JOINT BNC AND BINDLEY VIRTUAL SEMINAR

FRIDAY | JULY 31ST, 2020 | 11:00AM
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DR. NATE CERMAK

BUILDING NEW INSTRUMENTS TO STUDY BIOLOGICAL PROCESSES, FROM SINGLE CELL GROWTH TO WHOLE-ORGANISM BEHAVIORAL COORDINATION

Bio: My background is a mixture of biology and hardware and software engineering, and I am especially interested in developing new instruments for biological research. I am currently a neuroscientist/engineer working at Neuralink, a startup developing a high-bandwidth brain machine interface. In my postdocs, I studied neuronal information processing using multiphoton microscopy, as well as neuronal mechanisms of behavioral coordination in C. elegans by building a custom tracking microscope and image processing suite. Prior to that, my PhD work focused on developing microfluidic instruments for ultra-precise measurements of single-cell mass, growth rates, and mechanical properties.

Abstract: I will talk about two research projects. In the first, I'll discuss a microfluidic method I developed during my PhD to make precise, high-throughput measurements of single-cell biomass accumulation. This method utilizes an array of suspended microchannel resonators (SMRs), which are silicon microcantilevers with an interior fluidic channel. As cells in suspension flow through the interior fluidic channel, they transiently change the mass of the microcantilever, changing its resonant frequency, which we measure. To measure cell growth, We developed a "serial SMR array", consisting of 10-12 SMRs interspersed along a single long microfluidic channel. Cells are periodically weighed over a span of minutes as they flow through this channel. The change in a cell's mass between when it enters and exits the channel tells us how fast it is growing. Importantly, an entire queue of cells can transit this array nearly simultaneously, yielding growth rate measurements of hundreds of cells per hour. These measurements are significantly more precise than is achievable by microscopy or other existing methods, enabling us to quantify growth rates during a fraction of the cell cycle and see rapid responses toperturbations.

In the second part, I'll discuss some of my postdoc work to understand behavioral coordination and its generation by small nervous systems. The hermaphrodite of the nematode C. elegans has only 302 neurons and 143 muscle cells, yet displays a range of motor behaviors including changes in body posture (typically coupled to locomotion), feeding, egg-laying and defecation. Because C. elegans is small and transparent, it is feasible to observe all of its motor behaviors by microscopy, yet long-term behavioral studies have been hampered by an inability to perform long-term tracking and automated behavioral analysis. I'll discuss our development of a new low-cost (scalable) microscopy platform and software suite for analyzing C. elegans behavior. With this platform, we identified a previously unknown role for the neurotransmitter dopamine in regulating egg-laying, that likely had not been previously identified because it is locomotor-state-dependent.

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