TRIPURA UNIVRERSITY
SURYAMANINAGAR: 799022

9/10/2020

Revised syllabus (CBCS) as approved by Board of Post Graduate Studies

Name of the Department: **Department of Molecular Biology and Bioinformatics**

Name of the Course Curriculum: **M.Sc. in Molecular Biology and Bioinformatics**

CORE COURSES

Sl No.	Course code	Subject Name of the Course	Credit	Semester number
Semester - I				
1.	Theory-I	Cell Biology	4	I
2.	Theory-II	Biomolecules and Molecular Biology	4	I
3.	Practical	Laboratory – I	4	I
Semester - II				
4.	Theory-I	Genetics	4	II
5.	Theory-II	Recombinant DNA Technology	4	II
6.	Practical	Laboratory – II	4	II
Semester - III				
7.	Theory-I	Immunology	4	III
8.	Theory-II	Structural Bioinformatics, Molecular Modelling and Drug Designing	4	III
9.	Practical	Laboratory – III	4	III
Semester - IV				
10.	Project	Project Work and Presentation	12	IV

ELECTIVE CORSES

Sl No.	Course Code	Subject Name of the Course	Credit	Semester Number
Semester - I				
1.	Elective I	Computer Skills	4	I
2.	Elective II	Fundamentals of Bioinformatics	4	I
Semester - II				
3.	Elective I	Bioinformatics - Genomics and Proteomics	4	II
4.	Elective II	Bioenergetics, Enzymes and Metabolism	4	II
Semester - III				
5.	Elective I	Statistics	4	III
6.	Elective II	Animal cloning, Tissue Culture (Animal and Plant)	4	III
Semester - IV				
7.	Elective I	Bioprocessing, Biophysical and Microbiological Techniques	4	IV
8.	Elective II	Biological Databases, Data Mining and Analysis	4	IV

Surajit Bhattacharjee 9/10/2020

Dr. Surajit Bhattacharjee
(Coordinator)

Prof. Samir Kumar Sil
(Convener)

M.Sc. Molecular Biology and Bioinformatics

Tripura University (A Central University)

Semester I

2020

MBB 701C - Cell Biology (Core) (Total Credit -4)

Course Outcomes

On completion of the course, the student should be able to:

CO1: Describe different types of cells, especially eukaryotic cells.

CO2: Identify functional and structural similarities and dissimilarities between prokaryotic and eukaryotic cells.

CO3: Able to distinguish characteristics of different types of animal and plants.

CO4: Describe structure and function of important cellular organelles and other cellular components.

CO5: Understand the fundamental facts regarding structure and function of cell membrane.

CO6: Understand the fundamental facts about cellular processes such as intracellulartransports, cellular growth and division and programmed death.

CO7: Understand the application of different techniques to study cells and organelles in the laboratory.

CO8: Independently use scientific literature for evaluating information about cellular processes.

Course content

Unit - I

History of cell biology, cell as basic unit of life, cell theory, protoplasm theory and organismal theory, broad classification of cell types, Bacteria, Archaea (prokaryotic) and eukaryotic cells and their similarities and differences. Evolution of cells, cell architecture.

Unit – II

Membrane structure and function: Structure and functions of cell wall: bacterial cell wall – plant cell wall and fungal cell wall, plasma membrane – exocytosis, endocytosis, phagocytosis Structure of model membrane, lipid bilayer and membrane proteins, fluid mosaic model, structure and function of lipid rafts and caveolae; ion channels and ion pumps. Electricalproperties of membranes.Membrane transport: Passive diffusion, osmosis, facilitated diffusion, primary and secondary active transport, uniport, symport and antiport. Patch clamp technique.

Unit – III

Structure and functions of cell organelles – nucleus, endoplasmic reticulum (rough endoplasmic reticulum and smooth endoplasmic reticulum), mitochondria, chloroplasts, Golgi apparatus, endosomes, lysosomes, microbodies (peroxysomes and glyoxysomes), vacuoles, ribosomes, centriole and basal bodies.

Unit – IV

Cellular Thermodynamics: Isolated, closed, open systems and cell. Order, disorder and cell. Thermodynamic parameters and cellular activities. Cellular equilibrium.

Unit – V

Cellular transport: Molecular mechanisms of membrane transport and the maintenance of compartmental diversity. Transport from ER to golgi apparatus, transport from the trans golgi network to lysosomes, transport into the cell from the plasma membrane (endocytosis), transport from the trans golgi network to the cell exterior (exocytosis).

Unit – VI

The cytoskeleton structure and function: Self-assembly and dynamic structure of cytoskeletal filaments, regulation of cytoskeletal filaments, molecular motors, cytoskeleton and cell behavior, muscle contraction.

Unit – VII

Cell junctions, cell adhesion and the extracellular matrix: Cadherins and cell-cell adhesion, tight junctions and the organization of epithelia, passageways from cell-cell: gap junctions and plasmodesmata, the basal lamina, integrins and cell matrix adhesions.

Unit – VIII

Cell division, cell cycle and cellular life span: Cell division cycle general strategies of the cell cycle, Mitosis and meiosis, cytokinesis, their regulation, steps in cell cycle and control of cell cycle. Programmed cell death, Cell life span and Senescence.

Unit – IX

Techniques to study cell structure and function: Light Microscopy and Electron Microscopy, Subcellular fractionation, Centrifugation, Cell culture.

Recommended Books:

1. Alberts, B. et al. (2014) Molecular Biology of the Cell. 6th edition. W. W. Norton & Co.
2. Karp G. (2013) Cell Biology, Wiley; Seventh edition.
3. Cooper, G. M. and Hausman, R. E. (2015) The Cell: A Molecular Approach. 7th edition. Sinauer Associates.
4. Lodish, H. et al. (2016) Molecular Cell Biology. 8th edition. W. H. C Freeman.
5. Phillips, R. et al. (2012) Physical Biology of the Cell. 2nd edition. Garland Science.

M.Sc. Molecular Biology and Bioinformatics

Tripura University (A Central university)

Semester I

2020

MBB 702C- Biomolecules and Molecular Biology (Core) (Total Credit -4)

Course Outcomes

On completion of the course, the student should be able to:

CO1: Independently use scientific literature for evaluating information about Biomolecules and Molecular Biology.

CO2: Understand about different chemical/biochemical concepts and about important compounds and reactions and of the properties of solutions to explain the biochemical background of different chemical and biological phenomena or processes.

CO3: Account for basic chemical concept such as chemical binding, reversible processes, chemical equilibrium.

CO4: Identify the most common biochemical building blocks and macromolecules and explain relationships between structure and function for these molecules and how their properties influence analysis of the molecules.

CO5: Describe how biomolecules (proteins, carbohydrates and lipids) are turned over in living cells and how the processes are regulated normally and under certain pathological conditions.

CO6: Generate basic idea about complete structures of DNA/RNA components, the different forms of nucleic acids (A, B, Z) and the types of amino acids that mediate backbone and sequence-specific binding.

CO7: Understand the biochemical information transfer i.e. the processes replication, transcription and translation and explain how the processes are controlled and regulated and further be able to discuss differences in these processes.

CO8: Explain and illustrate how differences at the genetic level can give effects at the biological level.

CO9: Explain the gene regulation at all levels, and the structure-function relationships of nucleic acids and proteins.

C10: Explain how the structure and chemistry of nucleic acids relate to their functions, their relative stability, and their interactions with proteins.

C11: Understand the regulation of protein and nucleic function by structure-function relationships and macromolecular interactions.

C12: Relate DNA structure to forms of DNA damage.

C13: Compare & contrast mechanisms of DNA replication, repair, recombination, transcription, gene regulation,

C14: Explain how recent genomics and functional genomics advances are altering our views of molecular biology.

Course content

Unit-I

Chemistry of life: Importance of Carbon, water, polymerization, permeability and self-assembly, energy and coordination of anabolism and catabolism. The chemical unity of life: chemical bonding and interactions– synthesis and cleavage of covalent bonds. Reactive species– electrophiles, nucleophiles and radicals. Types of organic reaction and mechanism (SN1, SN2, E1, E2). Properties of water– ionization of water, Kw– weak acids and weak bases – pH, pKa– buffers– Henderson Hasselbalch equation.

Unit-II

Proteins and Amino acids: Amino acids classification and chemistry. Proteins, primary structure, sequence determination, Ramachandran plot, peptide synthesis (automated solid phase), secondary, tertiary, quaternary, super secondary structures. Globular and fibrous proteins structures and functions (triple helix collagen, keratin, haemoglobin and myoglobin). Protein folding and dynamics, Molten globule state, Molecular chaperones, HSPs. Denaturation (pH, temperature, chaotropic agents) refolding, misfolding and aggregation- associated diseases-amyloid fibrils, inclusion bodies.

Unit-III

Carbohydrates: Monosaccharides, Stereochemistry, optical activity, specific reactions, Disaccharides, Oligosaccharides, Sugar derivatives. Homo and hetero polysaccharidesstructures and functions. Glycoproteins, Proteoglycans, Glycosaminoglycans, structures and biological functions. Bacterial cell wall polysaccharides, blood group substances and Sialic acid.

Lipids: Classification, structure, properties and functions of fatty acids, essential fatty acids, fats, phospholipids, sphingolipids, cerebrocides, steroids, bile acids, prostaglandins, lipo-amino acids, lipoproteins, proteolipids, phosphatidopeptides, lipopolysaccharides.

Unit-IV

DNA: Watson - Crick model of DNA structure- A, B and Z - DNA Cruciform structure in DNA, formation and stability of cruciforms, Polarity of strands. Parallel duplex. Pyrimidine-purine pyrimidine and pyrimidine- purine-purine triplexes. Quadruplexes and miscellaneous alternative conformations of DNA, slipped mispaired DNA, parallel stranded, palindrome and anisomorphic

DNA. DNA melting, denaturation, strand separation, Chemical and physical properties of nucleic acids (stability of nucleic acids, buoyant density, purity of DNA, effect of acids, alkali on DNA, viscosity, physical and thermal properties of nucleic acids). C value paradox, repetitive DNA, Genome Analysis and complexity. Cot, Rot analysis, Supercoiling of DNA topology, Linking number. Writhing and twisting, Super helix energy and topoisomerases.

RNA: Different types of RNA, RNA world hypothesis. Secondary and tertiary structure of RNA; RNA folding problems; Ribozymes; RNA interference Non sense mRNA mediated decay, RNA editing.

Unit-V

History of 20^{th} & 21^{st} century molecular biology, Genomics & 'Post-Genomics. DNA as the genetic material. DNA replication, Models of DNA replication (Semi-conservative, semi- discontinuous, bidirectional replication, rolling circle, mitochondrial D loop), Enzymolozy, Mechanisms and control. Recombination: Homologous recombination, transposition and site specific recombination;Mutation: Classification, random or spontaneous, agents, Repair: Proofreading and MMR, postreplication repair and SOS, photoreactivation repair,excision and DSB repair,

Unit-VI

Mechanism of Transcription: RNA Polymerase; Sigma Subunits; The Structure of Promoters; Enhancers and Enhancer-Binding Proteins; DNA, Abortive Initiation; Pre-Initiation complex assembly in Eukaryotes and general transcription factors; Initiation. Elongation and termination, PolII CTD phosphorylation and PolII recycling during eukaryotic transcription; Inhibitors of transcription.

Unit-VII

Discovery of the genetic code, Protein Synthesis: Ribosome composition; tRNA; Fidelity of aminoacylation; Shine Dalgarno hypothesis and its experimental verification; Initiation;Ribosome translocation and translational elongation; EF-Tu –GTP regeneration; Termination and nonsense suppression; Messenger instability; Stringent Response, inhibitors of protein synthesis. Cap dependent initiation, IRES, uORFs and role of eIF2 kinases in translationinitiation.

Unit-VIII

Regulation of Gene expression in Prokaryotes: Overview of regulatory strategies; araBADOperon, trp Operon: DNA looping and unlooping; Riboswitches; Heat shock response in E.coli, Flagellar variation in salmonella; Lux Operon and quorum sensing, Two component systems in nutrient sensing; Ordered gene expression, Lac operon: Model to understand the logic ofexperimental design for investigating various aspects of gene expression and its regulation,RNA as a regulator of gene expression.

Recommended Books:

1. “Biochemistry”, J.M. Berg, J.L. Tymoczko and L. Stryer, pub. W.H. Freeman.

2. “Biochemistry”, D. Voet and J.G. Voet, pub. Wiley.
3. “Lehninger’s Principles of Biochemsitry” by Nelson and Cox.
4. “Harper’s Biochemistry” by Murray R K
5. “Principles and Techniques of Biochemistry and Molecular Biology” by Wilson/Walker.
6. BRS Biochemistry, Molecular Biology, and Genetics.
7. “Molecular Biology” by Friefelder David
8. “Molecular Biology: Principles of Genome Function” by Nancy Craig and Rachel Green.
9. Genetics-A conceptual approach by BENJAMIN A
10. Molecular Biology of the Gene, Watson D.

M.Sc. Molecular Biology and BioinformaticsTripura

University (A Central University)

Semester I

2020

MBB 703C Laboratory – I

(Biochemistry and Bioinformatics) (Core) (Total Credit -4)

Learning Outcomes

On completion of the course, the student should be able to:

CO1: Get acquainted with basic instrumentation, principle andprocedure of various sophisticated instruments used in biochemistry laboratory.

CO2: The students will learn about Centrifugation & Electrophoresis, The students will be able to implement the use of instruments like chromatography, UV-VIS spectroscopy in biological research.

CO3: The student will learn about the Computer basics like Operating systems, Programming in Visual Basic, Data Access, Internet and Nucleic acid Sequence andprotein Data Banks.

CO4: The course will help to understand the Database Similarity Searches like BLAST, FASTA etc. Multiple sequence alignments, Primer Designing, Homology Modeling.

Course content

Biochemistry:

Clearing and autoclaving of glass wares. Preparation of buffers, reagents, media etc. Measurement of

Ph of a solution,

Titration of Polybasic/Amino acids and evaluation of pKa's.

Estimation of nucleic acids, protein, carbohydrate and lipid from given samples.

Estimation of microbial load by total microbial plate count and bacterial growth curve. Estimation of

amylase activity (I.U.) and calculation of specific enzyme activity, determination of Ph optima,

Kinetics.

Bioinformatics:

Bioinformatics resources: NCBI, EBI, DDBJ, RCSB, ExPASY.

Sequence databases: Nucleic acid sequence databases: GenBank, EMBL, DDBJ; Protein sequence

databases: Uniprot- KB: SWISS-PROT, Tr-EMBL, Uniprot; Genome Databases at NCBI, EBI, TIGR.

Structure Databases: PDB.

Sequences file formats: GenBank, FASTA.

Pairwise alignment, BLAST

Multiple sequence alignment: Clustal W

Sequence patterns and Profiles: Generation of sequence profiles PSI- BLAST

Protein motif and domain analysis: Prosite, prodom, pfam

Phylogenetic analysis- Mega

M.Sc. Molecular Biology and Bioinformatics

Tripura University (A Central university)

Semester I

2020

MBB 704E Fundamentals of Bioinformatics (Elective) (Total Credit -4)

Course Outcomes

On completion of the course, the student should be able to:

CO1: Knowledge and awareness of the basic principles and concepts of biology,computer science and mathematics, implement solutions to basic bioinformatics problems.

CO2: Discuss the use of bioinformatics in addressing a range of biological questions,

CO3: Describe how bioinformatics methods can be used to relate sequence, structure and function.

CO4: Use existing software effectively to extract information from large databases and to use this information in computer modeling

CO5: Problem-solving skills, including the ability to develop new algorithms and analysis methods

CO6: Understand the intersection of life and information sciences, the core of shared concepts, language and skills the ability to speak the language of structure- function relationships, information theory, gene expression, and database queries.

CO7: use and describe some central bioinformatics data and information resources,

Course content

Unit - I

Introduction and scope of Computational Biology and Bioinformatics.

Unit - II

Major Biological Databases and Information Retrieval.Major

Bioinformatics Resources: NCBI, EBI, ExPaSy.

Unit - III

Application of Blast tool, Concept of Scoring matrix (PAM and BLOSUM), Database searching using BLAST.

Unit - IV

Pairwise sequence alignments: Sequence similarity, identity, and homology. Global and local alignment, Dot plots for sequence comparison, Dynamic programming, BLAST andPSI-Blast, Gap penalties.

Multiple sequence alignments: Progressive Alignment Algorithm (ClustalW), Application of multiple sequence alignment.

Unit - V

Basic concepts in Computational Phylogenetic analysis: Definition and description of phylogenetic trees, a primer on computational phylogenetic analysis.

Unit - VI

Introduction to Computational Gene Prediction, Computational gene prediction methods, analysis of codon usage bias, Genome annotation, computational prediction and analysis of regulatory sites. Submission and retrieval of data in GenBank. Basic principle of genome assembly and annotation.

Unit - VII

Schematic representations and structure visualization of proteins structure, ProteinDataBank.

Suggested Readings

1. Claverie, J.M. and Notredame C. 2003 Bioinformatics for Dummies. Wiley Editor.
2. Letovsky, S.I. 1999 Bioinformatics. Kluwer Academic Publishers.
3. Baldi, P. and Brunak, S. 2001 Bioinformatics: The machine learning approach, The MIT Press.
4. Setubal, J. and Meidanis, J. 1996 Introduction to Computational Molecular Biology. PWS Publishing Co., Boston.
5. Lesk, A.M. 2005, 2nd edition, Introduction to Bioinformatics. Oxford University Press.
6. Fogel, G.B. and Corne, D.W., Evolutionary Computation in Bioinformatics.
7. Mount, D.W., Bioinformatics: 2001, Sequence and Genome Analysis. CSHL Press.
8. Durbin R., Eddy S., Krogh A. and Mithchison G. 2007 Biological Sequence Analysis, Cambridge University Press.
9. Rastogi et al 2003. Bioinformatics: Concepts, Skills and Applications. CBS
10. Rashidi and Buchler 2000. Bioinformatics Basics. CRC Press
11. Mount, D.W., Bioinformatics 2004. Sequence and Genome Analysis. CSHL Press

Department of Molecular Biology and Bioinformatics
Tripura University
Syllabus for Two years PG program
Semester-II

MBB- 801C
Syllabus for Genetics (Core) (Total Credit -4)

Course outcomes:

On completion of the course, the student should be able to:

CO1: Comprehend the chemical basis of heredity, and the laws and theories of inheritance.

CO2: Understand the heritable traits in families and populations which provides insight into cellular and molecular mechanisms.

CO3: Learn about the reasons responsible for changes in gene frequencies and understand the role of genetic mechanisms in evolution.

CO4: Comprehend the detailed molecular basis of 'Central Dogma' of molecular biology and different mechanisms involved in the processes of DNA replication, transcription and translation.

CO5: Get a comprehensive understanding of the process of regulation of gene expression in prokaryotic organisms.

CO6: Understand the role of epigenetics in biological phenomena and different human diseases.

Unit-I

History of Genetics: Pre- Mendelian genetic concepts: Preformation, Epigenesis, Inheritance of acquired characters and Mutation theory. Heredity and Environment: Concepts of Phenotype, Genotype, Heredity, variation, Pure lines and Inbred lines. Laws of inheritance: Mendel's Laws, concept of dominance, segregation, independent assortment; Chromosome theory of inheritance; Extensions of Mendelian Genetics: Concept-Multiple alleles, lethal alleles, Epistasis, penetrance, expressivity, pleiotropy, phenocopy.

Unit -II

Linkage: Concept-recombination, genetic mapping eukaryotes (Drosophila); Sex-linked inheritance: Conceptual basis, sex influenced traits, mechanism of sex determination; Cytoplasmic (extranuclear) inheritance: Basis and mechanism; Changes in Chromosome number and structure: Polyploidy, aneuploidy, chromosomal rearrangements - deletion, duplication, inversion, and translocation; Population genetics: Random mating population, Hardy-Weinberg principle, Sources responsible for changes in gene frequencies: Mutation, selection, migration and random genetic drift.

Unit -III

DNA replication: Models of DNA replication (Semi-conservative, semi-discontinuous,

bidirectional replication, rolling circle, mitochondrial D loop), Enzymolozy, Mechanisms and control. Recombination: Homologous recombination, transposition and site specificrecombination Mutation: Classification, random or spontaneous, agents, Repair: Proofreading andMMR, post-replication repair and SOS, photoreactivation repair, excision and DSB repair,

Unit -IV

Mechanism of Transcription: RNA Polymerase; Sigma Subunits; The Structure of Promoters; Enhancers and Enhancer-Binding Proteins; DNA, Abortive Initiation; Pre-Initiation complex assembly in Eukaryotes and general transcription factors; Initiation. Elongation and termination, Pol-II CTD phosphorylation and Pol-II recycling during eukaryotic transcription; Inhibitors of transcription.

Unit -V

Discovery of the genetic code; Protein Synthesis: Ribosome composition; tRNA; Fidelity of aminoacylation; Shine Dalgarno hypothesis and its experimental verification; Initiation; Ribosome translocation and translational elongation; EF-Tu –GTP regeneration; Termination and nonsense suppression; Messenger instability; Stringent Response, inhibitors of protein synthesis. Cap dependent initiation, IRES, uORFs and role of eIF2 kinases in translation initiation.

Unit-VI

Regulation of Gene expression in Prokaryotes (4): Overview of regulatory strategies; araBAD Operon, trp Operon: DNA looping and unlooping; Ribo-switches; Heat shock response in E.coli, Flagellar variation in salmonella; Lux Operon and quorum sensing, Two component systems in nutrient sensing; Ordered gene expression, Lac operon: Model to understand the logic of experimental design for investigating various aspects of gene expression and its regulation , RNA as a regulator of gene expression

Unit-VII

Post-transcriptional processing: mRNA processing -5’ and 3’ modifications, Splicing, Editing and RNAi; tRNA and rRNA processing; Post-translational Modifications- possible site of modifications; Enzymatic and non-enzymatic modifications; Protein Acetylation; Protein Methylation; Protein Phosphorylation; Ubiquitination; Proteolytic Cleavage; Glycoproteins; Cellular Sites of Major Posttranslational Modifications; Significance of Post-translational modifications;

Unit-VIII

Epigenetics : Nucleosomes and histones , Levels of packaging of DNA to Chromosome. DNAse I sensitivity of locus, Dnase I hypersensitivity, boundary elements experimental methods, and model organisms. Histone Modifications. Discussion of the histone code. DNA methylation, Nucleosome positioning, shifting and chromatin remodeling complexes Chromatin associated proteins, the formation and maintenance of heterochromatin, Model locus like PHO, Globin etc. Role of

epigenetics in biological phenomena such as imprinting, X-inactivation, cellular reprogramming, tumorigenesis, and the onset of certain types of neurological disorders.

Recommended Books:

1. “Biochemistry”, J.M. Berg, J.L. Tymoczko and L. Stryer, pub. W.H. Freeman.
2. “Biochemistry”, D. Voet and J.G. Voet, pub. Wiley.
3. “Lehninger’s Principles of Biochemsitry” by Nelson and Cox.
4. “Harper’s Biochemistry” by Murray R K
5. BRS Biochemistry, Molecular Biology, and Genetics.
6. “Molecular Biology: Principles of Genome Function” by Nancy Craig and Rachel Green.
7. Genetics-A conceptual approach by BENJAMIN A
8. Molecular Biology of the Gene by Watson JD, Losick R. Pub Pearson Education
9. Gardner JE, Simmons MJ & Snustad DP (1991). Principles of Genetics. John Wiley & Sons
10. Nucleosome Histone, and Chromatin; Part-A; Carl Wu and C. Allis, Academic Press (2012).
11. Lewin B(2008). gene XI , Oxford University press.
12. Freifelder D (2008). Molecular Biology Jones and Bartlett Publishers USA
13. Lodish et al (2007). Molecular Cell Biology W.H freeman.
14. Genetics, Strick Berger, M.W. (1990) 3rd edn. McMillan.
15. Introduction to Genetics: A Molecular Approach; T A Brown, Garland Science (2011).

MBB 802C

Recombinant DNA Technology (Core) (TotalCredit -4)

Course outcomes

On completion of the course, the student should be able to:

CO1: Learn about polymerase chain reactions, construction of cDNA libraries, gene sequencing, gene transfer and genetic manipulation methods.

CO2: Get a comprehensive understanding of the characteristic properties and mode of action of different types of restriction endonucleases and also other relevant enzymes like, DNA polymerase I, Reverse transcriptase, terminal transferase, etc. required in recombinant DNA technology.

CO3: Brief understanding about the minisatellite and microsatellite DNAs.

CO4: Get a comprehensive understanding of various cloning vectors and cloning methods.

CO5: Learn about Tissue culture, commonly used mammalian cells and transfection into mammalian cells.

CO6: Be aware of the different prokaryotic and eukaryotic systems for the over expression of proteins.

CO7: Understand the role of recombination process as an important tool of molecular biology.

CO8: Learn about the methods of transformation (both $CaCl_2$ and electroporation).

CO9: Learn about the application of RDT in agriculture, medicine and industry.

Unit-I

PCR and its applications, construction of cDNA libraries, differential cloning, sequencing genes and short stretches of DNA, genetic, cytological and physical maps of chromosome, map position based cloning of genes, mapping and sequencing of human genome, RNA and protein assays of genome function (functional genomics), gene transfer to animal cells and genetic manipulation of animal.

Unit-II

Restriction Endonucleases; characteristics, properties & mode of action of type I, II, III & IV; characteristics & mode of action of dam and dcm methylase; Three-step recognition mechanism by EcoRV, Binding Energy of EcoRV Endonuclease Bound to Cognate Versus Non-cognate

DNA; Blunt vs Sticky Ends; NOMENCLATURE of RE; Isoschizomers and Neoschizomers; Star Activity; Construction of a restriction map; RFLP, VNTR, Minisatellite & Microsatellite DNA; Detection of sickle-cell gene by the DdeI RFLP; Establishing linkage between a dominant trait and an RFLP allele; Diagnosis of β-thalassemia Deletion by Southern Blotting; Procedure for DNA typing as used for a paternity case; Several problems are given on restriction enzyme mapping.

Unit-III

Cloning Vectors, plasmid, phage, BAC, YAC, PAC, FOSMID; Retroviral vectors; methods of cloning; conjugative, nonconjugative, relaxed and stringent plasmids; plasmid incompatibility; advantages and disadvantages of these cloning vectors; shuttle vectors; yeast vector development, Yep, YRP, Ycp, Yip, 2μ plasmid; Characteristics & properties of Enzymes required in RDT: E. coli DNA polymerase I, Klenow fragment, Reverse transcriptase, Terminal transferase, T4 polynucleotide kinase, alkaline phosphatase, DNAse I footprinting, ligation reaction: T4 & E. coli DNA ligase. Cloning foreign DNA by adding linkers and adaptors, Terminal transferase to add polynucleotide tails to foreign DNA and vector DNA; Generalized overview of cloning strategies; Cloning Taq PCR products; Directional cloning; Easy cloning: PCR products; Maniatis' strategy for producing a representative gene library; Chromosome walking; Creation of a genomic DNA library using the phage-λ vector EMBL3A; Early library construction; Improved library construction.

Unit-IV

Design of nucleic acid probes; A degenerate oligonucleotide probe; "guessmers": long, degenerate oligo probes; α –complementation, Blue-white screening system; Marking Recombinant DNA by Inactivating a Gene; An early cDNA cloning strategy; Full length cDNA synthesis; Efficient cDNA cloning (Heidecker & Messing); Addition of two different restriction sites at the ends of duplex cDNA; Homopolymer tailing; Types of expression systems; Transcribable vector containing a cDNA insert (T7 promoter).

Unit-V

Transfection into mammalian cells; Commonly Used Mammalian Cells; Tissue Culture; Expression Vector; RBS, START, and STOP codons; Genetic Elements Essential for Expression; Selectable Marker for mammalian cells: Selection conditions +Basis for selection+ Comments→ADA, CDA, hisD, DHFR, TK, HGPRT, APRT, XGPRT, APH, HPH: Reporter genes

& reporter assay→ CAT, GFP, GAL, LUC, SEAP (secreted human placental alkaline phosphatase), hGH, GUS; Transformation methods-CaCl2 and electroporation, Chemical transfection using Ca3(PO4)2 & DEAE dextran, Lipofection - liposome mediated transfection, transfection by Viral infection, Stable and transient transfection.

Unit-VI

Screening of recombinant: Sequence-dependent screening→Screening by hybridization& Screening by PCR; Screening of expression libraries→. Immunological screening, Screening with alternative ligands, Functional cloning, Screening by functional complementation, Screening by 'gain of function'. South-western and north-western screening, Hybrid arrested translation and hybrid released translation.

Unit-VII

Using yeast to study Eukaryotic gene function→ Yeast biosynthetic genes are cloned by complementation of E. coli mutations, Shuttle vectors replicate in both E. coli and yeast, complement strategies, Homologous recombination, Cloning genes required for mating reveals signalling pathway similar to that seen in higher organisms, Genetic experiments in yeast (answer precise biochemical questions and exploited to identify and study genes from higher organisms).

Unit-VIII

Gene transfer to plants →Plant callus culture, plant cell culture and protoplasts, Agrobacterium and genetic engineering in plants, Crown gall disease, Tumour inducing principle and the Ti-plasmid, Incorporation of T-DNA into nuclear DNA of plant cells, Gene maps and expression of of T-DNA, Disarmed Ti-plasmid derivative as plant vectors, Selectable markers for inclusion in T-DNA, Insertion of foreign DNA into T-DNA, Binary Ti-vectors, Microprojectiles for transfecting living cells: biolistics. Application of RDT in agriculture, medicine and industry; Gene therapy.

Recommended Books:

1. Old & Primrose (1994). Principles of gene manipulation. Blackwell Scientific Publications.
2. Sambrook & Russel (2001). Molecular Cloning, 3rd volume. CSH Press.
3. Genome Analysis. 4th volume. (2000). CSH Press.
4. Lewin B (2004). Genes VIII, International Edition, Pearson Education
5. Alberts B, Johnson A, Lewis J, Raff M, Roberts K, & Walter P(2008). Molecular Biology of theCell, 5th ed., Garland Science Publishing

Course Code 805C

Syllabus for Laboratory Exercise- rDNA technology and Genomics, Proteomics (Core)

(Total Credit -4)

Course Outcomes:

On completion of the course, the student should be able to:

CO1: Isolate and quantify genomic DNA from both prokaryotic and eukaryotic organisms.

CO2: Clone desired DNA/gene.

CO3: Prepare competent cells by $CaCl_2$ and electroporation and perform transformation.

CO4: Design desired primers for a gene sequence and perform polymerase chain reaction (PCR).

CO5: Get familiar with southern and northern hybridization techniques.

CO6: Access relevant genomic and proteomic databases.

rDNA technology:

- Isolation and quantitaion of genomic DNA from E.coli, plant and animal cells
- Cloning of DNA / gene
- Preparation of vector for cloning, Dephosphorylation and ligation
- Competent cell reparation by cacl2 and electroporation.
- Transformation and preparation by glycerol stocks for long term maintenance of clones. Designing primers using website
- PCR, RT-PCR and cloning of amplified product
- FLP, RAPD, AFLP
- Southern and northern hybridization
- Recombinant protein expression, Transformation of an expressing plasmid to a bacterial strain.
- Induction of recombinant protein.

Genomics and Proteomics

- Important databases: OMIM, dbSNP, GEO, SAGE, COG
- Whole genome alignment using Artemis, MuMmer.
- Protein- protein Interaction: DIP, PPI server and analysis of protein- protein interactions.

Course Code 803E

Bioenergetics, Enzyme and Metabolism (Elective) (Total Credit -4)

Course Outcomes:

On the completion of the course, the student should be able to:

CO1: Have knowledge about basic concepts of metabolic pathways and thermodynamics.

CO2: Learn about the detailed central metabolic pathways of carbohydrate metabolism, lipid metabolism, nucleic acid metabolism, amino acid metabolism, and micro nutrient metabolisms.

CO3: Have in-depth knowledge about enzymes, their classification, mechanism of enzyme reactions and their regulation.

CO4: Comprehend the thermodynamics of enzyme-substrate interactions, the fundamental principles of reaction Kinetics and equilibria and physiological significance of kinetic parameters.

Unit-I

Overview of Metabolism; Homeostasis of Metabolism; basic concepts of Metabolic Pathways and thermodynamics; Metabolic Flux; "High-Energy" Compounds; High Phosphoryl Group-Transfer Potential of ATP; ATP cycle; Coupled Reactions Drive Endergonic Processes; Compounds with High Phosphoryl Group-Transfer Potentials; Oxidation–Reduction Reactions; NAD+ and FAD as Electron Carriers; The Nernst Equation to describes Oxidation–Reduction Reactions

Unit-II

Lipid Metabolism: Lipid digestion, absorption and transport. Lipid Oxidation (β- oxidation: Staurated & Unsaturated, Minor pathways of fatty acid oxidation : α - oxidation, γ-oxidation); Lipid biosynthesis - fatty acids, triacylglycerols, glycerophospholipids; Ketone bodies -synthesis, functions; Cholesterol -utilization and synthesis; Liporoteins structure, classification, functions; Regulation of lipid metabolism and metabolic disorders (fatty acids, cholesterol, lipoproteins).

Unit-III

Amino acid Metabolism: An overview of source and utilization of amino acids in human body. Breakdown of amino acids (Amino group: transamination, oxidative deamination; Carbon skeleton: glucogenic, ketogenic); Urea cycle (complete reactions, regulation of the urea cycle); Biosynthesis of the nonessential amino acids, nitrogen cycle as the source of cellular biosynthetic

intermediates; Metabolic disorders (PKU, BCAA, Hyper-homocysteinemia).

Unit-IV

Carbohydrate metabolism; Catabolism (EMP, HMP, Glycogen Breakdown); Anabolism (Glycogen Synthesis, gluconeogenesis); TCA Cycle (anaplerotic) Nucleic Acid Metabolism; Macro nutrients: Carbohydrates, proteins, lipids, essential lipids and amino acids; Protein sparing foods, Calorific value of nutrients; Caloric metabolism, activity, BMR; Factors affecting BMR, Body mass index (BMI), Food safety and toxicity.

Unit-V

Metabolism of micro nutrients: Vitamins- Water soluble Vitamins, Fat soluble Vitamins metabolism; Vitamins in relation to coenzyme concept and one carbon metabolisms; Xenobiotics metabolism; Factors regulate metabolic homeostasis; Importance of different organs and tissues in metabolism-With special emphasis on liver, skeletal muscle, brain, heart; brown and white adipocytes etc. Importance of endocrine organs and hormones in metabolic regulations with special emphasis on Leptin and obesity; Interconnections between carbohydrate, protein and lipid metabolism; inborne errors of metabolism.

Unit-VI

Enzymes Classification, comparison between chemical and biological (enzyme) catalysis, coenzyme, cofactors, enzyme specificity, diversity and different factors influencing enzyme activities; isoenzymes; stereochemistry of enzymatic reactions; Mechanism of enzyme reactions: serine protease, carbonic anhydrase (metalloenzyme) and restriction endonuclease; Regulation of enzyme activity: Covalent modifications (examples), Zymogens, isozymes and their significance (LDH); Allosteric enzymes, Sigmoidal kinetics; Aspartate transcarbamoyase (ATCase), T & R states (quaternary structures), positive and negative modulators; PKA and role of cAMP; Transition state analogue, catalytic antibodies, suicide inactivation.

Unit-VII

Thermodynamics of enzyme-substrate interactions, Binding energy in catalysis; Fundamental principles of reaction Kinetics and equilibria; Steady state enzyme kinetics; differences between a chemical equilibrium and steady state kinetics; enzyme inhibition kinetics; Limitation of Michealis-Menten equation, Briggs Haldane kinetics ; Van Slyke-Cullen behavior, Physiological

significance of kinetic parameters.

Unit-VIII

Cooperativity, allosteric enzymes and their modes of action; concerted, sequential and morpheein theory of allosterism; Ensemble models for allosterism Design of protein switches based on an ensemble model of allostery. Multisubstrate systems and their kinetics; Multienzyme complexes; Immobilised enzyme systems; Enzyme Inhibition; Irreversible inhibitors; Abzyme.

Recommended texts

1. Nelson, D. M. and Cox, M. M. (2017) Lehninger Principles of Biochemistry. 7th edition. W. H. Freeman &Co.
2. Berg, J. M. et al. (2015) Biochemistry. 8th edition. W. H. Freeman & Co.
3. Voet, D. and Voet, J. G. (2010) Biochemistry. 4th edition. Wiley.
4. Voet, D., Voet, J. G. and Pratt, C. W. (2016) Fundamentals of Biochemistry: Life at the Molecular Level.5th edition. Wiley.
5. Biochemistry-Jeremy M Berg, John L Tymoczko,and Lubert Stryer. Publisher: WH Freeman.
6. Biochemistry; David Rawn, J. (1989) Neil Patterson Publishers. 6. Principles of Biochemistry; Smith et al.,[Ed.] (1986) McGarw Hill
7. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.
8. Fundamentals of Ezymology; 3rd Edn. Nicholas C. Price and Lewis Stevens, Oxford University Press(2012).
9. Enzymes; Trevor Palmer, East – West Press Pvt. Ltd., Delhi (2004).
10. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis; Robert A. Copeland,Wiley-VCH Publishers (2000).
11. Enzyme Kinetics and Mechanism; Paul F. Cook, W. W. Cleland, Garland Science (2007).
12. Biochemical Calculations, Irwin H. Segel (1976) 2nd Ed. John Wiley and Sons

Course Code 804E

Bioinformatics: Genomics and Proteomics (Elective) (Total Credit -4)

Course outcomes:

On the completion of the course, the student should be able to:

CO1: Learn about the principles and methods of various genome sequencing strategies.

CO2: Comprehend the basic principles of genome assembly and annotation.

CO3: Predict genes, promoters and gene/protein function employing different bioinformatics approaches.

CO4: Learn about whole genome comparison.

CO5: Learn to access and analysis of proteomics data using the tools available at ExPASY Proteomic server.

Unit-I

Large scale genome sequencing strategies, Methods of Genome sequencing, EST, STS, GSS database and their generation. Basic principles of genome assembly and annotation, prediction of genes, promoters. Whole Genome comparison.

Unit-II

Identification of disease genes, role of bioinformatics – OMIM database, identification of SNPs, use of SNPs for identification of genetic traits, SNP database (dbSNP) and its use: Metagenomic approach towards genome analysis.

Unit-III

DNA microarray: Understanding of microarray data and correlation of gene expression data to biological processes and computational analysis tools (especially clustering approaches), normalizing a microarray data, Gene Expression Omnibus (GEO), Array Express, SAGE database.

Unit-IV

Comparative genomics: Basic concepts and applications, whole genome alignments: Artemis, MuMmer. Synteny and gene order, Comparative genomics database, COG. Genome annotation;

Gene networks (basic concepts). Completed genomes and bioinformatics approaches to analyze the genomes of Viruses, Bacteria, Archaea, Nematode, Plant and Human. Molecular evolution: Lateral or Horizontal Transfer among Genomes.

Unit-V

Protein arrays: bioinformatics- based tools for analysis of proteomics data (Tools available at ExPASY Proteomic server); databases (such as InterPro) and analysis tools. Transcriptome and Proteome- General Account; Tools of proteome analysis.

Unit-VI

Gene/ protein function prediction using machine learning tools. Protein- protein interactions: databases such as DIP, PPI server and tools for analysis of protein- protein interactions.

Recommended Books:

1. Wilkins, M.R., Williams, K.L., Appel, R.D., Hochstrasser, D.F. (Editors) 1997 Proteome Research: NewFrontiers in Functional Genomics. Springer Verlag Berlin Heidelberg.
2. Baxevanis, A. and Ouellette, F.B.F (Editors) 1998 Bioinformatics: A Practical Guide to the Analysis of Genesand Proteins. John Wiley and Sons, New York.
3. Dale and Schartz 2003 From Genes to Genomes. Humana.
4. Hawley and Mori 1999 The Human Genome. Academic.
5. Primrose and Twyman 2003 Principles of Genome Analysis & Genomics. Blackwell.
6. Pasternak 2000 An Introduction to Molecular Human Genetics. Fitzgerald.
7. Sudbery 2002 Human Molecular Genetics. Prentice Hall.
8. Liebler, D. 2002 Introduction to Proteomics: Tools for New Biology. Human Press Totowa.
9. Brown, T.A. 2002 Genome. John Wiley Press, US.
10. Campbell, A.M. & Heyer, L.J. 2002 Discovering Genomics, Proteomics and Bioinformatics.Benjamin/Cummings.
11. Jerome, P.E. 2002 Mathematics for Genome Analysis. Cambridge.

Course Code 807E

Molecular Analysis of Cellular Function (Elective) (Total Credit -4)

Course Outcomes:

On the completion of the course, the student should be able to:

CO1: Learn about the structure of cells, proteins, membranes, DNA and chromatin and their significance in cell regulation.

CO2: Comprehend the significance of gene expression, protein folding and the mechanisms by which protein folding and misfolding is regulated.

CO3: Learn about the intra and inter regulation of cellular processes by means of signal transduction molecules.

CO4: Understand the processes of regulation of cellular metabolisms.

CO5: Comprehend the significance of cytoskeleton, cytoskeletal remodeling and protein trafficking.

Subject content focuses on modern research techniques in biochemistry and molecular cell biology.

Topics include:

Unit-I

The structures of cells, proteins, membranes, DNA and chromatin, and the importance of these structures in regulation of the cell.

Unit-II

The way that the expression of genes is controlled and how this impacts cell structure and function. Gene expression regulation,

Unit-III

The importance of protein folding and the mechanisms by which this is controlled, the regulation of protein folding and misfolding,

Unit-IV

The regulation of cellular processes within and external to cells and communicated by signal transduction molecules. The transduction of cellular signals.

Unit-V

The metabolic mechanisms which cells use to extract, convert and store biochemical energy. The regulation of cellular metabolism.

Unit-VI

The transport of molecules into, out of, and throughout the cell, and the importance of the cytoskeleton in these processes. Cytoskeletal remodeling and protein trafficking.

References:

1. Molecular Biology of the Cell, latest edition; Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff,Keith Roberts, and Peter Walter. New York: Garland Science.
2. Lodish et al (2013), Molecular Cell Biology, 7th Edition, W.H. Freeman Company, USA.
3. Karp, Cell and Molecular Biology 9th Edition, By Gerald Karp, Janet Iwasa, and Wallace Marshall.
4. Hardin J., Bertoni G. and Kleinsmith, L.J (2012). Becker's world of Cell. 8th Edition, Pearson.

Department of Molecular Biology and Bioinformatics
Tripura University
Syllabus for Two years PG program
Semester-III

Course Code MBB901C
Syllabus for Immunology (Core) (Total Credit -4)

Course Outcome:

At the end of the course, learners will be able to:

CO1: Understand the fundamental concepts of immunity, contributions of the organs and cells in immune responses.

CO2: Demonstrate the basic knowledge of immunological processes at a cellular and molecular level

CO2: Get the idea about MHC genes and products and realize how the MHC molecule's function and host encounters an immune insult.

CO3: Understand the involvement of Immunoglobulin and complement system in immune response.

CO4: Understand the mechanisms involved in initiation of specific immune responses

CO5: Differentiate the humoral and cell mediated immune mechanisms

CO6: Understand and explain the basis of hypersensitivity reactions, allergy and allergic diseases

CO7: Understand and explain the basis of immunological tolerance, autoimmunity and transplantation

CO8: Gain knowledge about immunologic processes governing graft rejection and therapeutic modalities for immunosuppression in transplantation

CO9: Understand the genetic basis of immune cell receptors, proteins involved in humoral andcell mediated immune response.

CO10: Understand the principles governing vaccination and the mechanisms of protection against infectious diseases.

Unit 1

Basic concepts in immunology, types of immunity - innate, acquired. Ontogeny and Physiology of immune system- Primary and Secondary lymphoid organs, lymphoid tissues. Immunoreactive cells- structure and functions - macrophages, granulocytes, NK cells. T and B lymphocytes – origin, development, differentiation, lymphocyte subpopulation in humans. Genetics of T – lymphocytes – Surface receptors, Antigens – Diversity of TCR, T cell surface alloantigens, other markers of Human T and B lymphocytes.

Unit-2

Antigens and immunogenicity- terminologies and definition- antigen, immunogen, haptens, super antigen, tolerates, epitope, paratope. Features associated with antigenicity and immunogenicity. Basis of antigen specificity. MHC – types and importance- distribution and function. Antigen processing and presentation to T- lymphocytes. Major Histocompatibility antigens – MHC genes and products, Structure of MHC molecules, Genetics of HLA Systems – Antigens and HLA typing, Transplantation, graft vs host reaction, mixed lymphocyte reaction. Genetic basis and significance of ABO and other minor blood groups in humans, Bombay blood groups, Secretors and Non-secretors, Rh System and genetic basis of D- antigens. Clinical and forensic relevance of ABO and minor blood groups.

Unit-3

Immunoglobulin- structure, types, distribution, biological and chemical properties - Theories of antibody production- its regulation and diversity. Monoclonal and polyclonal antibodies. Complement system – mode of activation- Classical, Alternate and Lectin pathways, biological functions. Genetics of Immunoglobulins – isotypes, class switching, Molecular biology of immunoglobulin - biosynthesis, generation of antibody diversity, allotypes, and idiotypes and Immunoglobulin purification techniques. Genetics of complement components. Antigen-Antibody reactions- Precipitation- types-immunodiffusion methods-Agglutination-types-immunofluorescent techniques-principles- typical protocol -types- RIA-principles-typical protocol-ELISA-different types-Ag coating-Ab coating-linking of enzymes to Abs-substrates.

Immunoelectrophoresis- immunoblotting.

Unit 4

Antigen recognition – TCR, BCR, MHC restriction, lymphocyte activation, clonal proliferation and differentiation. Physiology of acquired immune response – various phases of Humoral and Cell mediated Immune responses, DTH response. Genetics of neoplastic cell antigens – TL antigens, CEA and others in humans, expression of tumorantigens and humoral and cell – mediated immune responses against tumor antigens in humans. Microbial pathogens – Bacterial, Viral and Fungal Pathogens and Parasitic diseases. Immune response vs infection. Immunity against bacterial infections – Innate and Acquired Immune responses – Effector mechanisms of HI and CMI – involvement of cytokines, lymphokines and chemokines. - cellular involvement – Macrophages, Neutrophils, NK cells, Defensins, Intracellular infections. Immunodeficiency. Inflammatory responses. Immunity to fungal and parasitic infections –Immunomodulation in infections.

Unit 5

Hypersensitivity: types, features and mechanism of immediate and delayed hypersensitivity reactions; immune tolerance and autoimmunity, mechanism of autoimmunity; immunity to microbes (protozoa, bacteria, fungi, intracellular parasites, helminthes & viruses); Immune response to tumor; AIDS and immunodeficiencies. Hybridoma technology and monoclonal antibodies;

Introduction to Vaccines and Adjuvants - Types of vaccines – Whole cell - Killed and Live Attenuated vaccines. Sub–unit vaccines – polysaccharides, proteins, Toxoids. Recombinant vector vaccines, DNA vaccines, Development of vaccines and antibodies in plants. Vaccine: natural, synthetic &genetic, problem and prospect associated with development of vaccine for diseases like AIDS, Cancer and Malaria. Vaccines for control of fertility, Anti – HCG Vaccines and Anti – sperm antigen vaccine. Immunization – Active and Passive.

Suggested Readings

1. Kuby Immunology, Goldsby RA., Kindt Thomas J, Osbarne BA., WH Freeman &Company, 8th ed. (2018).
2. Immunology-Understanding the Immune System Elgert K.D, Wiley-Blackwell, 2nd Ed.(2009).
3. Roitt's essential Immunology, Roitt I.M. and Delves P.J., willey- Blackwell Science Ltd.,13th Ed.

(2017).
4. Immunology – A Short Course. Richard Coico, Geoffrey Sunshine, Eli Benjamini. Wiley-Blackwell,New York. 5th ed., 2003.
5. WR Clark, The experimental foundations of modern immunology. John Wiley and SonsInc.New York.4th edition 1991.
6. Janeway ,Travers ,Walport,Shlomchik, Immunobiology- the immune system in health anddisease. Garland Science 6th ed. 2006.
7. Peter J. Delves, Ivan M. Roitt, Encyclopaedia of Immunology; Academic Press. 2nd Ed.,1998.
8. Chapel H and Halbey M, Essentials of Clinical Immunology. Wiley- Blackwell.6thedition,2013 .
9. Leslie Hudson and Frank C. Hay. Practical Immunology. Blackwell ScientificPublication.4th edition, 2002.
10. Pravash Sen. Gupta, Clinical Immunology. Oxford University Press. 2003.
11. Noel R. Rose, Herman Friedman, John L. Fahey. Manual of Clinical Laboratory Immunology.ASM. 3rd ed., 1992.
12. Christiansen, Frank T., Tait, Brian D.; Immunogenetics: Methods and Applications;Humana. 2012.
13. Benacerraf B, Immunogenetics and Immunodeficiency; Springer. 1975.
14. Zaleski MB, Dubiski S, Niles EG and Cunningham RK, Immunogenetics; Pitman, Toronto.1984.
15. Hugh Fudenberg H, Pink JRL, Wang A and Ferrera GB, Basic Immunogenetics; Oxford University Press, NY. 1985.
16. Williamson AR and Turner MN, Essential Immunogenetics; Blackwell ScientificPulications, London. 1988.
17. K.S.N. Reddy, The Essentials of Forensic Medicine and Toxicology, 34th edition ; 2017.
18. Mark Peakman, Basic and Clinical Immunology; Churchill Livingstone. 2nd Ed., 2009.
19. Talwar GP, Rao KVS and Chauhan VS, Recombinant and Synthetic Vaccines; Narosa, NewDelhi. 1994.
20. Benjamini E, Coico R and Sunskise G; Immunology – A short course, Wiley – LissPublication, NY. Ed.4; 2000.
21. D.P. Stites, JD Stobo, H.H. Fudenberg, J.V. Wells; Basic and Clinical Immunology. LangeMedical Publications. Ed.8; 1994.
22. Goding J.W., Monoclonal Antibodies: Principle and Practice; Academic Press.3rdedition,1996.
23. Carl A. K. Borrebacck, Antibody Engineering, Oxford University Press. Ed.2; 1995.
24. Leonore A. Herzenberg, Donald M. Weir, Leonard A. Herzenberg, Caroline Blackwell, Weir'sHandbook of Experimental Immunology, Vol. I – IV; Blackwell Science.5th edition1996.
25. Stefan H.E. Kaufmann and Dieter Kabelitz, Immunology of Infection. Methods in Microbiology. Vol. 32; Academic Press. 2002.
26. Sringer, T.A, Hybridoma Technology in the Biosciences and Medicine; Springer 19845.
27. Garrison Fathman. C., Fitch, F.W., Isolation, Characterization and Utilization of T lymphocyteclones; Academic Press. 2012.
28. G.P.Talwar and S.K.Gupta., A Handbook of Practical and Clinical Immunology, Vol.I-II; CBSPublishers and Distributors. Delhi. 2nd edition 2017.

Course Code MBB902C

Syllabus for Structural Bioinformatics, Molecular Modelling and DrugDesigning (Core)

(Total Credit -4)

Course Outcome:

At the end of the course, learners will be able to:

CO1: The student would be able to identify the steps for designing new drugs, target identification and validation

CO2: They would acquire the capacity to apply the ideas of atomic displacement, Quantum and Molecular Mechanics, bonded interactions, hydrogen bondings and its significance in the application of drug development

CO3: They would be able to execute protein structure prediction and would be able to predict the derivatives of the molecular mechanics energy function

CO4: They will find it easy for the understanding of the Molecular Dynamics simulation using the simple models, continuous potentials at constant temperature and pressure

CO5: They will be very capable to present the docking strategies based on the ligand, receptor and de novo ligand design.

CO6: Understanding of the combinatorial chemistry and library design, virtual screening and compound filtering.

CO7: They would be able to understand the theory of inhibition and inactivation of enzymes, drug deactivation and susceptibility

Unit 1

Properties of amino acids and peptide bonds, Ramachandran Plot. Motifs and Folds; Protein structure related databases, Protein Data Bank format, Protein Structure Visualization; tools and analysis of protein structures. Concepts of B-factor and R-factor. Protein Fold Classification, Protein structure comparison, Protein Structural Alignment and Superposition. Protein Fold Classification, CATH, SCOP and FSSP Databases. Protein structure prediction methods, Homology modeling, Fold recognition and ab-initio method, Molecular dynamics and simulation study of protein, Force field concepts.

Unit-2

Relation between sequence, structure and function. Structural basis for macromolecular dynamics, binding specificity and catalysis. Overview of biological databases, servers and information

centres. Sequence comparisons. Basic macromolecular structure: three-dimensional structure, PDB co-ordinates, classification of proteins in structure families, programs for analysis and comparison of structures. Introduction to the theory of classification and comparison of sequences and extraction of common distinctive features (e.g., motifs). Sequence analysis for prediction of secondary and tertiary structures, and homology modelling of three-dimensional structures based on sequence data.

Unit-3

Drug discovery process, Role of Bioinformatics in drug design, Target identification and validation, lead optimization and validation, Structure- based drug design and ligand-based drug design.

Modelling of protein and target-small molecule interactions, Molecular simulations Quantum mechanics and Molecular Mechanics, Potential energy, van der Waals and non-bonded interactions, hydrogen bonding in Molecular mechanics, Features of molecular mechanics, derivatives of molecular mechanics energy function

Unit 4

Bond structure and bending angles, Electrostatic forces analysis, Molecular dynamics simulation methods with the help of simple models, continuous potential, Molecular dynamics simulation with the constant temperature and pressure, Solvent effects in Molecular dynamics. Conformation changes incorporation in Molecular dynamics. Molecular docking, lead optimization, types of Molecular docking, docking algorithms, Structure based docking, de novo ligand design. Genetic algorithms, Neural networks and Principle component analysis in QSAR Equation.

Unit 5

Various approaches of target identification, validation, lead identification, optimization and validation, Combinatorial chemistry and library design, Virtual screening, Drug likeness analysis, compound filtering, Absorption, distribution, metabolism, excretion and Toxicity (ADMET) property analysis, Pharmacophore and QSAR, Pharmacophore derivation, 3D pharmacophore prediction and application in drug discovery, QSAR methodology, Electronic Topology, Quantum chemical-based Descriptors.

Suggested Readings

1. Textbook of structural biology, Liljas, Anders; Liljas, Lars; Ash, Miriam-Rose; Lindblom,

Göran; Nissen, Poul; Kjeldgaard, Morten, Second edition.: [Hackensack] New Jersey: World Scientific, 2017.
2. Wilkins, M.R., Williams, K.L., Appel, R.D., Hochstrasser, D.F. (Editors) 1997 Proteome Research: New Frontiers in Functional Genomics. Springer Verlag Berlin Heidelberg.
3. Baxevanis, A.D. and Francis Ouellette, B.F. 2004 Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Second Edition, Wiley.
4. Graur, D. and Li, W-H. 2000 Fundamentals of Molecular Evolution. Sinauer Ass., Mass., USA.
5. Tisdall, D., 2003 Mastering Perl for Bioinformatics. O'Reilly.
6. Lesk, A.M. 2005, 2nd edition, Introduction to Bioinformatics. Oxford University Press.
7. Fogel, G.B. and Corne, D.W., 2003 Evolutionary Computation in Bioinformatics.
8. Mount, D.W., Bioinformatics: 2004, Sequence and Genome Analysis. CSHL Press.
9. Phil Bourne and Helge Weissig, 2009 Structural Bioinformatics, Wiley-Blackwell
10. Leech Andrew, 2001 Molecular Modelling: Principles and applications (2nd Edition) Prentice Hall
11. Hinchliffe Alan, 2003 Molecular Modeling for Beginners, Wiley
12. Bourne, P.E., and Gu, J. 2009 Structural Bioinformatics (2nd edition), John Wiley & Sons, New York
13. Andreas D. Baxevanis, B. F. Francis Ouellette 2001 Bioinformatics: A Practical Guide to the Analysis of Genes, Wiley-Interscience
14. Attwood and Parry-Smith 2002. Introduction to Bioinformatics. Pearson
15. Barnes and Gray (ed) 2003. Bioinformatics for Geneticists. Wiley.
16. Westhead et al 2003. Bioinformatics Instant Notes. Viva Books

Course Code MBB903C

Syllabus for Practical On Immunology and Structural Bioinformatics, Molecular Modelling and Drug Designing (Core) (Total Credit -4)

Immunology (Practical)

Course Outcome

At the end of the course, learners will be able to:

CO1: Basic Understanding of various immunological techniques

CO2: Understand the evaluating effect of immune cells.

CO3: Understanding of the principles of immunohaematology methods and their use in diagnostics, medicine, biotechnology, and scientific research.

CO4: Identify various immune cells and enumerate them

CO5: Competently perform serological diagnostic tests such as RF, ASO, and CRP.

CO6: Identify blood groups and types

CO7: Analyze the components of human sera by performing agarose and polyacrylamide gel electrophoresis

CO8: Antigen-antibody interactions demonstrated in gels and to visualize the bands

CO9: Isolating of lymphocytes from blood by density gradient centrifugation

CO10: The student will be able to describe and comprehend the fundamental concepts of molecular modelling and computational-driven drug discovery.

CO11: The student will learn some of the advanced techniques such as Hit-to-lead optimization and Multi-conformation Docking.

CO12: The student will be well versed in theoretical and practical aspects of molecular modelling.

Practical on Immunology

1. Identification of various immune cells by morphology – Leishman staining, Giemsa staining.
2. Differential counts.
3. Total counts.
4. Agglutination Reactions- Latex Agglutination reactions- RF, ASO, CRP.
5. Heamagglutination Reactions- Blood Grouping – forward and reverse, Rh Typing, Coomb's test, TPHA.
6. Visit to blood bank.
7. Serum electrophoresis.
8. PAGE of serum proteins.
9. Precipitation reactions in gels – SRID, ODD, RE, CIE, Immunoelectrophoresis and staining of precipitation lines.
10. Preparation of lymphocytes from peripheral blood by density gradient centrifugation.
11. Purification of immunoglobulin – Ammonium Sulphate Precipitation.
12. Separation of IgG by chromatography using DEAE cellulose or Sephadex.
13. Western Blotting.
14. Tissue typing – Mixed Lymphocyte Reaction and Primed Lymphocyte Typing.

Practical on Structural Bioinformatics

1. Building of Molecules by using freely available web applications.
2. Structure-based drug design using freely available molecular modelling tools.
3. Energy minimization and simulation techniques by using freely available web applications. Molecular visualization tool (applications such as molecular interaction, Molecular surface visualization, electrostatics, H-bond calculation etc. with PyMol) and Visualization of structural motifs.
4. Analysis of PDB (NMR and X – ray) structures (Quality of structure, analyzing molecular interactions, protein – ligand/ protein – protein if any, from PDB).
5. Homology based protein structure prediction.

6. Quality estimation of modeled protein structure (ProCheck, PROSA, Verify3D, Errat and MolProbity).
7. Contact map based protein structure comparison.
8. Energy minimization based mutational analysis of proteins.
9. Protein – Ligand docking using Autodock and MGLTools and Pharmacophore analysis.

Suggested Readings

1. Leslie Hudson and Frank C. Hay. Practical Immunology. Blackwell Scientific Publication.4th edition, 2002.
2. Pravash Sen. Gupta, Clinical Immunology. Oxford University Press. 2003.
3. Noel R. Rose, Herman Friedman, John L. Fahey. Manual of Clinical Laboratory Immunology.ASM. 3rd ed., 1992.
4. K.S.N. Reddy, The Essentials of Forensic Medicine and Toxicology, 34th edition; 2017.
5. Mark Peakman, Basic and Clinical Immunology; Churchill Livingstone. 2nd Ed., 2009.
6. D.P. Stites, JD Stobo, H.H. Fudenberg, J.V. Wells; Basic and Clinical Immunology. Lange Medical Publications. Ed.8; 1994.
7. Leonore A. Herzenberg, Donald M. Weir, Leonard A. Herzenberg, Caroline Blackwell, Weir'sHandbook of Experimental Immunology, Vol. I – IV; Blackwell Science.5th edition 1996.
8. Garrison Fathman. C., Fitch, F.W., Isolation, Characterization and Utilization of T lymphocyte clones; Academic Press. 2012.
9. G.P.Talwar and S.K.Gupta., A Handbook of Practical and Clinical Immunology, Vol.I-II; CBSPublishers and Distributors. Delhi. 2nd edition 2017.
10. Principles of Medicinal Chemistry by W.O. Foye, T.L. Lemke, and D.A. Williams. Williams and Wilkins, Seventh Edition 2013.ISBN: 978-0683033236
11. Essentials of Drug Designing by V. Kothekar, Dhruv Publications 2005. .ISBN: 9788182400078.
12. Sheridan RP, Kearsley SK: Why do we need so many chemical similarity search methods? Drug Discov Today 2002, 7:903-911.
13. Andrew Leach, Molecular Modeling: Principles and Applications (2nd Edition), Addison Wesley Longman, Essex, England, 1996. ISBN: 978-0582382107

Course Code MBB904E

Syllabus for Animal Cloning Tissue Culture (Animal and Plant) (Total Credit -4)

Course Outcome:

After the completion of the course, students will be able to:

CO1: Learn about the concept of clones and the processes involved in animal cloning.

CO2: Understand the significance of animal cloning in medical researches and saving endangered species.

CO3: Learn about the basics of cell culture techniques and their applications.

Course:

Animal Cloning: History,

Methodology to produce cloned animals and their utility in basic research and application.
Animal and Plant Tissue Culture: History,
Methodology to set up primary culture,
Callus culture,
Permanent cell line development and characterization.

Suggested Reading:

1. Cibelli, Jose, et al., eds. Principles of cloning. Academic press, 2013.

2. Butler, Michael. Animal cell culture and technology. Taylor & Francis, 2004.

3. Freshney, R. Ian. Culture of animal cells: a manual of basic technique and specialized applications. John Wiley & Sons, 2015.

4. Smith, Roberta H. Plant tissue culture: techniques and experiments. Academic Press, 2012.

5. Davey, Michael R., and Paul Anthony. Plant cell culture: essential methods. John Wiley & Sons, 2010.

Department of Molecular Biology and Bioinformatics
Tripura University
Syllabus for Two years PG program

Semester-IV

MBB-1001C

Syllabus for Project Work and Presentation (Core) (Total Credit - 12)

Course Outcomes:

This course will help the students to:

CO1: Engage in an independent and sustained critical research and assessment of a desired research topic relevant to environment and society.

CO2: Identify appropriate theories and concepts relating appropriate methodologies/evidence to apply relevant techniques and draw scientific conclusions.

CO3: Develop critical review of important relevant information from various scientific literatures.

CO4: Appropriately apply qualitative/quantitative evaluation processes to original data.

CO5: Develop efficient analytical approaches and ethical standards of conduct in the collection and evaluation of data and other relevant resources.

CO6: Communicate research concepts and contexts clearly and effectively both in writing and viva voce presentations.

Rules for Project Work and Presentation

Each student should submit a project report for evaluation. A minimum of 5 months period shall be given to each student for the project.

Project work shall be carried out under the supervision of a teacher in the department.

A candidate may, however, in certain cases be permitted to work on the project in an industrial / Research Organization/ Institute on the recommendation of the Supervisor.

After completing the project the report should be submitted to the department for internal and external evaluation.

There should be an internal assessment and external assessment for the project work in the ratio of 30:70.

The external evaluation of the Project work is followed by presentation of work including dissertation and Viva-Voce.

MBB- 1002E

Syllabus for Bioprocessing, Biophysical and Microbiological Techniques (Elective)

(Total Credit -4)

Course Outcomes:

On the completion of the course, the student should be able to:

CO1: Comprehend the basic physical principles of all the relevant scientific techniques and instrumentations involved and get familiar with the different approaches for analyzing the resultant data.

CO2: Get familiar with different biophysical techniques like, spectrophotometry, microscopy, centrifugation, chromatography etc. and also their applications.

CO3: Get familiar with different microbiological techniques like staining methods (Simple staining, Grams staining, capsule, spore and acid fast staining), sample selection, sample collection and transport, various preservation techniques, and antibiotic susceptibility techniques.

CO4: Get aware about different sterilization principles, handling of vital microorganisms and the significance of Biosafety, Institutional Biosafety Committee, Institutional Ethical Committee and Biodiversity Act.

Unit-I

Bioprocess techniques: Stages in bioprocess development, selection of a microbial strain, Microbial culture, preparation of liquid medium, separation of particulate and inhibitory chemicals from the medium, sterilization, air purification etc. Screening and selection for fermentation processes; Preservation and improvement of industrially important microorganisms, Strain development. Fermentation for large-scale production of microbial products. surface (emersion) and submersion techniques, batch, fed batch, continuous reactors. Downstream processing which involves separation of cells from the fermentation broth, purification and concentration of desired product and waste disposal or recycle.

Unit -II

Techniques and methods for recovery, purification, and characterization of the desired fermentation product. A vast array of methods for downstream processing, such as centrifugation, filtration, and chromatography, Media for industrial fermentations: Media ingredients, medium formulation, oxygen requirements, antifoams, medium optimization, Ingredients for mammalian cell culture and plant cell culture. Inoculum production for bacterial and fungal processes. Media sterilization, Batch Process (thermal death kinetics), continuous sterilization process; sterilization

of fermenter and other ancillaries, filter sterilization of air and media.

Unit -III

Inoculum development for industrial fermentation & Microbial Kinetics: Introduction, Criteria for transfer of inoculum, development of inocula for bacterial processes, yeast processes and mycelial processes. Inoculum development for plant fermenter, aseptic method of inoculation, achievement and maintenance of aseptic conditions. Fermentation Material and Energy balance, Microbial growth kinetics: Microbial growth cycle, measurement of growth, Batch culture, continuous culture, fed-batch culture, applications and examples.

Unit -IV

Biophysical techniques I: Basics of crystallography: Introduction, symmetry in crystals, lattices and unit cells, crystal systems, Bravais lattices, elements of symmetry, X-ray diffraction and Bragg equation UV & Visible absorption spectrophotometry: Lambert Beer's Law, molar extinction coefficient and its determination, instrumentation & applications. Fluorescence Spectroscopy: principles and applications, Polarization of light, Fluorescence studies of plane-polarized light.

Unit -V

Biophysical techniques II: Microscopy: Optical Microscope, Fluorescent Microscope, Confocal Microscope, Electron Microscope, Applications of each microscopic method. Hydrodynamic Methods: Viscosity, Sedimentation equilibrium and Velocity Centrifugation, Density Gradient method, applications to bio-macromolecules and biomaterials.

Chromatography: Partition and Adsorption Chromatography, paper and thin layer chromatography, gel filtration, ion-exchange and affinity chromatography. GLC, HPLC and FPLC. Emerging trends in chromatography. Electrophoresis: Behavior of bio-macromolecules in electric fields, Types of electrophoresis, PAGE, Agarose Gel Electrophoresis, 2D Electrophoresis.

Unit-VI

Microbiological Techniques: Aseptic techniques: (Physical and chemical methods of Sterilization and Disinfection), Isolation and pure culture Techniques, Staining (Simple staining, Grams staining, Capsule, Spore and Acid fast staining), Sample selection, sample collection and sample transport. Preservation Techniques. Antibiotic susceptibility techniques: disc diffusion and Minimum Inhibitory Concentration. Brief overview of Biosafety, Institutional Biosafety Committee, Institutional Ethical Committee. Biodiversity Act.

Recommended texts

- Holtzhauer, M. (2006) Basic Methods for the Biochemical Lab. 1st English edition. Springer. 2. Nadeau, J. L. (2015) Introduction to Experimental Biophysics. CRC Press.
- Comprehensive biotechnology, vol 1, 2, 3 and 4 Murray moo young, Pergamon press2004.
- Principles of fermentation technology P.F. Stanburry & Whitaker Pergamon Press, II Ed, Butterworth Heinemann-Elsevier, 2005.
- Bioprocess Engineering, Basic Concepts, II Ed. Michael L Shuler, Fikret Kargi, Prentice Hall of India pvt. Ltd. 2002.
- Pauline M. Doran, Bioprocess Engineering Principles, Academic Press an Imprint of Elsevier.
- Coulson & Richardson's Chemical Engineering, R.K. Sinnotl, III Ed. Vol 6 Butterworth Heinemann-Elsevier Pub, 1999.
- Industrial Biotechnology: Sustainable Growth and Economic success by Wim Soetaert, Erick J. Vandamme.

Course Code MBB-1003E

Syllabus for Biological Databases, Data mining and Analysis. (Elective) (Total Credit - 4)

Course Outcomes:
On the completion of the course, the student should be able to:

CO1: Handle computational data for plotting graphs, formulate and interpret results of statistical tests.
CO2: Learn about various databases (Genome databases, Protein interaction databases and transcriptome databases) relevant to Biology and Medicine.

Databases

Unit-I
Introduction to databases; Use of spreadsheet for data handling and graph plotting Formulating and interpreting the result of a statistical test, measures of central tendency, measures of dispersion, measures of skewness,

Unit-II
Creating database, Selecting database, Deleting database, Creating table, Modifying Table, Deleting table: SQL; Basic SQL commands; Inserting, updating and deleting records, retrieving records;

Unit-III
Using Joins – joining a table to itself, joining multiple tables, Search engine Page design using HTML and PhP and connecting them to database, Submitting sequence data to NCBI database Genome Databases (Browsers, Resources, File Formats); Introduction to R and Writing Functions in R, R in Medicine and Biology,

Unit-IV
Transcriptome Databases (Resources for retrieval and analysis); Pathway and Gene Regulatory databases (Agris, TransFac)
Unit-V
Protein Interaction Databases (Biogrid, String), Building and Querying an Interaction Network Database
Unit-VI
Information Gain / Differential Gene Expression / Clustering, Differential Gene Expression / Correlation / Clustering, Decision Trees, Case study discussion.

Recommended texts

1. Gollery, Martin. "Bioinformatics: sequence and genome analysis." Clinical Chemistry 51.11 (2005): 2219-2220.

2. Sharma, T. R. Genome Analysis and Bioinformatics: A Practical Approach. IK International Publishing House pvt. Limited, 2009.

3. Karolchik, Donna, et al. "The UCSC genome browser database." Nucleic acids research 31.1 (2003): 51-54.

4. Han, Jiawei, Jian Pei, and Hanghang Tong. Data mining: concepts and techniques. Morgan kaufmann, 2022.