University of Haifa Special Workshop:

Enzymes and Dragons: Taming biological complexity with mathematical models

May 11-15th, 08:30-16:30, University of Haifa. Rooms TBD. 40 hours, 3 academic credit points.

Coordinated by: Daniel Sher, Igal Berenstein (Dept. of Marine Biology, University of Haifa)
Daniel Segrè (Dept. of Biology & Faculty of Computing and Data Science, Boston University)

Guest lecturers: Shlomit Sharoni, MIT, and TBD.

Developing quantitative mathematical models of fundamental processes is a key step to understand complex systems such as living organisms, and predict their behavior. In fact, the very act of translating a diagram or a mental image of a biological system into a formal mathematical description, such as a set of equations, can bring into focus gaps in understanding and identify needs for new experimental data. However, to those unfamiliar with these approaches, the mathematical language and computational tools used to build models can seem daunting. In this workshop, we will introduce fundamental aspects of mathematical modeling of living systems from enzymes to communities, combining theoretical lessons, case studies and hands-on tutorials. Furthermore, we will explore ways to include mathematical modeling into your own research, teaching and outreach activities. Participants will leave the course better-suited to incorporate mathematical modeling into various biological contexts—from enzymatic processes to ecosystem interactions—enhancing their capabilities as researchers and educators.

Some of the key topics we will discuss are:

- Mass-balance and molecular stoichiometry as fundamental constraints on biological networks, and their application through Flux Balance Analysis.
- Encounter and handling equations and their uses in biochemistry, cell biology and ecology.
- Consumer-resource, gene regulation and ecosystem models
- Best practices for designing, implementing, testing and presenting mathematical models

The workshop is open to 30 advanced (MSc and PhD) students, postdocs and research scientists from around the world. Basic experience with Python is required (links to relevant online tutorials will be provided). ***Registration is now open - please register online*** at https://forms.gle/Bb3KmhRcTLVJxYMv7. Accepted participants will be notified early March. Participants taking the course must complete and submit the online tutorial. Participants taking the course for academic credit will then be required to register through the secretariat of their university and to submit a final course project.

For more information please contact Daniel Sher (dsher@univ.haifa.ac.il)

Registration closes March 10th, 2025

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Preliminary course schedule

	Sunday 11/5/25	Monday 12/5/25	Tuesday 13/5/25	Wednesday 14/5/25	Thursday 15/5/25
08:30-10:30	**Introduction to mathematical modeling in biology** (Daniel Segrè)	**Consumer-resource models from molecules to oceans** (Daniel Sher)	**Metabolism as a resource allocation problem: flux balance modeling** (Daniel Segrè)	**Ecosystem models** (Igal Berenstein)	**Gene regulatory networks (TBD)**
10:30-11:00	Coffee break				
11:00-13:00	**Encounter and handling equations across scales** (Daniel Sher)	**Competition, selection and the limits of evolvability** (Daniel Segrè)	***Guest lecturer: Shlomit Sharoni*** *(MIT), title TBD*	*Guest lecturer: TBD*	*Guest lecturer: TBD*
13:00-14:00	Lunch (on your own)				
14:00-16:00	**Tutorial: Who's afraid of differential equations?** (Daniel Segrè)	**Tutorial: Consider a Spherical Cow – deciding what to model** (Daniel Sher)	**Tutorial: Sensitivity analysis and model-data comparisons** (Osnat Weissberg)	**Tutorial: Flux Balance Analysis in practice** (Daniel Segrè)	**Tutorial: Visualizing results, preparing models for publication and/or outreach** (Osnat Weissberg)
16:00-16:30	Coffee break				
16:30-18:30	**Beer, mingling and one-minute presentations**	**Tutorial: Writing the model equations, documentation, initial tests** (Osnat Weissberg)	**Tutorial: Michaelis Menten, Holling disks, LEGO and the TCA cycle dance** (Daniel ^2)	**Tutorial: Ecosystem modeling** (Igal Berenstein)	