Course Code	Course Title	L	T	P	C
BABIT305	**Computational Biology**	**2**	**1**	**2**	**4**
Pre-requisite	BAMAT101 - Multivariable Calculus and Differential Equations	**Syllabus Version**			
		1			

Course Objectives

1. Relate and connect mathematical theories with biological concepts
2. Solve problems in emerging areas of genomics using computational approaches
3. Gain knowledge on the latest trends in computational analysis of biological data

Course Outcomes

1. Understand the basic biological data and mathematical concepts involved in biology.
2. Gain basic knowledge of modern molecular biology, sequencing and genomics.
3. Develop an algorithm for analysis of biological sequences
4. Apply molecular methods to study genetic variation within and between species
5. Explain and evaluate different phylogenetic optimal criteria

Module:1	**Overview of Biological data and database search algorithms**	**6 hours**

Studying genomes; maps and sequences; specific techniques; the human genome project; sequence databases; Strings; Graphs; and Algorithms; Comparing two sequences; Global comparison the basic algorithm; Database search; PAM matrices; BLAST, FASTA, other issues; Similarity and distance; Parameter choice in sequence comparison.

Module:2	**DNA Sequencing and Fragment Assembly**	**6 hours**

454-Pyrosequencing; Ion torrent; Reversible dye terminator sequencing and Ion semiconductor sequencing; Nanopore sequencing; Shortest common superstring; Reconstruction; Multicontig; Algorithms; representing overlaps; Paths originating; Superstrings; Shortest superstrings as paths; Finding overlaps; Ordering fragments; Alignment and Consensus; The Maximum Overlap Graph; Graph formulation of Shortest Common Superstrings

Module:3	**Gene Expression Analysis and Transcript Discovery**	**5 hours**

Expression microarrays; Methods for Measuring Gene Expression; Clustering Algorithms; Classification Techniques: Bayesian; Support Vector Machines; Semi-supervised learning; Epigenomics: Epigenetic information; Epigenomic assays; Primary processing of ChIP data

Module:4	**Biological Networks and Organism Remodelling**	**5 hours**

Introduction to biological networks; Interactions between networks; Representation; Centrality measures; Communities and modules; Regulatory networks: Introduction;

Structural inference; Abstract mathematical representation; Structural properties; Synthetic biology.		
Module:5	**Phylogeny Construction and Validation**	**6 hours**
Character states and the perfect phylogeny problem; Binary character states; Two characters; Parsimony and compatibility in phylogenies; Algorithms for distance Matrices; Reconstructing additive trees; Reconstructing ultrametric trees; Agreement between phylogenies; Validation and visualization of phylogeny trees		
Module:6	**Contemporary Topics**	**2 hours**
Contemporary Topics		
	Total Lecture Hours:	**30 hours**
	Tutorial Hours:	**15 hours**
Text Book(s)		
Manolis Kellis, "**Computational Biology: Genomes, Networks, Evolution**", Massachusetts Institute of Technology LibreTexts Online Textbook, 1st Edition, **2016** Konopka A K, M James C Crabbe, "**Compact Handbook of Computational Biology**", CRC Press, 1st Edition, **2019**		
Reference Books		
Phillip Compeau, Pavel Pevzner, "**Bioinformatics Algorithms: An Active Learning Approach**", Active Learning Publishers, 1st Edition, **2018** Jonathan Pevsner, "**Bioinformatics and Functional Genomics**", Wiley Blackwell, 3rd Edition, **2018**		
Indicative Experiments		
1. Exploring Biological Data Resources		4 hours
2. Computational approaches for DNA Data processing and Analysis		5 hours
3. Computational approaches for Protein Data processing and Analysis		5 hours
4. Transcriptomics Data Processing and Gene Expression Profiling		4 hours
5. Phylogenetic Computation and Mapping of Biological Data		4 hours
6. Network-Based Computational Analysis of Biological Systems		4 hours
7. Computational Processing and Modeling of Large-Scale Biological Data		4 hours
	Total Laboratory Hours:	**30 hours**
Mode of Evaluation : Continuous Assessment Test, Digital Assignment, Quiz, Final Assessment Test, Lab Continuous Assessment, Lab Final Assessment, Oral Examination, Seminar, Group Discussion, Presentaion		
Recommended by Board of Studies :	26-05-2025	

Approved by Academic Council : No. 78	12-06-2025