Shri Vile Parle Kelavani Mandal's

Dwarkadas J. Sanghvi College of Engineering

(Autonomous College Affiliated to the University of Mumbai)

Scheme and detailed Syllabus (DJS23)

Third Year B. Tech
in
Artificial Intelligence (AI) and Data Science
Honors Degree Program
in
Computational Biology

(SEMESTER V)

Prepared by:- Board of Studies in Artificial Intelligence (AI) and Data Science

Recommended by:- Academic Council of Dwarkadas. J. Sanghvi College of Engineering

Approved by:- Governing Body of Dwarkadas. J. Sanghvi College of Engineering

With effect from the Academic Year: 2025-2026

Shri Vile Parle Kelavani Mandal's
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC Accredited with "A" Grade (CGPA : 3.18)

Scheme for Third Year Undergraduate Program in Artificial Intelligence (AI) and Data Science - Honors in Computational Biology: SEM V (Autonomous)

Academic Year: 2025-26

Sr. No.	Course Code	Course	Teaching Scheme			Continuous Assessment (A)						Semester End Examination (B)						Aggregate (A+B)	Credits
			Theory (hrs.)	Practical (hrs.)	Tutorial (hrs.)	Term Test 1 (TT1) - a	Term Test 2 (TT2) - b	Assg/CP/GD /Presntation/ Quiz) - c	Total (a+b+c)	Term work	CA Total	Duration	Theory	Oral	Pract	Oral & Pract	SEE Total		
		SEM III																	
1	DJS23SCH1301	Computational Cellular Biology	3	–	–	15	15	10	40	–	40	2	60	–	–	–	60	100	3
		SEM IV																	
2	DJS23SCH1401	Computational Molecular Biology	3	–	–	15	15	10	40	–	40	2	60	–	–	–	60	100	3
		SEM V																	
3	DJS23SCH1501	Algorithms for Computational Biology	3	–	–	15	15	10	40	–	40	2	60	–	–	–	60	100	3
	DJS23SLH1501	Algorithms for Computational Biology Laboratory	–	2	–	–	–	–	–	25	25	–	–	–	–	–	–	25	1
		SEM VI																	
4	DJS23SCH1601	Computational Models for Biology	3	–	–	15	15	10	40	–	40	2	60	–	–	–	60	100	3
	DJS23SLH1601	Computational Models for Biology Laboratory	–	2	–	–	–	–	–	25	25	–	–	–	–	–	–	25	1
		SEM VIII																	
5	DJS23SCH1801	Bigdata in Bioinformatics	4	–	–	15	15	10	40	–	40	2	60	–	–	–	60	100	4
		Total	16	4	0	75	75	50	200	50	250	10	300	0	0	0	300	550	18

Prepared by | Checked by | Head of Department | Vice Principal | Principal

Program: B. Tech in Artificial Intelligence (AI) and Data Science - Honors in Computational Biology **T. Y B. Tech** **Semester: V**

Course: Algorithms for Computational Biology (DJS23SCH1501)

Prerequisite:

1. Basic knowledge of biological sciences

Course Objectives: The Objective of course is

2. Apply Algorithmic Techniques.
3. Design and Analyze Algorithms for Sequence Analysis and Genome Assembly.
4. Analyze Biological Networks.

Course Outcomes: On completion of the course, the learner will be able to:

1. Understand Computational Biology and Algorithms
2. Apply Sequence Alignment and Evolutionary Analysis Techniques
3. Analyze Protein Structures and Molecular Interactions
4. Interpret Gene Expression Data Using Advanced Algorithms
5. Model and Analyze Biological Networks
6. Leverage Machine Learning for Biological Data Analysis

Algorithms for Computational Biology (DJS23SCH1501)		
Unit	**Description**	**Duration**
1	**Module 1: Introduction to Algorithms and Biological Data** Introduction to computational biology and its applications. Overview of biological data types (sequences, structures, pathways). Basic algorithms and data structures commonly used in computational biology (e.g., sorting, searching), Basic data handling (FASTA, CSV), Introduction to simple programming concepts for biological data processing.	6
2	**Module 2: Sequence Alignment and Analysis Techniques** **Align sequences**: Utilize basic and advanced alignment algorithms to compare DNA, RNA, and protein sequences. Identify simple patterns and signatures in sequences. **Reconstruct evolutionary history:** Build phylogenetic trees using sequence data to visualize relationships between species.	7
3	**Module 3: Structural Analysis Algorithms** Introduction to protein structure prediction with homology modeling, Basics of Protein-protein interaction prediction. Molecular docking algorithms, Structural alignment and comparison techniques.	5
4	**Module 4: Gene Expression Analysis Algorithms** Microarray analysis, RNA-seq analysis and differential expression, clustering algorithms for gene expression data (e.g., K-means, hierarchical clustering), Dimensionality reduction techniques (PCA)	7

5	**Module 5: Network Analysis Algorithms** Introduction to biological networks (protein-protein interaction, metabolic, signaling), Network topology analysis (centrality measures, community detection), Algorithms for network modeling and simulation, Applications of network analysis in systems biology	7
6	**Module 6: Machine Learning for Computational Biology** Supervised learning for classification and prediction (e.g., support vector machines, random forests), Unsupervised learning for clustering and dimensionality reduction, Deep learning for biological data analysis (e.g., convolutional neural networks for protein structure prediction)	7
	Total	**39**

Suggested List of Practicals

1. Implementing the Needleman-Wunsch algorithm for global sequence alignment.
2. Using BLAST to perform sequence similarity searches.
3. Evaluating the quality of multiple sequence alignments using ClustalW or MAFFT Algorithms.
4. Implementing an overlap-layout-consensus (OLC) genome assembly algorithm.
5. Constructing phylogenetic trees using distance-based methods (Neighbor-Joining, UPGMA).
6. Analyzing gene family evolution using comparative genomics tools.
7. Analyzing protein-protein interaction networks and Identifying modules and hubs in biological networks.
8. Project-based Research
9. Undertaking a research project using computational biology algorithms.
10. Developing a bioinformatics tool or pipeline for specific biological analysis.
11. Presenting and demonstrating the project outcomes to the class.

Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept.

Minimum eight tutorials from the above suggested list or any other tutorial based on syllabus will be included, which would help the learner to apply the concept learnt.

Books Recommended:

Textbooks:

1. *"Bioinformatics Algorithms: An Active Learning Approach" by Phillip Compeau and Pavel Pevzner,2015.*
2. *"Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids" by Richard Durbin, Sean R. Eddy, Anders Krogh, and Graeme Mitchison,1998.*

Reference Books:

1. *"Computational Biology: A Practical Introduction to BioData Processing and Analysis with Linux, MySQL, and R" by Röbbe Wünschiers,2004*
2. *"Bioinformatics: Sequence and Genome Analysis" by David W. Mount,2004*

Web Links:

1. *National Center for Biotechnology Information (NCBI), https://www.ncbi.nlm.nih.gov/*
2. *Bioinformatics research and education, https://www.bioinformatics.org/community-driven platform, https://rosettacode.org/wiki/Rosetta_Code*
3. *European Bioinformatics Institute (EBI), https://www.ebi.ac.uk/*

Online References:

1. *Biology Meets Programming: Bioinformatics for Beginners, https://www.coursera.org/learn/bioinformatics*
2. *Bioinformatics Specialization, https://www.coursera.org/specializations/bioinformatics*
3. *Systems Biology and Biotechnology Specialization, https://www.coursera.org/specializations/systems-biology*

Evaluation Scheme:

Semester End Examination (A):

Theory:

i. Question paper based on the entire syllabus total comprising of 60 marks.
ii. Total duration allotted for writing the paper is 2 hrs.

Continuous Assessment (B):

Theory:

i. Term Test 1 (based on 40 % syllabus) of 15 marks for the duration of 45 min.
ii. Term Test 2 (on next 40 % syllabus) of 15 marks for the duration of 45 min.
iii. Assignment / course project / group discussion /presentation / quiz/ any other for 10 marks

Prepared by | Checked by | Head of the Department | Vice Principal | Principal