BY 504   Metabolic Systems Biology

Credit: 3-0-0-3   Approval: Approved in 8th Senate

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

Students intended for: 3rd and 4th year UG and PG

Elective or Compulsory: Elective   **Semester:** Odd/Even

Course Preamble: This course will introduce the concepts of modern systems biology approaches for studying metabolism. Metabolic profiling and measuring *in-vivo* reaction rates (i.e. flux) via pathways provide critical insights into understanding the cellular physiology. The course introduces the aspects of computational, statistical and analytical methods and tools, with emphasis on understanding the biological aspects. Much focus is laid on introducing metabolomics and fluxomics that has wide range of applications in rational metabolic engineering. As a result of this course, the students will have strong foundations and first hand scientific understanding of current trends in Metabolic Systems Biology.

Course Outline:
Module 1 [6 Lectures]
Introduction to systems biology and metabolism: Components of Biological systems (DNA, RNA, Protein, Metabolites), their properties and function. Overview of cellular metabolism, enzyme kinetics and metabolic pathways. Online resources and Tools to study metabolism – KEGG, ECOCYC etc.
Module 2 [8 Lectures]
Introduction to -omics with focus on metabolomics: Biological networks and their significance – at the level of genome, transcriptome, proteome, metabolome and fluxome. Metabolomics - applications and its role in systems biology. Analytical methods for detecting and quantifying metabolites. General work flow and Statistical methods in metabolomics. Pathway and metabolome databases. Case study on metabolomics from literature.
Module 3 [14 Lectures]
Metabolic pathways, network reconstruction and constraint based flux analysis: Pathways of central and secondary metabolism in selected model systems (microbes, plant and animal), Reconstruction of metabolic networks, Stoichiometric matrix. Topological analysis of metabolic network with Elementary flux modes and/or Extreme pathways, Introduction to Constraint based metabolic modelling and Flux Balance analysis. Related software tools and online resources. Case study/studies on Constraint based flux analysis from literature with applications in metabolic engineering and/or drug target identification.
Module 4 [14 Lectures]
Introductory 13C based fluxomics**:** Metabolic Phenotypes, Fundamentals of Metabolic Flux analysis. Current practices of 13C Metabolic Flux Analysis – Stable isotope labelling, steady

state vs Non-stationary, Isotopomer analysis, Carbon transition networks, mathematical modelling for quantifying fluxes (in-vivo reaction rates), Flux maps. Software tools and online resources. Case study/studies on 13C metabolic flux analysis from literature with applications in metabolic engineering and/or understanding metabolic features in diseases such as cancer.

Reference Books:

1. Systems Biology: Properties of Reconstructed Networks Edited by Bernhard O. Palsson, Cambridge University Press, 2006, ISBN: 978-0521859035

2. Introduction to Systems Biology, Edited by Choi, Sangdun, Springer Publishers, 2007

3. Metabolomics – A powerful Tool in Systems Biology, Edited by J.Nielsen and M.C. Jewett, Springer Publishers, 2007

4. Metabolic Flux Analysis-Methods and protocols Edited by Jens O. Krömer, Lars K. Nielsen, Lars M. Blank, Springer Publishers, 2014

5. Additional reference material and scientific papers will be provided.