CARNEGIE MELLON UNIVERSITY
BME 2023 SPRING SEMINAR SERIES

DNA Mechanotechnology for Sensing and Generating Piconewton-scale Forces

PRESENTED BY

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SCHEDULE

Hall of Arts (HOA) 160

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(11:00AM-12:00PM)

Mechanical forces drive and regulate countless biological processes including muscle contraction, embryogenesis, immunity, and coagulation. Such processes are mediated by networks of biomolecular motors, sensors, and structures that generate, sense, and transmit piconewton-scale forces. Our growing ability to engineer similar nanoscale mechanical devices de novo is paving the way for nanorobotics and functional nanomachines of the future. In turn, these engineered mechanical nano devices can be used as tools to study the properties of biological mechanical systems.

DNA nanotechnology, which can be used to design nanodevices with unprecedented precision, has been central to such engineering efforts. In recent decades, dozens of devices – including rigid DNA beams that resemble cytoskeletal fibers, DNA-based mechanosensors, and DNA motors that mimic motor proteins such as kinesin – have been developed for use in diverse fields including biophysics research, molecular sensing, and the development of active nanomaterials. To collectively describe this emerging field of technological development, we recently introduced the term DNA mechanotechnology (Blanchard & Salaita, Science, 2019).

In my talk, I will highlight two exciting examples of DNA mechanotechnology and their emerging applications. First, I will discuss DNA hairpin tension sensors that transduce piconewton-scale mechanical tension into fluorescence (Brockman & Blanchard et al., Nature Methods, 2018; Blanchard et al., Nature Communications, 2021). These sensors provide a molecularly specific, quantitative method for imaging molecular forces transmitted by cellular receptors such as integrins and the T cell receptor. Second, I will present the world's strongest synthetic DNA-based motor ever reported (Blanchard et al., Nano Letters, 2019). These motors are paving the way for the development of synthetic materials that, as in biological systems such as muscles, are powered by molecular machines.

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