SARDAR PATEL UNIVERSITY
Programme & Subject: B.Sc. (Bioinformatics)
Syllabus with effect from: June – 2020

**BSc Bioinformatics Programme Outcomes**

After successful completion of B.Sc Bioinformatics Course the graduates

➢ Eligible for pursuing higher education, M.Sc. programmes in the different field of life science, IT and computer science.

➢ Eligible for doing jobs in pharmaceutical and IT Industry.

➢ Understand the potentials, and impact of bioinformatics outcome on environment and to find out the sustainable solutions to problems regarding web designing, drug designing, software development, medical, and agriculture sector, etc.

➢ Can work individually as well as in team to thrive in multidisciplinary environment.

➢ Both oral and written communication skills
SARDAR PATEL UNIVERSITY
Programme & Subject: B.Sc. (Bioinformatics)  Semester: V
Syllabus with effect from: June – 2020

<table>
<thead>
<tr>
<th>Paper Code: US05CBNF21</th>
<th>Total Credit: 4</th>
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</thead>
<tbody>
<tr>
<td>PERL programming Language</td>
<td>(4 lectures/wk)</td>
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### UNIT

#### I Getting started with Scripting Language
- A Low and Long Learning Curve, Perl’s Benefits, How to Install PERL, How to run PERL Program, Text editors, Representing Sequence data, A Program to store DNA sequence
- Concating DNA fragments, DNA to RNA :Transcription, Calculate Reverse Complement

#### Protein Files and Arrays
- Files, Arrays, Proteins Reading Proteins in File, Arrays, Scalar and list Context

#### II Motifs and Loops
- Flow Control, Code Layout, Finding Motifs, Counting Nucleotides, Exploding String into Array
- Operating on String, Writing to Files

#### III Subroutines and Bugs
- Subroutines, Scoping and Subroutines, Command Line Argument and Array, Passing Data to Subroutine, Modules and Libraries of Subroutine, Fixing Bugs in Your Code

#### IV Mutations and Randomization
- Random Number Generator, A Program Using Randomization
- A Program to Simulate DNA Mutation
- Generating Random DNA
- Analyzing DNA

#### The Genetic Code
- Hashes, Genetic Code, Translate DNA to Protein

### Basic Text and Reference Books:

1. Beginning of PERL for bio Informatics by James D. Tisdall

### Learning outcome:

- proficient programming in the Perl language and programming in general
- design and revision of Perl scripts
- debugging techniques appropriate for the Perl language
SARDAR PATEL UNIVERSITY

Programme & Subject: B.Sc. (Bioinformatics)  Semester : V

Syllabus with effect from: June – 2020

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>US05CBNF22</td>
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Relational Database Management Systems

Unit

I  Introduction to DBMS, RDBMS and Data Modeling

DBMS: Meaning, Advantages, Disadvantages, The three-schema architecture for a Database Management System (DBMS), Codd Rules, Entity-relationship modeling (different types of entities, attributes, relationships and their representation in the E-R diagram), Case studies of data modeling using E-R modeling

Consequences of poor Data base Design, Normalization, 1st Normal Form, 2nd Normal Form, 3rd Normal Form, Boyce-Codd Normal Form, Examples of normalization

II  Introduction to SQL

SQL - introduction , advantages and disadvantages, Data types – built-in (number, char, varchar2, date, raw, long raw), Types of SQL Statements : DDL (Data Definition Language), DML (Data Manipulation Language), DCL (Data Control Language), TCL (Transaction Control Language)

Working with SQL*Plus – overview and basic commands like ed, start, get, save, exit, connect, set linesize, set pagesize and host, Creating table and inserting data - CREATE TABLE, INSERT, retrieving data using query – SELECT, manipulating data – DELETE and UPDATE, modifying and removing table – ALTER TABLE and DROP TABLE.

III  Data Constraints and Functions

Pseudo columns – ROWID, ROWNUM, USER, UID, SYSDATE

Null values, TAB table, DUAL table, Operators – arithmetic, relational, logical, range searching, pattern matching and set, Data constraints – Introduction, advantages and disadvantages

Type of data constraints – NOT NULL, UNIQUE, PRIMARY KEY, FOREIGN KEY and CHECK

Modifying constraints, working with data dictionary and use of USER_CONSTRAINTS

Functions – introduction, merits and demerits, types of functions (scalar and aggregate)

Scalar : Numeric functions (FLOOR, MOD, POWER, ROUND, SQRT and TRUNC), Character functions (CHR, ASCII, CONCAT, INITCAP, LOWER, SUBSTR, TRIM, UPPER), Date functions (ADD_MONTHS, LAST_DAY, NEXT_DAY, MONTHS_BETWEEN), Conversion functions (TO_NUMBER, TO_CHAR and TO_DATE)

Aggregate fun : AVG, COUNT, MAX, MIN, SUM

IV  Query, Subquery, Joins, Transaction Management, Basics of PL/SQL

Query and subquery, types of subquery

Creation and manipulation of database objects – indexes, views, sequences.

Joining tables – ANSI Style, types of joins (cross join, natural join, equijoin, outer joins, self join)

Data control language statements – GRANT and REVOKE

Transaction control language statements – COMMIT, ROLLBACK and SAVEPOINT

PL/SQL - Introduction and advantages

Understanding PL/SQL Block structure

Basic Text and Reference Books:

5. Oracle9i The Complete Reference : Kevin Loney, George Koch, Oracle Press

Learning outcome: Demonstrate an understanding of the elementary & advanced features of DBMS & RDBMS Prepare various database tables and joins them using SQL commands. Understand the basic concept how storage techniques are used to backup data and maintain data access performance in peak hours. Evaluate options to make informed decisions that meet data storage, processing, and retrieval needs.
UNIT-I Recombinant DNA technology: Introduction to rDNA, Cutting and Joining DNA – Restriction Endonucleases, Nucleic acid modifying enzymes (Polymerase, Alkaline phosphatase, Exonuclease, Dnasel and RNAse) Ligation, How to clone a gene - What is clone, Overview and steps of the procedure.

UNIT-II Vectors: Vectors – Plasmid vectors, Vectors based on the lambda Bacteriophage, Cosmids, M13 vectors, Expression vectors, Vectors for cloning and expression in Eukaryotic cells, retroviral vector, Super vectors : YACs and BACs. Application of vector in construction of genomic and cDNA library


UNIT-IV Stem cell technology: Potential, Classes and application of stem cell (tissue engineering, Gene and cancer therapy). Methods to create transgenic animals (Microinjection and retrovirus). Application of transgenic animals.

Basic Text and Reference Books:

1. Principle of Genetic Manipulation by Old and Primrose
2. Genomes by T. A. Brown
3. Gene Cloning T.A.Brown
4. An introduction to Genetic Analysis – Griffith Miller, Suzuki Levonting

Learning Outcome:

• The objective of the course is to familiarize the students with the basic concepts in genetic engineering; to acquaint the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology; and to appraise them about applications genetic engineering.

• Student will able to understand general techniques used by genetic engineers to modify DNA.

• Analyze the benefits and drawbacks of manipulating an organism's DNA.

Second Generation of Sequencing techniques: Roche/454 sequencing, Ion torrent sequencing, Illumina/Solexa sequencing
Third Generation of Sequencing technique: Pacific Biosciences SMRT sequencing, nanopore sequencing
Comparison of Next generation sequencing techniques, Significance and Drawbacks of NGS, NGS File formats, Softwares for NGS data analysis.


Reference Readings
8. Patterson, B.K., Techniques in Quantification and Localization of Gene Expression.
9. Mont, D.W., Bioinformatics: Sequence and Genome Analysis.

Learning outcome:
The course aims to appraise the students to basic and high throughput techniques in Genomics and Proteomics and their applications.
Suggest and outline solution to theoretical and experimental problems in Genomics and Proteomics fields.
SARDAR PATEL UNIVERSITY
Vallabhbh Vidyanagar
Programme & Subject : B.Sc. BIONFORMATICS
Semester – V
US05CBNF25 : Practicals
(Syllabus Effective from June 2020)

Credits : 2     External : 15 Marks
Contact Hrs per Week : 4     Internal : 35 Marks
All units carry equal weightage
University Examination Duration: 2 Hrs

<table>
<thead>
<tr>
<th>Description</th>
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<tr>
<td>Practicals Based on US05CBNF21 and US05CBNF22</td>
<td>50%</td>
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1. Problems based on reagent preparations: Molarity, Molality.
2. Isolation of genomic DNA from plant cells.
3. Isolation of genomic DNA from E.coli cells.
4. Isolation of Plasmid DNA.
5. Gel electrophoresis- Agarose (for separation of above isolated genomic DNA)
6. Competent cells preparation and transformation
7. SDS PAGE. (Demo)
8. Radial Immunodiffusion,
9. ELISA.
10. Separation and identification of amino acid by paper chromatography.

1. Multiple alignment using tool M-Coffee.
2. To perform Sequence analysis by using EMBOSS.
3. To study the phylogenetic relationships of nucleotide and protein sequence(s) by using PHYLIP Package and PhyML.
4. To model a protein sequence using swiss model.
5. To model a protein sequence using modeler software.
6. To study physiochemical properties of protein using Protparam.
7. To perform secondary structure analysis using GOR.
8. Gene identification using ORF Finder at NCBI.
9. To study protein structure using RASMOL.
10. Use Finger PRINTScan program to get information about protein functions.
11. To study conserved region in the sequence using Sequence logo.
UNIT I: VITAMINS
Vitamins: Definition, Overview of General characteristics, Properties, Metabolism, Effects of deficiencies of water soluble & fat soluble vitamins, Vitamin related co-enzymes and chemical reactions. Structure and Hydrolysis of ATP & introduction to energy rich compounds-Biological oxidation-reduction reactions and Redox potential.

UNIT II: ENZYMES
Definition, Nomenclature and Classification of enzymes, Introduction to Allosteric enzymes, Inhibitors, Active site (lock and key theory, induced fit theory). Enzyme kinetics- Derivation of Michaelis-Menten equation, Km and its significance, line-weaver Burk plot and its limitations and solutions(Eadie Hofstee and Hannes Woolf’s curve and equations).

UNIT III: LIPIDS
Lipids: Definition, Overview of [Importance, Nomenclature, General Structure of Fatty acids (Saturated, Unsaturated, Hydroxy and Cyclic)], Biological Roles of Lipids, Lipid metabolism (β, α, ω oxidation, lipolysis, fatty acid synthesis)

UNIT IV: METABOLISM
Carbohydrate metabolism (Glycolysis, Kreb’s cycle). Nucleic acid metabolism: de novo synthesis and degradation of purines and pyrimidines Proteins: General features of Transamination, Trans-deamination and Urea cycle.

REFERENCES:
5. Outlines of biochemistry-Conn & Stumpf 5th Ed, John Wiley & Sons,
7. Medical Biochemistry - Chhaterjee and Ranashinde.7th Ed, Jaypee Publishers

Learning outcome: Students will be able to know about Vitamins, enzymes, lipids and metabolism
Unit Description

I Introduction to Python

II Python Data Structures and Manipulation
Understanding Strings, Lists, Tuples, Sets and Dictionaries, Data Structure Manipulation using loops

III Functions, File Management, Exception Handling and Debugging
Functions- Defining Functions, Testing Functions, Name Scopes, Inline Functions, Using global names inside function, Recursive Functions, Modules, File Handling – Introduction, Creating files, Read and Write files, Delete files, Exception handling, Debugging

IV Object-Orientated Concepts, Regular Expression, Python MySQL
Class, Object, Instances, Inheritance, Encapsulation, Polymorphism, Method Overriding, Object Overloading, Packages, Regular Expression, Python MYSQL – Create Database, Create Table, Insert, Select, Where, Order By, Delete, Drop Table, Update, and Join.

Basic Text and Reference Books:
4. Allen Downey, Jeffrey Elkner, Chris Meyers : How to think like a computer scientist learning with Python, Freely available online.2012
5. Exploring Python, Timothy A. Budd, McGraw Hill

Online Reading / Support material:
3. http://www.ibiblio.org/g2swap/byteofpython/read/

The learning objectives of this course are:

• To understand why Python is a useful scripting language for developers.
• To learn how to design and program Python applications.
• To learn how to use lists, tuples, and dictionaries in Python programs.
• To learn how to identify Python object types.
SARDAR PATEL UNIVERSITY
Programme & Subject: B.Sc. (Bioinformatics)  Semester: VI
Syllabus with effect from: June – 2020

<table>
<thead>
<tr>
<th>Unit</th>
<th>Description in detail</th>
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<tbody>
<tr>
<td>I</td>
<td>Introduction to R</td>
</tr>
<tr>
<td></td>
<td>History of R, Features of R, How to install R, How to run R, Comments in R, Reserved words, Identifiers, Constants, Variables</td>
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<td></td>
<td>Operators: Arithmetic, Relational, Logical, Assignment, Miscellaneous,</td>
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<tr>
<td></td>
<td>Basic Data Types: Numeric, Integer, Complex, Logical, Character</td>
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<td>Vectors: Creating Vectors, Combining Vectors, Accessing Vector Elements, Modifying Vectors, Deleting Vectors, Vector Arithmetic &amp; Recycling, Vector Element Sorting, Reading Vectors</td>
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<tr>
<td>II</td>
<td>Data Structure in R</td>
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<tr>
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<td>Matrices: Creating Matrices, Accessing Matrix Elements, Matrix Manipulation, Matrix Operations</td>
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<td>Arrays: Creating Arrays, Accessing Array Elements, Array Element Manipulation, Array Arithmetic</td>
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<td>Lists: Creating Lists, Accessing List Elements, Updating List Elements, Merging Lists, List to Vector Conversion</td>
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<td>Factors: Creating Factors, Accessing Factor Components, Merging Factors</td>
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<td>Data Frames: Creating Data Frames, Accessing Data Frame Components, Modifying Data Frames, Aggregating Data, Sorting Data, Merging Data, Reshaping Data, Subsetting Data</td>
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<tr>
<td>III</td>
<td>Flow Control &amp; Functions in R</td>
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<td></td>
<td>Decision Making: if statement, if..else statement, Nested if..else statement, switch statement,</td>
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<td>Loops: for Loop, while Loop, repeat Loop, Loop Control Statements: break Statement, next Statement</td>
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<td>Built-in Functions: Mathematical Functions, Character Functions, Statistical Functions, Date and Time Functions</td>
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<td>Functions Definition, Function Calling: Function without arguments, Functions with named arguments, Function with default arguments.</td>
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<tr>
<td>IV</td>
<td>Connecting R to External interfaces</td>
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<td>Packages: Installing a Package, Loading a Package</td>
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<td>Charts and Graphs: Bar Charts, Line Graph, Pie Chart, Scatter Plots, Dot Plots</td>
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<td>CSV Files: Reading from a CSV File, Writing to a CSV File</td>
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<td>Microsoft Excel: Reading from a xlsx File, Writing to xlsx File</td>
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<td>Databases: Connecting R to MySQL, Creating Tables, Inserting Rows, Updating Rows, Deleting Rows, Querying Tables, Dropping Table</td>
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Basic Text and Reference Books:

The learning objectives of this course are: how to program in R and how to use R for effective data analysis.
- Install and configure software necessary for a statistical programming environment.
- Reading data into R, accessing R packages, writing R functions, debugging, profiling R code, and organizing and commenting R code.

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PaperCode: US06CBNF22  TotalCredit: 4
R Programming  (4 lectures/wk)
SARDAR PATEL UNIVERSITY
Programme & Subject: B.Sc. (Bioinformatics)  Semester: VI
Syllabus with effect from: June – 2020

PaperCode:US06CBNF23
Title of Paper: Immunotechnology
Total Credit: 4
(4 lectures/wk)

Unit - I: Introduction to Immunology, Types of Immunity-Innate & Acquired, Humoral & cell mediated, Active & passive immunity, Antigens- Antigenic determinants, Haptens, Components of Innate & acquired immunity. Primary and secondary Immune response, Cells of the immune system,

Unit - II: Primary and secondary lymphoid organs - Bone Marrow, Thymus, Lymph nodes, Spleen, MALT & GALT. Antibodies-structure, types & function. Monoclonal antibodies-Hybridoma technology (HAT selection), Applications of Monoclonal Antibodies.

Unit-III: Antigen–Antibody interactions – Agglutination and precipitations reactions, variants and applications, ELISA- principle, variants (Indirect, sandwich & competitive) and applications. MHC-structure, types & function,

Unit-IV: Cytokines-Introduction & types, Role of cytokines in immune response, Classical, Alternative & lectin pathway, Disorders of the immune system: Autoimmunity, Hypersensitivity and Immunodeficiency (Introduction and examples), Role of Bioinformatics in Immunology & vaccine development.

References

Learning outcome:
This course will provide students with knowledge on how the immune system and able to articulate the roles of innate recognition receptors (i.e. Toll-Like Receptors) in immune responses and to compare and contrast humoral versus cell-mediated immune responses. The students will be able to describe the roles of the immune system in both maintaining health and contributing to disease.
SARDAR PATEL UNIVERSITY
Programme & Subject: B.Sc. (Bioinformatics)  Semester : VI
Syllabus with effect from: June – 2020

PaperCode: US06CBNF24
Title of Paper: Structural Bioinformatics

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<td>(4 lectures/wk)</td>
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Unit 4: Drug design & discovery: Definition of drugs, steps in development of new drugs, chemical & physiochemical parameters in drug-designing, drug metabolism, Interaction energy calculations, structure based drug designing, Combinatorial chemistry, virtual & high throughput screening, Docking and its importance, Introduction to Molecular Dynamics.

Reference Readings

3. Structural Bioinformatics by Philip E. Bourne and Helge Weissing, Wiley.
4. Introduction to Protein structure by Brandel C. and Tooze, J.
5. Structure and Mechanism in Protein science – Fersht WH freeman & Co
6. Protein folding – Creighton TE (ed) WH Freeman & Co.
7. Structural Bioinformatics by Philip E. Bourne and Helge Weissing, Wiley

Learning outcome: Student at the end of course will be able-

- To estimate the validity of information in macromolecular structure databases, and use computer programs to visualise and analyse macromolecular structures from a functional perspective
- use bioinformatics tools for sequence alignment, sequence motif identification and prediction of secondary and tertiary structures
- account for the purpose, theoretical background, and limitations of the above mentioned bioinformatics methods and use this knowledge to interpret relevant results.
SARDAR PATEL UNIVERSITY
Vallabh Vidyanagar
Programme & Subject : B.Sc. BIONFORMATICS
Semester – VI
US06CBNF25 : Practicals
(Syllabus Effective from June 2020)

Credits                     : 2    External : 15 Marks
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PRACTICAL VI SEM
1. Separation and identification of Amino Acids by Thin Layer Chromatography
3. Quantitative estimation of reducing sugar by DNS method (Dinitro salicylic acid)
5. Enzyme assay: effect of pH, temperature and incubation time on enzymatic activity.
6. Restriction digestion and ligation
7. RAPD analysis of plant DNA.
10. Study of chromosomal Abberrations using colchicine.

A mini Project in Bioinformatics.
SARDAR PATEL UNIVERSITY  
Discipline specific  
Subject: B.Sc. (Bioinformatics)   Semester : VI  
Syllabus with effect from: June – 2020  

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<thead>
<tr>
<th>Paper Code: US06DBNF26</th>
<th>Total Credit: 2</th>
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<tbody>
<tr>
<td>Title of Paper: Instrumental Methods of Analysis</td>
<td>(2 lectures/wk)</td>
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UNIT I: MICROSCOPY  
Microscope: Definition. Properties of Light (Def. of Wavelength, Frequency, Amplitude, Polarization, Diffraction, Refraction, Magnification, Resolution) Compound microscope, Phase contrast microscope, Fluorescent microscope and Electron microscope (SEM & TEM), Tissue processing for electron microscope.

UNIT II: CENTRIFUGATION AND SPECTROSCOPY  
Basic principle of sedimentation – Relative centrifugal force (RCF), Sedimentation rate, Svedberg unit or Sedimentation coefficient, Types of Centrifugation: Analytical and Preparative, Differential, Density gradient, Types of Centrifuge & rotors.  

UNIT III: CHROMATOGRAPHY  
Principles of Chromatography (Distribution Coefficient), Types of Chromatography: Principles, Instrumentation and applications of - Thin Layer Chromatography (TLC), Column Chromatography, Ion-Exchange Chromatography, Affinity Chromatography, Gel permeation Chromatography, GLC, High Performance Liquid Chromatography (HPLC)

UNIT IV: ELECTROPHORESIS  
Gel Electrophoresis: General Principles, Agarose gel electrophoresis, SDS-PAGE, Pulse Field Gel Electrophoresis (PFGE), Iso electric Focusing, Capillary Electrophoresis.

5. Outlines of biochemistry-Conn & Stumpf 5th Ed, John Wiley & Sons,

Learning outcome: Students will be able to know techniques and instrumentation microscopy, centrifugation, chromatography, electrophoresis