

Course Name: Quantitative and Computational Biology

Course Number: BY512

Credit: 3-0-0-3

Prerequisites: - IC 136 - Understanding Biotechnology & its Applications **OR** Consent of Faculty member

Students intended for: B. Tech. 3rd and 4th year, MS/MSc. /M. Tech., Ph.D.

Elective or Core: Core for M. Tech. Biotechnology, elective for others

Semester: Odd/Even

Course objective: This course teaches the students with the fundamentals of quantitative biology and computational biology. These are essential components for statistical analysis of biological data and will allow student to learn the basic mathematical and statistical tool required to biologists. The computational biology aspects will introduce the students with additional practical skills that will allow them to handle biological data comprehensively.

Course Outline:

Module 1 [21 Lectures]

Quantitative Biology

Probability Theory, Probability Distributions - Binomial, Gaussian and Poisson Distributions. Descriptive statistics: mean, variance and sum of squares; mean and variance of a distribution, random numbers, random sampling.

Regression analysis: linear, multiple and nonlinear.

Test of hypotheses: t-test, z-test; Chi-square test of independence.

Multivariate Analysis: various types of classification, ANOVA, PCA

Examples of Statistics in biological data analysis.

Module 2 [21 Lectures]

Computational biology: Bioinformatics, bio-algorithms and Tools

Introduction to Basic Programming: Introduction to basic scripting and programming routinely used in computational biology.

Biological Databases and Sequence File Formats: Introduction to different biological databases, their classification schemes, and biological database retrieval systems.

Sequence Alignments: Introduction to concept of alignment, Scoring matrices, Alignment algorithms for pairs of sequences, Multiple sequence alignment.

Gene Prediction Methods: What is gene prediction? Computational methods of gene prediction-prokaryotic & eukaryotic.

Molecular Phylogeny: Introduction to phenotypic and molecular phylogeny. Representation of phylogeny, Molecular clocks, Methods of phylogenetic construction, statistical evaluation of the obtained phylogenetic trees.

Introduction to systems biology: Different Omics, Metabolic pathways and networks.

Text and Reference books

- A Modern Introduction to Probability and Statistics - Understanding Why and How, Authors: Dekking, F.M., Kraaikamp, C., Lopuhaä, H.P., Meester, L.E. ISBN 978-1-84628-168-6, Springer Publisher
 - Statistical methods in Biology by Norman Bailey (latest edition) ISBN 978-0521469838
 - Bioinformatics: Methods and Applications Genomics, Proteomics, and Drug Discovery S.C. Rastogi, N. Mendiratta, P. Rastogi (3rd Edition) PHI Learning Private Limited New Delhi (2011) ISBN 978-8120347854
 - Bioinformatics Principles and Applications. Z. Ghosh and B. Mallick Oxford University Press. ISBN 978-0195692303
 - Introduction to Bioinformatics. Arthur M. Lesk (3rd Edition) Oxford University Press. ISBN 978-0199208043
- Latest research articles will be advised related to the topic being taught.