DEGREE OF BACHELOR OF SCIENCE

CHOICE BASED CREDIT SYSTEM

Syllabus for

B.SC. BIOINFORMATICS

(SEMESTER PATTERN)

(For Candidates admitted in the Colleges affiliated to Periyar University from 2021 - 2022 onwards)
REGULATIONS

1. ELIGIBILITY

2. DURATION OF THE COURSE
The course shall extend over a period of three years comprising of six semesters with two semesters in one academic year. There shall not be less than 90 working days for each semester. Examination shall be conducted at the end of every semester for the respective subjects.

3. COURSE OF STUDY
The course of study shall comprise instruction in the following subjects according to the syllabus and books prescribed from time to time. The syllabus for various subjects shall be clearly demarcated into five viable units in each paper/subject. Part -I, Part-II, Part – III and Part – IV subjects are as prescribed in the scheme of examination.

4. EXAMINATIONS
The theory examination shall be three hours duration to each paper at the end of each semester. The candidate failing in any subject(s) will be permitted to appear for each failed subject(s) in the subsequent examination. The practical examinations for UG course should be conducted at the end of the even semester.

4.(a) Submission of record note books for practical examinations
Candidates appearing for practical examinations should submit bonafide Record Note Books prescribed for practical examinations, otherwise the candidates will not be permitted to appear for the practical examinations. However, in genuine cases where the students, who could not submit the record note books, they may be permitted to appear for the practical examinations, provided the concerned Head of the department from the institution of the candidate certified that the candidate has performed the experiments prescribed for the course. For such candidates who do not submit Record Books, zero (0) marks will be awarded for record note books.

5. Revision of Regulations and Curriculum
The University may revise/amend/change the Regulations and Scheme of Examinations, if found necessary.
6(a). Passing Minimum – Theory
The candidate shall be declared to have passed the examination if the candidate secure not less than 40 marks out of 100 (CIA – 10 marks out of 25 and EA – 30 marks out of 75) in the University examination in each theory paper.

6(b). Passing Minimum – Practical
The candidate shall be declared to have passed the examination if the candidate secure not less than 40 marks put together out of 100 (CIA – 16 marks out of 40 and EA – 24 marks out of 60) in the University examination in each practical paper.

7. Question Paper Pattern
(a). THEORY - Question Paper Pattern [EA] (Total Marks: 75)

Time: Three Hours

Maximum Marks: 75

Part - A (15 X 1 = 15 Marks)
Answer ALL Questions Multiple Choice

Part - B (2 X 5 = 10 Marks)
Answer ANY TWO Questions out of Five

Part - C (5 X 10 = 50 Marks)
Answer ALL Questions
Either (or) Type Five questions
(One question from Each Unit)

(b). THEORY - Internal Marks Distribution[CIA] (Total Marks: 25)
- Attendance : 5 Marks
- Assignment : 5 Marks
- Internal Examinations : 15 Marks

(a). PRACTICAL – Marks Distribution & Question paper Pattern (Max. Marks: 100)
[External [EA]: 60 Marks & Internal [CIA]: 40 Marks]

8. Commencement of this Regulation
These regulations shall take effect from the academic year 2021-2022, i.e, for students who are to be admitted to the first year of the course during the academic year 2021-2022 and thereafter.
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**SEMESTER I**

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**SEMESTER II**
# B Sc BIOINFORMATICS

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### BS Sc BIOINFORMATICS

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UNIT I
Cell as a basic unit, classification of cell types, cell theory, organization of plant and animal cells, comparison of microbial, plant and animal cell.

UNIT II
Ultrastructure of cells, Biochemical composition of cells (nucleic acid, carbohydrate, protein and lipids).

UNIT III
Subcellular organization- cytosol, endoplasmic reticulum, nucleus, cytoskeleton, ribosomes, mitochondria, chloroplast, vacuoles, peroxisomes, lysosomes and cell wall.

UNIT IV
Structure and functions of cell membranes, cell division (eukaryotic and prokaryotic), mitosis, meiosis and cell cycle.

UNIT V
Specialized cell-motile cells, nerve cells, muscle cells, cell death and apoptosis.

Recommended Books:
- De Robertis and De Robertis. 2005. 8th Eds. Cell and Molecular Biology. Lippincott Williams & Wilkins
UNIT I

Energetics of a living body, sources of heat limits to temperature (qualitative treatment), heat dissipation to conservation, laws of thermodynamics. Nature of chemical bonds, intra and intermolecular interaction in biological systems.

UNIT II

Chromatography- Principles behind chromatography techniques; Types-Paper, Thin Layer, Column, HPTLC, ion-exchange, affinity & Gas chromatography; Electrophoresis-PAGE & SDS.

UNIT III

Spectroscopic techniques- Beer-Lambert's law, colorimetry, spectrophotometry (UV-visible, Fluorescence, Atomic absorption, IR to Ramanspectra).

UNIT IV

Physical methods of imaging, intact biological structures (X-ray, CAT-Scan, ECG, EEG &NMR) and radioactive pollution- GM counter.

UNIT V

Structure of proteins-primary, secondary, tertiary and quaternary. X-ray crystallography. Physical methods for determining size and shape of macromolecules – diffusion to sedimentation, reverse osmosis, ultracentrifugation

Recommended Books:

- Volkones, HV, General Biophysics Vol I&II.
- Pullman, B and M.Voino. Molecular biophysics.
B. Sc. BIOINFORMATICS
SEMESTER - I & II

CORE PRACTICAL – I - CELL BIOLOGY & BIOPHYSICS

1. Cell types – Microbial, animal and plant morphometric measurements.
2. Fractionation of cellular components.
5. Enzymes: Assay of urease, demonstration catalytic activity.
6. Titration curve of amino acids.
7. Selection of complementary filters.
UNIT I

UNIT – II

UNIT – III

UNIT – IV
MS-EXCEL: Creating a Simple Spreadsheet – Editing a Spreadsheet – Working with Functions and Formula – Formatting Worksheets – Completing Your Spreadsheet – Creating Charts

UNIT – V
MS-POWERPOINT: Creating and Viewing Presentations – Editing a Presentation – Working with Presentation Special Effects

Recommended Books
B. Sc. BIOINFORMATICS

SEMESTER II

ALLIED PRACTICAL – I: COMPUTER LAB

(This practical lab is introduced instead of Allied Practical - I: Computer fundamentals and Basic programming)

LAB EXERCISE

MS Office

1. Create a document with tables, and do the following: Formatting, tab setting, page setting for printing, and Header & Footer setting

2. Drawing flow chart using drawing toolbar, inserting picture and setting frames

3. Mail Merge in word (Creating main document, data source, inserting merge fields and viewing merge data, viewing and printing merged letter, using main merge to print envelope creating mailing labels)

4. Create a document, Format the document and edit the document as follows:
   
   (i) Find and Replace options

   (ii) Cut, Copy and Paste options

   (iii) Undo and Redo options

   (iv) Using Bold, Underline and Italic.

   (v) Chance Character size using the font dialog box.

   (vi) Formatting paragraph: Center, Left aligns & Right aligns

   (vii) Changing paragraph and line spacing Using Bullets and Numbering in paragraphs

   (viii) Creating Hanging paragraphs

MS – EXCEL

1. Create a work sheet, moving / copying / inserting / deleting rows and Columns. (Usage of cut, paste commands, copying a single cell, copying a range of data, filling up a cell. Undo command, inserting a row, column Deleting rows and columns).
2. Create a worksheet and perform to date, time, Math functions, and Logical and financial functions

3. a. Database concept: Database, Record field and field name – creating and sorting a database and maintaining a database (date form)
   b. Using auto filter, advanced filter
   c. Creating subtotals and grand totals – Using database functions

4. Creating charts (Pie, Bar, Line)
   a. Using chart wizard (five steps)
   b. Changing the chart type (Pie, Bar, Line)
   c. Inserting titles for the Axes x, y
   d. Changing colors
   e. Printing charts

MS – POWER POINT

1. Creating a presentation using auto content wizard

2. Different views in power point presentation

3. Setting animation effects / grouping / ungrouping / cropping power/ point objects

4. Design to presentation to market the product using animation effects/ buttons/links
UNIT 1
Microbial study: Types of Microscopes (Light, Phase-contrast and Electron microscopy) – classification of microorganisms- viruses, bacteria, fungi, algae and protozoans.

UNIT II

UNIT III
Viruses (Lytic and Lysogenic), Bacterial genetics: Plasmids and conjugation, transduction and transformation. Mutations, mutagenesis and recombination.

UNIT IV

UNIT V

Recommended Books

B. Sc. BIOINFORMATICS
SEMESTER – III
SKILL BASED ELECTIVE COURSES
SBEC I – BASICS OF BIOINFORMATICS

Unit – I
Bioinformatics-Definition, History, Scope and Applications. Opportunities in Bioinformatics. Emerging areas of Bioinformatics

Unit II
Computers and Programming Languages. Internet, World Wide Web, Browsers, Search Engines – Google, Yahoo

Unit III
Cell Structures and Cell Organelles. Introduction to Macromolecules like DNA, RNA and Proteins

Unit IV
Introduction to Molecular Biology and genetics. Central dogma of life: DNA – RNA - Protein. Role of Bioinformatics in Human Genome Project

Unit – V
Biological databases, Importance of databases, Nucleic acid sequence databases, Protein databases and Structure databases

Recommended Books
UNIT 1


UNIT II

Data : primary and secondary. Methods of data collection. Merits and limitations. Classification, tabulation and presentation of data.

UNIT III


UNIT IV

Correlation and regression, similarities and dissimilarities of correlation and regression methods.

UNIT V

Statistical interference – hypothesis: simple hypothesis, Hypothesis testing. Student's t-test, Chi-Square test, ANOVA.

Recommended Books


Freedman, P, 1950.The principles of scientific research, Pergamonpress, NY.
B. Sc. BIOINFORMATICS
SEMESTER - IV
SKILL BASED ELECTIVE COURSE
SBEC - II - APPLICATIONS OF BIOINFORMATICS

Unit –I
Protein Structure prediction, Gene and Protein expression data. Protein interaction data, Similarity and database searching tools – FASTA, BLAST

Unit II
Protein sequence data banks, NBRF, PIR, SWISSPROT, Nucleic Acid Sequence Data Bank, EMBL & NCBI

Unit III
Sequence analysis and Phylogeny – sequence search alignment- pair wise and multiple sequence. Scoring matrices. Introduction to Phylogenetic Trees.

Unit IV

Unit V
Structure of commonly used drugs in medical field. New drug design for cancer. Identification of novel drug design with least side effect.

Recommended Books

1. Introduction to Bioinformatics - S.Sundararajan and Balaji
3. Bioinformatics basic skills and applications - Rastogi
1. Staining techniques - gram staining, negative staining, flagellar staining and spore staining.
3. Various sterilization techniques – surface, glassware, media, dry heat, wet heat, radiation, chemicals and filtration.
4. Preparation of solid and liquid media.
5. Isolation of microorganisms from soil, air, plants and water by streak plate, pour plate and spread plate methods
6. Maintenance of cultures – soil stock, glycerol stock and lyophilisation
7. Biochemical test- starch hydrolysis, catalase production, milk curdling, fluorescence, acid and gas production by Durham tube, IMVIC.
B.Sc. BIOINFORMATICS

SEMESTER - IV

ADD ON INTERSHIP COURSE

ADD-ON - BASICS OF INTERNET PROGRAMMING

Unit I

Unit II
Internet Technologies: Modem - Internet addressing - Physical connections - Telephone Lines - Internet browsers

Unit III
HTML: Designing a home page - HTML documents - Anchor tag - Hyper Links.

Unit IV
Traditional text and formatting - tables - images - frames.

Unit V
HTML Style sheets- Introduction about Javascript.

Recommended Books

B. Sc. BIOINFORMATICS

SEMESTER V

CORE - V - MOLECULAR BIOLOGY

Unit I
Cell structure and function: Membrane architecture, membrane associated process, ATP synthesis and photosynthesis, Subcellular organelles: Mitochondria and chloroplast.

Unit II

Unit III

Unit IV
Mutations and mutant, Biochemical basis of mutation, types of mutation – spontaneous and conditional. Chemical and physical mutagens- point mutation.

Unit V
Transposons and insertion sequences: Types of transposons – prokaryotes and eukaryotes. DNA rearrangement mediated by transposons.

Recommended Books
B. Sc. BIOINFORMATICS

SEMESTER V

CORE - VI - BIOLOGICAL DATA BANKS AND THEIR ANALYSIS

Unit I
DNA and protein sequence data banks, NCBI, EMBL, DDBJ, NBRF-PIR, SWISSPROT, signal peptide databank.

Unit II
Analytical tools for sequences databanks: BLAST, FASTA, Pairwise alignment- Multiple alignment- ClustalW, PRAS.

Unit III
Structural databanks: Protein databank (PDB), the Cambridge structural database, Genome databank, metabolic pathway databanks- KEGG and Meta Cyc.

Unit IV
Introduction to microbial strain data network, numerical coding system of microbes, hybridoma data bank structure, virus and cell line information system.

Unit V
Protein structure classification databases: SCOP and CATH, Human genome and diseases database – OMIM.

Recommended Books

UNIT I

UNIT II

UNIT III
Organization and expression of immunoglobulin genes. Major Histocompatibility Complex (MHC) and antigen.

UNIT IV

UNIT V
Immune regulation, Vaccines, autoimmunity, immune response to infectious and immuno-deficiency diseases.

Recommended Books

UNIT I
Application of plant tissue culture, organogenesis and somatic embryogenesis. Protoplast culture and fusion. *Agrobacterium* mediated transformation in plants, production of secondary metabolites by cell culture.

UNIT II

UNIT III
Animal cell culture: historical perspectives and applications, manipulation of animal cells (microinjection, electroporation, liposome mediated transformation). Production of native and recombinant proteins- animal viral vectors.

UNIT IV

UNIT V
Transgenic animals: gene targeting, types of vaccines recombinant and DNA vaccines, production and its applications.

**Recommended Books**
B. Sc. BIOINFORMATICS

SEMESTER V

CORE - ELECTIVE-II - RELATIONAL DATABASES MANAGEMENT SYSTEMS

Unit I
Purpose of database systems-Entity relationship model: mapping constraints-primary keys-ER diagram.

Unit II
Relational model: Structure-formal query languages-relational Algebra-relational calculus-commercial query language.

Unit III

Unit IV
Hierarchical data model: Tree structure diagram-data retrieval, Networks data model: Data structure diagram-DBTG CODASYL model, updating and set processing.

Unit V
Interpretation-equivalence of expressions-Query processing cost-query optimizer. Basic concepts of database recovery-currency control, database security and integrity-distributed database.

Recommended Books
B. Sc. BIOINFORMATICS
SEMESTER – V
SKILL BASED ELECTIVE COURSES
SBEC III – PERL PROGRAMMING

Unit –I
Introduction to Perl: Introduction to Perl - scalars, Arrays and Hashes - Perl Interpreter – Operators - Using standard Perl modules – CPAN – Array-Based Character Manipulation - simple programs

Unit II
Control Structures And Perl Subroutines: Perl debugger - Perl control structures-if, elsif, else, unless, while, do-while, until, do-until, for and foreach - Perl subroutines and Functions - simple programs

Unit III
Perl Regular Expressions and Patterns: Perl regular expressions – match, substitute and translate – Metacharacters - Patterns – Atoms, Special Atoms, Quantifiers, Assertions and Alternatives - Perl one liners using command-line options

Unit IV
File Handling: File Handling- Input/Output operator - open() and close() commands Project

Unit –V
BioPERL: Introduction to BioPERL Modules – Bio::Seq, Bio::SeqIO, Bio::PrimarySeq, Bio::Search, Bio::DB - simple bioinformatics application programs

Recommended Books
1. James Tisdall, Beginning Perl for Bioinformatics, O”Reilly, 2000
B. Sc. BIOINFORMATICS
SEMESTER VI
CORE – VIII - SYSTEMIC EVOLUTION AND ENVIRONMENTAL BIOLOGY

UNIT-I
Morphological classification of plants: Various systems, Binomial nomenclature; Cyto and chemotaxonomy.

UNIT-II
Morphology and Whittaker's five kingdom classification of animals, animal diversity, classification of chordates and non-chordates up to classes.

UNIT-III

UNIT-IV
Environmental biology: Autoecology, synecology, ecosystem and its components, energy flow, primary productivity, food chain. Wild life preservation and management, water, air and noise pollution. Global warming and Marine pollution (Oil spills).

UNIT-V
Function of ecosystems. Vegetation pattern in South India. Pollution and soil conservation. Afforestation and social forestry. A general account of renewable and non-renewable resources.

Recommended Books
B. Sc. BIOINFORMATICS

SEMESTER VI

CORE – IX - DRUG AND MOLECULAR MODELLING

UNIT I

UNIT II
Importance of Phase I and Phase II biotransformation. Role of cytochrome p-450, enzyme inhibition strategies, enzyme induction and pharmacological activity, detoxification enzyme system, LD$_{50}$ and IC$_{50}$.

UNIT III
Drugs receptors: Drug-receptor interaction, Drug action not mediated by receptors. Structural based drug design, mechanism of their action. Lipinski’s rule of 5, Clinical trials 1-4 phases.

UNIT IV

UNIT V
Molecular modelling- Homology modelling, Abinito methods and modelling, structure validation, Prochem, Ramachandran plot, stability- Molecular dynamics stimulation

Recommended Books

UNIT I
Algorithms and applications of proteomics: proteome mining, protein expression profiling, protein-protein interaction, protein modification and automation.

UNIT II
Protein digestion techniques, SDS-PAGE, 2D-Electrophoresis, Isoelectric focusing (IEF), High Performance Liquid Chromatography- Mass Spectroscopy (HPLC-MS).

UNIT III
Overview of genome, genome sequence acquisition and analysis, comparative homologies, evolutionary changes, Single Nucleotide Polymorphism (SNPs). Genetic analysis: linkage mapping and analysis; physical mapping, Microarrays; sequence specific tags, sequence tagged sites, ISH, FISH.

UNIT IV

UNIT V
Construction of cDNA and genomic DNA libraries; Polymerase Chain Reaction (PCR), Yeast two-hybrid system, SAGE Adaptation for Downsized Extract (SADE), ESTs,

Recommended Books
B. Sc. BIOINFORMATICS
SEMESTER VI
CORE – ELECTIVR-IV- DATA MINING AND WAREHOUSING

UNIT – I

UNIT – II

UNIT – III

UNIT – IV

UNIT – V
Data warehousing: Introduction – Operational data sources- data warehousing - Data warehousing design – Guidelines for data warehousing implementation - Data warehousing metadata - Online analytical processing (OLAP): Introduction – OLAP characteristics of OLAP system – Multidimensional view and data cube - Data cube implementation - Data cube operations OLAP implementation guidelines

Recommended Books
1. Isolation of plasmid and genomic DNA and further confirmation by Agarose gel electrophoresis
2. SDS-PAGE
3. Preparation of culture medium and basic sterilization techniques
4. Cell suspension
5. Callus induction
6. Extraction of secondary metabolites using cold percolation technique
7. Thin Layer chromatography.
B. Sc. BIOINFORMATICS
SEMESTER-VI
CORE PRACTICAL - IV

LAB IN DATABASE ANALYSIS, PROGRAMMING IN PERL, C++ AND MOLECULAR MODELLING

1. PDB analysis of protein structure by RASMOL
2. NCBI, EMBL and DDBJ (accession of information)
3. BLAST and FASTA search
4. Alignments – pair wise and multiple sequence alignment-ClustalW and X
5. Program for function , operation overloading
6. program for multiple constructors in a class
7. program for multiple handling
8. program for error handling
9. program for friend and virtual functions
10. Molecular mechanics and dynamics of nucleotides and proteins
11. Molecular modelling using HEX
B. Sc. BIOINFORMATICS

SEMESTER - VI

SBEC-IV-OBJECT ORIENTED PROGRAMMING AND C++

Unit I
Principles of object oriented programming (OOP): Software evolution-OOP paradigm-basic concepts of OOP-object oriented languages-applications of OOP.

Unit II

Unit III
Classes and objects: constructors and destructors and operating overloading and type conversions.

Unit IV

Unit V
Working with files: Classes for file stream operations-opening and closing a file-end of file (EOF), file detection-file pointers-updating a file-error handling during file operations-command line arguments.

Recommended Books

• Balagurusamy, E. 1995.Object oriented programming with C++, TMH.
B. Sc. BIOINFORMATICS

SKILL BASED ELECTIVE COURSES

1. Basics of Bioinformatics
2. Applications of Bioinformatics
3. PERL Programming
4. Object Oriented Programming and C++

PART -IV

1. Professional English
2. Environmental Studies
3. Value Education - Yoga
4. Add-on (Internship) Basics of Internet Programming

NON MAJOR ELECTIVE COURSES

1. Bioinstrumentation I
2. Bioinstrumentation II

PART V

1. Extension Activities