inhibition kinetics
3. Operation of pH control and dissolved oxygen measurement
4. Enzyme immobilization techniques
5. Bioconversion using immobilized enzyme preparation
6. Aerobic and anaerobic bioconversion process
7. Product formation kinetics in a fermentation process
8. Online analyses of process parameters
9. Effect of mixing and agitation in bioreactors
10. Mass transfer in immobilized cell
11. Estimation of volumetric oxygen transfer coefficient

Text Books/References:

1. Michael Shuler, Fikret Kargi, Matthew DeLisa, Bioprocess Engineering: Basic Concepts, 3rd Edition
2. Pauline Doran, Bioprocess engineering principles
3. Colin Ratledge, Bjorn Kristiansen, Basic Biotechnology, 2nd Edition, Cambridge University Press, 2001.
4. Roger Harrison et al., Bioseparations Science and Engineering, Oxford University Press, 2003.

5. Bioreaction Engineering, Bioprocess Monitoring (Bioreaction Engineering) by Karl Schügerl

Subject – Metabolic Engineering

Course Outcome (CO): -	
CO 1:	students will learn and systematically analyze the complexities defining the regulation of various metabolic pathways.
CO 2:	Students will be able to design and learn strain-engineering strategies.
CO 3:	Students will learn to alter cellular behavior, metabolic flux, and product formation.
CO 4:	Students will appreciate the vast industrial applications of metabolic engineering in the field of medicine, energy, and environment.

Course Content:

Unit 1: Introduction to metabolism, catabolism, anabolism. Key differences between metabolic controls of prokaryotes and eukaryotes. Stoichiometry of cellular reactions, enzyme kinetics, reaction rates, dynamic mass balance, yield coefficients and linear rate equations, the black box model.

Unit 2: elementary balance, heat balance different models for cellular Reactions-Induction-Jacob Monod Model and its regulation, differential regulation by isoenzymes, concerted or cumulative feedback regulation. Regulation in branched pathways, permeability and transport of metabolites.

Unit 3: Building stoichiometric matrix; Steady state and pseudo steady state assumptions; Using different optimizing functions to solve linear programming problem; understanding flux cone and constraints; Introducing additional constraints from thermodynamics; Experimental determination of metabolic fluxes C13 labeling, NMR and GC-MS based methods for flux determination.

Unit 4: Introduction to MATLAB. Synthetic circuit design, metabolic flux analysis. MOMA (Minimization of Metabolic Adjustment), iFBA (Integrated Flux Balance Analysis), dFBA; Enhancement of product yield and productivity.

Unit 5: Industrial applications pathway engineering strategies for overproduction of some commercially important primary and secondary metabolites (e.g. amino acids, organic acids, alcohols and therapeutic compounds) or industrially relevant enzymes and recombinant proteins, bioconversion- applications and factors affecting bioconversion, mixed or sequential bioconversions, regulation of enzyme production, strain selection and improvement, the modification of existing or the introduction of entirely new metabolic pathways

Practical

1. Develop engineering strategies to boost production of industrially relevant compound in *E. coli*.
2. Strain engineering (deletion or overexpression of genes) to boost production of target compound followed by metabolite extraction and quantification.
3. Demonstration of feed-back regulation and product inhibition
4. Development of a flux model and correlation of the model with experimental data.

Text Books/References:

1. Metabolic Engineering: Principles and Methodologies by Gregory N. Stephanopoulus, Aristos A. Aristidou, and Jens Nielsen.
2. Pathway Analysis and Optimization in Metabolic Engineering by Néstor V. Torres and Eberhard O. Voit.
3. The Metabolic Pathway Engineering Handbook by Christina D. Smolke.
4. Biochemical Engineering by Harvey W. Blanch and Douglas S. Clark.

SEMESTER- VI

Subject – Bioinformatics II

Course Outcome (CO): -	
CO 1:	Students will be able to understand the various tools and techniques related to *insilico* modeling of biomolecules.
CO 2:	Students will be able to understand the methods of drug designing, protein docking.
CO 3:	Students will be able to analyze problems related to collection and analysis of biological data.
CO 4:	Students will be able to develop steady and time dependent solutions along with their limitations.

Course Content:

UNIT I: Inference problems and techniques for molecular biology. Overview of key inference problems in biology: Homology identification, Genomic sequence annotation (Genes and ORFs identification), Protein structure prediction (Secondary and Tertiary structure prediction), Protein function prediction, biological network identification, Next generation sequencing, Microarray data analysis.

UNIT II: Basics of RNA Structure prediction and its limitations, Features of RNA Secondary Structure, RNA structure prediction methods: Based on self-complementary regions in RNA sequence, Minimum free energy methods, Suboptimal structure prediction by MFOLD, Prediction based on finding most probable structure and Sequence co-variance method. Application of RNA structure modeling.

UNIT III: Machine learning: Decision tree induction, Artificial Neural Networks, Hidden Markov Models, Genetic Algorithms, Simulated Annealing, Support vector machines; The relation between statistics and machine learning; Evaluation of prediction methods: Parametric and Nonparametric tests, cross-validation and empirical significance testing (empirical cycle), Clustering (Hierarchical and K-mean).

UNIT IV: Basic concept of Force field in molecular modeling (Potential energy calculation); Overview of key computational simulation techniques: Introduction to simulation, Computer simulation techniques, Types of computer simulation (Continuous, Discrete-event and Hybrid simulation), Differential equation solvers, Parameter estimation, and Sensitivity analysis.

UNIT V: Overview of key techniques for the management of large document collections and the biological literature: Document clustering, Information retrieval system; Natural Language Processing: Introduction, Major areas of NLP, Natural language information extraction; *Insilico* Drug Designing: Major steps in Drug Designing, Ligand and Structure based drug designing,

Protein-ligand docking, QSAR Modeling, Pharmacodynamics (Efficacy & Potency) &Pharmacokinetics (ADME), Lipinski's rule of five, Pharmacogenomics.

Practicals

1. Identification of Distantly related homologous sequences of a given query protein sequence using PSI-BLAST
2. Construct Phylogenetic tree of five evolutionary related protein/nucleotide sequences
3. Prediction of secondary structure of RNA using any web server.
4. Construction and analysis of Ramachandran Plot using any suitable web server
5. Align two homologous protein structure and calculation the RMSD for the superposition result
6. Comparative assessment of best available tools for genome annotation
7. Construction of restriction maps for various vectors used in genetic engineering using tool "NEB cutter".
8. Primer Design: Construct primers for the given DNA sequence using any suitable web-based tool
9. Generate 2D QSAR model of a set of legend descriptor data

Text Books / References:

1. Computational Methods in Biotechnology – Salzberg S. L. et al., Elsevier Science 1998
2. D.W.Mount; Bioinformatics- Sequence and genome analysis; Cold Spring Harbour Lab press 2004
3. Protein Structure Prediction-A Practical Approach, MJE Sternberg, Oxford University Press. 1996
4. Statistical Methods in Bioinformatics-Evens & Grants, Springer-Verlag, NY. 2006
5. Purifing Protein for Proteomics, Richard J. Sinpson, I.K. International Pvt. Ltd. 2004
6. Computational Molecular Biology- Setubal and Meidanis, PWS publishing Co., 1997.

Subject – Plant Biotechnology

Course Outcome (CO): -	
CO 1:	Students will be able to understand the principle and basic requirements for plant tissue culture.
CO 2:	Students will be able to explain the difference between tissue and organ culture and their applicability.
CO 3:	Students will be able to uunderstand haploid culture and in vitro selection of mutants.

CO 4:	Students will be able to analyze soma clonal variation for improved crop varieties in vitro cultures.

Course Content:

Unit I: Introductory history of plant biotechnology: Laboratory organization; Principles of Plant Tissue Culture. Concepts of totipotency, explants, inoculums, acclimatization. Nutrition of plant cells; Nutrient media: Composition of commonly used nutrient culture media with respect to their contents like inorganic chemicals, organic constituents. An appraisal of different media, selection of media, Sterilization of the media. Hormones: Auxins, Cytokinins, Gibberellins, Abscisic Acid, Ethylene etc. Explant preparation and Surface sterilization. Basic procedure for Aseptic Tissue transfer.

Unit II: Culture of plant materials- explants selection and technique of culturing. Organogenesis, Embryogenesis, Somaclonal variation, germiclonal variation. Establishment, growth and maintenance of Callus and cell suspension culture, Methods of sub culturing and transfer of regenerated plants to the field. Tissue and organ culture; Cellular differentiation and regulation of morphogenesis; Somatic embryogenesis; Control of organogenesis and embryogenesis; Single cell culture.

Unit III: Haploid production: Androgenesis; Anther and microspore culture; Gynogenesis; Embryo culture and rescue in agricultural and horticultural corps; Protoplast isolation; Culture–regeneration; Somatic hybrid-cybrids; In vitro selection of mutants – mutants for salts, disease, cold, drought, herbicide and other stress conditions; Micropropagation: Application of micropropagation in agriculture and forestry. Meristem culture and virus elimination; Shoot tip culture.

Unit IV: Improved crop varieties through somaclonal variation in invitro cultures. Application of tissue culture for crop improvement in agriculture, horticulture and forestry. Cryopreservation and slow growth cultures, Freezing and storage, thawing, reculture. Application of plant tissue culture production of secondary metabolites and other industrial products.

Unit V: Genetic transformation using Ti plasmid Manipulation of gene expression in plants; Production of marker free transgenic plants. Developing insect-resistance, disease - resistance, herbicide resistance plants. Genetic manipulation of flower pigmentation, Developing quality of seed storage, Provitamin A, iron proteins in rice, modification of food plant taste and appearance, yield increase in plants.

Practicals

1. Preparation of Stocks solution for plant tissue culture media.
2. Preparation of MS/B5 medium (semi-solid) and sterilization.
3. Explant selection, preparation and surface sterilization.
4. To learn culturing, sub culturing and maintenance using selected explants.
5. Initiation of in vitro cultures through axillary bud induction.
6. Initiation of callus cultures from different explants.
7. Preparation of artificial seed/synthetic seed for conservation of germplasm.
8. Extraction of DNA/RNA from plants and its estimation.
9. Isolation and characterization of plant secondary metabolites from selected medicinal plants.
10. Extraction of proteins from plants and its estimation.

Text Books / References:

1. Hudson T Hartmann: Plant Propagation-Principle and Practices, Pearson Education India; 8 editions, 2015
2. Principles of Plant Biotechnology- An Introduction of Genetic Engineering in Plants by S.H. Mantell, J.W. Mathews and R.A. Mckee, Blackwell Scientific Publications, 1985
3. Chopra V L, Sharma R P &Swaminathan M S: Agricultural Biotechnology by Science Pub Inc.,1996
4. Hamish A, Collin & Sue Edwards: Plant Cell Culture, BIOS Scientific Publishers, 1998
5. Razdan M K: An Introduction to Plant Tissue Culture, Science Publishers 2003
6. Plant Tissue Culture: Theory and Practice by S.S. Bhojwani M.K. Razdan, Elsevier Science, 1996
7. H.S. Chawla. Plant Biotechnology, Oxford & IBH Publishing 2020

Subject – Animal Biotechnology

Course Outcome (CO): -	
CO 1:	Students will be able to understand basics of animal tissue culture and its importance.
CO 2:	Students will be able to understand techniques to establish animal cell cultures invitro as well as different types of reactors and their working learn the strategies involved in developing clones in lab.
CO 3:	Students will be able to understand the methods of transgene delivery and production of transgenic animals.
CO 4:	Students will be able to understand the process of stem cell differentiation and their applications with case studies.

Course Content:

Unit I: Basic cell culture techniques, Types of cell culture media; Ingredients of media; Physiochemical properties; CO2 and bicarbonates; Buffering; Oxygen; Osmolarity; Temperature; Surface tension and foaming; Balance salt solutions; Antibiotics growth supplements; Foetal bovine serum; Serum free media; Trypsin solution; Selection of medium and serum; Conditioned media; Other cell culture reagents; Preparation and sterilization of cell culture media, serum and other reagents.

Unit II: Different tissue culture techniques; Types of primary culture; Chicken embryo fibroblast culture; Chicken liver and kidney culture; Secondary culture; Trypsinization; Cell separation; Continuous cell lines; Suspension culture; Organ culture etc.; Behavior of cells in culture conditions: division, growth pattern, metabolism of estimation of cell number; Development of cell lines; Characterization and maintenance of cell lines, stem cells; Cryopreservation; Common cell culture contaminants.

Unit III: Cell cloning and selection; Transfection and transformation of cells; Commercial scale production of animal cells, stem cells and their application; Application of animal cell culture for in vitro testing of drugs; Testing of toxicity of environmental pollutants in cell culture; Application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.

Unit IV: Cell culture reactors; Scale-up in suspension; Scale and complexity; Mixing and aeration; Rotating chambers; Perfused suspension cultures; Fluidized bed reactors for suspension culture; Scale-up in monolayers; Multi Surface propagators; Multiarray disks, spirals and tubes; Roller culture; Microcarriers; Perfused monolayer cultures; Membrane perfusion; Hollow fiber perfusion; Matrix perfusion; Microencapsulation; Growth monitoring.

Unit V: Transgenic animal production; Methods of transgene delivery; Integration of foreign genes and their validation; Gene targeting; Methods and strategies; Improving transgene integration efficiency; Cell lineages and developmental control genes in drosophila and mice; Differentiation of germ layers; Cellular polarity; Stem cell differentiation; Blood cell formation; Fibroblasts and their differentiation; Differentiation of cancerous cells and role of protooncogenes.

Practical

1. Introduction to media, other relevant reagents and equipments required for various cell lines.
2. Basic and sophisticated methods of handling animal cells in culture.

3. Freezing and reviving the cell lines and maintaining them in culture.
4. Extraction of culture and preparing the samples for DNA/RNA/PROTEIN.
5. Staining of animal cells and counting in a microscope.

Text Books / References:

1. B. Hafez and E.S.E Hafez, Reproduction in farm animals, 7th Edition, Wiley Blackwell, 2000
2. G.E. Seidel, Jr. and S.M. Seidel, Training manual for embryo transfer in cattle (FAO Animal Production and Health Paper-77), 1st Edition, W.D. Hoard and sons FAO, 1991
3. I. Gordon, Laboratory production of cattle embryos, 2nd edition, CAB International, 2003
4. Louis-Marie Houdebine, Transgenic Animals: Generation and Use 5th Edition, CRC Press,1997

ख्वाजा मुईनुद्दीन चिश्ती भाषा विश्वविद्यालय, लखनऊ, उत्तर प्रदेश (भारत)
Khwaja Moinuddin Chishti Language University, Lucknow, U.P. (India)
U.P. STATE GOVERNMENT UNIVERSITY,
(Recognised Under Section 2(f) & 12(B) of the UGC Act, 1956 & B.Tech. Approved by (AICTE)

Professional Electives (Semester V)

Subject – (PE 411) Nano Biotechnology

Course Outcome (CO): -	
CO 1:	Students will know about the use of nanomaterial and nanotechnology in basic biology, biomedical and agro applications.
CO 2:	Students will learn how to design, fabricate nanomaterials and nanodevices.
CO 3:	Students will explore biomimetic nanotechnology, protein-based nanostructures, DNA nanotechnology, and their applications in microarray platforms, lab-on-a-chip devices, and tissue engineering.
CO 4:	Students will evaluate the use of nanomaterials in drug delivery and biosensing, and assess their health impacts, including routes of entry and toxic effects on humans, plants, and microbes.

Course Content:

Unit 1: Duality of light, de Broglie waves, electrons in potential well, structure of hydrogen atom, classic atomic bonding, LCAO theory, band theory, energy bands for metals, semi-conductors and insulators, crystal structure, close packed structures – FCC, HCP and BCC, surface structure for close-packed surfaces, surface reconfiguration (surface relaxation & surface reconstruction) adsorption, wetting, surface area in nanomaterials.

Unit 2: Carbon nanotubes (CNT), fullerene ('C60'), quantum dots and semiconductor nanoparticles, metal-based nanostructures, nanowires, polymer-based nanostructures, gold nanostructures, X-ray diffraction, electron microscopy, interaction between electron beam and solids, TEM, SEM, SPM (STM & AFM), AES, XPS, SIMS.

Unit 3: Biomimetic nanotechnology, protein-based nanostructures, Nano motors, bacterial (E. coli) and mammalian (Myosin family), DNA nanotechnology, nanostructures in cells study, microarray platforms, Nano printing of DNA, RNA, and proteins biochips applications in nano scale detection, lab-on-a-chip devices (LOC), tissue engineering.

Unit 4: Micro- and Nano electromechanical devices in drug delivery, other applications in drug delivery, photodynamic therapy in targeted drug administration, Nano biosensors, applications of quantum dots in biotechnology, DNA based nanomaterials as biosensors.

Unit 5: Engineered nanomaterial of relevance to human health, routes of entry into the body, toxic effects on health, plants and microbes are nanofactories.

Text Books/References:

1. Fundamentals and applications of nanomaterials by Guo Z and Tan L, Artech house (2009).
2. Nanobiotechnology by Balaji S, MJP Publishers (2010).
3. Nanobiotechnology: concepts, applications and perspectives by Niemeyer CM and Mirkin CA, Wiley-VCH (2004).
4. Introduction to Nanoscience by Lindsay SM, Oxford University Press (2010).

Subject – (PE 301) Big Data Analytics

Course Outcome (CO): -	
CO 1:	Student will identify Big Data and its Business Implications.
CO 2:	Student will learn the components of Hadoop and Hadoop Eco-System.
CO 3:	Student will learn to access and process Data on Distributed File System.
CO 4:	Student will learn to manage Job Execution in Hadoop Environment.

Course Content:

Unit I: Types of Digital Data, Introduction to Big Data, Big Data Analytics, History of Hadoop, Apache Hadoop, Analysing Data with Unix tools, Analysing Data with Hadoop, Hadoop Streaming, Hadoop Echo System, IBM Big Data Strategy, Introduction to Infosphere Big Insights and Big Sheets.

Unit II: HDFS (Hadoop Distributed File System), The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures.

Unit III: Map Reduce, Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features.

Unit IV: Hadoop Eco System Pig : Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators. Hive : Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions. Hbase HBasics, Concepts, Clients, Example, Hbase Versus RDBMS, Big SQL.

Unit V: Data Analytics with RMachine Learning : Introduction, Supervised Learning, Unsupervised Learning, Collaborative Filtering. Big Data Analytics with BigR.

Text Books

1. Tom White " Hadoop: The Definitive Guide" Third Edit on, O'reily Media, 2012.
2. Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley 2015.

Subject – (PE 403) Rational Drug Discovery

Course Outcome (CO): -	
CO 1:	Students will understand the drug discovery process and the role of bioinformatics and computer-aided methods in ligand design, target validation, and lead optimization.
CO 2:	Students will grasp the concept of molecular mechanics force fields, including electrostatic and van der Waals interactions, and apply energy minimization techniques to bond structures and bending angles.
CO 3:	Students will apply molecular dynamics methods to simulate molecular behavior, study solvent effects, and analyze conformational changes under various conditions.
CO 4:	Students will use molecular docking, lead optimization, pharmacophore derivation, and QSAR techniques to predict drug-likeness, optimize compounds, and validate lead structures.

Course Content:

Unit-I Molecular Modelling in Drug Discovery:

Drug discovery process, Role of Bioinformatics in drug design, Methods of computer aided drug design, ligand design methods, drug design approaches, Target identification and validation, lead optimization and validation, Structure and ligand-based drug design, modelling of target-small molecule interactions, Molecular simulations. Protein Modelling.

Unit-II Quantum Mechanics and Molecular Mechanics:

Features of molecular mechanics force fields; Bond structure and bending angles – electrostatic, van der Waals and non – bonded interactions, hydrogen bonding in molecular mechanics; Derivatives of molecular mechanics energy function; Application of energy minimization.

Unit-III Molecular Dynamics simulation methods:

Molecular Dynamics using simple models; Molecular Dynamics with continuous potentials and at constant temperature and pressure; Time – dependent properties; Solvent effects in Molecular Dynamics; Conformational changes from Molecular Dynamics simulation and application.

Unit-IV Molecular Docking and lead optimization:

Molecular Docking; Types of Molecular Docking, docking algorithms and programs, Structure-based methods to identify lead compounds; de novo ligand design; Applications of 3D Databases Searching and virtual Screening; Strategy for target identification and Validation, lead identification, optimization and validation. Combinatorial chemistry and library design, virtual screening, drug likeness and compound filtering, Absorption, distribution, metabolism, excretion and toxicity (ADMET) property prediction, computer-based tools for drug design.

Unit-V Pharmacophore and QSAR:

Pharmacophore derivation, 3D pharmacophore prediction and application in drug discovery; QSARs and QSPRs, QSAR Methodology, Various Descriptors used in QSARs: Electronic; Topology; Quantum Chemical based Descriptors. Use of Genetic Algorithms, Neural Networks and Principal Components Analysis in the QSAR equations.

Text Books/References:

1. Computational methods in drug design Fred E. Cohen, Walter Hamilton Moos Publisher: ESCOM Science, 1993.

2. Molecular Modelling for Beginners - Alan Hinchliffe Publisher: John Wiley & Sons Inc, 2008. ISBN: 978-0470513149.

3. Combinatorial Library Design and Evaluation: Principles, Software, Tools, Applications in Drug Discovery – Arup Ghose, Vellarkad Viswanadhan Publisher: CRC Press, 2001. ISBN: 0-8247-0487-8.

4. Molecular Modeling Basics - Jan H. Jensen Publisher: CRC Press, 2010. ISBN 978-1420075267.

5. 3D QSAR in Drug Design: Recent Advances – Hugo Kubinyi, Gerd Folkers, Yvonne C. Martin Publisher: Springer Science & Business Media. ISBN: 0-306-46858-1.

6.

Computational Chemistry and Molecular Modeling - K. I. Ramachandran, Gopakumar Deepa, Krishnan Namboori Publisher: Springer – Verlag Berlin Heidelberg. ISBN: 978- 3540773023.

Subject – (PE 306) Stem Cell Technology

Course Outcome (CO): -	
CO 1:	Students will understand the principles, properties, and types of stem cells, including their niches in various tissues and the differences between embryonic and adult stem cells.
CO 2:	Students will analyze cell cycle regulators, differentiation, reprogramming, and epigenetic modifications affecting stem cell self-renewal and therapeutic potential.

CO 3:	Students will explore sources of stem cells, including amniotic fluid and cord blood, and understand procedures for transplantation, donor selection, and cryopreservation.
CO 4:	Students will gain hands-on experience with stem cell isolation, differentiation techniques, and understand their applications in treating diseases and ethical considerations in stem cell research.

Course Content:

Unit I: Introduction to Stem Cells: Principles and properties of stem cells, types of stem cells, comparison of embryonic and adult stem cells, Introduction to stem cell niches in gut epithelium, bone marrow, epidermis, testis and neural tissues.

Unit II: Cell Cycle and Development: Cell cycle regulators and checkpoints, cell fusion, differentiation of stem cells and their role in self-renewal, DNA-methylation and histone modifications, genomic imprinting, telomerase regulation, X-chromosome inactivation, reprogramming of cells, induced pluripotent stem cells and their therapeutic applications.

Unit III: Types and Regeneration: Stem cells derived from amniotic fluid, extra embryonic membrane, germ cells, hematopoietic organs, neurons and kidney, cord blood transplantation, donor selection, HLA matching, patient selection, peripheral blood and bone marrow transplantation, bone marrow and cord blood collection procedures and cryopreservation and their applications.

Unit IV: Experimental Methods: Isolation and differentiation of human adult stem cells, embryonic stem cells and mouse stem cells, stem cell techniques: fluorescence activated cell sorting (FACS), time lapse video, green fluorescent protein tagging.

Unit V: Applications: Stem cells applications in cancer, diabetes, heart disease, muscular dystrophy, regeneration of epidermis; stem cell regulations, debate, social and ethical concerns, Organ farming.

Text Books/References:

1. Hematopoietic Stem Cell Transplantation by Treleaven, J., first edition 2009.
2. Essentials of Stem Cell Biology by Lanza, R., second Edition, 2009 Academic Press.
3. Molecular Cell Biology by Lodish et al., sixth Ed., W.H. Freeman & Co. 2008.
4. Stem Cells: From Bench to Bedside by Bongso and Ariff.

Professional Electives
(Semester VI)

Subject – (PE 303) Genome Editing

Course Outcome (CO): -	
CO 1:	Students will understand traditional gene editing techniques, including homologous recombination, RNAi, and Cre-LoxP and Flp-FRT systems for gene knockout and functional studies.
CO 2:	Students will explore advanced engineered enzyme systems such as ZFNs, TALENs, meganucleases, and CRISPR/Cas9, including their mechanisms and applications in targeted gene editing.
CO 3:	Students will learn to design single-guide RNAs (sgRNAs) and apply Multiplex Automated Genomic Engineering (MAGE) for targeted gene mutations and complex genomic modifications.
CO 4:	Students will examine applications of gene editing in gene therapy, chromosome rearrangements, transgenic animals, GM plants, and evaluate the ethical, safety, and risk considerations associated with these technologies.

Course Content:

Unit I: Overview of traditional methods: homologues recombination for gene knockout. RNAi system, Cre-LoxP and Flp-FRT systems.

Unit II: Engineered enzyme systems: Zinc finger nucleases (ZFNs), transcription-activator like effector nucleases (TALEN), meganucleases and the clustered regularly interspaced short palindromic repeats (CRISPR/Cas9) system.

Unit III: Design of sgRNA. Multiplex Automated Genomic Engineering (MAGE). Applications in targeted gene mutation.

Unit IV: Gene therapy, creating chromosome rearrangement, Study gene function with stem cells, Transgenic animals, Endogenous gene labeling, targeted transgene addition.

Unit V: GM plants, application is biofuel production and in bioremediation. Ethics, safety and risk of targeted gene editing.

Text Books/References:

1. CRISPR Gene Editing, Methods and Protocols, Editors: Luo, Yonglun (Ed.)
2. Genome Editing and Engineering, From TALENs, ZFNs and CRISPRs to Molecular Surgery. Edited by Krishnarao Appasani.
3. Progress in Molecular Biology and Translational Science Vol 149-Genome Editing in Plants. Edited by Donald P. Weeks and Bing Yang. Academic Press.

Subject – (PE 305) Biosimilars Technology

Course Outcome (CO): -	
CO 1:	Understand the principles of biologics and biosimilars, including their definitions, market potential, and regulatory challenges.
CO 2:	Identify and differentiate various types of biosimilar drugs, including peptides, proteins, antibodies, and cell-based therapies.
CO 3:	Apply characterization methods to assess protein structure, stability, and aggregation, using analytical and spectrophotometric techniques.
CO 4:	Analyze bioequivalence and immunogenicity of biosimilars, including experimental designs, statistical considerations, and regulatory references from key publications like the ORANGE and PURPLE BOOK.

Course Content:

Unit I: Introduction to Biopharma

Generics in Biopharma, definition of biologics, biosimilars, super biologics, differences between chemical genetics and biosimilars, The developmental and regulatory challenges in biosimilar development, Prerequisites for Biosimilar development, Biosimilar market potential.

Unit II: Types of biosimilar drugs

Peptides, proteins, antibodies, Enzymes, Vaccines, Nucleic acid based therapies (DNA, RNA, etc), Cell based therapies (including stem cells).

Unit III: Characterization methods

Aggregation- precipitation, floccule strength, precipitate ageing & kinetics, adsorption of proteins & peptides on surfaces, effect of temperature on protein structure, hydration & thermal stability of proteins - solid powders, suspension on non-aqueous solvents, reversed micelles, aqueous solution of polyols, analytical and spectrophotometric characterization of proteins, protein sequencing and structure determination.

Unit IV: Bioequivalence studies

Immunogenicity & allergenicity of biosimilars; factors affecting immunogenicity - structural, post-translational modifications, formulations, impurities, manufacturing and formulation methods for biosimilars; types of bioequivalences (average, population, individual), experimental designs & statistical considerations for bioequivalence studies (non-replicated designs – General Linear Model, Replicated crossover designs), introduction to "ORANGE BOOK" & "PURPLE BOOK".

Unit V: Case studies

Indian companies working in this space & their product pipeline (Biocon, Intas, Dr Reddy's, Reliance, Bharat Biotech, Lupin, Cipla, Shanta, etc); products - Erythropoietin, growth hormone, granulocyte stimulating factors, interferons, streptokinase, monoclonal antibodies.

Text Books/References:

1. Laszlo Endrenyi, Paul Declerck and Shein-Chung Chow, Biosimilar Drug Development, Drugs and Pharmaceutical Sciences, Vol 216, CRC Press.

2. Cheng Liu and K. John Morrow Jr., Biosimilars of Monoclonal Antibodies: A Practical Guide to Manufacturing, Preclinical and Clinical Development, Wiley, Dec 2016.

Subject – (PE 302) Machine Learning

Course Outcome (CO): -	
CO 1:	Understand and apply various machine learning algorithms, including supervised, unsupervised, and reinforcement learning methods, to real-world problems.
CO 2:	Implement and evaluate linear models such as Perceptrons, Multi-layer Perceptrons, and Support Vector Machines for classification and regression tasks.
CO 3:	Develop and optimize decision trees, ensemble methods, and probabilistic models to improve predictive performance and handle complex data structures.
CO 4:	Utilize dimensionality reduction techniques and evolutionary algorithms to enhance model efficiency and address high-dimensional data challenges.

Course Content

Unit I: Introduction

Learning – Types of Machine Learning – Supervised Learning – The Brain and the Neuron – Design a Learning System – Perspectives and Issues in Machine Learning – Concept Learning Task – Concept Learning as Search – Finding a Maximally Specific Hypothesis – Version Spaces and the Candidate Elimination Algorithm – Linear Discriminants – Perceptron – Linear Separability – Linear Regression.

Unit II: Linear Models

Multi-layer Perceptron – Going Forwards – Going Backwards: Back Propagation Error – Multi-layer Perceptron in Practice – Examples of using the MLP – Overview – Deriving Back-Propagation – Radial Basis Functions and Splines – Concepts – RBF Network – Curse of Dimensionality – Interpolations and Basis Functions – Support Vector Machines.

Unit III: Tree and Probabilistic Models

Learning with Trees – Decision Trees – Constructing Decision Trees – Classification and Regression Trees – Ensemble Learning – Boosting – Bagging – Different ways to Combine Classifiers – Probability and Learning – Data into Probabilities – Basic Statistics – Gaussian Mixture Models – Nearest Neighbor Methods – Unsupervised Learning – K means Algorithms – Vector Quantization – Self Organizing Feature Map.

Unit IV: Dimensionality Reduction and Evolutionary Models

Dimensionality Reduction – Linear Discriminant Analysis – Principal Component Analysis – Factor Analysis – Independent Component Analysis – Locally Linear Embedding – Isomap – Least Squares Optimization – Evolutionary Learning – Genetic algorithms – Genetic Offspring: - Genetic Operators – Using Genetic Algorithms – Reinforcement Learning – Overview – Getting Lost Example – Markov Decision Process.

Unit V: Graphical Models

Markov Chain Monte Carlo Methods – Sampling – Proposal Distribution – Markov Chain Monte Carlo – Graphical Models – Bayesian Networks – Markov Random Fields – Hidden Markov Models – Tracking Methods.

Text Books:

1. Stephen Marsland, — Machine Learning – An Algorithmic Perspectivel, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.

2. Tom M Mitchell, —Machine Learningl, First Edition, McGraw Hill Education, 2013.

3. Jeeva Jose, - Introduction to Machine Learning using Pythonl, First Edition, Khanna Publishing House, 2019.

Subject – (PE 405) State of the art Imaging

Course Outcome (CO): -	
CO 1:	Master advanced imaging techniques, including confocal and super-resolution microscopy, to overcome limitations of traditional imaging methods.
CO 2:	Apply deterministic functional imaging techniques such as STED, GSD, and SSIM for high-resolution biological imaging.
CO 3:	Utilize stochastic optical reconstruction methods like STORM and PALM for precise localization and detailed structural analysis.
CO 4:	Integrate multi-photon imaging, CT, PET, MRI, and AI-based image recognition for comprehensive tissue analysis and real-time imaging applications.

Course Content:

Unit I: Overview and limitations of traditional imaging methods. Confocal microscopy, Super-resolution microscopy.

Unit II: Deterministic functional techniques- Stimulated emission depletion (STED), Ground state depletion (GSD), Saturated structured illumination microscopy (SSIM).

Unit III: Stochastic optical reconstruction microscopy (STORM), photo activated localization microscopy (PALM) and fluorescence photo-activation localization microscopy (FPALM).

Unit IV: Points accumulation for imaging in nanoscale topography (PAINT), Label-free localization microscopy.

Unit V: Multi-photon imaging systems, Real time imaging, computerized tomography (CT) imaging, Positron Emission Tomography (PET), Magnetic Resonance Imaging (MRI), Functional MRI (fMRI), Tissue imaging through mass spectroscopy. Image recognitions and artificial intelligence.

Text Books/References:

1. Super-Resolution Microscopy: A Practical Guide, By Udo J. Birk. Wiley

2. Super-Resolution Microscopy, Methods and Protocols,, Editors: Erfle, Holger (Ed.). Springer

3. Super-Resolution Imaging in Biomedicine, By Alberto Diaspro, Marc A. M. J. van Zandvoort. CRC Press

4. Magnetic Resonance Imaging: Physical and Biological Principles, By Stewart C. Bushong. Elsevier

5. Imaging Mass Spectrometry, Protocols for Mass Microscopy. Editors: Setou, Mitsutoshi.

ख्वाजा मुईनुद्दीन चिश्ती भाषा विश्वविद्यालय, लखनऊ, उत्तर प्रदेश (भारत)
Khwaja Moinuddin Chishti Language University, Lucknow, U.P. (India)
U.P. STATE GOVERNMENT UNIVERSITY,
(Recognised Under Section 2(f) & 12(B) of the UGC Act, 1956 & B.Tech. Approved by (AICTE)

Open electives

Open elective I (Semester V)

Subject – (OS 407) Food and Nutrition Technology

Course Outcome (CO): -	
CO 1:	Students will understand the historical development, scope, and modern applications of food biotechnology, including ancient processing techniques and biochemical pathways in food production.
CO 2:	Students will apply modern biotechnological methods for enhancing livestock productivity, animal product quality, and detecting contaminants in food.
CO 3:	Students will utilize biotechnological tools to produce food additives, process and preserve foods, and improve enzymes in the food industry.
CO 4:	Students will grasp the principles of bioreactor use, microbial applications in food manufacturing, and address ethical and safety concerns related to GMOs and food biotechnology in India.

Course Content:

Unit I: Introduction to food biotechnology:
Introduction, History and scope of food Biotechnology, development and prospects of biotechnology in animal products, ancient and traditional food processing techniques; Biochemical and metabolic pathways of biological systems used in food production.

Unit II: Methods in food biotechnology:
Role of biotechnology in productivity of livestock, Modern biotechnological methods and processes in animal product development, chemical and physical factors required for growing microbial cultures in nutritive substrate; Meat species identification, Quality control, Screening products for contaminants.

Unit III: Biotechnology methods in food processing:
Use of biotechnology in the production of food additives, use of biotechnological tools for the processing and preservation and foods of animal origin, use of biotechnology improved enzymes in food processing industry.

Unit IV: Bioreactors and food manufacturing:
Basic principles of the industrial use of bio-reactions for production of biomass-upstream and downstream processing application of microorganisms as starter cultures in meat industry, microbial production of food ingredients; Biosensors and novel tools and their application in food science.

Unit V: Food safety & security:

Consumer concerns about risks and values, biotechnology & food safety, Ethical issues concerning GM foods; testing for GMOs; current guidelines for the production, release and movement of GMOs; Future and applications of food biotechnology in India.

Text Books/References:

1. Potter, Norman. M. Food Science, 5th Ed. Springer US
2. Manay, S.; Shadakshara Swamy, M., (2004). Foods: Facts and Principles, 4 th Ed. New Age Publishers.
3. B. Srilakshmi., (2002) Food Science, New Age Publishers.
4. Meyer, (2004). Food Chemistry. New Age
5. Deman JM. (1990) Principles of Food Chemistry. 2 nd Ed. Van Nostrand Reinhold, NY
6. Ramaswamy H and Marcott M. Food Processing Principles and Applications. CRC Press

Course Outcomes: On completion of this course, students should have gained knowledge about recent advances in biotechnology related to food technology.

Open Elective II (Semester VI)

Subject – (OS 411) Bioterrorism and National Security

Course Outcome (CO): -	
CO 1:	Students will define and differentiate between traditional and new forms of terrorism, including bioterrorism, and understand the historical context and psychological aspects of bioterrorism.
CO 2:	Students will identify primary classes of microbes and their interactions with the immune system, detailing how these interactions impact health and bioterrorism threats.
CO 3:	Students will analyze the characteristics, symptoms, and epidemiology of bioterrorism agents, including their methods of dispersal and case studies of key biological threats.
CO 4:	Students will evaluate strategies for bioterrorism prevention and control, including surveillance, detection, response, and ethical considerations in information management and public communication.

Course Content:

Unit I: Terrorism and Bioterrorism

Definition-Traditional Terrorists-New Terrorists-Nuclear, chemical, and radiological weapons-The psychology of Bioterrorism-Historical perspective.

Unit II: Microbes and Immune System

Primary classes of Microbes-bacteria, virus, and other Agents-Immune systemInteraction between microbes and the immune system.

Unit III: Bioterrorism Weapons and Techniques

Characteristics of microbes and the reasons for their Use, Symptoms, Pathogenicity, Epidemiology-natural and targeted release, The biologicaltechniques of dispersal, and case studies of Anthrax, Plague-Botulism, Smallpox, and Tularemia and VHF.

Unit IV: Prevention and Control of Bioterrorism

Surveillance and detection- Detection equipment and sensors, Diagnosis-TreatmentVaccinations, Supplies- Effectiveness, Liability, Public Resistance, Response, First Responders, Infectious Control by hospital and Prevention, , Protection, Decontamination Notification, Role of Law Enforcement-Economic impact.

Unit V: Bioterrorism Management

Ethical issues: personal, national, the need to inform the public without creating fear, cost-benefit Rations-Information Management-Government control and industry Support-Microbial forensics.

Text Books:

1. Bioterrorism: Guidelines for Medical and Public Health Management, Henderson, Donald, American Medical Association, 1st Edition, 2002.
2. Biological Weapons: Limiting the Threat (BCSIA Studies in International Security), Lederberg, Joshua (Editor), MIT Press ,1999.
3. Bioterrorism and Infectious Agents: A New Dilemma for the 21st Century (Emerging Infectious Diseases of the 21st Century), I.W. Fong and Kenneth Alibek, Springer, 2005.

Reference Books:

1. The Demon in the Freezer: A True Story, Preston, Richard, Fawcett Books, 2003.
2. The Anthrax Letters: A Medical Detective Story, Cole, Leonard A., Joseph Henry Press, 2003.
3. Biotechnology research in an age of terrorism: confronting the dual use dilemma, National Academies of Science, 2003.