ANDHRA PRADESH STATE COUNCIL OF HIGHER EDUCATION

MINOR

Subject: Bioinformatics

w.e.f. AY 2023-24

COURSE STRUCTURE

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
I	II	1	Cell Biology and Microbiology	3	3
			Cell Biology and Microbiology Practical Course	2	1
II	III	2	Basics of Computer application inBiology	3	3
			Basics of Computer application inBiology Practical Course	2	1
	IV	3	Genomics and Proteomics	3	3
			Genomics and Proteomics Practical Course	2	1
		4	Programming in C	3	3
			Programming in C Practical Course	2	1
III	V	5	Structural Bioinformatics	3	3
			Structural Bioinformatics Practical Course	2	1
		6	Programming in Pearl	3	3
			Programming in Pearl Practical Course	2	1

SEMESTER-II

COURSE 1: CELL BIOLOGY AND MICROBIOLOGY

Theory Credits: 3 3 hrs/week

I Learning Objectives:

1. To acquaint students with basic concepts of Cell Biology
2. To complement students with knowledge on chromosome structure and packaging.
3. To enable them learn concepts of Microorganisms and their growth aspects

II. Learning Outcomes:

Students after successful completion of the course will be able to:

1. Explain cells structure of prokaryotes and eukaryotes
2. Illustrate stages of mitosis, meiosis and structure and organization of chromosomes
3. Learn classification of microorganisms, basic structure of bacteria and viruses
4. Perform sterilization of microbial media and narrate microbial growth
5. Narrate simple and differential methods of identification of bacteria

III. Syllabus: (Total Teaching Hours: 45)

Unit 1: **(08h)**

Cell Biology:

1. Cell as a basic unit of life.
2. Cell organization of prokaryotic and eukaryotic cells.
3. Structural and functional capitalization of cell:– Mitochondria, Chloroplast, Lysosomes, Golgibodies, Plasma membrane, Cytoskeleton, Cell wall and Nucleus.

Unit 2: **(12h)**

1. Cell cycle, cell division - mitosis and meiosis.
2. Chromosome structure, gene, gene number, gene clusters and Pseudogene.
3. Polytene and lamp brush chromosomes.
4. Packing of DNA, supercoiled DNA, nucleosome.
5. Inverted repeats, repetitive DNA sequence, satellite DNA

Unit 3: **(10h)**

Microbiology:

1. Introduction to Microbiology and microbial diversity
2. Classification of microorganisms.
3. Bacterial structure and reproduction
4. Introduction to viruses- plant and animal viruses- structure and life cycle

Unit 4: **(8h)**

1. Sterilization-Application of sterilization methods in biotechnology, Various sterilization methods, Microbial contamination control and Sterility testing.
2. Microbial growth: The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yield, synchronous growth, continuous culture.

Unit 5: **(7h)**

1. Principles of microscopy – Light microscopy, Bright field and Electron microscopy (SEM and TEM).
2. Staining Techniques - Simple and Differential staining techniques.
3. Direct methods for measuring microbial growth: viable plate counts, membrane filtration. Indirect methods: Metabolic activity – measurements of DNA, Protein, Microscopic counts, electronic counters, most probable number

SEMESTER-II

COURSE 1: CELL BIOLOGY AND MICROBIOLOGY

Practical Credits: 1 2 hrs/week

IV. Skill Outcomes:

On successful completion of this practical course, student shall be able to:

1. Work with microscopes and observe plants cell to microorganisms
2. Isolate cell organelles from plant cells
3. Culture bacteria and fungi in culture media
4. Perform sterilization of media
5. Identify stages of mitosis and meiosis from biological samples

V. Practical Syllabus: Hours 2 hours per week= 30 hours

1. Microbiology Good Laboratory Practices and Biosafety.
2. Preparation of culture media for cultivation of bacteria
3. Preparation of culture media for cultivation of fungi
4. Sterilization of medium using Autoclave
5. Sterilization of glassware using Hot Air Oven
6. Light compound microscope and its handling
7. Study of mitosis on onion root tips
8. Study of meiosis on onion buds
9. Isolation and separation of cell organelles from plant cell.
10. Study of growth curve of *E.coli*

VI. References:

1. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. (1993). Microbiology. 5th Edition, Tata Mc Graw Hill Publishing Co., Ltd., New Delhi.
2. Dube, R.C. and Maheswari, D.K. (2000) General Microbiology. S Chand, New Delhi. Himalaya Publishing House, Mumbai.
3. Power, C.B. and Daginawala, H.F. (1986). General Microbiology Vol I & II
4. Prescott, M.J., Harley, J.P. and Klein, D.A. (2010). Microbiology. 5th Edition, WCB Mc Graw Hill, New York.
5. Reddy, S.M. and Reddy, S.R. (1998). Microbiology Practical Manual, 3 rd Edition, Sri Padmavathi Publications, Hyderabad.
6. Singh, R.P. (2007). General Microbiology. Kalyani Publishers,
7. Stanier, R.Y., Adelberg, E.A. and Ingram, J.L. (1991). General Microbiology, 5th Ed., Prentice New Delhi.Hall of India Pvt. Ltd., New Delhi.
8. Microbiology Edited by Prescott
9. Jaya Babu (2006). Practical Manual on Microbial Metabolisms and General Microbiology. Kalyani Publishers, New Delhi.
10. Gopal Reddy *et al.,* Laboratory Experiments in Microbiology

VII. Co-Curricular Activities

Suggested Co-Curricular Activities

1. Training of students by related aspects using pure cultres

2.Assignments on handling microscopic techniques with safety and precautions)
3.Seminars, Group discussions, Quiz, Debates etc
4.Preparation of videos on tools and techniques on mitosis and meiosis
5.Collection of material/figures/photos related to stages of cell division, microbial growth curve and staining methods.
6.Visits to advanced laboratories to get exposure to SEM and TEM
7.Invited lectures and presentations on related topics by experts.

SEMESTER-III

COURSE 2: BASICS OF COMPUTER APPLICATION IN BIOLOGY

Theory Credits: 3 3 hrs/week

I Learning Objectives:

1. To obtain basic knowledge about computers and internet.
2. To develop the computational methods to utilize expression data's of cellular biology.
3. To study of the inherent structure of biological information.
4. To analyze the gene and protein sequences to reveal protein evolution.

II. Learning Outcomes:

Students after successful completion of the course will be able to:

1. Identify components of computer
2. Connect to internet and email or download information
3. Understand basic history of bioinformatics
4. Illustrate about biological databses
5. Retrieve PDB formats of proteins from respective databases

III. Syllabus: (Total Teaching Hours: 45)

Unit 1: **(10h)**

Computers –

1. Characteristics of Computers – Areas of computer applications- I-P-O Cycle.
2. Components of Computers – Memory and control units-Input devices and output devices- Hardware and Software -Operating Systems.

Unit 2: **(10h)**

Internet –History of Internet-Uses of internet. Connection to Internet - Getting connection-Web page-Modem-Internet Service providers-E-mail and Voice Mail, Creating E-mail Address.

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Unit 3: **(10h)**

Introduction to bioinformatics – history and its development – Scope and applications of bioinformatics

Unit 4: **(8h)**

Biological database – NCBI-GenBank, EMBL, DDBJ. Sequence Alignment-Pairwise (BLAST and FASTA) and Multiple sequence alignment (ClustalW).

Unit 5: **(7h)**

Structure of Protein, Classification –PDB, Swiss-PROT, SCOP, CATH. Protein visualization tools-RASMOL, Swiss PDB viewer.

SEMESTER-III

COURSE 2: BASICS OF COMPUTER APPLICATION IN BIOLOGY

Practical Credits: 1 2 hrs/week

IV. Skill Outcomes:

On successful completion of this practical course, student shall be able to:

1. Login computer and perform booting
2. Learn about operating systems
3. Retrieve data from databases
4. Perform emailing of retrieved data from databases
5. work with basics of pair wise alignment and multiple sequence alignment

V. Practical Syllabus: Hours 2 hours per week= 30 hours

1. Login operations of a computer and its characteristics
2. Hardware, software and booting of computers
3. Operating systems UNIX and LINUX
4. Emailing
5. Exposure to Databases- NCBI and DDBJ
6. Retrieve data from Databases
7. Pairwise alignment
8. Multiple sequence alignment

VI. References:

1. Computer basic knowledge; hardware, connection, cables, typing, Windows98/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. T.A.Attwood and D.J.Parry–smith, 2001, Introduction of Bioinformatics.
5. A.D.Baxevaris,1998, Bioinformatics: A practical guide to the analysis of Genes and proteins,(Edited) B.F.Publication.
6. David W, 2005, Bio-informatics; sequence and Genome Analysis, 2nd Edition By Mount CBS publishers

VII. Co-Curricular Activities

Suggested Co-Curricular Activities

1. Training of students on working with computers
2. Help them know about booting and also operating systems in labs
3. Assignments on data retrieval and alignments studies
4. Groups discussion, quizzes and video making on basic concepts
5. Invited lectures on the course

SEMESTER-IV

COURSE 3: GENOMICS AND PROTEOMICS

Theory Credits: 3 3 hrs/week

I Learning Objectives:

1. To introduce students to the concepts of Genomics, Human genome project and databases
2. To enhance knowledge on gene structure and identification
3. to enable them learn advanced concepts of proteomics

II. Learning Outcomes:

Students after successful completion of the course will be able to:

1. Imbibe concepts of Nucleotide sequence databases
2. Understand identification of gene and its functional sites
3. Illustrate concepts of gene expression, microarrays and concepts of Proteomics
4. Explain concepts of functional proteomics and phylogenetic analysis
5. Illustrate applications of Bioinformatics in various fields

III. Syllabus: (Total Teaching Hours: 45)

Unit 1: (10h)

1. **Genomics:** Nucleotide sequence Databases, its Analysis and Identification.
2. Goals of the Human Genome Project, cloning vectors, concept of maps, physical maps, shotgun libraries, DNA polymorphism, nucleotides, DNA sequences.
3. **Sequence databases:** GeneBank, EMBL Nucleotide sequence databank, DNA Data Bank of Japan (DDBJ), database formats.

Unit 2: (10h)

1. Recombinant DNA technology, restriction enzymes, resource for restriction enzyme (REBASE), similarity search. Polymerase chain reaction, primer selection for PCR, BLASTn,application of BioEdit.
2. Genome information and special features, coding sequences (CDS), untranslated regions(UTR's), cDNA library, expressed sequence tags (EST).
3. Approach to gene identification; masking repetitive DNA, database search, codon-bias detection, detecting functional sites in the DNA.
4. Internet resources for gene identification, detection of functional sites, gene expression.

Unit 3: (10h)

Gene expression, DNA microarray and Proteomics:

1. **Gene expression:** Introduction, Basic steps for gene expression.
2. **Microarray:** Concept of microarrays; spotted arrays, oligonucleotide arrays, designing the experiment, Two-color microarray experiments.
3. **Proteomics**:-Protein sequence information, composition and properties, physico-chemical properties based on sequence, sequence comparison,
4. Primary databases, Secondary databases.
5. Pair-wise sequence alignment, gaps, gap-penalties, scoring matrices, PAM250,BLOSUM62, local and global sequence alignment, multiple sequence alignment, useful programs, ClustalW, BLASTp.

Unit 4: **(10h)**

1. **Proteomics classification;** Tools and techniques in proteomics; 2-D gel electrophoresis, gelfiltration, PAGE, isoelectric 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 peptidefingerprinting (PMF).
2. Protein Micro array in protein expression, profiling and diagnostics, drug target discovery. Database searching, 3-dimensional structure determination by X-ray and NMR.
3. **Phylogenetic analysis:** Evolution, elements of phylogeny, methods of phylogenetic analysis, Phylogenetic tree of life, comparison of genetic sequence of organisms, phylogenetic analysis tools-Phylip, Clustal W.

Unit 5: **(5h)**

Applications of Bioinformatics in various fields:
Environment, biotechnology, molecular biology, neurobiology, agriculture, drug designing,biomedical genome medicines, medical microbiology.

SEMESTER-IV

COURSE 3: GENOMICS AND PROTEOMICS

Practical Credits: 1 2 hrs/week

IV. Skill Outcomes:

On successful completion of this practical course, student shall be able to:

1. Retrieve biological information from various databases
2. Retrieve literature from PUBMED and related databases
3. Perform Pair-wise and multiple sequence alignments and compare biological sequences
4. Analyze 3-dimensional protein structure
5. Performphylogenetic analysis

V. Practical Syllabus: Hours 2 hours per week= 30 hours

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 centraldatabase 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.

VI. References:

1. Daniel, 2006, Biostatistics, Eighth Edition. John Wisley and sons.
2. Durbin, Eddy, Krogh, Mithison, Biological sequence analysis.
3. T.A.Attwood and D.J.Parry–smith, 2001, Introduction of Bioinformatics.
4. A.D.Baxevaris,1998, Bioinformatics: A practical guide to the analysis of Genes and proteins,(Edited) B.F.Publication.
5. David W, 2005, Bio-informatics; sequence and Genome Analysis, 2nd Edition By Mount CBS publishers

VII. Co-Curricular Activities

a) Suggested Co-Curricular Activities

1. Training of students in accessing data bases and retrive information
2. Assignments on data retrieval and structure prediction
3. Seminars, Group discussions, Quiz and projects on aspects of genomics and proteomics
4. Preparation of videos on tools and their usage
5. Visits to facilities and organizations working on advanced concepts of Genomics and proteomics
7. Invited lectures and presentations on related topics by field experts.

SEMESTER-IV

COURSE 4: PROGRAMMING IN C

Theory Credits: 3 3 hrs/week

I Learning Objectives:

1. To know the Basic concepts of Programming.
2. To gain the knowledge of C- programming language.
3. To develop logics which will help them to create programs and applications in C using functions, pointers, file handling.

II. Learning Outcomes:

Students after successful completion of the course will be able to:

1. Explain about C and their applications in bioinformatics analysis.
2. Understand the concepts of Arrays, Strings and Structures which helps them to solve the real time problems.
3. Describe the concepts of Unions
4. Explains about the concepts of File handling and its operations
5. Gain knowledge about pointers and their applications

III. Syllabus: (Total Teaching Hours: 45)

Unit 1: (10h)

Introduction to C

1. History of C
2. Characteristics of C
3. Program Structure, Constants.
4. Data types, Variables, Keywords, Console Input/output Statements, Compilation and Execution.

Unit 2: (10h)

Operators, Branching & Looping Statements

1. Arithmetic Unary Assignment Relational & Logical Conditional
2. If Statement, Nested if, Statement else-if.
3. Ladder switch, Statement Looping.
4. Concepts for loop while loop do-while loop Jump Statements.

Unit 3: (10h)

Arrays

1. Array Concepts Rules & Restrictions.
2. Single & Multi-Dimensional Arrays
3. Types of Functions, Functions and Arrays Function.
4. Prototyping, Scope of Variables Built-in Functions

Unit 4: (10h)

1. String Functions, String Manipulation.

2.Pointer Concepts, Pointers and Functions Pointers and Arrays.Array of Pointers, Static Initialization, Pointers and Structures, Illegal indirection.

3. Defining New Data types, Unions Type Casting Enumerated, Data types Static Variables,Type

Definition.

Unit 5: **(5h)**

Pointers

1. Null pointers, pointers and settings
2. Pointer and two – dimensional arrays
3. Function philosophy
4. Function basics, Function prototype

SEMESTER-IV

COURSE 4: PROGRAMMING IN C

Practical Credits: 1 2 hrs/week

IV. Skill Outcomes:

On successful completion of this practical course, student shall be able to:

1. Understand how to write the programs by using C-language.
2. Expertise in solving the problems by application of C- programming.
3. Perform Multithreading
4. Write program for stacking
5. Work with Applet

V. Practical Syllabus: Hours 2 hours per week= 30 hours

1. Find the prime numbers between 1 to 50
2. Write a program which uses switches and break case statements.
3. Find out length of given string
4. Write a program of insertion sort.
5. Write a program which implements stack operation.
6. Multithreading using get property.
7. Multithreading using sleep property.
8. Write a program which implements mouse listener and mouse motion listener.
9. Creating a frame window in an applet.
10. Draw line, rectangle, oval in an applet.

VI. References:

1. Let us C by Yashwant K., 4th Ed.
2. The C programming language by Ritchie, D.M., 2nd Ed.
3. C: The Complete Reference is written by Herbert Schildt.
4. Programming in ANSI C is written by E Balagurusamy.

VII. Co-Curricular Activities

a) Suggested Co-Curricular Activities

1. Training of students on C programming
2. Assignments on Topics related in course
3. Seminars, Group discussions, Quiz and projects on aspects C programming
4. Preparation of videos on tools and their usage
5. Invited lectures and presentations on related topics.

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SEMESTER-V

COURSE 5: STRUCTURAL BIOINFORMATICS

Theory Credits: 3 3 hrs/week

I Learning Objectives:

1. To introduce students to structural bioinformatics and structural analysis
2. To enhance knowledge on structural prediction
3. To educate them on the topic Macro-molecular interaction

II. Learning Outcomes:

Students after successful completion of the course will be able to:

1. Understand the structural basis for biological phenomena
2. Explain conformational analysis of proteins using computational methods
3. Describe features about forces that determine the conformational analysis of nucleic acids
4. Learn aspects of protein structure prediction
5. Examine the aspects of genome sequencing

III. Syllabus: (Total Teaching Hours: 45)

Unit 1: (10h)

Introduction:

Overview of structural bioinformatics – understanding structural basis for biological phenomena– challenges in structural bioinformatics – integration of structural data with other data.

Protein structures

Conformational Analysis of proteins – Forces that determine protein structure – polypeptide chain geometries – Ramachandran Map – potential energy calculations – observed values for rotation angles.

Unit 2: (10h)

Structural analysis

Conformational analysis of nucleic acids – general characteristics of nucleic acid structure – geometries, glycosidic bond – rotational isomers and ribose puckering - forces stabilizing ordered forms – base pairing– base stacking.

Unit 3: (10h)

Structural Prediction

Structure Prediction Methods – Homology Modeling – Fold Recognition Methods – ab initio methods – Rosetta – CASP – prediction of secondary structure – Chou-Fasman, Garnier, Osguthorpe-Robson (GOR) methods (qualitative aspects only) – transmembrane structure prediction – solvent accessibility calculations and prediction

Unit 4: (10h)

Macro-molecular interactions

Interactomes – macromolecular interactions – protein-protein interactions – protein-DNA interactions – protein-ligand interactions – interactions databases – BIND, ProNIT – Docking – principles and methods

Unit 5: (5h)

Current contours

Genome sequencing – Proteomics – Phylogeny – Gene expression – Protein-protein interaction network

SEMESTER-V

COURSE 5: STRUCTURAL BIOINFORMATICS

Practical Credits: 1 2 hrs/week

IV. Skill Outcomes:

On successful completion of this practical course, student shall be able to:

1. Access free online repositories of structural data
2. Retrieve right PDB structures and visualize them using PyMOL
3. Identify structural and functional domains of proteins
4. Predict structure of transmembrane proteins
5. Understand about protein-protein interaction networks

V. Practical Syllabus: Hours 2 hours per week= 30 hours

1. Access public repositories of structural data- Protein Data Bank (PDB) and Electron Microscopy Data Bank (EMDB)
2. Access repositories and retrive information from Protein Data Bank in Europe (PDBe) and PDBe-KB
3. Finding the right structures - UniProt and PDB
4. Viewing the structure - PyMOL
5. Domain identification in proteins using HMMER, Inter Pro and CATH
6. Access MemBrain for trans membrane protein prediction
7. DNAproDB for DNA protein interactions
8. Access STRING for protein-protein interaction networks

VI. References:

1. C.R.Cantor & P.R.Schimmel, Biophysical Chemistry Part - I, W.H. Freeman & Co., San Fransisco, 1980.
2. C. Branden and J. Tooze, Introduction to Protein Structure, Garland Publishing Inc., NewYork, 1999.
3. P.E. Bourne and H. Weissig (Eds.) Structural Bioinformatics, John-Wiley and Sons, 2003
4. Molecular Modeling and Simulation, Tamar Schlick, 2002
5. Structural Bioinformatics, 2nd Edition, Jenny Gu and Philip Bourne, 2009
6. Protein Structure Prediction: a practical; approach, M. Sternberg, 1996
7. Textbook of Structural Biology, Liljas et all, 2010
8. Molecular Biophysics, Michael Daune, 1999
9. Introduction to Proteins: Structure, Function, and Motion, Kessel et al, 2010
10. Understanding Bioinformatics, M. Zvelebil, J. Baum, 2007

VII. Co-Curricular Activities

a) Suggested Co-Curricular Activities

1. Training of students on aspects of course using free online tools
2. Assignments on protein structure prediction and importantly domain identification
3. Seminars, Group discussions, Quiz, online tests etc.
4. Preparation of videos on tools as assignments for better understanding of students as peer group teaching
5. Collection of material related to every topic and share in google classroom
6. Visits to research organizations or firms on the aspects of topic
7. Invite guest lectures and presentations on related topics of structural Bioinformatics.

SEMESTER-V

COURSE 6: PROGRAMMING IN PEARL

Theory Credits: 3 3 hrs/week

I Learning Objectives:

1. To acquaint with on basics in perl and more on usage of scalar, arrays and hashes.
2. To gain knowledge of regular expressions concepts in perl and its major role in bioinformatics.
3. To understand the significance of perl modules in the advance programming skills.

II. Learning Outcomes:

Students after successful completion of the course will be able to:

1. Understand basic concepts of biodiversity and its distribution.
2. Gain the knowledge of patterns of the biodiversity.
3. Appreciate the Biodiversity present in the India.
4. Acquire the knowledge on terminology of Biodiversity.
5. understand the importance information technology to identify the biodiversity in global way.

III. Syllabus: (Total Teaching Hours: 45)

Unit 1: (8h)

Introduction to Perl

1. The Organization of DNA and Organization of Proteins ,
2. In Silico, Limits to ComputationGetting started with perl:- A Low and Long Learning Curve.
3.Perl's Benefits, Installing Perl on Your Computer, How to Run Perl Programs, Text Editors andFinding Help.
4. The art of programming: Individual Approaches to programming, Edit-Run-Revise (and Save),An Environment of Programs, Programming Strategies.

Unit 2: (10h)

Programming

1. The Programming Process, sequences and strings: Representing Sequence Data,
2. Transcription: DNA to RNA, Using the Perl Documentation
3. A Program toStore a DNA Sequence, Concatenating DNA Fragment.
4. Calculating the Reverse Complement in Perl, Proteins, Files, and Arrays , Reading Proteins in Files.

Unit 3: (10h)

Arrays, Motifs and Loops

1. Arrays Scalar and List Context.
2. Motifs and Loops:-Flow Control , Code Layout, Finding Motifs, Counting Nucleotides, Exploding Strings into Arrays,
3. Operating on Strings Writing to Files.

Unit 4: (10h)

Subroutines and Bugs

1. Subroutines, Scoping and Subroutines
2. Command-Line Arguments and Arrays

3. Passing Data to Subroutines, Modules and Libraries of Subroutines,
4. Fixing Bugs In YourCode

Unit 5: **(7h)**

Mutations and Randomization

1. Random Number Generators, A Program Using Randomization,
2. .A Program to Simulate DNA Mutation, Generating Random DNA, Analyzing DNA.
3. The genetic code:-Hashes, Data Structures and Algorithms for Biology,
4. The Genetic Code, Translating DNA into Proteins, Reading DNA from Files in FASTA Format, Reading Frames

SEMESTER-V

COURSE 6: PROGRAMMING IN PEARL

Practical Credits: 1 2 hrs/week

IV. Skill Outcomes:

On successful completion of this practical course, student shall be able to:

1. Understand and Expertise in programming in Perl.
2. Write the programs for Biological data with the application of Perl programming
3. Do MAP construction
4. Work with different software tools
5. Create databases

V. Practical Syllabus: Hours 2 hours per week= 30 hours

1. Installing Perl on your PC.
2. Create Perl script.
3. Write a program to store protein sequence.
4. Write a program to store DNA sequence.
5. Write a program to store RNA sequence.
6. Use Perl to concatenation of DNA
7. Use Perl to concatenation of protein sequence.
8. Perl script for to simulate DNA mutation

VI. References:

1. Beginning Perl for Bioinformatics by James Tisdall, O-Reilly publication.
2. Perl: Complete Reference Perl by Martin C. Brown, McGrawHill publication.
3. Mastering Perl for Bioinformatics by James D. Tisdall, O-Reilly Publication.
4. Teach Yourself Perl 5 in 21 days by David Till, Sams publishing.
5. Mastering Algorithms with Perl by Jon Orwant, Jarkko Hietaniemi and John Macdonald, O-Reilly Publication

VII. Co-Curricular Activities

Suggested Co-Curricular Activities

1. Invited talks by subject experts of Perl
2. Give assignments on programming to store biological sequences
3. Quiz, Group Discussions etc.,
4. Making of videos and material creating and sharing
5. Guest lectures and field visits.