Physics of Living Systems

Global Initiative on Academic Network (GIAN)

Course

3th March to 7th March 2025

Jawaharlal Nehru University, India

Overview

The Physics of living matter has emerged as a new way to understand biological systems in the last decades. Concepts of 'biological networks', 'self-organization', 'living matter' provide frameworks to revisit biological phenomena with new angles and unprecedented approaches. This field has also revealed new directions in theoretical physics with quantitative comparisons with experiments. The goal of this lecture will be to provide basic background. In this domain at the Interfaces between Physics and Biology with tutorials and experiments.

Course Objectives

The objectives will focus on giving scientific visions related to observations of biological phenomena together with their quantitative characterizations and their tight comparisons with predictions of theoretical models.

Lectures

Lectures by visiting faculty will be complemented by hands-on tutorial sessions and additional presentations.

Day 1

Lecture 1 (2 hrs): Life at Low Reynolds Number and orders of magnitude. This lecture will report the typical timescales and length scales relevant in biological physics. Scaling arguments will be presented to explain their consequences for cells and organs.

Tutorial/Experiment 1 (2 hrs): Brownian motion visualised and quantified. Comparisons with directed motion.

Day 2

Lecture 2 (2 hrs): Cell Dynamics and self-organisation. How does a cell move? How do the cytoskeleton structures undergo their dynamics to orchestrate cell motion? How can this motion be modeled and tested experimentally?

Tutorial/Experiment 2 (2 hrs): Cell motion visualised and quantified with microscopy and compared with a model for cell motility.

Day 3

Lecture 3 (2 hrs): Systems Biology. How do signaling feedbacks and motifs affect signal processing in cells? How can they be tested theoretically and experimentally? How do fluctuations contribute to dynamics of signaling networks and to their functions?

Tutorial/Experiment 3 (2 hrs): Numerical simulations for biological networks.

Day 4

Lecture 4 (2 hrs): Physics of morphogenesis. How do organs form? How do collections of cells self-organize to undergo changes in shapes and pilot essential morphogenetic phenomena? Theory and experiments will be presented.

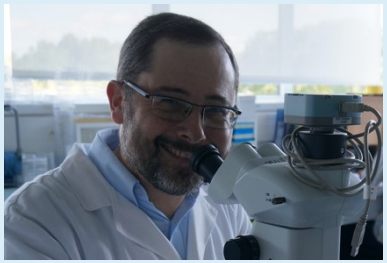
Tutorial/Experiment 4 (2 hrs): Extracting measurements in a developmental model system and comparing to a theoretical model.

Day 5

Lecture 5 (2 hrs): Classics in Cell Physics. Many ideas in biological physics have been formulated since decades and these pioneering concepts are still topics of research. Articles from Thompson, Feynman, Turing, Wolpert will be presented with their modern impacts.

Tutorial 5 (2 hrs): Reading seminal articles in biological physics and analyzing their experimental tests and designs over time.

Invited Faculty



Prof. Daniel Riveline
Research Director at the French National Centre for Scientific Research (CNRS) and group leader at the Institute of Genetics and Molecular and Cellular Biology (IGBMC) of the University of Strasbourg, France. His research is focused on "*Self-organization in living matter: from cell motility and cytokinesis to morphogenesis".*

Registration

The participation fee for joining the course is as follows:

JNU MSc Students: Free

JNU Research Students (MTech, MPhil, & PhD): INR 1000

JNU Faculty: INR 2000

Other Institutions (Faculty/Research Students): INR 2000 Academic Institutions: INR 10,000 Industry and Private Institutions: INR 30,000 Participants from Outside India: US$ 500

Venue: JNU Convention Centre and School of Physical Sciences

Host Faculty

Dr. Manoj Munde
School of Physical Sciences
mundemanoj@gmail.com

Prof. Sobhan Sen
School of Physical Sciences
sobhan.sen@gmail.com

Online Registration from 1st February 2025 :

http://www.jnu.ac.in/gian/