Systems and Synthetic Biology

Course Code: JAL 211
Credits: 3 (2+1+0)

Instructor: Dr. Ravindra Peravali

1. **Systems Biology: Basic principles**
    - Introduction to systems biology
    - Fundamentals of mathematical modelling, properties of models.
    - Biological systems and models. Some example models.
    - Understanding Systems Biology Graphical notation (SBGN).
    - Introduction and types of biological networks.

2. **Network Biology**
    - Principles of Biological networks, Network representation and statistics, networkperturbations.
    - Optimality and robustness of biological networks.
    - Reconstruction of Gene regulation networks - Negative and positive regulation in transcription networks with example.

3. **Metabolic fluxes**
    - Properties and control of metabolic flux.
    - Metabolic flux analysis: Flux Balance Analysis (FBA), Flux Variability Analysis, Flux Map.
    - Applications of metabolic flux analysis.
    - Lab

4. **Introduction, concepts and practice of synthetic Biology and its subfields**
    - Bioengineering, synthetic genomics, protocell synthetic biology, unconventional molecular biology, and in silico techniques
    - Impact of synthetic biology on culture and life.

5. **Basic research, Case studies and applications of synthetic biology tools**
    - Genetic code expansion and Protein engineering: A case study. Principles and applications of genetic code expansion, a powerful tool in synthetic biology and protein engineering.
    - Self-assembled biomaterials: Applications in drug discovery, drug-delivery tools addressing the unmet clinical needs

Suggested readings:

Books

1. **Systems Biology in Practice: Concepts, Implementation and Application** by Edda Klipp, RalfHerwig, Axel Kowald, Christoph Wierling and Hans Lehrach.
2 **Introduction to systems biology (Springer)**, edited by Sangdun Choi.
3 **Genetic Code Expansion: Methods and Protocols** edited by Jason W. Chin.

Published articles

1. Fang X, Lloyd CJ, Palsson BO. Reconstructing organisms in silico: genome-scale models and their emerging applications. Nat Rev Microbiol. 2020;18(12):731-43.
2. Ohno S, Uematsu S, Kuroda S. Quantitative metabolic fluxes regulated by trans-omic networks. Biochem J. 2022;479(6):787-804.
3. "Piecing together a puzzle. An exposition of synthetic biology". EMBO Rep. 2009 May;10(5):428- 32. doi: 10.1038/embor.2009.76. PMID: 19415076; PMCID: PMC2680885.
4. "Intermittent scavenging of storage lesion from stored red blood cells by electrospun nanofibrous sheets enhances their quality and shelf-life." Nat Commun 13, 7394 (2022). https://doi.org/10.1038/s41467-022-35269-3
5. "Enhancement of the gut barrier integrity by a microbial metabolite through the Nrf2 pathway." Nat Commun 10, 89 (2019). https://doi.org/10.1038/s41467-018-07859-7
6. "Expanding and reprogramming the genetic code", Nature. 2017 Oct 4;550(7674):53-60. doi: 10.1038/nature24031.
7. "Expanding the genetic code", Annu Rev Biophys Biomol Struct. 2006:35:225-49.
8. "A chemical toolkit for proteins--an expanded genetic code", Nat Rev Mol Cell Biol. 2006 Oct;7(10):775-82. doi: 10.1038/nrm2005.
9. "Expanding the genetic code for biological studies", Chem Biol. 2009 Mar 27;16(3):323-36. doi: 10.1016/j.chembiol.2009.03.001.