SISP 1114
Mathematical Wonders in Biology

Course Description

The field of biology has undergone a major paradigm shift in the past two decades in which the discipline has become increasingly data-centric. Consequently, possessing a quantitative reasoning mindset has become essential for the upcoming generation of biomedical scientists, for whom the skills to measure and analyze biological phenomena in quantitative terms are indispensable in their daily practices.

This course aims to offer an overview of fundamental concepts in quantitative biology, including biological numeracy, biophysical laws and quantitative research methodologies. Concepts such as stoichiometry, energies, forces, information and dynamics will be introduced to help students develop an intuition for the spatiotemporal scales (space-time) of various biological entities and processes. Quantitative reasoning is at the core of all topics covered. Guided by examples from both classic and contemporary scientific findings, students will learn to move beyond phenomenological descriptions (subjective interpretation) and (re)think biology in terms of quantitative and generalizable principles (objective representation). Along the way, students will cultivate an appreciation for numbers, equations, and math models as effective tools for describing, comprehending, and predicting living systems.

Topics

Biological numeracy, Biophysical principles, Biophysical techniques, Biological data analysis

Grading Scheme

- In-class test (10%)
- Final exam (50%)
- Project report (15%)
- Presentation (10%)
- Course participation (15%)

Teaching Mode

The course will be delivered face-to-face

Attendance Requirement

Attendance is expected and required. The minimum attendance required is 70%. Attendance for the assessment activities [e.g group presentation and final exam] is mandatory.

Instructor(s) Profile

Prof. Yi LIAO

Prof. Liao received his Ph.D. from the University of Michigan where he worked with Prof. Julie S. Biteen on single-molecule dynamics in bacterial cells. After completing his Ph.D., he joined the laboratory of Prof. Michael J. Rust at the University of Chicago as a postdoctoral scholar to study biological oscillators and self-organizing processes in bacteria. His research emphasizes that even relatively simple biochemical networks can give rise to complex spatiotemporal phenomena and sophisticated stress-adaptation strategies in bacteria. He started his independent career at HKUST in 2023, where his laboratory continues to investigate the relationship between gene regulatory networks and emergent properties in bacteria using experimental and computational approaches.