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)

Shri Vile Parle Kelavani Mandal's

Dwarkadas J. Sanghvi College of Engineering

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Scheme and detailed Syllabus (DJ19)
of
Honors Degree Program
in
Computational Biology

Proposed Scheme for Honors in Computational Biology
Department of Artificial Intelligence and Data Science
(Academic Year 2023-24)

Sr. No.	Course Code	Course	Teaching Scheme (hrs.)				Continuous Assessment (A) (marks)			Semester End Assessment (B) (marks)					Aggregate (A+B)	Total Credits
			Th.	P	T	Credits	Th.	T/W	Total CA (A)	Th.	O	P	O &P	Total SEA (B)		
SEM V																
1	DJ19ADHN1C1	Introduction To Biological Science	4	--	--	4	25	--	25	75	--	--	--	75	100	4
SEMVI																
2	DJ19ADHN1C2	Algorithms For Computational Biology	4	--	--	4	25	--	25	75	--	--	--	75	100	4
3	DJ19ADHN1L1	Algorithms For Computational Biology Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1
SEM VII																
4	DJ19ADHN1C3	Bioinformatics	4	--	--	4	25	--	25	75	--	--	--	75	100	4
5	DJ19ADHN1L2	Bioinformatics Laboratory	--	2	--	1	--	25	25	--	--	--	--	--	25	1
SEM VIII																
7	DJ19ADHN1C4	Genomic Data Science	4	--	--	4	25	--	25	75	--	--	--	75	100	4
Total			16	4	0	18	100	50	150	300	0	0	0	300	450	18

Th.: THEORY **P:** Practical **T:** Tutorial **O&P:** Oral & Practical **T/W:** Term work

Prepared by Checked by Head Of Department Principal

Honors in Computational Biology **Program: Third Year B.Tech. in Artificial Intelligence & Data Science**	**Semester : VI**
Course : Algorithm for Computational Biology	**Course Code: DJ19ADHN1C2**
Course : Algorithm for Computational Biology Laboratory	**Course Code: DJ19ADHN1L1**

Teaching Scheme (Hours / week)				Evaluation Scheme						
				Semester End Examination Marks (A)			Continuous Assessment Marks (B)			Total
Lectures	Practical	Tutorial	Total Credits	Theory			Term Test 1	Term Test 2	Total	marks (A+ B)
				75			25	25	25	100
				Laboratory Examination			Term work		Total Term work	25
4	2	--	5	Oral	Practical	Oral & Practical	Laboratory Work	Tutorial / Mini project / presentation/ Journal		
				--	--	--	25	--	25	

Pre-requisite: --

1. Basic knowledge of biological sciences

Objectives:

Students will be able to apply algorithmic techniques to solve biological problems and analyze and design algorithms for sequence analysis, genome assembly, and biological network analysis.

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

1. Demonstrate proficiency in using algorithms for biological sequence analysis and genome assembly.
2. Implement and evaluate algorithms for comparative genomics and biological network analysis.
3. Present and communicate biological findings and computational methods effectively.
4. Apply critical thinking and problem-solving skills to address complex biological problems using computational approaches.

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, graphs) • Programming fundamentals for scientific computing (Python, R)	8
Module 2: Sequence Alignment and Analysis Techniques • **Align sequences**: Utilize basic and advanced alignment algorithms to compare DNA, RNA, and protein sequences. • **Identify hidden patterns:** Discover recurring motifs and signatures in sequences that reveal functional elements. • **Reconstruct evolutionary history:** Build phylogenetic trees using sequence data to visualize relationships between species.	8
Module 3: Structural Analysis Algorithms • Protein structure prediction algorithms (Homology modeling, Ab initio modeling) • Protein-protein interaction prediction algorithms • Molecular docking algorithms • Structural alignment and comparison techniques	8
Module 4: Gene Expression Analysis Algorithms • Microarray analysis and differential expression • RNA-seq analysis and differential expression • Clustering algorithms for gene expression data (e.g., K-means, hierarchical clustering) • Dimensionality reduction techniques (PCA, SVD)	8
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	8

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)	8
Total	**48**

Artificial Intelligence Laboratory (DJS22)	
Exp.	**Suggested experiments**
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 • Undertaking a research project using computational biology algorithms. • Developing a bioinformatics tool or pipeline for specific biological analysis. • 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.

Books Recommended:

Text books:

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

Reference Books:

1. "Computational Biology: A Practical Introduction to BioData Processing and Analysis with Linux, MySQL, and R" by Röbbe Wünschiers

2. "Bioinformatics: Sequence and Genome Analysis" by David W. Mount

Online References:

1. https://www.ncbi.nlm.nih.gov/
2. https://www.bioinformatics.org/
3. https://rosettacode.org/wiki/Rosetta_Code
4. https://www.ebi.ac.uk/

Continuous Assessment (B):

Theory:

Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems.

Total duration allotted for writing each of the paper is 1 hr.

Average of the marks scored in both the two tests will be considered for final grading.

Laboratory: (Term work)

Laboratory work will be based on the experiments.

The distribution of marks for term work shall be as follows:

Laboratory work (Performance of Experiments): 10 Marks

Project Work: 10 Marks

Journal Documentation (Write-up and solution of selected problem statement): 5 marks
The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

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