A PROPOSAL FOR ESTABLISHMENT OF

DEPARTMENT OF BIOINFORMATICS

New Revised Syllabus
M.Sc. Bioinformatics

University Grants Commission
(UGC XIIth PLAN)

New Delhi- 110 002

(Introduced from June 2012 onwards)

A) Preamble:

Bioinformatics is an emerging branch in the field of life science. Bioinformatics is information technology applied to the management and analysis of biological data with the aid of computers. It is the science of using information to understand biology. It is a field in which biological information collected, compared, studied and analyses to find the interrelation between them for solving structural, functional and evolutionary problems using computational technologies. The biological information stored in various databases is available online through internet.

Bioinformatics refers to the creation and development of databases, software, computational and statistical techniques and theory to solve problems generated from the management and analysis of biological data. On the other hand, computational biology refers to the hypothesis based investigation of a specific biological problem using computers, carried out with experimental or simulated data, with the primary goal of discovery and the advancement of biological knowledge.

Bioinformatics solves the following problems and put more emphasis on understanding the disease related problems at molecular level.

- Protein sequencing, Nucleic acid sequencing and their analysis.
- Find proteins their interaction, activity, modification and function.
- Elucidation of function of a molecule based on its structure.
- Gene expression, analysis, prediction and establish genomic library.
- Find homology for studying evolutionary relationship among different species.
- Molecular modeling and molecular dynamics methods to study structure from sequence.
- Drug designing and discovery from data of functional genomics and proteomics.

In the recent years in this age of Internet and sequenced genome we have more information at our fingertips than ever before. Organizing this entire data and combating information overload is becoming more and more important. The advent of genetic engineering vastly increased size of the information. It is thus necessary for institutes like university evolve a system, which is most accurate and more student friendly. Keeping this view in mind we have decided to establish Department of Bioinformatics. Under this department we would like to start new post graduate courses such as M.Sc. M.Phil. and Ph.D.

After expert training in the department about the bioinformatics subject students can be accommodated in any national/multinational drug designing pharmaceutical/biotechnology/software industry. This course will provide common basic knowledge of Bioinformatics including Mathematics, Statistics, Computer Science, Biochemistry, Microbiology, Botany and Zoology. This will be the first of its own kind department in this part of Maharashtra. In a nutshell the following are the objectives of this course.

B) Objectives:

This department is expected to bring direct benefit to students of this university, strengthening ongoing university research in the area of life sciences.

i. Develop an expert manpower to help bioinformatics industry, academia and thereby society.

ii. Strengthening ongoing university research in the area of bioinformatics, in particular and life science in general.

iii. Perform Computer Assisted Drug Designing and Drug Discovery.

iv. Create an advanced research facility to carry out research in frontier areas of bioinformatics, biotechnology, and molecular modeling.

C) Expertise available:

At present one person having expertise in bioinformatics is available in the Department of Biochemistry, Shivaji University, Kolhapur. New teaching staff can be hired from outside institutes/universities or appointed. At least four staff members of bioinformatics specialization or doing research in bioinformatics are required.

The staff present in Department of Biochemistry, Biotechnology, Microbiology, Statistics, Mathematics, Computer Science, Botany, and Zoology department are available for the teaching as well research purpose. The experts from National and International Institutions will be invited to deliver lectures and to monitor/review the teaching and research activities of the department.

D) Space required:

There would be need of separate building to run the courses like M.Sc. M.Phil. and Ph.D. under this department. For time being theory and practical courses can be conducted in the Department of Biochemistry, and Microbiology.

Department of Biochemistry is running one year Post Graduate Diploma in Bioinformatics since 2008. The intake capacity for this course is 20. The course structure includes four theory papers and two practical courses along with research project. Examination pattern is annual based. Some of the infrastructural facilities developed for these courses are;

Department of Biochemistry has one computer room (10 Pentium IV PC's) with Internet connectivity and necessary infrastructural facility to carry out quality research in the field of bioinformatics and biotechnology such as one *HCL* workstation successfully loaded with '*Spartan*' software to do molecular modeling research, two HP workstations with commercial software SYBYL from Tripos, Inc., USA, and AMBER programme from UCSF, USA. Other HP servers are with GROMACS, AMBER, MODELLER, AutoDock, etc. software.

- **Software and Computer Workstations available for this course in the Department of Biochemistry, Shivaji University, Kolhapur:**

Sr. No.	Software	Computers & Accessories
i.	SYBYL	HCL Workstation (01)
ii.	SPARTAN	HP Workstations (02)
iii.	AMBER	HP Servers (03)
iv.	GROMACS	HCL Computers (10)
v.	Modeller	Acer Desktop (02)
vi.	Auto-Dock	LCD Player (01)
vii.	RasMol	Projector (01)
viii.	ClustalW	
ix.	Bio-Edit	

However, following facilities would be required to make good bioinformatics department.

- **Required Facilities for the proposed Department of Bioinformatics:**

Sr. No.	Facility Name	Number	Size
1.	Bioinformatics laboratory with internet connectivity	02	10mx10m
2.	Bioinformatics research laboratory with internet connectivity	02	10mx10m
3.	General laboratory	01	10.5mx6m
4.	Room for Rack/Blade servers	01	6mx6m

5.	Software to do bioinformatics and molecular modeling research.	Annexure-I	-
6.	Room for Co-ordinator / Head (I/c)	01	6mx6m
7.	Room for staff members/contributory teachers	05	6mx6m each
8.	Room for Office	01	6mx6m
9.	Room for store	01	10mx6m
10.	Class rooms	02	10mx6m each
11.	Ladies Room	01	6mx6m

All laboratories will be provided with the necessary service lines such as electricity, gas, water, compressed air and required instrumentation along with good exhaust. General laboratory will be provided with tables of appropriate height for laboratory work and instrumentation

E) Budgetary Provisions:

A general budgetary provision to be made to buy computers, workstations, software, Rack/Blade servers, building construction, library material etc. are given in Annexure –I.

Technical as well as secretarial staff required to commence this activity will be recruited as the procedures followed in the University. Budgetary provision for the same is given in Appendix II.

Laboratory expenses, purchase of teaching aids, honorarium to contributory teachers and T. A. to visiting professors and contributory teachers, internet bills/stationary are listed in Annexure III.

F) Justification:

It would be good to have Bioinformatics Department in our university campus to train students, faculties of affiliated colleges and to undserstand biological processes at molecular level. It would also be helpful to do Computer Assisted Drug Designing by using this facility. Presently, one faculty of Department of Biochemistry is working in few different areas such as; nucleic acids structure-function, prediction of three-dimensional structures of enzymes responsible for the degradation of amyloid beta peptides; a causative agent of Alzheimer's disease, enzymes, identification of interactions between enzyme-substrate, enzyme-inhibitor enzyme-dyes interactions and enzyme-drug molecules. This facility would be useful to solve biologically tricky problems by computationally expensive quantum chemical, molecular dynamics simulation techniques.

We have also planned to develop databases of protein sequences of mangrove medicinal plants, gene sequences of endangered species, and medicinal plants of Western Ghats of this region. We also plan to do data mining work of various biological databases that are available at NCBI site.

This department would be useful for all the faculties of this university who wish to do computational biology related work. This facility would also be useful to provide advanced training in bioinformatics to students and teachers of our university as well as affiliated colleges. Finally it will be useful to do quality research and get publications in high quality reputed journals. This department will be helpful to students/researchers of all life science subjects. Considering the facts that;

i) University and its affiliated collages do not have Bioinformatics Department to do research activities in bioinformatics.

ii) Interest of students for bioinformatics.

iii) Bioinformatics is an essential subject to understand life processes at molecular level and which is required for all life science departments within the university campus for teaching as well as for research purpose.

By starting this bioinformatics department within the university campus would be helpful to enhance the teaching and research activities of university with collaborative efforts of all life sciences departments viz. Biotechnology, Biochemistry, Microbiology, Botany, Zoology, Statistics, Mathematics, and Computer Science departments.

G) Organization of work elements:

The activity will be co-ordinated by co-ordinator or Head (I/c) by any teacher from the university departments of life sciences who is aware of bioinformatics and doing research in bioinformatics subject.

H) M. Sc. intake Capacity: 20 students.

I) Eligibility for M.Sc. students: B. Sc. degree in Science (Life Sciences, Physical, Chemical Mathematical, Computational, and Statistics) or B.E./B.Tech, pharmacy, medical, engineering, agriculture and veterinary science.

J) Ph.D. intake Capacity: 08 Ph.D. students per faculty who has recognition in the subject of bioinformatics by university.

K) M. Phil. intake Capacity: 05 M.Phil. students per faculty who has recognition in the subject of bioinformatics by university.

L) Eligibility for M.Phil./Ph.D. students: M.Sc. Bioinformatics / Biochemistry/ Biotechnology/ Microbiology /Botany / Zoology / Computer Science/ Statistics/ Mathematics.

M) Course Fee: Fee structure for M.Sc. M.Phil and Ph.D. course would be as per the University norms.

N) Teachers Qualification: M. Sc./ M.Tech./ Ph.D. in Bioinformatics/ Biochemistry/ Biotechnology/ Microbiology / Computer science/ Chemistry/ Statistics/ Mathematics with knowledge in Bioinformatics.

O) M.Sc. M.Phil., Ph.D. Course Structure: As per University norms. This course syllabus has been approved by Ad-Hoc BOS in Biochemistry.

A) Course structure of M.Sc. Bioinformatics syllabus (Outline) :

Paper code.	Name of paper
SEMESTER - I	
THEORY	
BIOINFO: I	Cell biology, Microbiology and Virology
BIOINFO :II	Proteins structure and functions
BIOINFO:III	Biomolecules
BIOINFO:IV	Basic of computer, Mathematics and Biostatistics
PRACTICAL	
	Lab Course- I
	Lab Course- II
SEMESTER - II	
THEORY	
BIOINFO :V	Molecular Biology
BIOINFO:VI	Genomics and Proteomics
BIOINFO:VII	Bioenergetics
BIOINFO:VIII	Programming language C
PRACTICAL	
	Lab Course- III
	Lab Course- IV

SEMESTER-III	
THEORY	
BIOINFO :XI	Genetic engineering
BIOINFO : X	Chemoinformatics
BIOINFO : XI	Visual Basic and .net programming
BIOINFO: XII	Immunology
PRACTICAL	
	Lab Course- V
	Lab Course- VI
SEMESTER - IV	
THEORY	
BIOINFO:XIII	Advances in Structural Bioinformatics
BIOINFO:XIV	Drug designing
BIOINFO: XV	Biodiversity informatics
BIOINFO:XVI	Programming in Perl
PRACTICAL	
	Lab Course- VII
	Lab Course- VIII (Project work)

M.Sc. Bioinformatics Syllabus

Topic No.	BIOINFO: I Cell Biology, Microbiology and Virology.	Lectures 60
	Unit- I	
1.	**Cell Biology**	**15**
	1.1 Cell as a basic unit of life. 1.2 Cell organization of prokaryotic and eukaryotic cells. 1.3 Structural and functional capitalization of cell:– Mitochondria, Chloroplast, Lysosomes, Golgi bodies, Plasma membrane, Cytoskeleton, Cell wall and Nucleus.	
	Unit-II	
2.	2.1 Cell cycle, cell division - mitosis and meiosis. 2.2 Chromosome structure, gene, gene number, gene clusters and Pseudogene. 2.3 Polytene and lampbrush chromosomes. 2.4 Packing of DNA, supercoiled DNA, nucleosome. 2.5 Inverted repeats, repetitive DNA sequence, satellite DNA. 2.6 Cell trafficking.	**15**
	Unit- III	
3.	**Microbiology**	**15**
	3.1 Structure, classification and general characteristics of Bacteria (including ribotyping), Micoplasma, Protozoa, archea and yeast, fungi. Association of bacteria. 3.2 Methods in microbiology: Pure culture techniques, principles of microbial nutrition, construction of culture media, enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms. 3.3 Sterilization-Application of sterilization methods in biotechnology, Various sterilization methods, Microbial	

	contamination control and Sterility testing. 3.4 Microbial growth: The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yield, synchronous growth, continuous culture.	
	Unit- IV	
4.	**Virology**	**15**
	4.1 Classification and General properties of plant, animal and bacterial viruses, Bacteriophages - lytic cycle & lysogeny. 4.2 Structure of viruses, assembly of viral membrane. 4.3 Life cycle and replication of viruses: RNA-negative strand (VSV), positive strand (Polio), segmented [Influenza], Retrovirus- RSV and HIV, DNA- adenovirus and SV-40. 4.3 Cultivation in cell culture, chick embryo and animal inoculation. 4.4 Persistent chronic and acute viral infections. 4.5 Mechanism of interferon and antiviral therapy. 4.6 Host virus interactions; plant and animal.	
Topic No.	**BIOINFO: II Proteins – Structure and Functions**	**Lectures** **60**
	Unit- I	
1.	**Amino Acids and Proteins**	15
	Amino Acids 1.1 Chemical structure and general properties of amino acids, pI of amino acids, acid base concepts. 1.2 Henderson and Hasselbaclh equation. 1.3 General metabolism scheme of amino acids and Urea cycle. Proteins 1.4 Classification- size, shape, degree of association, complexity. Classification of proteins according to biological functions (Enzymes, transport, storage, contractile, structural, defense and regulatory) 1.5 Structure of peptide bond - restricted rotation, cis - trans bending, Ramchandran plot. Peptides.	

	Unit-II	
2.	**Protein structure**	**15**
	2.1 Secondary structure - alpha helix and beta pleated structure, triple helix (collagen) and Super secondary structures. 2.2 Tertiary structure - forces stabilizing tertiary structure, unfolding/refolding experiment. 2.3 prediction of secondary and tertiary structure. 2.4 Dynamics of protein folding, role of molecular chaperones in protein folding, Lysosomal and membrane proteins. 2.5 Quaternary structure - forces stabilizing quaternary structure. 2.6 Structure function relationship - myoglobin and hemoglobin. 2.7 Techniques for studying primary sequence of proteins, experimental methods, end group analysis, finger printing and sequenators.	
	Unit- III	15
3.	3.1 Chemical synthesis of peptides, solid phase automated synthesis. 3.2 Prediction of conformation from amino acid sequence. 3.3 Zymogens and their conversion into active proteins 3.4 Protein evolution - phylogenic tree, convergent and divergent trees, sequence analysis, comparison matrix, Dot matrix and substitution matrix. 3.5 Protein turnover: Ubiquitination, proteasome and protein degradation.	
	Unit- IV	
4.	**Coenzymes and cofactors**	15
	4.1 Concept of prosthetic group, apoenzyme, holoenzyme, enzyme. Coenzyme. 4.2 Vitamins as coenzymes: sources, requirements, functions and deficiency symptoms of water soluble vitamins. Structure and biochemical role, Assay of vitamins. 4.3 Cofactors: Role of trace elements, their bound forms in biological systems and in enzyme structure and function.	

Topic No.	BIOINFO: III Biomolecules	Lectures 60
	Unit- I	
1.	**Classification, Structures and Carbohydrate Metabolism**	**15**
	1.1 Classification, characteristics and functions of monosaccharides, disaccharides - polysaccharides. 1.2 Epimers, isomers, anomers, chiral carbon atom, chair and boat form, glucopyranose and fructopyranose. 1.3 General scheme of metabolism, historical and experimental details in derivation of a metabolic pathway. 1.4 Glycolysis - aerobic and anaerobic, regulation of glycolysis. 1.5 Krebs cycle and its regulation; 1.6 Hexose monophosphate shunt.	
	Unit-II	
2.	**Pathways of Carbohydrate Metabolism and Complex Carbohydrates**	**15**
	2.1 phosphoketolase pathway, Entner Dudroff pathway, glyoxylate and glucuronate pathways, Cori cycle. 2.2 Interconversion of sugars, gluconeogenesis. 2.3 syntheses of disaccharides and polysaccharides. 2.4 Regulation of blood glucose and homeostasis. Glycogenesis and glycogenolysis and their regulation. 2.5 Types and general functions, amino sugars, sialic acid and mucopolysaccharides. 2.6 Structure and functions of glycoproteins and proteoglycans. 2.7 Blood group sugar compounds, sugar nucleotides, bacterial cell wall components. Lectins - specificity, characteristics and uses, pectin, xylans.	
	Unit- III	
3.	**Lipids**	**15**

	3.1 Definition and classification of lipids. Fatty acids - general formula, nomenclature and chemical properties Structure, function and properties of simple, complex, acylglycerols, phosphoglycerides, sphingolipids, waxes, terpenes, steroids and prostaglandins. 3.2 Beta oxidation - pathway and regulation. 3.3 Role of acyl carnitine in fatty acyl transport. 3.4 Synthesis of fatty acid - structure and composition of fatty acid synthetase complex, pathway and regulation. synthesis of triacyl glycerides. 3.5Ketone bodies - formation and utilisation.	
	Unit- IV	
4.	**Enzymes and Nucleic acids**	**15**
	4.1 Classification of enzymes, IUB system, enzyme substrate complex, active site of enzymes, stereo specificity and ES complex formation. 4.2 Effect of temperature and pH and substrate concentration on reaction rate, 4.3 Activation energy, transition state theory, enzyme activity. Michaelis-Menten equation, significance of Vmax and Km, 4.4 Enzyme inhibition, types of inhibitors and mode of action. Chemical modification of enzymes, Structure and functions of Ribonuclease, trypsin, chymotrypsin, Enzyme regulation, feedback control, product inhibition. 4.5 Structure of nucleoside, nucleotide. De novo and salvage pathways of nucleotide synthesis. Experimental evidence for nucleic acids as genetic material. 4.6 Secondary structure of DNA, Watson and Crick model of DNA. A, B and Z forms of DNA, Tm and its relation to GC content. 4.7 Chemical and enzymatic degradation of nucleic acids.	

Topic No.	BIOINFO: IV Basic of computer, Mathematics and Biostatistics	Lectures 60
	Unit- I	
1.	**Introduction to Computers**	**15**
	1.1 History and development of computers; generations of computers; (I, II, III, IV and V), 1.2 classifications of computers; analog computers, digital computers, mainframe computers, miniframe computers, microcomputers, fundamentals of logical concepts. 1.3 Digital Computers:- Basic principle of operation of digital computers, structure of digital computers; arithmetic unit, central unit, memory unit, Input unit and output unit. 1.4 Computer Coding:- Number system, decimal number system, binary number system, binary to decimal conversion, Binary arithmetic, octal number system, hexadecimal number system.	
	Unit-II	
2.		**15**
	2.1 Languages and flow charts and Operating Systems:-Machine level languages, assembly level languages, high level languages. 2.2 Input and Output devices :-Punched card reader, paper tape reader, magnetic tape, floppy disk, magnetic disk,optimal scanner, voice data, entry terminal, teleprocessing terminal, visual display unit,modern input devices, Output devices; CRT, printer, plotter. 2.3 Memory: - Primary memory or main memory; magnetic core memory, semi-conductor memory, RMA, ROM, PROM, EPROM, EEPROM. Secondary memory or auxillary memory or storage devices; Hard disk, discket, magnetic tape, ZIP, devices, digital tape,CD-ROM, DVD, virtual , memory, catche memory. 2.4 Operating Systems:- DOS, windows 98/XP/VISTA, UNIX/LINUX, Mac OS, VMS.	
	Unit- III	
3.	**Modern Computers**	**15**

	3.1 Workstations, parallel processing computers, supercomputers. 3.2 Internet and related programmes: - WWW, HTML, HTTP, telnet, FTP, computer domain. 3.3 Introduction to Biostatistics: Applications and uses, sample variable, statistical sampling, population, primary and secondary data, screening and representation of data. 3.4 frequency distribution, bar diagram, histogram. Pie diagram, cumulative frequency curves. 3.5 Mean, median, mode, Comparision between mean, median and mode. 3.6 Measures of dispersion: range, variation, standard deviation, coefficient of variation, symmetry, probability distribution.	
	Unit- IV	
4.	**Basic Mathematics**	**15**
	4.1 Sets:- Finite set, infinite set, null or void set, subset, Intervals; closed and open, universal set, operations of set. Relations and functions. 4.2 Matrices:-Types of matrices, properties of matrices, addition, substraction of matrices, matrix, multiplication, elementary transformation, inverse of matrices. 4.3 Determinants: - Definition, properties associated with determinants. Trignometry and Derivatives. 4.4 Introduction Of Databases:-Concept of data, data models, data representation, mining, various types of databases, biological data and data analysis. Related programs; Oracle, SQL, VB, Database management System (DBMS). Introduction to protein and nucleic acid databases.	

SEMESTER II

Topic No.	**BIOINFO: V Molecular Biology**	**Lectures** **60**
	Unit- I	
1.	**Genome Organization**	**15**

	1.1Organization of bacterial genome, Structure of eucaryotic chromosomes. 1.2 Role of nuclear matrix in chromosome organization and function, matrix binding proteins, heterochromatin and euchromatin, molecular components. 1.3 DNA reassociation kinetics (Cot curve analysis), repetitive and unique sequences, kinetics and sequence complexities. 1.4 Satellite DNA, DNA melting and buoyant density, packing and organization of chromatin, nucleosome phasing, DNase I hypersensitive regions, DNA methylation & Imprinting. 1.5 Mutation:-Nonsense, missense and point mutations, intragenic and intergenic suppression, frameshift mutations, physical, chemical and biological mutagens.	
	Unit-II	
2.	**DNA Replication, Repair & Recombination**	**15**
	2.1 Concepts of replication initiation, elongation and termination in prokaryotes and eukaryotes, enzymes and accessory proteins involved in DNA replication, Fidelity in replication, replication of single stranded circular DNA. 2.2 Gene stability and DNA repair, DNA repair enzymes, photoreactivation, nucleotide excision repair, mismatch correction, SOS repair. 2.3 Recombination:- homologous and non-homologous recombination, site specific recombination, Holliday structure, resolution, chi sequences in prokaryotes, gene targeting, gene disruption, FLP/FRT and Cre/Lox recombination RecA and other recombinases.	
	Unit- III	
3.	**Prokaryotic & Eukaryotic Transcription**	**15**
	3.1 Prokaryotic Transcription & Regulation: Promoters, Regulatory elements, Transcription unit, constitutive and inducible promoter, operators, Initiation, Attenuation, Termination, Rho-dependent and independent termination, Anti-termination, Transcriptional regulation, positive and negative regulation, 3.2 Operon concept, Regulation of transcription of lac, trp, ara, his, and gal operons, transcriptional control in lambda phage, Transcript	

	processing, 3.3 Processing of tRNA and rRNA. 3.4 Eucaryotic transcription and regulation: RNA polymerase structure and assembly, RNA polymerase I, II, III, Eukaryotic promoters and enhancers, General Transcription factors, TATA binding proteins (TBP) and TBP associated factors (TAF), Activators and repressors, transcription initiation, elongation and termination, activation and repression. 3.5 Transcriptional and post-transcriptional gene silencing, expression and processing of heterogeneous nuclear RNA, tRNA, rRNA, 5'-Cap formation,3'-end processing and polyadenylation, Splicing, RNA editing, Nuclear export of mRNA, mRNA stability, catalytic RNA.	
	Unit- IV	
4.	**Translation & Transport**	**15**
	4.1 The translation machinery, ribosomes, composition and assembly. 4.2 Universal genetic code, degeneracy of codons, termination codons, isoaccepting tRNA, wobble hypothesis. 4.3 Mechanism of initiation, elongation and termination, Co- and post-translational modifications, genetic code in mitochondria. 4.4 Protein synthesis. Transport of proteins and molecular chaperones. 4.5 protein stability, protein turnover and degradation.	

Topic No.	**BIOINFO: VI Genomics and Proteomics**	**Lectures** **60**
	Unit- I	
1.	Genomics: Nucleotide sequence Databases, its Analysis and Identification	15
	1.1 Goals of the Human Genome Project, cloning vectors, concept of maps, physical maps, shotgun libraries, DNA polymorphism, nucleotides, DNA sequences.	

	1.2 Sequence databases: GeneBank, EMBL Nucleotide sequence databank, DNA Data Bank of Japan (DDBJ), database formats. 1.3 Recombinant DNA technology, restriction enzymes, resource for restriction enzyme (REBASE), similarity search. Polymerase chain reaction, primer selection for PCR, BLASTn, application of BioEdit. 1.4 Genome information and special features, coding sequences (CDS), untranslated regions (UTR's), cDNA library, expressed sequence tags (EST). 1.5 Approach to gene identification; masking repetitive DNA, database search, codon-bias detection, detecting functional sites in the DNA. 1.6 Internet resources for gene identification, detection of functional sites, gene expression.	
	Unit-II	
2.	**Gene experience, DNA microarray and Proteomics.**	**15**
	2.1 Gene experience: - Introduction, Basic steps for gene expression. 2.2 Microarray:- Concept of microarrays; spotted arrays, oligonucleotide arrays, designing the experiment, Two-color microarray experiments. 2.3 Clustering gene expression profiles; Agglomerative, Hierarchical, Nearest neighbour (Single-linkage), complete-linkage, average-linkage, weighed pair-group average, k-means clustering, self-organizing maps (SOM) clustering. 2.4 Tools for microarray analysis; soft-finder, xCluster, MADAM, SAGE, Microarray design, microarray experimentation, fabrication computational analysis of Microarray data, Applications of microarray technology. 2.5 Proteomics:-Protein sequence information, composition and properties, physicochemical properties based on sequence, sequence comparison, 2.6 Primary databases, Secondary databases. 2.7 Pair-wise sequence alignment, gaps, gap-penalties, scoring matrices, PAM250,BLOSUM62, local and global sequence alignment, multiple sequence alignment, useful programs, ClustalW, BLASTp.	

	Unit- III	
3.	**Protein Microarray and Phylogenetic analysis**	**15**
	3.1 Proteomics classification; Tools and techniques in proteomics; 2-D gel electrophoresis, gel filtration, PAGE, isoelectrick focusing, affinity chromatography,HPLC, ICAT, fixing and spot visualization, Mass spectroscopy for protein analysis,MALDI-TOF, Electrospray ionization (EST), Tandem mass spectroscopy (MS/MS) analysis; tryptic digestion and peptide fingerprinting (PMF). 3.2 Protein Micro array in protein expression, profiling and diagnostics, drug target discovery. 3.3 Database searching, 3-dimensional structure determination by X-ray and NMR. 3.4 Phylogenetic analysis:-Evolution, elements of phylogeny, methods of phylogenetic analysis, Phylogenetic tree of life, comparison of genetic sequence of organisms, phylogenetic analysis tools-Phylip, ClustalW.	
	Unit- IV	
4.	**Applications of Bioinformatics in various fields**	**15**
	4.1Environment, biotechnology, molecular biology, neurobiology, agriculture, drug designing, biomedical genome medicines, medical microbiology.	

Topic No.	**BIOINFO: VII Bioenergetics**	**Lectures** **60**
	Unit- I	
1.	**Free energy concepts:**	**15**
	1.1Free energy concept: Molecular basis of entropy, concept of free energy, standard free energy and measurement of free energy, significance in metabolism.	

	1.2 Application of first and second law of thermodynamics to biological systems. 1.3 Energy rich bonds - ATP and interconversions of nucleotide phosphates. Phosphorylation potential. 1.4 Nitrogen fixation: Biological fixation of nitrogen, symbiotic and non-symbiotic nitrogen fixation. 1.5 Nitrogenase enzyme complex - azoferredoxin and molybdoferrodoxin. 1.6 Physiological electron donors and mechanism of nitrogen reduction, assimilation of ammonia, nitrogen cycle. 1.7 Nif genes and its regulation.	
	Unit-II	
2.	**Mitochondria**	**15**
	2.1 Architecture, chemical activity of mitochondria. 2.2 Sequence of electron carriers and sites of oxidative phosphorylation, ATP generation, heme and non- heme iron proteins. 2.3 Thermodynamic considerations, oxidation - reduction electrodes, standard electrode potential, redox couples, phosphate group transfer potential. 2.3 Respiratory controls. Theories of oxidative phosphorylation, uncouplers and inhibitors of energy transfer. ATP synthetase complex.	
	Unit- III	
3.	**Chloroplast**	**15**
	3.1 Architecture - light harvesting complexes, bacteriorhodopsin, plastocyanin, carotenoids and other pigments. 3.2 Hill reaction, photosystem I and II - location and mechanism of energy transfer, photophosphorylation and reduction of carbon dioxide. 3.3Calvin cycle , quantitative efficiency, photorespiration, C4 -	

	metabolism. 3.4Chemiosmotic theory and evidence for its occurance, ion transport through membranes, proton circuit and electro-chemical gradient, ionophores, Q cycle and stoichiometry of proton extrusion and uptake, P/O and H/P ratios, reverse electron transfer. 3.5Fractionation and reconstitution of respiratory chain complexes.	
	Unit- IV	
4.	**Hormones**	**15**
	4.1 General classification of hormones - synthesis, structure, secretion, transport, metabolism and mechanism of action of pancreatic, thyroid, parathyroid, hypothalamus, pituitary, adrenal and prostaglandins. 4.2 Hormonal control of spermatogenesis, menstrual cycle, pregnancy and lactation. 4.3 Cell membrane and intracellular receptors for hormones. 4.4 Secondary messengers 4.5 Plant growth hormones - auxins, gibberllins, abscessic acid, cytokinins.Phenoromones	

Topic No.	**BIOINFO: VIII Programming language C**	**Lectures 60**
	Unit- I	
1.	**Introduction**	**15**
	1.1 History of C 1.2 Characteristics of C 1.3 Program Structure, Constants. 1.4Data types, Variables, Keywords, Console Input/output Statements, Compilation and Execution.	
	Unit-II	
2.	**Operators, Branching & Looping Statements**	**15**

	2.1Arithmetic Unary Assignment Relational & Logical Conditional 2.2 If Statement, Nested if ,Statement else-if. 2.3 Ladder switch, Statement Looping. 2.4 Concepts for loop while loop do-while loop Jump Statements.	
	Unit- III	
3.	**Arrays & Functions**	**15**
	3.1 Array Concepts Rules & Restrictions. 3.2 Single & Multi Dimensional Arrays 3.3 Types of Functions, Functions and Arrays Function. 3.4 Prototyping, Scope of Variables Built-in Functions.	
	Unit- IV	
4.	**Strings, Pointers & Structures**	**15**
	4.1 String Functions, String Manipulation. 4.2 Pointer Concepts, Pointers and Functions Pointers and Arrays, 4.3 Array of Pointers, Static Initialization, Pointers and Structures, Illegal indirection. 4.4 Defining New Data types, Unions Type Casting Enumerated, Data types Static Variables, Type Definition.	

SEMESTER- III

Topic No.	**BIOINFO: IX Genetic Engineering**	**Lectures** **60**
	Unit- I	
1.	**DNA & basics of recombinant DNA technology**	**15**

	1.1 Structure of DNA: A-,B-,Z-, and triplex DNA, 1.2 Measurement of properties, spectrophotometric, CD, AFM, and electron microscope analysis of DNA structure. 1.3 Restriction analysis: Types of restriction enzyme, Type I, II and III, restriction modification systems, type II restriction endonucleases and properties, isoschizomers and neoschizomers, mcr/mrr genotypes, Cohesive and blunt end ligation, linkers, adaptors, homopolymeric tailing. 1.4 Labeling of DNA: Nick translation, random priming, radioactive and non-radioactive probes, use of Klenow enzyme, T4 DNA polymerase, bacterial alkaline phosphatase, polynucleotide kinase. 1.5 Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence *in situ* hybridization, Restriction maps and mapping techniques, 1.5 DNA fingerprinting, chromosome walking & chromosome jumping. 1.6 DNA-Protein interactions: - Electro mobility shift assay, DNase I footprinting, methyl interference assay.	
	Unit-II	
2.	**Cloning vectors**	**15**
	2.1 Gene Cloning Vectors: Plasmids, bacteriophages, Cloning in M13 mp vectors, phagemids, Lambda vectors. 2.2 Insertion and replacement vectors, EMBL, λDASH, λgt10/11, λZAP etc. 2.3 Cosmid vectors. Artificial chromosome vectors (YACs, BACs), 2.4 Animal Virus derived vectors- SV-40, vaccinia/bacculo & retroviral vectors. 2.5 Expression vectors; pMal, GST, pET-based vectors. 2.6 Protein purification; His-tag, GST-tag, MBP-tag etc. 2.7Restriction proteases, intein-based vectors.Inclusion bodies, methodologies to reduce formation of inclusion bodies. 2.8 Baculovirus and pichia vectors system.	
	Unit- III	

3.	**Cloning methodologies**	**15**
	3.1 Insertion of Foreign DNA into Host Cells: Transformation, Transfection. 3.2 Chemical and physical methods, liposomes, microinjection, macroinjection, electroporation, biolistics, somatic cell fusion, gene transfer by pronuclear microinjection. 3.3 Plant transformation technology: Basis of tumor formation, hairy root, features of Ti and Ri plasmids, mechanism of DNA transfer, role of virulence genes, use of Ti and Ri as vectors. 3.4 Cloning and expression in yeasts (Saccharomyces, Pichia etc.). Animal and plants cells. 3.5 methods of selection and screening, cDNA and genomic cloning, expression cloning, jumping and hopping libraries, southwestern and far western cloning, yeast two hybrid system, phage display, Construction of cDNA libraries in plasmids and screening methodologies, Construction of cDNA and genomic DNA libraries in lambda vector. 3.6 Principles in maximizing gene expression, Site-directed mutagenesis.	
	Unit- IV	
4.	**PCR and its applications**	**15**
	4.1 Primer design, Fidelity of thermostable enzymes, DNA polymerases, multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products, T-vectors, proof reading enzymes, PCR in gene recombination, deletion, addition, overlap extension, and SOEing, site specific mutagenesis, PCR in molecular diagnostics, viral and bacterial detection, PCR based mutagenesis. 4.2 Applications:-Sequencing methods: Enzymatic DNA sequencing, Chemical sequencing of DNA, principle of automated DNA sequencing, RNA sequencing. Chemical Synthesis of oligonucleotides. Gene silencing techniques: Introduction to siRNA and siRNA technology, micro RNA, construction of siRNA vectors, principle and application of gene silencing. Gene knockouts and Gene Therapy: Creation of knockout mice, disease model, somatic and germ-line therapy in vivo and ex-vivo, suicide gene therapy, gene replacement, gene targeting 4.3 Other applications: Transgenics, Genome projects and their	

	implications, application in global gene expression analysis. Applications of recombinant DNA technology in medicine, agriculture, veterinary sciences	
Topic No.	**BIOINFO: X Chemoinformatics**	**Lectures 60**
	Unit- I	
1.	**Basic Chemistry**	**15**
	Alkanes, Alkenes and alkynes, Alkyl halides: rearrangement reactions of alkyl carbocation, Grignard reactions, nucleophilic substitution reactions; Alcohols: esterification, dehydration and oxidation, reaction with sodium, phosphorus halides, ZnCl2/conc.-HCl, conversion of alcohols into aldehydes and ketones; Aldehydes and Ketones: oxidation, reduction reactions, Carboxylic acids: formation of esters, acid chlorides and amides, ester hydrolysis; Amines: basicity of substituted anilines and aliphatic amines, preparation from nitro compounds, reaction with nitrous acid, azo coupling reaction of diazonium salts of aromatic amines	
	Unit-II	
2.	**Basics of Chemoinformatics**	**15**
	2.1 Introduction to cheminformatics, Evolution of cheminformatics, History of chemical information science, 2.2Use of cheminformatics, Prospectus of cheminformatics, History of medicinal chemistry. 2.3Prodrugs and soft drugs , Drug targets , Drug solubility, Natural resources of lead compounds, 2.4 Pharmacokinetics & drug metabolism. 2.5 Biological testing and bioassays, Preclinical testing and clinical trial, Synthesis, 2.6 Patenting and manufacture, Complexes and chelating agents, 2.7Molecular modeling using computer.	
	Unit- III	
3.	**Chemistry & Chemical information sources**	**15**

	3.1 Combinatorial chemistry technologies & libraries. 3.2 Solution phase synthesis, High-throughput synthesis and screening. 3.3 Combinatorial libraries, Analytical methods, Biopanning. 3.4 Peptide display libraries:- Design and construction, Chemical literature, Chemical information searches, Chemical information sources, Chemical name and formula searching, Analytical chemistry (Constitutional Chemistry), Chemical history, Biography, Directories, and industry sources.	
	Unit- IV	
4.	**Chemoinformatics Database design & their management**	**15**
	Chemical Database Design. Bio Catalysts Database, The MOS Database, The Failed Reaction Database, Protecting Groups Database, Solid-Phase Synthesis Database Database concepts, structured query language, Design of chemical database, data abstraction, bio Catalysts Database, Reaction database, Failed reaction Database, Sequence Database, Spectra Database, Toxicology Database	

Topic No.	**BIOINFO: XI Visual Basic and .NET Programming**	**Lectures** **60**
	Unit- I	
1.	**Introduction to visual programming**	**15**
	1.1 Event driven programming, History of VB.Net, Features of VB.Net, Architecture of VB.Net [.Net server, framework, services etc.]. 1.2 Net Framework: framework components, classes, CLR, VB.Net IDE, VB.Net: Variables, Keywords, constants, Data types, Conditional statements, looping statements, case control statements.	
	Unit-II	
2.	**.NET controls**	**15**

	2.1 Activex controls, Forms, Controls & properties Text Boxes, Labels, Command Button, Radio Button, Option Buttons, Check Boxes, List Box ,ComboBox,Scoroll Bar, Progress Bar, Group Box, Calendar, Date Time Picker, Picture Box, Image List, Rich Text Box, Popup/Content Menus, List View Control , Tree View Box. 2.2 The array class collections, lists, string class, jagged array, array list String class and function. OOP using .net Classes Objects, constructor, destructor Methods, properties, delegates, assemblies, namespaces.	
	Unit- III	
3	**Inheritance and Polymorphism**	**15**
	3.1 Inheritance, Single, multiple, multilevel inheritance, Polymorphism-constructor overloading, method overloading, overriding, File operation-read, write, delete, Exception - type of errors, structured and unstructured exception. 3.2 Tracing errors: breakpoint, watch, quick watch, locals and autos.	
	Unit- IV	
4	**ADO.Net**	**15**
	Components of ADO.Net, Features of ADO.Net, Datasets, Data table, Datarow, datacolumn, Datareader, ADO.Net programming.	

Topic No.	**BIOINFO: XII Immunology**	**Lectures 60**
	Unit- I	
1.	**Immunology – fundamentals and anatomy of immune system**	**15**
	1.1 Immunity – Innate and acquired immunity. Components of innate and acquired immunity. 1.2 Antigen, Haptens, adjuvants, mitogens. 1.3 Antibodies – structure, functions. 1.4 The anatomy of the immune response: - Cells and organs of immune system.	

	1.5 Regulation of immune response: - Humoral and Cell mediated response.	
	Unit-II	
2.	**Immunity to infection**	**15**
	2.1 Antigen processing and presentation, MHC, complement system.Bacterial, viral, protozoal and parasitic infections with reference to (Diphtheria, influenza virus, malaria and helminthes) with specific representative examples of each group. 2.2 Vaccines – Active and passive immunization, DNA vaccines, multivalent subunit vaccines, synthetic peptide vaccines.	
	Unit- III	
3	**Clinical immunology and immunodeficiency diseases**	**15**
	3.1 Hypersensitivity:- Type I, II, III, and IV reactions. 3.2 Autoimmunity – organ specific and systemic autoimmune diseases. Treatment of autoimmune diseases. 3.3 Transplantation and tumor immunology: - Graft rejection, tissue typing, immunosuppressive therapy and clinical transplantation. Tumor antigens,cancer immunotherapy. 3.4 Immunodeficiency diseases:- Phagocytic, humoral, cell mediated deficiencies and SCID. AIDS- causes, syndrome, diagnostic tools, treatment and development of vaccine.	
	Unit- IV	
4	**Immunotechnology**	**15**
	4.1 Antigen antibody interactions – Principles, types and applications of agglutination, precipitation, complement fixation, viral neutralization, immunodiffusion, immunoelectrophoresis, ELISA and RIA. 4.2 Monoclonal antibodies – Hybridoma technology and various cellular technologies. 4.3 Automation in immunological techniques – auto analyzers used in immunology, FACS etc.	

SEMESTER – IV

Topic No.	BIOINFO: XIII Advances in Structural Bioinformatics	Lectures 60
	Unit- I	
1.	**Structural biology and structural databases**	**15**
	1.1 Nucleic acid structures, RNA folding, RNA loops, conformational study. 1.2 various ribose ring conformations, ribose-ring puckering. 1.3 protein-protein interactions, protein ligand interactions. 1.4 DNA-binding proteins, RNA-binding proteins. 1.5 Ramachandran plot, 3-dimensional structures of membrane proteins, importance of 310 helix and loops, biophysical aspects of proteins and nucleic acids. 1.6 1.6Strutural databases:- Protein Data bank (PDB), Nucleic Acid Data Bank (NDB),Molecular modeling Data Bank (MMDB). 1.7 Secondary structure, three-dimensional structure prediction, protein folding and functional sites, protein folding classes.	
	Unit-II	
2.	**Protein structure prediction**	**15**
	2.1Protein Structure Prediction:- Homology modeling, prediction of protein structure from sequences, functional sites. 2.2 Protein folding problem, protein folding classes, 2.3 protein identification and characterization:- AACompIdent, TagIdent, PepIdent and MultiIdent, PROSEARCH, PepSea, PepMAPPER, FindPept, 2.4 Predicting transmembrane helices, Primary structure analysis and prediction,Secondary structure analysis and prediction, motifs, profiles, patterns and fingerprints search. Methods of sequence based protein prediction.	

	Unit- III	
3	**Molecular Modeling and Molecular Mechanics**	**15**
	3.1 Molecular modeling:-Introduction, force field, quantum chemistry, Schrödinger equation, potential energy functions. 3.2 energy minimization, local and global minima, saddle point, grid search. 3.3 various approximations; LCAO, HF, semi-empirical calculations; single point calculations, full-geometry optimization methods, ZDO, MNDO, CNDO, NDDO, AM1, PM3, RM1. 3.4 conformational search, Z-matrix, docking, molecular modeling packages. 3.5 Molecular mechanics:-Definition, balls and springs, force fields, bond-stretching, bond-bending, dihedral motions, out of plane angle potential, non-bonded interaction, coulomb interactions, conformational search, united atoms and cut-offs. 3.6 Derivative methods:- First-order methods; Steepest descent, conjugate gradient, Second order methods; Newton-Raphson method.	
	Unit- IV	
4	**Molecular dynamics**	**15**
	Molecular dynamics:-Introduction, Newton's equation of motion, equilibrium point, radial distribution function, pair correlation functions, MD methodology, periodic box, algorithm for time dependence; leapfrog algorithm, Verlet algorithm, Boltzman velocity, time steps, duration of the MD run. Starting structure, analysis of MD job, uses in drug designing, ligand protein interactions.	

Topic No.	BIOINFO: XIV Drug designing	Lectures 60
	Unit- I	
1.	**Pharmaceutical Biotechnology**	**15**
	1.1 Introduction: - Antibacterial antibiotics; narrow spectrum and broad spectrum antibiotics. 1.2 Mechanism of action of antibiotic, antifungal antibiotics, antiviral agents, antitumor agents. 1.3 Chemical disinfectants, antiseptics, preservatives. Sulfa drugs. 1.4 Recent advances in pharmaceutical Biotechnology: synthetic vaccines, DNA vaccines, edible vaccines. 1.5 Policies in drug designing:- Quality assurance: ISO, WHO, certification, Good manufacturing practices, GMP, GLP, Government regulations, policies, Food and drug administration.IPR	
	Unit-II	
2.	**Introduction drug design and discovery**	**15**
	2.1 Introduction: - Natural product, Drugs; principles of drug Development. 2.2 Bioinformatics in drug development, Chemoinformatics and Pharmacoinformatics. 2.3 Applications of Drug Discovery and In-Silico Drug Designing,Area influencing drug discovery; Molecular Biology, pharmacogenomics and pharmacoproteomics.	
	Unit- III	
3	**Structure-based drug designing**	**15**
	Introduction, Structure-based drug designing approaches: - Target Identification and Validation, homology modeling and protein folding, receptor mapping, active site analysis and pharmacophore mapping, Grid maps.	

	Unit- IV	
4	**Ligand-based drug designing and docking**	**15**
	4.1 Introduction, Ligand-based drug designing approaches: Lead Designing, combinatorial chemistry, High Throughput Screening (HTS), QSAR, Database generation and Chemical libraries, ADME property. 4.2 Introduction to docking methods to generate new structure; Tools and Molecular docking programs: AutoDock, Dock, HEX.	

Topic No.	**BIOINFO: XV Biodiversity informatics**	**Lectures** **60**
	Unit- I	
1.	**INTRODUCTION TO BIODIVERSITY INFORMATICS**	**15**
	1.1 Introducing biodiversity informatics: - Global patterns of distribution of biodiversity, biomes, Composition and distribution of biodiversity in India. 1.2 Causes and consequences of biodiversity loss, Species extinctions. 1.3 Concept and the rapid development , introduction to biological database, Molecular databases, taxonomic databases and biodiversity databases. 1.4 Taxonomic Database Working Group (TDWG) standards, compatibility and interoperatability, taxonomically intelligent systems.	
	Unit-II	
2.	**Biodiversity assessment and Biodiversity analytical tools**	**15**
	2.1 Identification of plants and animals: Floral and faunal survey techniques, inventorying and monitoring of species and the use of diversity indices to assess habitats. 2.2 Biodiversity analytical tools:-Fundamental concepts of remote sensing, Introductory Geographical Information systems (GIS), bioclimatic and genetic algorithms for rule set production modeling, 2.3 Biodiversity hotspot analyses; Taxonomic names, classification, character data: nature and use of names and classification in	

	biodiversity informatics, significant global projects on taxonomic names; taxonomic character data, descriptions and keys, online keys and digital keys.	
	Unit- III	
3	**Phylogenetic data and phylogenies**	**15**
	3.1Cladistic method, parsimony and Bayesian approaches of data analysis. 3.2 Software used to discover phylogenies, use and status of specimen data, species distribution, example software projects for compiling data. 3.3 Current priorities in biodiversity informatics, challenges and future prospect.	
	Unit- IV	
4	**Basic principles of biodiversity management**	**15**
	4.1 Introduction to sustainable development: Valuation of biodiversity: Integrated and adaptive management. 4.2 Ecosystem and species approach: *Ex-situ* conservation: Protected Area Network of India, Assessing the status of species, Threats from invasive alien species. 4.3 Basic economic principles related to management of biodiversity:- National legislation, International conventions and treaties related to biodiversity conservation, Problems of law enforcement	

Topic No.	**BIOINFO: XVI Programming in Perl**	**Lectures** **60**
	Unit- I	
1.	**Biology and Computer science**	**15**
	1.1 The Organization of DNA ,The Organization of Proteins , In Silico, Limits to Computation 1.2 Getting started with perl:- A Low and Long Learning Curve, Perl's Benefits, Installing Perl on Your Computer, How to Run Perl Programs, Text Editors and Finding Help	

	Unit-II	
2.	**The art of programming , sequences and strings**	**15**
	2.1 The art of programming:-Individual Approaches to programming, Edit-Run-Revise (and Save), An Environment of Programs, Programming Strategies, The Programming Process 2.2 sequences and strings:- Representing Sequence Data, A Program to Store a DNA Sequence , Concatenating DNA Fragments Transcription: DNA to RNA, Using the Perl Documentation, Calculating the Reverse Complement in Perl, Proteins, Files, and Arrays , Reading Proteins in Files, Arrays Scalar and List Context	
	Unit- III	
3	**Motifs, Loops, Subroutines and Bugs**	**15**
	3.1 Motifs and Loops:-Flow Control , Code Layout, Finding Motifs, Counting Nucleotides, Exploding Strings into Arrays, Operating on Strings Writing to Files. 3.2 Subroutines and Bugs: - Subroutines, Scoping and Subroutines , Command-Line Arguments and Arrays, Passing Data to Subroutines, Modules and Libraries of Subroutines, Fixing Bugs In Your Code.	
	Unit- IV	
4	**Mutations, Randomization and The genetic code**	**15**
	4.1Mutations and Randomization: - Random Number Generators, A Program Using Randomization , A Program to Simulate DNA Mutation, Generating Random DNA, Analyzing DNA 4.2The genetic code:-Hashes, Data Structures and Algorithms for Biology, The Genetic Code, Translating DNA into Proteins, Reading DNA from Files in FASTA Format, Reading Frames	

Lab Course – I

Sr. No.	Name of the Practical
1	Computer basic knowledge; hardware, connection cables, typing, Windows 98/XP, Internet browsers, search engines.
2	LAN connections, setting up the IP address, network security.
3	Internet surfing and searching information, downloading and installing software.
4	Hands on session with Microsoft Word, Microsoft Excel (Spreadsheet Application).
5	Hands on session with Microsoft Access (Database related applications).
6	Measures of Central Tendency and Dispersion
7	Statistical Analysis using EXCEL. (Descriptive statistics and graphical presentation.)
8	Calculation of Mean, Mode and Median using spreadsheet application.
9	Sketching of pmf/pdf of Binomial, Poisson and Normal distributions.
10	Correlation and Regression Analysis.
11	Simple random sampling and stratified sampling.

Lab Course – II

Sr. No.	Name of the Practical
1.	Understanding PubMed database.
2	Analysis of protein sequence from protein database.
3	Analysis of gene sequence from nucleotide database.
4	Getting and analysis of primary protein structure.
5	Secondary structure analysis of protein.
6	Tertiary protein structure analysis using Rasmol.
7	Introduction of various bibliographic databases.
8	Getting the gene sequences by exploring and querying the nucleic acid databases.
9	Understanding of Kyto Encyclopedia of Genes and Genome (KEGG) database for biological pathways, metabolism, cellular process, genetic information processing.
10	Database retrieval system- SRS of EBI and DBGet.

11	Investigation of molecular interactions using the program KineMage.

Lab Course – III

Sr. No.	**Name of the Practical**
1	Introduction of National Center for Biotechnology Information (NCBI).
2	Introduction of biological search engine- Entrez
3	Introduction to literature database at NCBI and querying the PUBMED central database using the ENTREZ search engine
4	Analysis of 3D structure of protein using RasMol through command line.
5	Analysis of 3D structure of protein and nucleic acid using Cn3D.
6	Pair-wise sequence alignment by using ClustalW.
7	Multiple sequence alignment by using ClustalW.
8	Introduction of BioEdit. Effect of insertion INDEL from given amino acid using
9	Pairwise and Multiple sequence alignment using BioEdit.
10	Phylogenetic analysis using web tool.
11	Phylogenetic analysis of protein and nucleic acid by using MEGA-4.
12	Similarity search using the Blast and interpretation of the results.
13	Quaternary structural analysis.

Lab Course – IV

Sr. No.	**Name of the Practical**
1	Find prime number between 1 to 50.
2	Write a program which uses switch & break case statements.
3	Find out length of given string.
4	Find area of rectangle using constructor
5	Write a program of insertion sort.
6	Write a program which implements stack operation.
7	Multithreading using get property.
8	Multithreading using sleep property.
9	Write a program which implements mouse listener and mouse motion listener.
10	Creating a frame window in an applet.
11	Draw line , rectangle, oval in an applet.

12	AWT- Control and event handling

Lab Course – V

Sr. No.	**Name of the Practical**
1	Model building of nucleic acid, protein and organic molecules using the ISIS draw.
2	Model building of nucleic acid, protein and organic molecules using the chem-sketch
3	Introduction to PDB.
4	Downloading and analysis of the pdb file of the biomolecules.
5	Analysis of Secondary and tertiary structure of protein using visualizing software like Rasmol.
6	Analysis of quaternary structure of protein using visualizing software like Rasmol.
7	Analysis of the secondary structure of protein using web tool.
8	Three dimensional structure prediction by using the homology modeling technique using SPDBV.
9	Energy calculation of the biomolecules using molecular mechanics and quantum mechanics. (Argus lab).
10	Calculate PI/MW of protein.
11	Molecular Docking of protein and ligand by HEX.
12	Protein Structure Prediction (Homology Modeling) using SPDBV.
13	Model Building and Energy minimization using Sybyl7.3.
14	Model Building and Energy minimization using SPARTAN.
15	Model Building and Energy minimization Gaussian.
16	Quantum chemical (QM) and molecular mechanics (MM) practical using SPARTAN.
17	Quantum chemical (QM) and molecular mechanics (MM) practical using Gaussian.
18	Molecular dynamics (MD) simulation using Gromacs.
19	Molecular dynamics (MD) simulation using Sybyl.
20	Molecular dynamics (MD) simulation using AMBER.

Lab Course – VI

Sr. No.	Name of the Practical
1	Accept three numbers & find out the largest & lowest among these.
2	Calculate compound interest of given principal amount for given time period with given rate of interest. Use appropriate controls.
3	Implement a standard calculator.
4	Accept 10 elements in array & perform binary search.
5	Demonstrate string class method & properties.
6	List box & combo box demonstration with differences in properties.
7	Simple class & object based programs.
8	Calculate difference between two dates use proper User Defined data type.
9	Demonstrate simple polymorphism.
10	Connect your application to Ms-Access/SQL server database using ADO.Net classes.
11	Implement read and write operation of file.
12	Design different application using SQL/MS-Access and ADO.Net.

Lab Course – VII

Sr. No.	Name of the Practical
1	Understanding various functions of perl
2	Installing perl on your PC.
3	Create perl script.
4	Write a program to store protein sequence.
5	Write a program to store DNA sequence.
6	Write a program to store RNA sequence.
7	Use perl to concatenation of DNA
8	Use perl to concatenation of protein sequence.
9	Perl script for to simulate DNA mutation.

Lab Course – VIII - Project work