

1. Systems Genomics (SSB-812)

(CHR: 3-0)

Educational Objectives

The course is essential for students of Systems and Synthetic Biology for learning of the fundamental questions driving the field of Systems Genomics. They will also need to be introduced to traditional and advanced state-of-the-art technologies. They will learn how to use the genomics data available to develop models-based inference, recognize patterns, molecular inter relationships, and systems behavior. Finally, the students will gain a perspective of how Systems Genomics can be used for applied biological sciences e.g., drug discovery and screening, bio-production, cell line engineering, biomarker discovery, and diagnostics.

Course Outcomes

The students will be able to:

- Develop new research questions and understanding of the fundamental questions driving the field of systems- genomics and Biology.
- Derive data for developing mathematical models and efficient statistical inference algorithms to recognize patterns, molecular inter-relationships, and systems behaviour.
- Exploit biological data (Sciences) for processes including drug discovery and screening, bio-production, cell line engineering, biomarker discovery, and diagnostics.
- Incorporated the results into peer reviewed publications, patents, and part of the student thesis/research projects.

Course contents

- Introduction to post-genomic era
 - History and milestones in genomics
- Next-generation sequencing and downstream processes
 - (PacBio – Illumina Miseq/ HiSeq– Oxford Nanopore MinION),

post-sequencing analysis, QC, alignment, assembly, annotations, variant calling etc.

- Multi-omics data and methodologies in systems- genomics and biology
- Transcriptomics data and analysis frameworks
 - quantitative gene expression profiling,
 - analysis of non-coding RNAs (such as lncRNAs and microRNAs)
- Biological network analysis
 - gene regulations and interactions
 - network modeling tools and approaches
 - applications of biological networks and network biology
- Functional and perturbation genomics
 - biomarkers discovery and therapeutic targets identification
- Single-cell genomics (biology) and analysis
 - single cell sequencing and applications
 - identification of novel cellular phenotypes
- Genomic profiling (GP)
 - genotype-phenotype landscapes,
 - immune system-derived biomarkers and tests, and
 - personalize medicine.
- Ethical consideration in Systems Genomics

Recommended books

- Networks of Networks in Biology: Concepts, Tools and Applications by Narsis A. Kiani (2021)
- The Systems View of Life: A Unifying Vision by Capra, Fritjof (2016)
- Advances in Statistical Bioinformatics: Models and Integrative Inference for High-Throughput Data, by Do K-A, Qin ZS & Vannucci M (2013) Cambridge University Press
- Systems Biology by Klipp E. et al (2009), Wiley-Blackwell