Morris E. Fine Lecture: Rebecca Schulman

Associate Professor of Chemical and Biomolecular Engineering

Johns Hopkins University

Animating soft materials using molecular programs

Complex cellular behaviors such as motion and division are directed by far-from-equilibrium chemical networks that regulate the assembly and reconfiguration of a cell's architecture at the molecular scale. We have been asking how one can program the evolution of synthetic materials using designed chemical networks analogous to the biological networks that regulate cell and tissue architecture. In these systems, the dynamical evolution of molecular programs, or reaction processes, drive the evolution of the environment where materials assembly and act. This work thus amounts to controlling the pathways of assembly and reconfiguration. Molecular programs can comprise tens of species whose interactions are kinetically controlled, providing many new levers for controlling material formation and metamorphosis. These methods are thus promising routes toward building radically new materials that could grow into specific shapes, heal, or adapt to their environments.
I will describe our recent work focused on controlling the dynamic assembly and shape change of biomolecular materials such as hydrogels and semiflexible polymer networks. Different biomolecular signals can induce different dynamic polymerization and depolymerization processes in these materials and how chemical networks can be coupled to these materials to induce dynamic material behavior. To understand what new behaviors can arise in these systems when the chemical networks that regulate them become large and complex, we have recently developed integrated synthetic in vitro genetic regulatory networks consisting of oligonucleotide templates, T7 RNA polymerase and an RNase. These networks can consist of tens of different interconnected network elements, making it possible to construct synthetic regulatory networks of complexities comparable to those of simple viruses, enabling stepwise, multifaceted regulation of materials and chemistry.

Rebecca Schulman is an associate professor in the Departments of Chemical and Biomolecular Engineering, Chemistry and Computer Science and a member of the Institute for Nanobiotechnology, the Hopkins Extreme Materials Institute, the Chemistry-Biology Interface Program, the Center for Cell Dynamics and the Laboratory for Computational Sensing and Robotics at The Johns Hopkins University. She develops intelligent and adaptive biomolecular materials and nanostructures by combining ideas from materials science, circuit design and cell-free synthetic biology. Her work uses techniques from biophysics, biomolecular design, systems design and machine learning. Dr. Schulman joined JHU after working as a Miller Postdoctoral Fellowship in physics at UC Berkeley. She received undergraduate degrees in mathematics and computer science from MIT and a Ph.D. from the California Institute of Technology in computation and neural systems. She is the recipient of a Hartwell Individual Biomolecular Research Award, a President's Early Career Award in Science and Engineering (PECASE), a DARPA Young Faculty Award and Directors Fellowship, an NSF Career Award, a Turing Scholar Award and a DOE Early Career Award and is currently the co-Director of the Passport to Future Technology Leadership program for Ph.D. students at Johns Hopkins.

Tuesday, October 4 • 4 pm CT • Tech L211

In person only; no Zoom

Reception and Refreshments at 5:00 PM CT in Willens Wing Atrium of Tech (2nd floor between B and C wings). The whole MSE Community is welcome to attend!

Questions? Contact allison.macknick@northwestern.edu and megan.ray@northwestern.edu

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