COURSE TITLE	**COMPUTATIONAL ANALYSIS OF BIOMOLECULAR SEQUENCE & STRUCTURES**
COURSE CODE	**01CB0301**
COURSE CREDITS	**4**

Objective:

1 To provide introductory knowledge concerning the tools, techniques, and algorithms used in computational biology and their applications.

2 To provide introductory knowledge concerning the tools, techniques, and algorithms used in computational biology and their applications.

Course Outcomes: After completion of this course, student will be able to:

1 Acquire basic knowledge about computational biology algorithms and bioinformatics resources for studying genome organization, nucleic acid and protein sequence, structure and function

2 Understand how biological data are stored, retrieved and utilised.

3 Learn how to use R and Bioconductor packages to analyse biological data.

4 Learn about tools and techniques used for generation and analysis of metagenomics data.

5 Learn about tools and techniques used for generation and analysis of single-cell omics and spatial transcriptomics data.

Pre-requisite of course: To provide introductory knowledge concerning the tools, techniques, and algorithms used in computational biology and their applications.

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	0	2	50	30	20	25	25

Contents : Unit	Topics	Contact Hours
1	**Introduction to Computational Biology and Bioinformatics** Algorithms & Challenges in Computational Biology, Introduction to DNA and Protein sequencing methods, Human Genome Project; Bioinformatics databases;, Type of databases, Basic file formats; Nucleotide sequence databases- Primary and Secondary nucleotide sequence databases, Protein sequence and structure databases, RNA databases; Genome databases, Molecular interaction databases, Protein expression, Pathway and protein function databases;, Mass spectrometry data repositories, Human Cell Atlas; Single-Cell Omics databases; Microbial and Taxonomic databases; Image databases	12

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Contents : Unit	Topics	Contact Hours
2	**Sequence Representation & Analysis** ORFs, tandem and inverted repeats,, microsatellite, minisatellite, sequence profiles, sequence logos, sequence chromatograms; Concepts of similarity - homologous, orthologous and paralogous sequences, Codon usage bias, gene finding, splice site recognition, transcription factor binding site identification,, SNPs; Types of non coding RNAs- lncRNAs, miRNAs, piRNAs, siRNAs ceRNAs; RNA sequence analysis, RNA regulatory networks	6
3	**Omics data and computational approaches:** Concept of Transcriptome, Transcriptome assembly, Comparative transcriptomics, Epigenomic data analysis; Proteomics Standard Initiative (PSI) for proteomics data, storage, retrieval, preprocessing, and normalization of proteomics and metabolomics data, identification of differentially expressed features, unctional annotation on the level of biological processes and molecular pathways, interpretation of gene lists in the context of protein protein interaction networks, Integrating Omics data for signaling pathways, interactome reconstruction, and functional analysis	14
4	**Introduction to R and Bioconductor packages for analysis of Biological data:** Introduction to R and RStudio, Overview of Syntax and Data Types, Graphics and Data Visualization using R, , Introduction to Gviz, limma, edgeR, DESeq2, Analysis and interpretation of high-throughput biological datasets	10
5	**Analysis and Interpretation of metagenomics and single-cell omics data** Overview- Sequencing techniques & Applications, Taxonomic and Functional analysis; Databases,, Tools & Platforms used in metagenomics data analysis, Comparative metagenomics; Single-cell genomics and proteomics, Spatial Transcriptomics	8
Total Hours		**50**

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	**Introduction to Computational Biology and Bioinformatics** Download & Install R and R Studio	2
2	**Sequence Representation & Analysis** Installing, Loading and Getting Help on Packages	2
3	**Omics data and computational approaches:** Creating and Manipulating Vectors, Arrays, Matrices	2
4	**Introduction to R and Bioconductor packages for analysis of Biological data:** Creating and working with Data Frames	2

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Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
5	**Analysis and Interpretation of metagenomics and single-cell omics data** Plotting graphs and charts – Bar diagrams, Histogram, Boxplots, Basic Analysis of NGS Data.	2
Total Hours		**10**

Textbook :

1 Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Andreas D. Baxevanis, Gary D. Bader, David S. Wishart, 4th Edition, Wiley, 2020

2 Bioinformatics: Sequence and Genome Analysis, David W. Mount, 2nd edition, Cold Spring Harbor Laboratory Press,, 2004

References:

1 Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids,, Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids,, Richard Durbin, Sean R. Eddy, Anders Krogh, Illustrated edition, Cambridge University Press, 1998

2 , Essential Bioinformatics, , Essential Bioinformatics, Jin Xiong, Cambridge University Press,, 2007

3 Bioinformatics: Experiments, Tools, Databases, and Algorithms, Bioinformatics: Experiments, Tools, Databases, and Algorithms, Orpita Bosu, Simminder Kaur Thukral,, Illustrated edition, Oxford University Press, 2007

4 Getting Started with R: An Introduction for Biologists, Getting Started with R: An Introduction for Biologists, Andrew P. Beckerman, Dylan Z. Childs, Owen L. Petchey, 2nd edition, Oxford University Press, 2017

5 R Bioinformatics Cookbook,, R Bioinformatics Cookbook,, Dan MacLean, Packt Publishing Limited, 2019

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery					
Remember / Knowledge	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Higher order Thinking / Creative**
30.00	30.00	10.00	10.00	10.00	10.00

Instructional Method:

1 The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

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Instructional Method:

2 The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room.

3 Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.

4 Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory.

Supplementary Resources:

1 Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory

2 https://www.ebi.ac.uk/training/

3 https://omicstutorials.com/

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