SYSTEMS BIOLOGY –IT760 +IT461

Preamble: A wealth of biological data that has become available in recent years. In the post-genomic era sequence informationis routine, and proteomic, and metabolomics data on a wide variety of organisms under a range of physical conditions is accessible. In these circumstances, a more quantitative approach to analysing molecular biological data is possible and indeed is necessary. The quantitative approach needs also to go beyond enumerating the various components or constituent molecules: one needs to understand how they interact spatially and mechanistically, and how the entire machinery of a living cell operates. Methods of physics, techniques from mathematics, statistics, and computer science, bioinformatics, modelling techniques, all contribute in the systems approach. Cutting edge applications of quantitative biology are already beginning to have an impact in medical areas. A course on systems biology therefore needs to build background and expertise in diverse areas.

1. Introduction to systems Biology. Terms and definitions.

2. Genome regulation, expression, switches and micro RNA regulations, Biochemical kinetics and pathway, data generation, Extraction & Accuracy experimental.

3. Classification of Enzymes and Metabolic Pathways; KEGG database. Comparative Genomics & Proteomics,Genome Annotation through knowledge of Metabolic Pathways, Organism Specific Metabolic Pathways, Metabolic Control Analysis & Engineering of Metabolic Pathways**.**

4. Pathway databases, Comparison of Metabolic Pathways, Pathway inference, visualization tools, Gene Ontologies. Pathway Miner and similar software. Applications in chemical kinetics and Metabolic pathway analysis (model E coli), and Flux Balance Analysis.

5. Genetic and biochemical networks: Introduction to Network, building up and analysis, deterministic and stochastic descriptions. Other network types: Regulatory (e.g. fly), Signal transduction (e.g. MAP Kinase cascade in yeast), Neural, Mechanical, etc.

6. Software for systems biology, Graph & Network in biology.SBML, and open source programs like eCell, Virtual Cell, StochSim, BioNets, etc.

7. Dynamical systems, linear stability and bifurcation analysis. Limit cycles, attractors.

8. Quantitative models for E Coli: lac operon and lambda switch. The chemotactic module in E. Coli.

Reading Materials:

* Much of the course will be based on recent journal articles. A few textbooks are available in select aspects of the systems approach,

1. Mark Ptashne, The Genetic Switch, CSHL Press.
2. Hiroaki Kitano, ed, Foundations of systems biology, MIT Press 2001

3. JM Bower and H Bolouri, eds, Computational modeling of genetic and biochemical networks, MIT Press 2001
4. GB Benedek and FMH Villars, Physics with illustrative examples from medicine and biology, Vol. 1: Mechanics, 2nd ed, Springer 2000.
5. Klipp E Wolfran L, System Biology: A Text Book Wiley-VH VerlagGmbh ,2009
6. Choi Sangdun, Introduction to System Biology Humana Press/Trtowa/New Jersey
7. Alon Uri, Introduction to Systems Biology: Design Principles of Biology Circuits Chapman & Hall/CRC/2007
8. Alberghina L, System Biology: Definitions and Perspectives Springer-Verlag/Berlin/Heidlberg
9.Lee SY, System Biology & Biotechnology of Escherichia Coli
10. Najaviark, System Biology and Bioinformatics; A Computational Approach
11. Lee A Segel, Biological Kinetics CUP Cambridge
12. Ethel Cornish Bowden, Fundamentals of enzyme kinetics.