CSB2101   Cell Biology and Biochemistry   [3-0-3-4]

Introduction to Cell and Cell cycle: Cell structure- Prokaryotic and Eukaryotic Cell Structures, Cell cycle and check points, role of cyclins and CDK in cell cycle and its regulation. Types of Cellular Transport, cell-cell communication, Types of cell surface receptors.

Carbohydrate Biosynthesis pathways, their regulation, and metabolism: Gluconeogenesis, Glyoxylate, Glycolysis, Pentose phosphate pathway, Citric acid cycle, Oxidative Phosphorylation and Photophosphorylation, Photosynthesis, Respiration, and Electron transport chain.

Lipid Biosynthesis pathways, their regulation and metabolism: Fatty acids, Hormones, Neurotransmitters, Oxidation of Fatty acids, Transport of fatty acid, beta-oxidation, Ketone bodies

Protein Biosynthesis pathways, their regulation, and metabolism: Amino Acids, Structure of Protein, Protein folding, Amino acid oxidation and production of Urea - Metabolic fates of amino groups, Nitrogen excretion, and the urea cycle, Amino acid degradation, Nitrogen metabolism, Biosynthesis of amino acids

Nucleic acid Biosynthesis pathways, their regulation, and metabolism: Structure of DNA and RNA, Nucleotides Biosynthesis, and Nucleotides degradation.

Biomolecules associated with different disorders and their possible treatment.

Lab experiments:

1.   Basics of Biochemistry Lab
2.   Qualitative Analysis of Carbohydrates
3.   Qualitative Analysis of Lipids
4.   Qualitative Analysis of Amino acids and Proteins
5.   Qualitative Analysis of Nucleic Acids
6.   Anthrone Method
7.   Di Nitro Salicylic Acid Method
8.   Zak's Method
9.   Lowry's/Bradford's Method
10.   Ninhydrin Method
11.   Diphenylamine Method
12.   Thin Layer Chromatography
13.   Colorimetric Method for the detection of Polyphenol
14.   Assay of Acid Phosphate Enzyme in Potato
15.   Estimation of RNA by Orcinal Reaction

References

1. Nelson, D. L. and Cox, M. M. *Lehninger Principles of Biochemistry* (8th ed.). W. H. Freeman & Co Ltd. 2021.
2. Berg, J.M., Gatto, G. J., Hines, J.K., Tymoczko, J. L., and Stryer, L. *Biochemistry* (10th ed.). W. H. Freeman & Co Ltd. 2023.
3. Conn, E., Stumpf, P. K., Bruening, G., and Doi, R. H. *Outlines of Biochemistry* (5th ed.). Wiley. 2009.
4. Voet, D. J., Voet, J. G., and Pratt, C. W. *Principles of Biochemistry* (4th ed.). Wiley. 2012

5. Sathyanarayana, U. *Biochemistry.* (5th ed.). Elsevier India. 2017.

CSB2102   Genetics and Molecular Biology   [3-1-0-4]

Principles of Genetics: Genome Organization in prokaryotes and eukaryotes, DNA content and C-value paradox. Molecular structure of DNA and RNA, Forms of DNA and RNA, Introduction to laws of genetics, Gene interaction and linkage, extra-chromosomal inheritance, Sex determination, sex linked, sex limited and sex influenced inheritance.

DNA Replication: DNA replication- Semi conservative replication - Replication in prokaryotes and eukaryotes, Mutation and its types, DNA repair systems - methylation, mismatch repair, Photo reactivation repair, SOS repair, recombination repair.

Transcription: Transcription in prokaryotes and eukaryotes, Role of sigma factor in transcription, role of promoters and enhancers. Post- Transcriptional modifications.

Translation: Translation of prokaryotes and eukaryotes, post-translational modifications Regulation of gene expression in prokaryotes and eukaryotes, Gene silencing: antisense technique, RNA interference, Ribozymes.

References

1. David Friefelder. *Molecular Biology*. (6th edition). Narosa Publ. House. 2003.
2. Monroe W Strickberger. *Genetics*. (3rd edition). Macmillan Pub. Newyork.
3. Gardener, Simmons and Slustad. *Principles of Genetics*. (7th edition). Wiley Pub.
4. David R. Hyde. *Genetic and Molecular Biology*. (4th edition). Tata McGraw Publications. New Delhi. 2010.

CSB2120   R Programming   [3-1-0-4]

Introduction to R software: Basic fundamentals, installation and use of software, data editing, use of R as a calculator, functions and assignments, functions and matrix operations, missing data and logical operators, conditional executions and loops, data management with sequences, Data management (DM), Data frames, import of external data in various file formats, statistical functions, data compilation, Graphics and plots, statistical functions for central tendency, variation, skewness and kurtosis, handling of bivarite data through graphics, correlations, programming and illustration with examples.

Probability and statistical inference with R: Probability theory and random variables, Discrete and continuous probability distributions, sampling distributions, convergence of random variables, Central limit theorems and Law of large numbers, Statistical inference and point estimation, Methods of point estimation of parameters, Point and confidence interval estimation, Confidence interval estimation and test of hypothesis for attributes and other tests.

Sampling theory and linear regression analysis with R: Fundamentals of Sampling, Simple Random Sampling, Stratified Random Sampling, Bootstrap Methodology, Linear Models and Regression and Simple linear regression Analysis, Multiple Linear Regression Analysis.

References

1. Torsten Hothorn and Brian S. Everitt. *A Handbook of Statistical Analyses Using R*. (3rd edition). Chapman & Hall/CRC Press, Boca Raton, Florida, USA, 2014. ISBN 978-1-4822-0458-2.

2. Sarah Stowell. *Using R for Statistics*. (1st edition). Apress, 2014. ISBN 978-1484201404.
3. Michael J. Crawley. *Statistics: An Introduction using R*. (2nd edition). Wiley, 2014. ISBN 978-1-118-94109-6.
4. Victor A. Bloomfield. *Using R for Numerical Analysis in Science and Engineering.* (1st edition) Chapman & Hall/CRC, 2014. ISBN 978-1439884485.
5. Gergely Daróczi. *Mastering Data Analysis with R.* (1st edition). Packt Publishing, 9 2015. ISBN 9781783982028.

CSB2131   R Programming Lab   [0-0-3-1]

1. Download and Install R-Programming Environment and Install Basic Packages.
2. Learn the Basics of R-Programming (Data Types, Variables, Operators, etc.)
3. Implement R-Loops with different examples.
4. Learn the basics of functions in R and implement them with examples.
5. Implement data frames in R.
6. Implement different String Manipulation functions in R.
7. Implement different data structures in R(Vectors ,Lists ,Data Frames)
8. Read a CSV File and Analyze Data in R
9. Create Pie Charts and Bar Charts Using R.
10. Create a Data Set and Perform Statistical Analysis Using R.
11. Statistical analysis using R (Correlation, Covariance, principal component analysis)
12. Regression Modeling using R
13. Machine learning using R (build classification model using KNN algorithm)
14. Machine learning using R (build clustering model using K-mean algorithm).

CSB2240   Structural and Sequence Analysis   [3-0-0-3]

Sequence analysis of proteins: Overview of biomolecules: structure and domains, Chaperon assisted protein production, Effect of amino acids on protein structure, Sequence alignment, Principles of protein purification. **Protein structure prediction:** Structure determination; NMR sample preparation, Sample preparation for Cryo EM, X-ray crystallography, solution- and solid-state NMR spectroscopy, Single particle, Cryo Electron Microscopy, X-Ray Free-Electron Laser (XFEL). Anisotropy Use of Circular Dichroism. **Biological Databases and Aptamers:** Biological databases, Structure and organization of genomes, BioMagResBank (BMRB); Protein Structure Prediction; DNA and RNA secondary structures (duplex, triplex, quadruplexes and aptamers), RNA secondary structure prediction. Aptamer databases, structure prediction and modelling, modifications in aptamers. **Protein-Ligand stability:** Thermodynamic parameters of protein-ligand complex, molecular simulations, Protein functional dynamics, MD simulations, Protein dynamics studies by biophysical techniques.

Refrences

1. Keith Wilson and John Walker, *Principles and Techniques of Biochemistry and Molecular Biology*, 8th Edition, Cambridge University Press, UK, 2018.
2. Jean-Michel Claverie, Cedric Notredame, *Bioinformatics for Dummies*, Wiley, 2003.
3. David W. Mount, *Bioinformatics Sequence and Genome Analysis*, 8th Edition, Cold Spring Harbor Laboratory Press, 2004.

CSB2241   Immunodiagnostics & Vaccine Manufacturing   [3-0-0-3]

Introduction to Immunology: Specificity, memory, discrimination of self from non- self, Innate and Acquired immunity, Humoral and cell-mediated immune response. Cells of the immune system, cytokines, complement system. **Antibody, Antigens and Immune receptors:** Immunoglobins: structure, classes and function. Immunogenicity, antigenicity, epitopes-B cell epitopes, T cell epitopes, haptens, Antigen Recognition by immune system: recognition of antigens by T and B Cells. **Immunodiagnostics:** Antigen – Antibody Interaction, ELISA, Radial Immunodiffusion, Double Diffusion, Immunoelectrophoresis, Western Blot, Immunofluorescence. **Introduction to vaccines:** Different types of vaccines, Sub-unit vaccines, Nucleic acid vaccines, recombinant vaccines, synthetic vaccines. **Recent trends in vaccine production:** Vaccine delivery system and approaches to enhance immunogenicity, Large-scale production of vaccines and automation.

Refrences

1. Ivan M. Roitt and Peter J. Delves., *Roitt's Essential Immunology*, 12th Ed., Blackwell Scientific Publications, Oxford, 2012.
2. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne and Janis Kuby, *Kuby Immunology*, 7th Ed. W.H. Freeman and Co., New York, 2007.
3. Abbas K A and Litchman A. H., *Cellular and Molecular Immunology*, 8th Eds., W. B. Saunders Co. 2015.
4. R.M. Coleman, M.F. Lombard and R.E. Sichard, *Fundamental Immunology*, 5th Ed- Bookbarn International 2014.

CSB2220   Genetic Engineering   [3-1-0-4]

Introduction: Genetic engineering: gene cloning -concept and basic steps - rDNA Glossary, introduction to enzymes used in genetic engineering, Cloning and Expression Vectors. **Genomic libraries and Structural genomics:** Genomic library, cDNA library, Artificial chromosomes – BACs and YACs, Genome Analysis, Organization and structure of Genomes, genome complexity Sequencing genes and short stretches of DNA: Basic DNA Sequencing. **Sequencing and amplification of DNA:** Maxam Gilbert's and Sanger's methods of DNA sequencing. Next generation sequencing technologies, PCR- introduction, types and applications. **Introduction to Gene Mapping:** Genetic maps and Physical maps, STS content-based mapping, Restriction Enzyme Finger Printing, Hybridization mapping, Radiation Hybrid Maps, Optical mapping. ORF finding and functional annotation. **Applications of Genetic Engineering:** Applications in Medicine, Agriculture and Environmental, Food and Pharmaceutical studies.

Refrences

1. Old RW and Primrose SB, *Principles of Gene Manipulation: An Introduction to Genetic Engineering*, Blackwell Science Publications, 1993.
2. S.B.Primrose and R.M.Twyman, *Principles of Genome Analysis and Genomics*, 3rd Ed Wiley-Blackwell 2002.
3. Nicholl, Desmond S. T, *An Introduction to Genetic Engineering*, Cambridge University Press, 2008.
4. Saraswathy, N and Ramalingam, P (Eds.), *Concepts and Techniques in Genomics and Proteomics*, Woodhead Publishing, 2004.

CSB2270   Project based Learning 2   [L-T-P-C: 0-0-2-1]

Project-based Learning- 2 will be practical or simulation-based learning in the emerging areas.

CSB3101: BIOINFORMATICS [3 0 2 4]

I**ntroduction**: Biological Databases, structure and sequence analysis of biomolecules. **Sequence Analysis**: Introduction, types of Sequence alignment -Pairwise and Multiple sequence alignment, Global alignment, Local alignment, Dotplot, Different scoring methods, Substitution matrices (PAM and BLOSUM). Dynamic programming, Needleman-Wunsch algorithm, Smith-Waterman algorithm, Multiple Sequence Alignment methods (MSA), Scoring of a MSA, Progressive (CLUSTALW), Iterative and Hidden Markov Model (HMM), FASTA and BLAST algorithms. **Phylogenetic Analysis**: Phylogenetic tree and terminology, different methods of Phylogenetic tree prediction.

References:
1. Andreas D Baxevanis & B F Francis, Bioinformatics- A practical guide to analysis of Genes & Proteins, John Wiley, 2002
2. T K Attwood, D J Parry-Smith, Introduction to Bioinformatics, Pearson Education, 1st Edition, 11th Reprint 2005.
3. D.W. Mount, Bioinformatics: Genome and Sequence Analysis, Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York. 2001

CSB3120: Pharmaceutical Biotechnology [3 1 0 4]

Introduction: Drug and Pharmaceutical Industry, Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP). Regulatory aspects of quality control, pharmacopeia. **Pharmacokinetics:** Routes of drug administration, Absorption of Drugs - Passive and facilitated transport, Influence of pH on transport of molecules across membranes, Bioavailability. Distribution and Redistribution of drugs - Tissue storage, placental & brain transport. Biotransformation of drugs and types, Routes of excretion of drugs - Rate of Clearance and Plasma half-life. **Pharmacodynamics:** Principles and Mechanism of drug action on receptors, enzymes, ion channels and transporters. Transducer mechanism. Dose-Response Relationship, Therapeutic efficiency, Factors modifying drug action. **Pharmacovigilance** - Casualty assessment, Side, secondary and toxic effects of drugs, Accidental overdose of drugs and the treatment, Drug Intolerance and Drug allergy, Drug abuse and Treatment. Case studies on vaccine manufacturing.

References:
1. Laurence Brunton, Bjorn Knollmann, Randa Hilal-Dandan, Goodman and Gilman's - The Pharmacological Basis of Therapeutics, McGraw-Hill Education, 13th Edition 2018, ISBN: 978-1-25-958473-2.
2. Nicolay Ferrari, Rosanne Seguin, Oligonucleotide-Based Drugs and Therapeutics Preclinical and Clinical Considerations for Development, John Wiley & Sons, 1st Edition 2018.

CSB3121: Protein Engineering [3 1 0 4]

Introduction to Protein Engineering: Protein folding, misfolding & aggregation, Protein expression & purification systems, Post translational modifications, Protein structure determination (x-ray crystallography, NMR, Cryo-electron microscopy), Protein stability (enzymatic, thermodynamic and kinetic), Basic concepts for design of a new protein/enzyme molecule. Combinatorial protein engineering: Directed evolution, Site directed mutagenesis, Rational engineering: Backbone reversal, Surface reengineering to prevent aggregation, Enzyme active site remodelling, De novo engineering: computational protein design methods, Case studies of protein engineering (e.g.: Dihydrofolate reductase, Subtilisin).

References:
1. Jeffrey L. Cleland & Charles S. Craik (Eds), Protein Engineering: Principles and Practice, Wiley (1996).
2. Sheldon J. Park & Jennifer R. Cochran (Eds) Protein Engineering and Design, CRC Press (2009).

CSB3122: Bio-perl [3 1 0 4]

PERL PROGRAMMING: Perl overview, variables and data types, control Structure, loops- while loop, for loop, until loop, File handles - opening and closing files, reading and writing file handles, Library Functions: String specific functions, User defined functions. **OPERATORS**: Arithmetic Operators, Assignment Operators, Logical operators, Equality Operators, Increment and Decrement Operators, String Concatenation and Repetition, Operators precedence and Associativity, Conditional Operators, Logical Operators, Operators for manipulating arrays, Operators for Manipulating hashes. **REGULAR EXPRESSIONS:** Simple characters, * special character, . character, | character, grouping with () s, anchor characters, pattern matching, regular expression shortcuts, defining subroutines, returning values, using arguments, inheritance in Perl, polymorphism in Perl. **APPLICATIONS OF PERL IN BIOINFORMATICS**: Bio-perl Concatenating DNA Fragments, Transcription: DNA to RNA, Reading Protein Files, Finding Motifs, Simulating DNA, Generating Random DNA, Analyzing DNA, Translating DNA to Proteins, Reading DNA from Files in FASTA format, Separating Sequence and Annotation, Parsing Annotation, Parsing PDB files, Parsing BLAST output, Bio-perl.

References:
1. James Tisdall, Beginning Perl for Bioinformatics, O'Reilly & Associates, 2001
2. James Tisdall, Mastering Perl for Bioinformatics, O'Reilly, 2003

CSB3170   Project based Learning 3 [0-0-2-1]

Project based Learning- 3 will be focused on result analysis and interpretation, technical report writing and presentation skills.

CSB3101: Bioinformatics Lab   **[3 1 0 4]**

1. Retrieval of Data from Biological Database
2. Protein Sequence Retrieval from Uniprot
3. Global and Local Alignment
4. Dot Plot Sequence alignment
5. BLAST
6. Multiple Sequence Alignment and Phylogeny
7. Motif/Domain database search
8. PDB database
9. Protein secondary structure prediction
10. Protein 3D structure visualization
11. Primer Designing

CSB3130: Biostatistics Lab   **[0 0 2 1]**

1. Create a scatter plot to visually represent the relationship between two variables.
2. Create a histogram to represent the frequency distribution.
3. Create a frequency distribution table of the data provided and find the cumulative frequency.
4. Compute the standard deviation and coefficient of variation from the provided data.
5. Investigate the relationship via linear regression analysis.
6. Analyze the properties of the sampling distribution, including its mean, variance, and shape and interpret the findings to understand the implications for making inferences based on sample means.
7. Determine the probability distribution and analyze the data using binomial distribution to understand the likelihood of different outcomes.
8. Latin square experiment and analyze the data using analysis of variance (ANOVA) to determine significant differences.
9. Double-blind experiment to assess the efficacy
10. For a given dataset, utilize randomized complete block design (RCBD). Analyze the data using analysis of variance (ANOVA) to assess the significant differences.
11. Perform a Wilcoxon-Mann-Whitney Test to determine if there is a significant difference and state null and alternative hypotheses.
12. Analyze the data using a chi squared test.
13. Design a full factorial experiment.

CSB3241: **Transcriptomics and Gene Expression Informatics** **[3-0-0-3]**

RNA-seq workflows and preprocessing: Transcriptomics platforms, sequencing technologies, quality control using FASTQC and Trimmomatic. Read alignment (STAR), alignment-free quantification (Salmon, Kallisto), and read counting tools (featureCounts, HTSeq). Differential expression analysis: Normalization techniques (TPM, FPKM, DESeq2), DEG identification and visualization (MA plot, volcano plot), batch effect correction, case studies in cancer and neurological disorders. Functional and network-based interpretation: Functional annotation (GO, KEGG, Reactome), enrichment analysis tools (GSEA, DAVID, clusterProfiler), introduction to WGCNA for co-expression networks, network visualization using Cytoscape and STRING. Single-cell omics and biological insights: Principles of scRNA-seq, barcoding techniques, clustering and cell-type annotation (Seurat, Scanpy, SingleR, CellTypist), pseudotime analysis, and case studies in tumor microenvironment.

References

1. E. Korpelainen et al., RNA-seq Data Analysis, CRC Press, 2015.
2. V. Buffalo, Bioinformatics Data Skills, O'Reilly Media, 2015.
3. Bioconductor documentation and Seurat, Scanpy user guides.
4. NPTEL – Bioinformatics by Prof. Sowdhamini, IIT Delhi.
5. NCBS Bangalore, IISc Bangalore academic resources.

CSB3242: **Computer Vision in Biomedicine** **[3-0-0-3]**

Fundamentals of biomedical image analysis: Types of images (histopathology, X-ray, MRI, CT, microscopy), preprocessing techniques (filtering, thresholding, morphological operations), labeling tools (LabelImg, CVAT), biomedical image datasets (ISIC, TCIA, LUNA16). Deep learning for classification: CNN architectures (VGG, ResNet, EfficientNet), transfer learning, data augmentation, evaluation metrics for multi-class and multi-label classification problems. Medical image segmentation and localization: Techniques like semantic segmentation and object detection, architectures (U-Net, Mask R-CNN, DeepLabv3), applications such as tumor and cell segmentation, tools like MONAI, PyTorch Lightning, OpenCV. Explainable AI and clinical applications: Interpretability tools (Grad-CAM, saliency maps, SHAP), integration with omics data (radiogenomics), applications in oncology, dermatology, radiology, and ethical concerns in medical AI.

References

1. L. Zhou et al., Deep Learning for Medical Image Analysis, Academic Press, 2017.
2. MICCAI Conference Proceedings, ISIC, TCIA datasets.
3. Stanford, MIT, Kaggle biomedical tutorials.
4. Open-source tools: MONAI, PyTorch Lightning, OpenCV.
5. NPTEL and IIIT Hyderabad CVIT resources.

CSB4140: Python Programming for Biosciences [3-0-0-3]

Features of python, installing python packages via PIP, Variables, Assignment, Keywords, Input-output, Indentation, Basic data types, Operators and Expressions, Control structures; Python data structures. Strings - creation, accessing, operators, methods; Sets - creation, accessing, operators, methods; List comprehensions; Functions - defining functions, calling functions, passing arguments - keyword arguments, default arguments, variable-length arguments, anonymous functions (lambda); Classes, 'self-variable' methods, Constructor method, Inheritance, Overriding Methods, Data hiding. BIOPYTHON: Tetra nucleotide Frequency: Counting Things, Transcribing DNA into mRNA: Mutating Strings, Reading and Writing Files, Reverse Complement of DNA: String Manipulation, Computing GC Content: Parsing. FASTA and Analyzing Sequences, Functional Programming, Exploring Sequence Similarity, Motifs. Applications and case studies: end to end ML pipeline using python, handling real world datasets, introduction to deep learning libraries.

References

1. Mitchell L. Model, "Bioinformatics Programming Using Python: Practical Programming for Biological Data (Animal Guide)", 1st edition, O'Reilly Media, 2009.
2. Tim J. Stevens, Wayne Boucher, "Python Programming for Biology: Bioinformatics and Beyond", 1st edition, Cambridge University Press, 2015.
3. David Beazley, "Python essential reference", 2nd edition, New Riders, 2001.

CSB4141: Legal and Ethical Aspects of Health Informatics [3-0-0-3]

Ethical Issues in Biomedical and Health Informatics, Health-Informatics Applications: Appropriate Use, Users, and Contexts, Privacy, Confidentiality, and Data Sharing, Social Challenges and Ethical Obligations, Legal and Regulatory Matters. Ethical Standards, Ethical Decisions and Challenges, Bioethics Issues. Patient Record Requirements, Confidentiality and Informed Consent, Access to Health Information, Specialized Patient Records. Risk Management, Quality Management, and Utilization Management, Information Systems, Health Care Fraud and Abuse, Law and Ethics in the Workplace. Professional ethics for public health practitioners: Developing empathy, resolving conflicts and building consensus, conflict of interest, issues of integrity, transparency and accountability, communication skills, etc.

References

1. R. A. Spinello, Cyberethics: Morality and Law in Cyberspace, 6th ed., Burlington, MA: Jones & Bartlett Learning, 2020.
2. F. G. Miller, J. C. Moreno, and A. Caplan, Eds., The Ethics of Biomedical Big Data, Cham, Switzerland: Springer, 2016.
3. L. E. Terman, Biomedical Ethics in a Secular Society, 1st ed., West Conshohocken, PA: Templeton Press, 2020.
4. A. M. Rothstein, Health Privacy: The Medical and Genetic Information Privacy Handbook, Ann Arbor, MI: University of Michigan Press, 2020.

CSB4142: Genomics and Proteomics [3-0-0-3]

Brief overview of prokaryotic and eukaryotic genome organization and methods of preparing genomic DNA. DNA sequence analysis methods, Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing; Gene variation and Single Nucleotide Polymorphisms (SNPs); Expressed sequenced tags (ESTs), Genetic and physical maps; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, Recombinant DNA technology: DNA cloning basics, Human genome project and the genetic map. Introduction and scope of proteomics; Aims, strategies and challenges in proteomics. Transcriptome analysis for identification and functional annotation of gene, Contig assembly, chromosome walking and characterization of chromosomes, mining functional genes in genome, gene function- forward and reverse genetics, gene ethics; protein- protein and protein-DNA interactions; protein chips and functional proteomics; clinical and biomedical applications of proteomics; introduction to metabolomics, lipidomics, metagenomics and systems biology. Case studies and applications

References

1. Brown, T. A., Gene Cloning and DNA Analysis, An Introduction. Wiley –Blackwell publication. 2010.
2. Sandy B. Primrose, Richard M. Twyman. Principles of Gene Manipulation and Genomics, Blackwell Scientific Publication. 2009.
3. Old, R. W., Primrose, S. B., & Twyman, R. M., Principles of Gene Manipulation: An Introduction to Genetic Engineering. Oxford: Blackwell Scientific Publications. 2001.
4. Liebler, D. C. (2002). Introduction to Proteomics: Tools for the New Biology. Totowa, NJ: Humana Press.
5. Campbell, A. M., & Heyer, L. J. (2003). Discovering Genomics, Proteomics, and Bioinformatics. San Francisco: Benjamin Cummings.

CSB4143: AI and Systems Biology in Precision Medicine [3-0-0-3]

Deep learning for genomic modeling: Sequence encoding (one-hot, k-mers, embeddings), CNNs and RNNs for sequence modeling, use of frameworks like TensorFlow, PyTorch, Keras. Introduction to transformers (DNABERT, Enformer). Network biology and disease systems: Systems biology principles, GRNs, PPIs, metabolic and signaling networks. Topological features (hubs, bottlenecks), tools like Cytoscape and NetworkX, introduction to Graph Neural Networks. AI tools in drug discovery: Overview of the drug discovery pipeline, QSAR modeling, virtual screening, toxicity prediction using AI. Docking tools (AutoDock, SwissDock, DeepDock). Immunoinformatics and personalized therapies: Immune system overview, epitope prediction (NetMHC, IEDB), neoantigen identification.

References (IEEE format)

1. B. Ramsundar et al., Deep Learning for the Life Sciences, O'Reilly Media, 2019.
2. Y. Zhang and J. Rajapakse, Machine Learning in Bioinformatics, Wiley, 2009.
3. E. Klipp et al., Systems Biology: A Textbook, Wiley-VCH, 2016.
4. Tool documentation: NetMHC, IEDB, AutoDock, Cytoscape, AlphaFold2.