Nims University Rajasthan, Jaipur

Detailed Syllabus with Scheme of Examination

MASTER OF SCIENCE
(Bioinformatics)

16D52

BATCH-2024

Duration: 2 Years

Institute of Allied Medical Science & Technology, NIET,
Nims University Rajasthan, Jaipur-303121

About the Department

The Department of Allied Medical Science & Technology, is established with the motif to integrate engineering, science, technology and management for sustainable use of renewable sources and enhancement of industrial biotechnology. The Department is continuously striving to achieve excellence in education, academic and industry-oriented research as well as consultancy work with service to the society. We aim to provide our students with a perfect blend of intellectual and practical experiences that helps them to serve our society and address a variety of needs. Biotechnology engineering is a branch of engineering where technology is combined with biology for research & development. There are various applications of biotechnology in fields such as animal husbandry, growth of vaccines and medicines, agriculture, pollution control, energy production and conservation, healing of prolonged disease and ecological conservation. It also helps in development of insecticides, fertilizers and quality of seeds. The Department has been recognized as a center of The National Referral Centre for Fluoride Poisoning in India has been officially established on 26th Jan 2012(RepublicDayofIndia)withtherecommendationofIndianMedicalTrustandDepartmentofBiotechnology, India. Department offered the B.Sc., M.Sc. B. Tech, M. Tech and Ph.D. Program in various discipline. The faculty members are decorated with national and international recognitions. Students of the department are highly competitive and enjoy significant demand in biomedical, pharma and information technology sectors. A large number of students each year qualify for higher research programs within the University or elsewhere in India; a good proportion of meritorious students pursue further research in different laboratories overseas.

About The Course

Master of ScienceinBioinformaticsisatwoyearpostgraduateprogrammewhichisdesignedtoaddressthese needs through interdisciplinary training that bridges gap and meets the demand of pharmaceuticalindustryandstrengthensresearchcollaboration.Bioinformaticsisascientificdisciplineandassetofskillsthat has now become one of the most important information gathering, data mining, and knowledge building tools in recent current research and clinical applications.

Vision: To impart quality education which has broad range of application to molecular biology ,pharmacology, biotechnology, forensic science, drug designing, and various other disciplines.advancesengineeringfundamentalsandpromotesinnovationsintheareasofdesigning,manufacturingofbiotechnologyproductsandtheircomponents.**TheDepartmentofAllied**

MedicalScience&Technology at Nims University educates students that create manpower for the benefit of society and humankind with an emphasis on present and future global needs.

Mission:

DeveloptrainedmanpowerinthefieldofBioinformaticswithspecificemphasisforfulfillingexpectationsof Indian Pharma and Biotechindustry.
Todevelopskillsneededtocollect,understand,analyzeandmanagedatagenerated throughhighthroughputtechnology.
Explainhowtheboundariesofknowledgeinthisprofessionaldisciplineareadvancedthroughresearchandenablestudents toconductresearchthrough twotargeted research projects
Togive exposureto thestudents innational andinternationalwork.

ProgramEducationalObjectives(PEOs):

Theprogrameducationalobjectivesaresetinlinewith InstitutionalandDepartmentalmissionstatements.The program educational objectives of M.Sc. Bioinformatics is to produce engineers who later take theresponsibilityofengineering professionalsand researchers with followingqualities:

PEO1: The program aims to utilize and understand biological databases to gather, store, retrieve,manage,analyze andintegrate biologicaldata forgenerating new knowledge.

PEO2: Theprogramaimstoimpartextensiveunderstandingandlearningoftheoreticalconcepts inLifeSciences. Each semester exclusively devotes at least one core course in life sciences in eachsemester.Basicpracticalmethodologyisincorporatedaspracticalsessionsin Laboratorycoursesin eachsemester.

PEO3: Developingandimplementingcomputationallogic,learningprogramminglanguages,algorithmsand software for progressive life sciencesolutions.

PEO4: Betterunderstandingofdynamicbiologicalprocessesandtheirunderstandingatmolecularlevelenabledthrough and correlated usinginternet and Bioinformatics.

PEO5: Todevelopskilledbioinformatics professionalswhohavelifesciencebackground andwhoaresimultaneouslyproficient in computational aspects.

PEO6: Tointroduce newage conceptsof bigdata inthe 'omics' eraandtheiranalysis.

PEO7: Tolearnbasicnovelstrategiesimplementedthroughmachinelearningandartificialintelligenceandunderstanding how their applicationsin bioinformatics and allied domains.

ProgramOutcomes(POs):

InadditiontoPEOs,theM.Sc.BioinformaticsprogramestablishedasetofProgramOutcomes(POs),expectedtobe met by every graduating studentfromthe programat the time ofgraduation.

Thegraduates ofM.Sc.Bioinformaticswill have aptitude of:

PO1. Nurturingnovelideasand meaningfulinsightsthroughscientificthinking.

PO2.Enablingcritical analysisofproblems andsituationstoreachsolutions.

PO3. Developmentofcommunicationskillstopresentscientificdatainoralandwrittenformats.

PO4. Providingaplatformforindividualandcollective work.

PO5. Understandingthesignificanceofsustainable scientificprocessestosupport theenvironment

ProgramSpecificOutcomes(PSOs):

Program Specific Outcomes for M.Sc. Bioinformatics set by Faculty in the Department of AdvancedScience& Technology are as follows:

PSO 1. Students undertaking the course shall have fundamental knowledge in theoretical Biochemistry, CellBiology,MolecularBiologyandGenetics.Theywillpossessbasicbioinformaticspracticalskillsanditsapplication in research and industry.

PSO 2. As beginners the students will learn to use a computer, internet, scope and applications ofbioinformatics.

PSO 3. Students will later learn to use the vast array of biological databases and their resources.Knowledgeinlifescienceswouldbethekeyandtools,methodologiesandsoftware usedinbioinformaticswill give them a comprehensive edge in data analysis. This will be ideal for job opportunities for them inITenabledservices as well.

PSO 4. Drug discovery strategies from life science point of view and the concerted computationalapproachare learned,evaluated andpracticedthroughexperimental sessions andthoroughly learned.

PSO 5. Students learn Genomics and Proteomics as primary subjects in their quest for biologicalrepositories of information wherein they will find their data which they will later analyze using nextgenerationtechniques for predictionof function and annotation.

PSO 6. Students also learn basics of data mining, machine learning, and artificial neural networks as apart of curriculum in bioinformatics which can be considered as a stepping stone in comprehendingindustrydemands and hype surrounding big data analysis.

M.Sc.BIOINFORMATICS

COURSECURRICULUMANDEXAMINATIONSCHEME

SEMESTER

I

S. No.	Course Code	Course Title	Hours			Theory Marks (100)				Practical Marks (50)			Total	Cr
			L	T	P	IA (30)			ETE (70)	IA (15)		ETE (35)		
						IE	Ass.	Att.		Records	PP			
1	16D52101B	Cell Biology	3	1	2	15	10	5	70	5	10	35	150	5
2	16D52102B	General Microbiolog y	3	1	2	15	10	5	70	5	10	35	150	5
3	16D52103B	Fundamentals Of Biochemistry	3	1	2	15	10	5	70	5	10	35	150	5
4	16D52104T	Biostatistics & Research Methodology	3	1	0	15	10	5	70	-	-	-	100	3
5	16D52105B	Computational biology	3	1	2	15	10	5	70	5	10	35	150	5
		TOTAL	15	5	8	65	50	25	350	20	40	140	700	23

SEMESTER II

S. No.	Course Code	Course Title	Hours			Theory Marks (100)				Practical Marks (50)			Total	Cr
			L	T	P	IA (30)			ETE (70)	IA (15)		ETE (35)		
						IE	Ass.	Att.		Records	PP			
1	16D52201T	Database Management System	3	1	0	15	10	5	70	-	-	-	100	3
2	16D52202B	Object Oriented Programming with C++	3	1	2	15	10	5	70	5	10	35	150	5
3	16D52203B	Molecular modeling in Bioinformatics	3	1	2	15	10	5	70	5	10	35	150	5
4	16D52204B	Molecular Biology	3	1	2	15	10	5	70	5	10	35	150	5
5	16D52205B	Genetics and Evolution	3	1	2	15	10	5	70	5	10	35	150	5
		TOTAL	15	5	8	65	50	25	350	20	40	140	700	23

SEMESTER III

S. No.	Course Code	Course Title	Hours			Theory Marks (100)				Practical Marks (50)			Total	Cr
			L	T	P	IA (30)			ETE (70)	IA (15)		ETE (35)		
						IE	Ass.	Att.		Records	PP			
1	16D52301B	Bioinformatics Techniques in sequence and structure analysis	3	1	2	15	10	5	70	5	10	35	150	5
2	16D52302B	Genomics & Proteomics	3	1	2	15	10	5	70	5	10	35	150	5
3	16D52303B	Recombinant DNA Technology	3	1	2	15	10	5	70	5	10	35	150	5
4	16D52304B	Core Java	3	1	2	15	10	5	70	5	10	35	150	5
5	16D52305T	Enzymology	3	1	0	15	10	5	70	-	-	-	100	3
		TOTAL	15	5	8	65	50	25	350	20	40	140	700	23

SEMESTER IV

S. No.	Course Code	Course Title	Hours			Theory Marks (100)				Practical Marks (50)			Total	Cr
			L	T	P	IA (30)			ETE (70)	IA (15)		ETE (35)		
						IE	Ass.	Att.		Records	PP			
1	16D52401B	Advanced Human Genetics	3	1	2	15	10	5	70	5	10	35	50	5
2	16D52402T	Genetic Resources & IPRs	3	1	0	15	10	5	70	-	-	-	-	3
3	16D52403B	COMPUTER AIDED DRUG DESGN (CADD)	3	1	2	15	10	5	70	5	10	35	50	5
4	16D52404B	Advanced Bioinformatics Techniques with Machine learning	3	1	2	15	10	5	70	5	10	35	50	5
5	16D52405D	Dissertation	0	0	14					50		150	200	7
		TOTAL	12	4	18	60	40	20	280	80		220	700	23

SEMESTER I

CELL BIOLOGY (16D52101B)

1. Course Code: 16D27101B

2. Course Title: Cell & Developmental Biology

3. Contact Hours: L: 3 T: 1 P: 4

4. Examination Duration (Hours): Theory: 3 Practical: 3

5. Credits: 5

6. Semester: I

7. Course Learning Objectives:

   a. Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles
   b. Students will understand how these cellular components are used to generate and utilizeenergy in cells
   c. Students will understand the cellular components underlying mitotic cell division.
   d. Students will apply their knowledge of cell biology to selected examples of changes or losses in cell function. These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.

8. Course details:

THEORY

UNIT – I INTRODUCTION OF CELL & CYTOSKELETON (12-Hrs)

Cell diversity: Cell theory, cell size, shape. Structure and function of cell organelles in prokaryotic and eukaryotic cells. Cytoskeleton: The self assembly and dynamic structure of cytoskeletal filaments. How cells regulate their cytoskeletal filaments; molecular motors and movements.

UNIT-II EXPERIMENTAL MODEL OF CELL & MACROMOLECULE FUNCTIONS ENERGY CONVERSION OF CELL ORGANELLES (10-Hrs)

Transport of nutrients, ions and macromolecules across membranes. Signal transduction, cellular response to environmental signals. Cell motility-cilia, flagella of eukaryote and prokaryote.Cells as experimental models *E. coli, Caenorhadbitis, Drosophila, Arabidopsis* and vertebrates.

Energy conversion: Mitochondria and chloroplast, genetic system of mitochondria and plastids, electron transport chain and their protein pumps. The evolution of electron transport chains

UNIT-III CELL DIVISION, PROGRAM CELL DEATH & CELL DIVISION (8-Hrs)

The cell cycle – molecular events in plants and animals. The mechanism of cell division. Programmed cell death. Extra cellular control of cell division, cell growth and apoptosis. Cellular basis of differentiation and development-mitosis, gametogenesis and fertilization.

UNIT - IV Developmental Biology and Stages of fetal development (10-Hrs.)

Gametogenesis (Spermatogenesis, Oogenesis), Meiosis and its significance, types of eggs, fertilization and implantation, types and patterns of cleavage, Blastulation. Gastrulation in Frog, Germ layer formation, fetal membranes, placenta formation in mammals. Concept of dedifferentiation, redifferentiation, transdifferentiation and regeneration

Unit- V METHODS IN CELL BIOLOGY (10-Hrs)

Origin of microscopy, Different types of microscopy, Light microscope, Inverted microscopy, electron microscopy, cell fractionation methods, x-ray diffraction, Histology, Microtomy and staining method.

9. Course outcomes (COs):

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

b. Describe the cell structure, components of cell, enzymes to emphasize the importance of cellas the basic unit of an organism.

c. An understanding about the role of various cellular organelles in modifying the functions ofthe cells, especially, metabolism and protein synthesis.

d. The role of cytoskeleton and modes of cellular transport will be discussed.

e. Understanding the cellular regulation through various types of cell signaling, cell division,apoptosis and cell differentiation.

f. Provide an overall understanding of the epithelial cells and cancer with a focus onneurobiology and neurodegenerative diseases.

Suggested Readings & References

- Molecular Biology of cell, Alberts, B *et al.*
- Molecular Cell Biology, Lodish et al.
- Reproduction in Eukaryotic cells, D.M. Prescott, Academic Press.
- Developmental biology, S.F. Gillbert Sinaur Associates Inc.
- Cell in development and inheritance, E.B. Wilson, Mac Millan, NY
- The Coiled Spring, Ethan Bler, Cold Spring Harbour Press.
- Fertilization F.T.: Longo Chapman and Hall.

PRACTICALS (16D52101B)

- Microscopy: demonstration of different types of microscopes
- Microtomy
- Sub-cellular fractionation and marker enzymes.
- Histochemical localization of protein, carbohydrate, fats, starch, lignin, DNA, RNAetc.
- Mitosis and Meiosis
- Salivary gland chromosome.
- Study of frog development, observation of frog embryo of different developmentstages
- Study of eggs and sperms from animal samples

GENERAL MICROBIOLOGY [16D52102B]

1. Course Code: 16D27102B
2. Course Title: General Microbiology
3. Contact Hours: L: 3 T: 1 P: 4
4. Examination Duration (Hours): Theory: 3 Practical: 3
5. Credits: 5
6. Semester: I
7. Course Learning Objectives:

a. To familiarize the students with those concepts that is basic to viruses and prokaryoticand eukaryotic cells.
b. To provide depth knowledge about diversity of microorganisms, bacterial cell structure and function, microbial growth and metabolism, and the ways to control their growth by physical and chemical means.
c. Systematically apply the scientific method of investigation and hypothesis testing including the development of theoretical and practical skills in the design and executionof experiments as well as the development of oral and writing skills necessary for the effective communication of experimental results
d. Outside the formal lecture / laboratory structure, the student is expected to readassignments in the text, as well as assigned papers from the scientific literature, and study the concepts presented in lecture, laboratory and in the text.

8. Course details:

THEORY

UNIT –I **History and Microbial Diversity** [8Hrs]

The historical foundations and development of microbiology; An overview of microbial world; Microbial diversity - Prokaryotic and eukaryotic microbial diversity; The bacteria and the archaea; Principles of bacterial taxonomy Molecular methods in taxonomy; Intraspecies classification of bacteria. Morphology and structure of bacteria

UNIT –II CLASSIFICATION AND IDENTIFICATION OF MICROORGANISMS [10Hrs]

Study of classification systems, numerical taxonomy, polyphasic taxonomy, major characteristics used in taxonomy, identification of microorganisms - a general account, stainingtechniques. pure culture techniques, preservation methods.

UNIT –III MORPHOLOGY AND MAJOR GROUPS OF MICROORGANISM [8Hrs]

Morphology and fine structure of bacteria: cell wall, structure external and internal to cell wall, spore and cysts, characteristics of archeabacteria and eubacteria, characteristics of important groups of microorganisms.

UNIT – IV MICROBIAL METABOLISM, NUTRITION AND GENETICS [10Hrs]

An overview of microbial metabolism, Genetic materials in bacteria; Bacterial

chromosome; Extrachromosomal genetic elements; Plasmid, Transposons; Mutation, DNA repair, Mutant selection; Mechanism of gene transfer – transformation, transduction and conjugation

UNIT - V Microbial Growth and Culturing [12Hrs]

Factors influencing microbial growth. Environmental and nutritional factors; Nutritional types of bacteria; Microbial locomotion – flagellar motility, gliding motility and amoeboid motion; Chemotaxis, Phototaxis and other taxes. Cultivation of bacteria- culture media and methods; Measurement of bacterial growth. Bacterial growth curve; Binary fission, Growth cycle, Microbial growth at different temperature, pH and oxygen level

9. Course outcomes (COs):

a. Provide basic understanding of carbohydrates, lipids, and proteins and their roles innormal biological processes.

b. Explain the metabolic pathways of carbohydrates along with their roles in providingenergy will be discussed in detail.

c. Knowledge about the structural units of proteins, amino acids, and their metabolismwill be given.

d. Information about fatty acids and its metabolism and the structural units of genetic codewill be provided.

e. Cellular processes involved in the generation of energy will be discussed in detail.

Suggested Readings & References

- Microbiology by Presscort L.M., Harley, J.P and Klein, D.A. Mc Graw Hill.
- Microbiology by Pelczar, M.J. Chan ECS and Krieg NR, Tala McGraw Hill.
- General Microbiology by Roger Y. Stanier, Macmillan.
- Bergeys Manual of Systematic Bacteriology.
- General Microbiology by Prescott and Dunn.
- Microbiology by T. D. Brocks.

PRACTICALS: GENERAL MICROBIOLOGY [16D52102B]

- Introduction to the rules, tools and equipments used in microbiology.
- Examination of microorganisms by staining techniques.

- Preparation of media for cultivation of microorganisms.
- Isolation and Enumeration of microorganisms by serial dilution agar plating method.
- To obtain pure culture of microorganisms by pour, spread and streak plate method.
- To measure bacterial growth and determine the effect of various factors on bacterial growth.
- To assess biochemical activities viz., catalase, IMViC of given culture of bacteria.
- Assay of an antibiotic by zone-inhibition method using antibiotic impregnated discs.

Determination of bacterial transformation and conjugation.

GENERAL BIOCHEMISTRY [16D52103B]

1. Course Code: 16D27103B
2. Course Title: General Biochemistry
3. Contact Hours: L: 3 T: 1 P: 4
4. Examination Duration (Hours): Theory: 3 Practical: 3
5. Credits: 5
6. Semester: I
7. Course Learning Objectives:
    a. Enumerate the biochemical function of water, buffer and cell.
    b. learns the chemistry of carbohydrate, lipid and proteins and its importance in themolecular level, structure, classification, function for living organisms, as it providethe body with energy. Identify the metabolic fate of carbohydrate (glycolysis)andlipids (β- oxidation).
    c. Recognize the enzymes and coenzymes and their role in the biological processes inthebody .
    d. Know the hormones, structure, function and its role in regulating the metabolism.
    e. Recognize the vitamins how important it is to the human health.
    f. The student remembers some scientific terms in the field of biochemistry.
8. Course details:

THEORY

UNIT - I WATER, pH, & BIOLOGICAL BUFFERS (10Hrs)

Important properties of water, the law of mass action, dissociation of water and its ionic product, pH, Bronsted acids, ionization of weak acids and bases. Henderson Haeselbatch equation, Titration curves, buffering action and physiological buffers and solutions.

UNIT – II CARBOHYDRATES (10Hrs)

Definition classification, Basic structure, properties and functions of saccacharides and related compounds, Oligosaccharides: Glycosidic bonds; Classification: glycoproteins (Olinked and N- linked), glycolipids; Nature of carbohydrate moiety attached; Functions: as cell recognition factors, in intracellular targeting; Purification and Characterization of oligosaccharides from cell membranes di-saccharides and poly- saccharides. Structural polysaccharides-cellulose and chitin, storage polysaccharides-starch, glycogen, peptidoglycan and glycosaminoglycans, proteoglycans and glycoproteins.

UNIT - III PROTEINS AND ENZYMES (10Hrs)

Protein structure and function: Primary, Secondary, Tertiary and Quaternary structure of Proteins w.r.t: Globular protein (eg: Hemoglobin and Myoglobin), Fibrous protein: (Collagen), Membrane Protein (ATP synthetase) Nomenclature and classification, co- enzymes, Michaelis-Menten equation, Regulation of enzyme activity.

UNIT - IV LIPIDS, TYPES OF FATTY ACID, PIGMENTS (10-Hrs)

Structure, nomenclature and physical and chemical properties of fatty acids. Classification of lipids, general structure and functions of triacylglycerole, Phospholipids, Sphingolipids, glycolipids, cholesterol & lipoproteins structure, properties and function of steroids. Plant growth substances, plant and animal pigments.

UNIT-VI PHOTO SYNTHESIS, PHOTO RESPIRATION, VITAMINES & MENERALS (8-Hrs)

Photo synthesis and photo respiration. Nutritional aspects of vitamins and minerals in plant, Definition and classification of vitamins, Biological role of Vitamins in health and diseases.

Course outcomes (COs):

a. Provide basic understanding of carbohydrates, lipids, and proteins and their roles innormal biological processes.

b. Explain the metabolic pathways of carbohydrates along with their roles in providingenergy.

c. Knowledge about the structural units of proteins, amino acids, and their metabolismwill be given.

d. Information about fatty acids and its metabolism and the structural units of genetic codewill be provided.

e. Describe the cellular processes involved in the generation of energy using differentsource materials.

Suggested Readings & References

- Outlines of Biochemistry: Conn, E.E, Stumpf, P.K Bruening, G and Doi, R.H. JohnWiley and sons Inc, New York and Toranto.
- Biochemistry: Styer, L. Freeman WH and company, New York.
- Fundamentals of Biochemistry: Voet &Voet, PraH, CW John Wiley and Sons Inc,New York and Toranto.
- Biochemistry: Zubay G.L, W.C. Brown Publishers.

PRACTICALS: GENERAL BIOCHEMISTRY [16D52103B]

- Identification of different types of carbohydrates
- Difference between reducing & non-reducing sugar
- Preparation of Buffer solution
- Ninhydrin & Biuret test of protein
- Separation of protein & amino acids
- Enzymatic activity of salivery amylase on carbohydrates
- Identification of different types of vitamins
- Measurement of optical density of biomolecules.
- To determine the acid value of given oil.

BIOSTATISTICS & RESEARCH METHODOLOGY [16D52104T]

1. Course Code: 16D52104T
2. Course Title: Biostatistics & Research Methodology
3. Contact Hours: L: 3 T: 1 P: 0
4. Examination Duration (Hours): Theory: 3 Practical: 0
5. Credits: 3
6. Semester: I
7. Course Learning Objectives:
   a. Understand and apply statistical methods for the design of biomedical research and analysis of biomedical research data;
   b. Understand and use mathematical and statistical theory underlying the application of biostatistical methods; use and interpret results from specialized computer software for the management and statistical analysis of research data;
   c. Learn to participate in a research team setting in study design, data coordination and management, and statistical analysis and reporting of study results;
   d. Participate in a research team in the development and evaluation of new and existing statistical methodology.
8. Course details:

THEORY

UNIT–I SAMPLE ANALYSIS & DATA PRESENTATION (12-Hrs)

Introduction: types of biological data (data on ratio scale, interval scale, ordinal scale, nominal scale, continuous and discrete data), frequency distribution and graphical representations (bar graph, histogram and frequency polygon), cumulative frequency distribution, populations, samples, random sampling, parameters and statistics

UNIT–II CENTRAL TENDENCY AND PROBABILITY (10-Hrs)

Measures of central tendency and dispersion: Arithmetic mean, geometric mean, harmonic mean, median, quantiles, mode, range, variance, standard deviation, coefficient of variation. Probability: Permutations and Combinations, Probability of an event, addition andmultiplication of probabilities.

UNIT-III DISTRIBUTION AND HYPOTHESIS TESTING (12-HRS)

Normal distribution, skewness and kurtosis, binomial distribution, Poisson distribution, hypothesis testing, errors, one-tailed and two-tailed testing, t-test, Fisher exact test, chi square test, two sample hypothesis (testing difference

between two means), Non parametric tests (Mann-Whitney test), Paired sample hypothesis (testing mean difference), Wilcoxon paired sample test, Single factor ANOVA, Kruskal-Wallis test, Tukey test, Newman-Keuls test, two factor.

UNIT-IV CORRELATION AND REGRESSION (6-Hrs)

Linear regression, correlation and Pearson coefficient of correlation, rank correlation and Spearman rank correlation coefficient.

UNIT-V EPIDEMIOLOGY AND EXPERIMENTAL DESIGN (10-Hrs)

Epidemiological Study design- Descriptive, Analytical and Experimental, Epidemiological Measures – Rate, ratio, proportion, Incidence and prevalence , Relative risk, Risk ratio, Odds ratio, development of research tools, Protocol preparation, Proposal writing. Report writing and publishing. Critical review of research report and journal article

9. Course outcomes (COs):

a. Critically analyse research methodologies identified in existing literature.
b. Propose and distinguish appropriate research designs and methodologies to apply to aspecific research project.
c. Use basic and modern statistical software to analyse the biological and clinical data.
d. Develop a comprehensive research methodology for a research question.
e. Apply the understanding of feasibility and practicality of research methodology for aproposed project.

Suggested Readings & References

- Statistical methods in Biology by Norman T.J. Bailey., Cambridge University Press.
- Statistical methods by George W. and William G., IBH Publication.
- Introduction to Biostatistics by Ipsen J., Harper and Row Publication.
- Statistical methods in Biology by N.T.J. Bailey., English University Press.
- A Text Book of Agricultural Statistics by R. Rangaswami, New Age Intl. Pub.
- MS office; Sexena S, Vikas Publishing House.
- Statistical methods; Snedecor GW and Cohran WG, Oxford and IBH publishing COPvt. Ltd.
- Biometry; Sokal RR and Rohlf FJ, Freeman WH publishing House.
- Fundamentals of Biostatistics by Veer Bala Rastogi, Ane Books India

- Research Methodology: Methods and Techniques Paperback – Abridged, Audiobook,
- Box set by C. R. Kothari (Author) New age international publication

Computational Biology [16D52105B]

1. Course Code: 16D52105B
2. Course Title: General Biochemistry
3. Contact Hours: L: 3 T: 1 P: 4
4. Examination Duration (Hours): Theory: 3 Practical: 3
5. Credits: 5
6. Semester: I
7. Course Learning Objectives:

a. Enumerate the biochemical function of macro molecules.
b. learns the physiochemical properties of of carbohydrate, lipid and proteins and its importance in the molecular level, structure, classification, function for living organisms, as it provide the similarity between other biomolecules.
c. Recognize the enzymes and coenzymes and their role in the biological processes like various metabolic pathways.
d. Understand and apply statistical methods for the design of biomedical research and analysis of biomedical research data;
e. Understand and use mathematical and statistical theory underlying the application of biostatistical methods; use and interpret results from specialized computer software for the management and statistical analysis of research data;
f. Learn to participate in a research team setting in study design, data coordination and management, and statistical analysis and reporting of study results;
g. Participate in a research team in the development and evaluation of new and existing statistical methodology.

9. Course details:

Theory

Unit I:- Introduction to primary Databases

Types of Biological data- Genomic DNA,Primary Databases -Nucleotide sequence databases-GenBank, EMBL, DDBJ, Protein Sequence Databases- UniProtKB, UniProt, TrEMBL, Swiss-Prot, UniProt Literature Databases- PubMed, PLos, BioMed Central.

Unit II:-Introduction to Secondary or Derived Databases

PDB, CSD, MMDB, SCOP, CATH, FSSP, CSA, KEGG ENZYME, BRENDA; Sequence motifs Databases:-Prosite, Pfam, InterPro; Composite Databases-NRDB, Genome Databases-Bacterial Genome database (GOLD, MBGD), Organism specific database (OMIM/OMIA, FlyBase, TAIR), Genome Browsers (Ensembl, NCBI map viewer, UCSC Genome Browse). Bioinformatics Database search engines:-Text-based search engines (Entrez,).

Unit III:-Pairwise sequence alignments

Sequence similarity, identity, and homology; Global and local alignment, Dot plots for sequence comparison, Dynamic programming, BLAST and PSI-Blast, Application of Blast tool, Concept of Scoring matrix (PAM and BLOSUM).

Unit IV:-Multiple sequence alignments and Phylogenetic analysis

Progressive Alignment Algorithm (ClustalW), Application of multiple sequence alignment.Definition and description of phylogenetic trees, a primer on computational phylogenetic analysis.Types of Tree.UPGMA

Unit V:-Structural analysis

Protein identification based on composition, Primary structure of protein, Secondary structure

pridiction (Statistical method: Chou Fasman and GOR method,), Tertiary structures (Homology Modeling); Structure visualization methods (RASMOL, CHIME etc.); Protein Structure alignment and analysis

Course outcomes (COs):

a. After providing basic knowledge of .immunology, its two arms of immunity will be discussed in detail. Further, the external agents that provoke immune responses will be taught.

b. Information about humoral immunity, the involvement of B lymphocytes and its product, antibody, in immunity will be explained Monoclonal antibody production and its use in therapyand diagnosis will be taught. A basic understanding about the various immunological techniques will be taught.

c. Another important topic of MHC that governs antigen processing will explained.

d. The ways through which T and B lymphocytes get activated so that they can play a role inthe elimination of antigens will be discussed.

e. Some of the diseases that involve the innate and acquired immunity will be taught along withcurrent vaccine strategies used.

Suggested Readings & References

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.

PRACTICALS:16D52105B

1. Retrieving sequence data from Entrez.
2. Retrieving structural data of a protein using PDB database.
3. Retrieving articles using PubMed.
4. Pairwise sequence alignment using FASTA.

Pairwise Sequence Alignment using BLAST

SEMESTER II

Database Management System (16D52201T)

1. Course Code: 16D52201T

2. Course Title: Database Management System

3. Contact Hours: L: 3 T: 1

4. Examination Duration (Hours): Theory: 4

5. Credits: 4

6. Semester: II

7. Course Learning Objectives:

A database management system is important because it manages data efficiently and allows users to perform multiple tasks with ease. A database management system stores, organizes and manages a large amount of information within a single software application. Database management systems are important to businesses and organizations because they provide a highly efficient method for handling multiple types of data.

8. Course Details:

UNIT 1	**Overview of DBMS** Introduction to DBMS, Advantage of Database, Disadvantage of Database, Objective of Database, Data, Information and knowledge, Increasing Use of Data as a Corporate Resources, Database, Administrative Roles, DBMS Architecture, Different kind of DBMS Users, Importance of Data Dictionary, Contents of Data Dictionary, Types of Database Languages, Data Models.
UNIT 2	**Traditional Database Model Over Relational Database Mode** Hierarchical Model, Network Model, Relational Model, Data Definition and Data Manipulation, Constructs in each of the three models, A Comparison of Three Models, Relational Model, Definition of relation and properties of relation model, Concept of Keys (Super key, Candidate Keys, Primary Key, Alternate Key, Foreign Key), Relational Algebra, Different Types of Join (Simple or Eque join, Non-Eque Join, Self join, Outer Join).
UNIT 3	**Structured Query Languages (SQL)** Database Creation and Manipulation. Create Simple Queries Using (Where, Like, Group By, Having, Order By), View table Structure, Temporary Tables.
UNIT 4	**Entity Relationship Model:** Overview of Database Design, Entity, Attributes, Relationships and Relationship sets, Features of ER Model. Conceptual database design with ER model-Entity versus attribute, entity versus relationship.
UNIT 5	**Relatonal Model:** Introduction to relational Model, Foreign Key Constraints, enforcing integrity constraints, introduction to views, destroying/altering tables & views

9. Course Outcomes (COs):

On successful completion of the course students will be able to:

- Understand and evaluate the role of database management systems in information technology applications within organizations;
- Recognize and use contemporary logical design methods and tools for databases;
- Derive a physical design for a database from its logical design;
- Implement a database solution to an information technology problem;
- Understand the SQL data definition and SQL query languages;
- Have been introduced to the alternative design techniques utilized for Management Reporting applications.

***Suggested Readings & References*:**

1. The complete reference-By Coach and loney
2. A Beginners guide- By Abbey and corney
3. Database System-Elmasri and Navathe

Object Oriented Programming with C++ (16D52202B)

1. Course Code: 16D52202B

2. Course Title: Object Oriented Programming with C++

3. Contact Hours: L: 3 T: 1 P: 4

4. Examination Duration (Hours): Theory: 4 Practical: 4

5. Credits: 6

6. Semester: II

7. Course Learning Objectives:

This subject aims to introduce students oops programming language. Upon successful completion of this subject, the students should be able to create c++ programs that leverage the object-oriented features of the language, such as encapsulation, inheritance and polymorphism; use data types, arrays and other data collections; implement error-handling techniques using exception handling and implement I/O functionality to read from and write to text files

8. Course Details:

UNIT 1	**Introduction to OOPs and C++ Element** Introduction to OOPs, Features & Advantages of OOPs, Different element of C++ (Tokens, Keywords, Identifiers, Variable, Constant, Operators, Expression, String).
UNIT 2	**Program Control Statements** Sequential Constructs, Decision Making Construct, Iteration / Loop Construct, Arrays, Functions (User defined Function, Inline Function, Function Overloading), User Defined Data Types (Structure, Union and Enumeration).
UNIT 3	**Class, Object, Constructor & Destructor** Class, Modifiers (Private, Public & Protected), Data Member, Member Function, Static Data Member, Static Member Function, Friend Function, Object, Constructor (Default Constructor, Parameterized Constructor and Copy Constructor), Destructor.
UNIT 4	**Pointer, Polymorphism & Inheritance** Pointer (Pointer to Object, this Pointer, Pointer to Derive Class), Introduction to Polymorphism (Runtime Polymorphism, Compiletime Polymorphism), Operator Overloading, Virtual Function, Inheritance (Single Inheritance, Multiple Inheritance, Multilevel Inheritance, Hierarchical Inheritance, Hybrid Inheritance), Virtual Base Class, Abstract Class.
UNIT 5	**File Handling, Exception Handling** Files I/O, Exception Handling (Exception Handling Mechanism, Throwing Mechanism, Catching Mechanism, Re-throwing an Exception).

9. Course Outcomes (COs):

On successful completion of this course student will

- Understand the features of C++ supporting object oriented programming
- Understand how to produce object-oriented software using C++
- Understand how to apply the major object-oriented concepts to implement object oriented programs in C++, encapsulation, inheritance and polymorphism
- Understand how to apply the major object-oriented concepts to implement object oriented programs in C++, encapsulation, inheritance and polymorphism

Suggested Readings & References:

1. E. Balaguruswami – Object Oriented programming with C++

2. Kris James – Success with C++
3. David Parsons – Object Oriented programming with C++
4. D. Ravichandran – Programming in C++
5. Dewhurst and Stark – Programming in C++ Venugopal, Ravishankar

Practical

1. Write a C++ program to calculate average marks scored by a student for 3 subjects.
2. Write a C++ program to find the area and perimeter of a circle and rectangle.
3. Write a C++ program to swap two numbers.
4. Write a C++ program to find largest of three numbers.
5. Write a C++ program to find the maximum number among three numbers.
6. Write a C++ program to generate Fibonacci series.
7. Write a C++ program to perform string manipulation.
8. Find the length of a string. Compare two strings, Concatenate two strings, Reverse a string, copy a string to another location.
9. Write a C++ program to find quotient and remainder of 2 numbers.
10. Write a C++ program to manipulate the class account using classes and function. A user should be able to perform the following functions. a. Deposit money. b. Withdraw money, c. Calculate the interest d. Check the total balance in his account.
11. Write a C++ program to generate Prime numbers between 1 and 50.
12. Write a C++ program to perform matrix addition and multiplication.
13. Write a C++ program to check whether the given matrix is a sparse matrix or not.
14. Write a C++ program to overload unary minus operator.

Write a C++ program to calculate total sales and average sales made by a salesman

Molecular Modeling in Bioinformatics (16D52203B)

1. **Course Code:** 16D52203B
2. **Course Title**: Molecular Modeling in Bioinformatics
3. **Contact Hours**: L: 3T: 1 P: 0
4. **Examination Duration (Hours)**:Theory: 3Practical: 0
5. **Credits**:4
6. **Semester**:II
7. **Course Learning**

Objectives:

To make the students understand:

The basic methodology in Bioinformatics .The programming languages and techniques for Insilco drug design in Bioinformatics.Theutilizationofbioinformaticstoolsanddatabasesforretrieving, analyzing, understanding and managing biological data.

8. Course Details

UNIT I **(11)**

Molecular Modeling by Homology, construction of frame work, selecting variable regions, Back bone and side chain placement and refinement, Optimization and validation of protein models. Threading and Ab-initio modeling, Ramchandran plot.

UNIT II **(12)**

Introduction to QSAR for lead module: Linear and nonlinear modeled equations, Biological activities, Physicochemical parameters and Molecular descriptors, Application of QSAR modeling in drug discovery.

UNIT III **(13)**

Introduction to Molecular Modeling; What are models used for? Areas of application – Single molecule calculation, Assemblies of molecules; Molecular Mechanisms: Introduction to Force field, Use of various parameters for force field calculation (Bond length, angle angle, torsion angle, Electrostatic interaction, Vander waals interactions, Miscellaneous interaction);

UNIT IV **(9)**

Introduction Molecular Dynamics using simple models, Dynamics with continuous potentials, Constant temperature and constant dynamics, Conformation searching, Systematic search, Applications to protein folding.

UNIT V **(10)**

3D pharmacophores modeling, molecular docking, De novo Ligand design, Free energies and solvation, electrostatic and non-electrostatic contribution to free energies; 3D data base searching and virtual screening, Sources of data, molecular similarity and similarity searching, combinatorial libraries – generation and utility.

References

1. C.A.Orango,D.T.JonesandJ.M.Thornton-Bioinformatics –GenesProteinsandcomputers
2. AndreasD.BaxevarisBioinformaticsALaboratoryGuidetotheAnalysisofGenesandProteins
3. ZhumurGhosh&MallickBioinformaticsPrinciplesandApplications
4. JeremyJ.Ramsden –Bioinformatics:AnIntroduction
5. D.MauntBioinformaticssequence&GenomeAnalysis
6. JamesD Tisdall- MasteringPerl forBioinformatics
7. Wall,Christian&Orwant-ProgrammingPerl
8. HarshawardhanP.Bal -PerlProgrammingfor Bioinformatics
9. IngvarEidhammer,IngeJonassenandWilliamRTaylor-ProteinBioinformatics:AnAlgorithmicApproach to sequence and structureAnalysis.

Practicals

1. File format manage
2. Identification of biomolecules in 3D format
3. Analysis of PDB file
4. Characterization of molecules
5. Ligand prepration

MOLECULAR BIOLOGY (16D52204B)

1. **Course Code**: 16D23202B
2. **Course Title**: Molecular Biology
3. **Contact Hours**: L: 3 T: 1 P: 4
4. **Examination Duration (Hours)**: Theory: 3 Practical: 3
5. **Credits**: 5
6. **Semester**: II
7. **Course Learning Objectives**:

a. To understand the structure of nucleic acids & proteins and their interactions.
b. To understand the mechanisms of central dogma of life.
c. Study the molecular mechanisms of gene regulation in prokaryotes and eukaryotes.
d. To introduce students with antisense & ribozymes technologies and their applications.

8. **Course Details**:

THEORY

UNIT – I CHROMOSOME ORGANIZATION (14-Hrs.)

Structure of Nucleic Acid and, DNA as the genetic material, structure & types of DNA, chromatin Structure, Complexity of eukaryotic chromosome, cot value.

UNIT - II DNA REPLICATION (14-Hrs.)

DNA replication process in prokaryotes & Eukaryotes, Activity of DNA polymerases and Topoisomerases, Reverse transcriptase.

UNIT - III DNA TRANSCRIPTION (14-Hrs.)

Transcription process in prokaryotic and eukaryotic, Post transcriptional modification processes and open reading frames.

UNIT - IV GENETIC CODE AND TRANSLATION (13-Hrs.)

Genetic Code, Wobbel hypothesis, translation process in Prokaryotes and Eukaryotes. Regulation of gene expression in prokaryotes and eukaryotes, co and post translational modification of proteins, DNA binding proteins, Zinc finger motif and Leucine zipper.

UNIT - V ANTISENSE TECHNOLOGY AND GENE SEQUENCING (13-Hrs.)

Molecules, types & structure of ribozymes, strategies for ribozymes designing, Application of antisense & ribozymes technologies, methods of sequencing.

PRACTICALS (16D23202B)

- Separation of DNA by gel electrophoresis.
- Separation of bio-molecules by chromatography methods.
- Isolation of antibiotic resistant mutants by antibiotic disc method.
- Isolation of microorganisms from air, and soil.
- Ames test.

9. Course Learning Outcomes (COs):

a. Learning the building blocks involved in hereditary.
b. Knowing the mode of DNA replication and the chemistry of polynucleotides studying the key features involved in gene expression. Learning the mode of DNA replication in details.
c. Knowing the enzymes involved in DNA transcription.
d. Learning the genetic mutations that lead to genetic diseases.
e. Knowing the regulatory regions present in the promoter.
f. Learning about transcription and the enzymes involved in transcription.
g. Studying the processing of precursor mRNA into mature mRNA.
h. Studying the DNA sequences coding for amino acids.
i. Learning how proteins are modified in order to keep their role in activities.
j. Knowing how and why proteins are targeted into specific organelle.
k. Knowing how gene expression can be altered.
l. Learning co-factors that modulate gene expression without directly binding to the DNA.
m. Studying various regulatory elements that control gene expression at transcriptional level.

GENETICS AND EVOLUTION (16D52205B)

1. **Course Code**: 16D23201T
2. **Course Title**: Genetics and Evolution
3. **Contact Hours**: L: 3 T: 1 P: 0
4. **Examination Duration (Hours)**: Theory: 3 Practical: 0
5. **Credits**: 3
6. **Semester**: II
7. **Course Learning Objectives**:
   a. To provide a foundation in the field of Genetics that will be important for the topics covered in many more advanced courses.
   b. To understand the mechanisms of central dogma of life.
   c. To Study the molecular mechanisms of gene regulation in prokaryotes and eukaryotes.
   d. To demonstrate Mendelian Inheritance.
   e. To calculate recombinant frequencies and construct pedigree analysis.
   f. Study chromosomal aberrations in humans.
8. **Course Details**:

THEORY

UNIT – I HISTORY OF GENETICS (14-Hrs.)

Mendelism: Brief history of genetics and Mendel work, Mendelian laws, their significance and current status, chromosomal theory of inheritance. Genetic interaction: supplementary genes, complementary genes. Duplicate genes, epistasis, inhibitory and polymorphic genes. The relationship between genes and traits.

UNIT – II GENE INTERACTIONS (14-Hrs.)

Gene interactions; Quantitative inheritance; heritability; Extra nuclear genomes and inheritance; Chromosomal basis of inheritance and linkage; Construction of genetic and physical maps; Linkage and crossing over.

UNIT – III CHROMOSOMAL ABBERATION (14-Hrs.)

Chromosomal changes and gene mutations Gene transfer mechanism – transformation, transduction, conjugation and transfection. haploidy, diploidy, polyploidy, aneuploidy, euploidy and polysomy, Applications of polyploidy.

UNIT – IV GENETIC DISORDERS (13-Hrs.)

Genetic disorders Kleinfelter's syndrome, Down syndrome, Ptau's syndrome, haemophilia, color blindness, cat cry disease, genetic counseling, Population

genetics; Applications of genetics in agriculture and medicine.

UNIT – V EVOLUTIONARY PROCESS (13-HRS.)

Mechanisms producing genetic diversity, Phenotypic diversity by the regulation of gene expression, Natural Selection and Adaptation, The Hardy-Weinberg principle and analysis of gene frequencies in natural population, Constructing evolutionary trees, measures of genetic relationship among organisms, Molecular clock of evolution Molecular phylogeny.

9. Course Learning Outcomes (COs):

a. Recall and relate the role of genes, genetic code, recombinant methods in DNA technology.
b. Describe the role of various enzymes in genetic manipulation.
c. Make use of the techniques involved in isolation, purification and separation of nucleic acids.
d. Apply different phylogeny techniques to find the relation between distinct living organisms.
e. Appraise the use of genetic engineering principles for gene therapies.

Suggested Readings & References:

- Genetics- Strickberger, 2nd.
- Microbial Genetics – D. Frifielder.
- Baltimore- Molecular Biology of the Cell.
- Benjamin Levin – Genes VIII, 8th ed.
- Advance Genetics by G.S. Miglani, Narosa Publishing House.

Suggested Readings & References:

- Bacterial Genomes 1998. De Brujin et al. Chapman & Hall.
- Genetics of Bacterial Virulence Dorman C. J. 1994. Blackwell.
- Genome Analysis. Four volumes 2000. CSH publications.
- Molecular cloning. 3 volumes. Ambrose and Russell. 2000. CSH press.
- Principles of Gene Manipulation. 1994 Old & Blackwell Scientific Pulication.
- Gene VII. Lewin (Oxford University press) 2000.
- Microbial Genetics.Maloy et al. 1994. Jones & Bertiett Publishers.

- Modern microbial genetics.1991 & Yasbin, Niley Ltd.
- Molecular Genetics of Bacteria. J.W. Dale. 1994. John Wiley& Sones.
- Molecular Genetics of Bacteria- Larry Synder & Wendy Champness.
- Molecular Cell Biology (W.H. Freeman by Lodish, Berk, Zippursky).

Semester III

S. No.	Course Code	Course Title	Hours			Theory Marks (100)				Practical Marks (50)			Total	Cr
			L	T	P	IA (30)			ETE (70)	IA (15)		ETE (35)		
						IE	Ass.	Att.		Records	PP			
1	16D52301B	Bioinformatics Techniques in sequence and structure analysis	3	1	2	15	10	5	70	5	10	35	50	5
2	16D52302B	Genomics & Proteomics	3	1	2	15	10	5	70	5	10	35	50	5
3	16D52303B	Recombinant DNA Technology	3	1	2	15	10	5	70	5	10	35	50	5
4	16D52304B	Core Java	3	1	2	15	10	5	70	5	10	35	50	5
5	16D52305T	Enzymology	3	1	0	15	10	5	70	-	-	-	-	3
		TOTAL	15	5	8	75	50	25	350	20	40	140	200	23

Bioinformatics Techniques in sequence and structure analysis (16D52301B)

1. Course Code: 16D52301B

2. Course Title: Bioinformatics Techniques in sequence and structure analysis

3. Contact Hours: L: 3 T: 1 P: 4

4. Examination Duration (Hours): Theory: 3 Practical: 3

5. Credits: 5

6. Semester: III

UNIT-I **(12)**

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

UNIT-II **(12)**

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

UNIT-III **(11)**

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

UNIT-IV **(10)**

Protein identification based on composition, Physical properties based on sequence, Motif and pattern, Secondary structure (Statistical method: Chou Fasman and GOR method, Neural Network and Nearest neighbor method) and folding classes, specialized structure or features, Tertiary structures

UNIT-V **(6)**

Homology Modeling; Structure visualization methods (RASMOL, CHIME etc.); Protein Structure alignment and analysis. Application of bioinformatics in drug discovery and drug designing.

PRACTICALS

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

REFERENCE BOOKS:

1. D.W.Mount; Bioinformatics-Sequence and genome analysis; Cold Spring HarbourLab press. 2001

2. B.N.Mishra; Bioinformatics: Concept and application, Pearson Education (in press) 2020

3. O' Reilly; Developing Bioinformatics computer skills-1stIndian edition, SPD publication. 2001

4. Anthony J.F. Griffiths et al; An introduction to genetic analysis, 1stEd 1976

5. Michael Starkey and Ramnath Elaswarapu; Genomics protocols, Human

Genomics and Proteomics
(16D52302T)

1. **Course Code**: 16D52302B
2. **Course Title**: Genetic Engineering, Genomics and Proteomics
3. **Contact Hours**: L: 3 T: 1
4. **Examination Duration (Hours)**: Theory: 3 Practical: 3
5. **Credits**: 4
6. **Semester**: III
7. Course Learning Objectives:

   a) Provide the students a broader knowledge on the structure and function of genomes.

   b) Understand and learn about different protein characterisation and profiling techniques.

8. Course details:

Unit	Topics	Lectures
I	**INTRODUCTION :** Introduction to genome, transcriptome, and proteome; Overview of genomes of bacteria, archae, and eukaryote, Genomes of organelles.	
II	**GENOME MAPPING AND SEQUENCING** Genetic and physical mapping, Linkage analysis, RFLP, SNP, SSLP, Restriction mapping, STS mapping, FISH, Top-down and bottom-up sequencing strategies, Whole genome sequencing, Gap closure, Pooling strategies.	
III	**FUNCTIONAL GENOMICS** Genome annotation, ORF and functional prediction, Genefinding, Substractive DNA library screening, Differential display and Representational difference analysis, SAGE, TOGA, Introduction to DNA microarray	
IV	**TECHNIQUES IN PROTEOMICS** In-vitro and in vivo-labeling of proteins, One and two-dimensional gel electrophoresis, Detection of proteins on SDS gels, Protein cleavage, Edman protein microsequencing, Mass spectrometry-principles of MALDI-TOF, Peptide mass	

	fingerprinting.	
V	**PROTEIN PROFILING** Large-scale protein profiling using proteomics, Post-translational modifications, Phosphoprotein and glycoprotein analyses, Analysis of protein-protein interactions, Protein microarrays.	

SUGGESTED BOOKS:

1. Suhai, Sandor "Genomics and Proteomics: Functional and Computational Aspects". Springer, 2000.
2. Pennington, S.R. and M.J. Dunn "Proteomics: From Protein Sequence to Function". VivaBooksPvt. Ltd., 2002.
3. O'Connor, C.D. and B.D. Hames. "Proteomics". Scion Publishing, 2008.
4. Primrose, S.B. and Twyman. "Principles of Genome Analysis and Genomics". 7th Edition, Blakwell Publishing, 2006.

REFERENCE BOOKS:

1. Cantor, Charles R. and Cassandra L. Smith. "Genomics : The Science and Technology Behind the Human Genome Project". John Wiley & Sons, 1999.
2. Liebler, R.C. "Introduction to Proteomics". Humana Press, 2002.
3. Hunt, Stephen P. and Frederick J. Livesey. "Functional Genomics". Oxford University Press, 2000.
4. Conard, Edward. "Genomics". Apple Academics, 2010.

RECOMBINANT DNA TECHNOLOGY [16D52303B]

1. Course Code: 16D52303B
2. Course Title: Recombinant DNA Technology
3. Contact Hours: L: 3 T: 1 P: 4
4. Examination Duration (Hours): Theory: 3 Practical: 3
5. Credits: 5
6. Semester: III
7. Course Learning Objectives:
   a. Describe the key features of DNA, RNA and proteins and explain the inter-relationships between these molecules
   b. Outline the basis of current molecular biologic and genomic technologies and be able to contrast the structures of eukaryotic and prokaryotic genes and genomes

c. At the end of the course, the students will have sufficient scientific understanding of the subject.

d. Good knowledge of application of Recombinant DNA techniques in Life Sciences Research.

8. Course details:

THEORY

UNIT – I Gene Cloning (10-Hrs.)

Gene cloning and need to clone a gene; Isolation and purification of plasmid, chromosomal and genomic DNA from bacterial, plant and animal cells.

UNIT – II Cloning Vectors (12-Hrs.)

Different cloning vectors like plasmids, cosmids, phagemids, shuttle vectors, and other vectors for plant and animals; enzymes used in recombinant DNA technology like restriction endonucleases, ligases, polymerases, kinases and phosphatases.

UNIT – III Gene Expression (12-Hrs.)

Cloning of a specific gene; studying gene location and structure; studying gene expression; expression of foreign genes in research and biotechnology; maximization of recombinant proteins; brief introduction to sequencing and site directed mutagenesis, different types of PCR and applications; safety measures and regulations for recombinant DNA work

UNIT – IV Phase hybrid system and Mutagenesis (8-Hrs.)

A brief introduction to the followings: phage display system, Yeast two hybrid system, and RNAi technology. Mutagenesis techniques, Nucleic acid hybridization assays and micro-assays

UNIT – V Applications (10-Hrs.)

Applications of recombinant DNA technology in the fields of Medicine, Agriculture, Forensic and Environment.

Production of recombinant proteins from pro and eukaryotic hosts , Expression of industrially important products , Electrophoretic methods for mutation detection: SSCP, hetero-duplex analysis, DGGE MCC (Mismatch Chemical Cleavage),ASA (Allele Specific Amplification), PTT (Protein Truncation Test) , Gene therapy – ex vivo, in vivo, gene delivery systems, viral and non viral , Bio-pharming.

9. **Course outcomes (COs):**

a. Learn about the vectors and their ideal characteristics

b. Understand different methods of recombinant DNA techniques like labeling DNA,PCR and gene sequencing.

c. Gain knowledge about prokaryotic and mammalian expression vectors and cloning in plants.

d.Learn about preparation of genomic and cDNA libraries, mutagenesis, and cloning techniques for altering gene expression.

c. Learn about various applications of rDNA technology and how to handle the genetically modified organism.

Suggested Readings & References

- Watson, J.D., *et al.* : Recombinant DNA: Genes and (3rd ed.) Genomes,McGraw Hill Publications, 2007, H.W Freeman pub.
- Brown, T.A. (4th ed.) : Gene Cloning and DNA analysis, An Introduction,Blackwell Science.
- Watson, J. (5th ed.) : Molecular Biology of the Gene, Benjamin, Cummings, Pearson education, Schweiz AG, Germany, 2004.
- Primrose, S.B. and Twyman, R.M.: Principles of gene manipulation, Blackwell and Old, R.W. (6th ed.) Science, U.K.
- Alberts, B. *et al* . : Molecular Biology of Cell, Garland Publishers Inc.,London,1994.

PRACTICALS:

16D27302B

- Digestion of plasmid DNA by restriction endonuclease.
- Ligation assay.
- Southern Hybridization
- DNA fingerprinting
- Amplification of DNA using PCR.
- RAPD-PCR.
- Restriction mapping
- Induction and expression of a gene cloned in an expression vector in *E. coli*.

Core Java (16D52304B)

1. Course Code: 16D52304B

2. Course Title: Core Java

3. Contact Hours: L: 3 T: 1 P:4

4. Examination Duration (Hours): Theory: 4 Practical:4

5. Credits: 6

6. Semester: III

7. Course Learning Objectives:

To learn the basic syntax and semantics of the Java language and programming environment. To understand the concepts of classes and objects. To understand the primitive data types built into the Java language and the difference between variables of primitive types and variables of class types. To understand features of a strongly typed language: variable declaration and type compatibility checking. To learn about lifetime, scope and the initialization mechanism of variables. To be able to implement decisions using if statements. To be able to program loops with while, for and do statements. To learn about parameter passing mechanisms.

8. Course Details:

UNIT 1	**Introduction to JAVA** Introduction to Java, Java Virtual Machine, Object Oriented Principle, Object and Classes, Java Keywords, Variable, Data types and Literals in Java, String, Operators and Casting, Control of Flow, (Selection Statements, Iteration Statements), Command Line Argument.
UNIT 2	**Classes and Inheritances** Introduction to Class and Object, Method, Overloading Method, Constructor, Constructor Overloading, this Keyword, Introduction to Inheritance, Using Super, Multilevel Hierarchy, Abstract class, Using Final.
UNIT 3	**Package and Interface** Package (Defining Package, Finding Package), Introduction to Interface, Defining, and Implementing of Interface, Predefined Package.
UNIT 4	*Exception Handling and Threads* Exception Handling, Type of Exception, Try, Catch, and Finally. Multiple Catch blocks, Nested Try Statements, throw, throws, Thread Model, Multithreading.

9. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

- Implement exception handling in Java
- Implement Object Oriented Programming Concepts
- Use and create packages and interfaces in a Java program
- Use graphical user interface in Java programs
- Handle security implementations in Java
- Use Input/Output Streams

Suggested Readings & References:

1. Complete Reference (Java 2) – Herbert Schildt - Tata McGraw Hill
2. Java in a nut shell – Flanagan – Orielly Publication

Practical

1. Program for student Mark-List preparation
2. Program for reverse and finding sum of individual digits of a given number
3. Program to generate Fibonacci series
4. Program for finding Factorial of a given number
5. Program for find whether a given number is prime or not.
6. Program for sorting the given numbers in Ascending and Descending order.
7. Program for Matrix Multiplication
8. Program for finding roots of the given quadratic equation
9. Program for finding volume of a sphere (Concept: Class and Object)
10. Program for preparing Employee salary Report (Concept : Array of Objects)
11. Program for implementing stack Operations (Concept : Constructor)

    Program for checking whether a given number is palindrome or not

ENZYMOLOGY (16D52302T)

1. Course Code: 16D52302T

2. Course Title: Enzymology

3. Contact Hours: L: 3 T: 1 P: 0

4. Examination Duration (Hours): Theory: 3 Practical: 3

5. Credits: 5

6. Semester: III

7. Course Learning Objectives:

a. To integrate the practical aspects of enzymology.

b. To introduce students with kinetic theories of enzymes to provide a mechanistic overview of *enzyme activity* and *regulation* in cells.

c. To prepare students to confidently and competently work with enzyme systems in both Academia and Industry.

8. Course Details:

THEORY

¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬**UNIT-I INTRODUCTION**

(8-Hrs.)

IUB enzyme classification (specific examples), enzyme specificity, methods for isolation, purification and characterization of enzymes, tests for homogeneity of enzyme preparation.

UNIT II KINETICS OF ENZYME ACTION (12-Hrs.)

Concept of ES complex, active site, specificity, derivation of Michaelis-Menten equation for uni-substrate reactions. Different plots for the determination of Km & Vmax and their physiological significances. Kinetics of zero & first order reactions. Michaelis – pH functions and their significance. Classification of multi-substrate reactions with examples of each class. Use of initial velocity, inhibition and exchange studies to differentiate between multi-substrate reaction mechanisms. Reversible and irreversible inhibition. Competitive, non-competitive, uncompetitive, linear-mixed type inhibitions and their kinetics, determination of Ki and numerical based on these. Suicide inhibitor.

UNIT III MECHANISM OF ENZYME ACTION (10-Hrs.)

Acid-base catalysis, covalent catalysis, proximity, orientation effect. Strain and distortion theory. Chemical modification of active site groups. Site directed mutagenesis of enzymes. Mechanism of action of chymotrypsin, lysozyme, glyceraldehyde 3-phosphate dehydrogenase, aldolase, carboxypeptidase, triose phosphate isomerase and alcohol dehydrogenase.

UNIT IV ENZYME REGULATION (12-Hrs.)

General mechanisms of enzyme regulation, product inhibition. Reversible (glutamine synthase & phosphorylase) and irreversible (proteases) covalent modification of enzymes. Mono-cyclic and multi -cyclic cascade systems with specific examples. Feed back inhibition and feed forward stimulation. Allosteric enzymes, qualitative description of “concerted” & “sequential” models for allosteric enzymes. Half site reactivity, positive and negative co-operativity with special reference to aspartate transcarbamoylase and phosphorfructokinase. Protein-ligand binding measurement, analysis of binding isotherms, Hill and Scatchard plots.

UNIT V MULTIENZYME SYSTEM (10-Hrs.)

Occurrence, isolation and their properties: Mechanism of action and regulation of pyruvate dehydrogenase complex. Enzyme-enzyme interaction, multiple forms of enzymes with special reference to lactate dehydrogenase.

9. Course Learning Outcomes (COs):

- To understand the IUBMB system of enzyme classification.
- To learn the factors involving and factors affecting the enzyme activity.
- To know the catalytic activity of enzyme and its regulation.
- To learn the enzyme used in clinical diagnosis and industries.
- To learn the kinetics of single and multi-enzyme substrate enzyme catalyzed reaction.
- Know to solve the problems based on single and multi-substrate reactions.
- To learn the enzyme inhibition kinetics and the problems related to it.
- To learn the enzyme immobilization; methods of immobilizing the enzymes and their kinetics.
- To understand the analytical techniques available for enzyme analysis.

Suggested Readings & References:

- Fundamentals of Enzymology Price and Stevens
- Enzymes Dixon and Webb
- Isoenzymes By D. W. Moss
- Immobilized Biocatalysts W. Hartneir
- Selected papers Allosteric Regulation M. Tokushige

SEMESTER IV

ADVANCED HUMAN GENETICS [16D52401B]

Course Learning Objectives:

a. Appreciate the overall complexity of genomes in humans and other organisms and the nature of coding and non-coding sequences.
b. Understand the nature of genetic variation in humans.
c. Be able to interpret genetic changes and predict their clinical outcome.
d. Be able to provide an introduction to the key areas of genomics, human genetics and genetic variation.
e. It prepares participants to understand disease genetics and how genomic medicine can be utilized to elucidate disease mechanisms and biology.

8. Course details:

THEORY

UNIT-I GENETIC MAPPING OF MENDELIAN TRAITS [12Hrs]

(a) History of human genetics, Pedigree, Pattern of inheritance. (b) Identifying recombinants and non-recombinants in pedigrees (c) Somatic cell fusion, cell hybrids and Radiation hybrids, (d) Genetic and physical map distances, (e) Twopoint mapping - LOD score analysis (f) Multipoint mapping (g) Homozygosity mapping.

UNIT-II GENETIC MAPPING OF COMPLEX TRAITS [10Hrs]

(a) Difficulties in mapping complex traits (b) Allele sharing methods- Affected sib pair analysis (c) Allelic association mapping (d) Linkage disequilibrium mapping e) Transmission disequilibrium test (f) Whole genome scan and mapping (g) Integration of Cytogenetic, genetic and physical maps.

UNIT-III GENETIC BASIS OF SYNDROMES AND DISORDERS [12Hrs]

(a) Monogenic diseases (b) Inborn errors of metabolism (c) Neurogenetic disorders (d) Genetic disorders of Haemopoetic systems (e) Genetic disorders of eye (f) Genetic disorders in skeleton and skin (g) Congenital heart diseases. (h) Complex polygenic syndromes (Atherosclerosis, Diabetes mellitus and Rheumatoid Arthritis) (i) Learning disorders.

UNIT-IV DIAGNOSIS, GENETIC COUNSELING AND ETHICS [14Hrs]

a) Prenatal diagnosis: (i) Noninvasive methods- X- radiation, Ultrasonography and Fetal echocardiography (ii) Invasive methods- Maternal serum screening, Amniocentesis, Chorionic villus sampling and Fetoscopy, b) Genetic counseling: Definition, Models of eugenics and human right, Psychotherapeutic counseling, Decision making, Risk assessment and counseling in Mendelian and multifactorial syndromes. (c) Human genetics and legal, social and ethical considerations.

9. **Course outcomes (COs):**

a. Describe the levels of genetics, from nucleic acids to chromosomes, to cells, body parts, families, and populations.

b. Explain how genetics underlies evolution.

c. Discuss how genes and environmental factors interact to sculpt traits.

d. Provide examples of how genetics is used in identification of people, in health care, in agriculture, and in ecology.

e. Applications of Genetics.

Suggested Readings & References

- White, M.J.D. Modes of Speciation, W.H. Freeman & Co.
- Gardner, Simmons, &Snustad, 1997. Principles of Genetics 8th Ed., John Wiley and Sons.
- Lewin, B., 1996. Genes VI, John Wiley and Sons.
- Mark H. F. L., 2000. Medical Cytogenetics, Marcel Dekker Inc, N.Y.
- Sambamurthy, A.V.S., 1999. Genetics, Narosa Publishing House, New Delhi.
- Sumner, A.T. 2003. Chromosomes : Organization and Function, Blockwell Publishing, USA.

PRACTICALS:

1. Induction of Human leukocyte culture.
2. Preparation of Human chromosomes and G banding.
3. Karyotyping of normal chromosomes and syndromes.
4. Creation of pedigrees and study on patterns of inheritance.
5. Studies on phenotypes of different diseases and syndromes.
6. Barr body analysis.

GENETIC RESOURCES & IPRs [16D52402T]

1. Course Code: **16D52402T**
2. Course Title: Genetics resources & IPR
3. Contact Hours: L: 3 T: 1 P: 0
4. Examination Duration (Hours): Theory: 3 Practical: 0
5. Credits: 3
6. Semester: II
7. Course Learning Objectives:
   a. *T*o conserve biological diversity
   b. To promote the sustainable use of its components
   c. To achieve fair and equitable sharing of the benefits arising out of the utilisation of *genetic resources*.
8. Course details:

THEORY

UNIT-I BIODIVERSITY VS GENETIC RESOURCES (12-Hrs)

Definition, alpha vs beta biodiversity and methods of their study, present levels of biodiversity and rate of loss of biodiversity, extent of biodiversity in different groups of animals, plants and microbes.

UNIT-II USE OF GENETIC RESOURCES FOR HUMAN WELFARE (6-Hrs)

With reference of agriculture, pharmaceuticals, in maintenance of ecosystem, ethnobotany in use of genetic resources.

UNIT-III TECHNIQUES FOR GERM PLASM CONSERVATION (10-Hrs)

In situ, Ex-situ methods of conservation, cryopreservation of genetic materials. Global network for access to information about genetic resources, role of FAO/CGIAR for access to genetic resources.

UNIT-IV FUNDAMENTALS OF IPR (8-Hrs) Intellectual property rights: Meaning,-Evolution – Classification and forms, Rationale for protection of IPRs – Importance of IPRs in the fields of science and technology.

UNIT-V PATENTS (12-Hrs)

Patents – Concepts and principles of patenting – Patentable subject matter, Procedure of obtaining patents – Rights of patents – Infingement of patent rights, Remedies for

infringement of patent rights – Patentability and emerging issues. Patenting of biological materials; Patents for higher plants and higher animals, patenting of transgenic organisms, patenting of isolated genes and DNA, sequences.

9. **Course outcomes (COs):**

a. Understand the Fundamentals of intellectual property systems and the new regimes for trade and exchange of genetic resources and the prospects/problems/risks for developing countries.

b. Description and discussion of various IPR regimes governing the exchange of genetic resources.

c. Skilled and able to describe the subjects of strategic importance to economic and social development.

d. Make the long-term perspective and help to contribute to institutional strengthening and capacity development in the cooperating countries.

Suggested Readings & References

- Dr. B.L.Wadehra 2011, Law Relating To Intellectual Property, Fifth Edition, Universal Law Publishing Co.Pvt. Ltd.
- TIFAC 2002 Some questions and answers on Patents and Copyrights
- H K Das 2010, Text book of Biotechnology,4th edition, Wiley India Pvt. Ltd, New Delhi
- H S Chawala 2009, Introduction to Plant Biotechnology, 3rd Edition, Science Publishers
- Hirvani R 2009, Patents in Plant Breeding: Guarding the Green Gold- Biotech News issue vol 4., No.4
- GanguliPrabuddh 2001, Intellectual Property Rights, Tata McGraw-Hill Publishing Company Ltd.

COMPUTER AIDED DRUG DESGN (CADD) (16D52403B)

1. Course Code: 16D52403B

2. Course Title: COMPUTER AIDED DRUG DESGN (CADD)

3. Contact Hours: L: 3 T: 1 P: 3

4. Examination Duration (Hours): Theory: 3 Practical: 3

5. Credits: 5

6. Semester: IV

7. Course Learning Objectives:

a. Appreciate the overall complexity of target and lead interaction.
b. Understand the complex of lead and macromolecules.
c. Be able to interpret interaction of complex protein.
d. Be able to provide an introduction to the key areas of genomics, human genetics and genetic variation.
e. It prepares participants to understand disease genetics and how genomic medicine can be utilized to elucidate disease mechanisms and biology.

1. Course details:

THEORY

UNIT I **(12)**

Homology modelling of protein. Conformational analysis: Secondary structure prediction, 3D structure prediction, fold recognition and sequence-structure alignment of proteins. Molecular modelling of drug-receptor interaction: Prediction of active site in receptor, building small molecules.

UNIT II **(10)**

ADME Predictions. Ligand-based drug designing: Protein-ligand docking, Protein-protein docking, Combinatorial library generation. Pharmacophore mapping. Molecular shape-based drug designing: Structure based designing. Molecular Docking.

UNIT III **(13)**

MOLECULAR MODELING: Constructing an Initial Model, Refining the Model, Manipulating the Model, Visualization. Structure Generation or Retrieval, Structure Visualization, Conformation Generation, Deriving Bioactive Conformations, Molecule Superposition and Alignment, Receptor Mapping, Estimating Biological Activities, Calculation of Molecular Properties, Examples of Small Molecular Modeling Work,

UNITIV **(15)**

DOCKING METHODS: Insilico Drug Designing: Major steps in Drug Designing, Ligand and Structure based drug designing, Protein-ligand docking, QSAR Modeling, Pharmacodynamics (Efficacy & Potency) & Pharmacokinetics (ADME), Lipinski's rule of five, Pharmacogenomics.

Practicals

1. Identication of target
2. Cheracterization of target
3. Refinement of a target
4. Identification and characterization of lead
5. ADMET cheaking
6. Docking

REFERENCE BOOKS:

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

Advanced Bioinformatics Techniques with Machine learning (16D52404B)

1. Course Code: 16D52404B
2. Course Title: Advanced Bioinformatics Techniques with Machine learning
3. Contact Hours: L: 3 T: 1 P: 3
4. Examination Duration (Hours): Theory: 3 Practical: 3
5. Credits: 5
6. Semester: IV
7. Course Learning Objectives:
    f. Appreciate the overall complexity of target and lead interaction.
    g. Understand the complex of lead and macromolecules.
    h. Be able to interpret interaction of complex protein.
    i. Be able to provide an introduction to the key areas of genomics, human genetics and genetic variation.

j. It prepares participants to understand disease genetics and how genomic medicine can be utilized to elucidate disease mechanisms and biology.

2. Course details:

THEORY

UNIT I

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

UNIT II

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

UNIT III

Machine learning:, Artificial Neural Networks, Hidden Markov Models, Genetic Algorithms, Simulated Annealing, Support vector machines;; Evaluation of prediction methods: Parametric and Nonparametric tests, Clustering (Hierarchical and K-mean)

UNIT IV

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

UNIT V

Overview of key techniques for the management of large document collections and the biological literature: Document clustering, Information retrieval system; Natural Language Processing: Introduction, Major areas of NLP, Natural language information extraction

Text Books & References

1. Computational Methods in Biotechnology – Salzberg S. L. et al., Elsevier Science.

2. D.W.Mount; Bioinformatics- Sequence and genome analysis; Cold Spring Harbour Lab press.

3. Statistical Methods in Bioinformatics-Evens & Grants, Springer-Verlag, NY.

4. Computational Molecular Biology- Setubal and Meidanis, PWS publishing Co., 1997. 18/ 24
5. Protein Structure Prediction-A Practical Approach, MJE Sternberg, Oxford University Press.

Practicals

1. Identification of Distantly related homologous sequences of a given query protein sequence using PSI-BLAST.
2. Prediction of secondary structure of RNA using any web server.
3. Construction and analysis of Ramachandran Plot using any suitable web server.
6. Comparative assessment of best available tools for genome annotation.