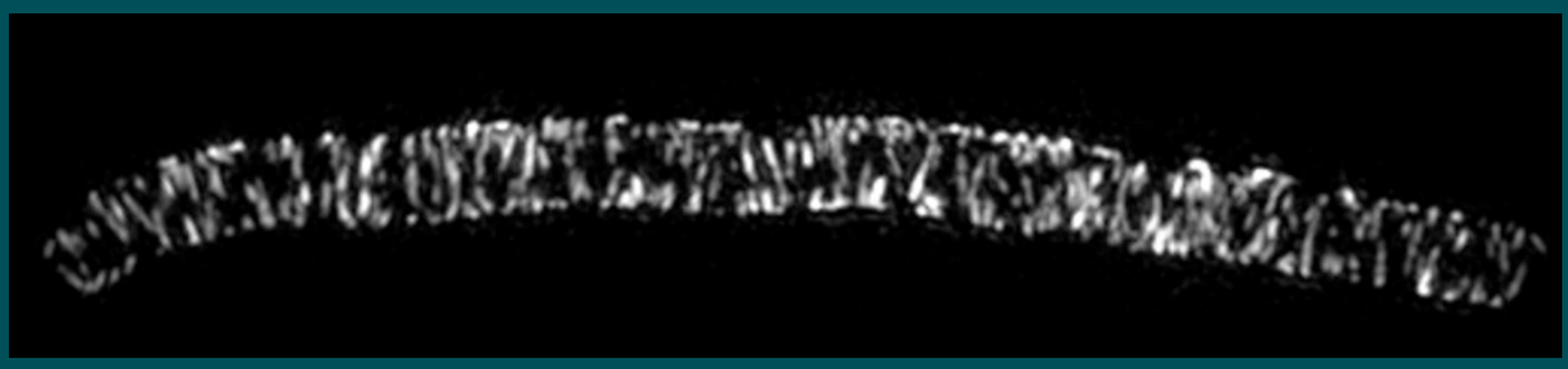
Chemical & Physical Sciences
UNIVERSITY OF TORONTO
MISSISSAUGA

COLLOQUIUM SEMINAR SERIES

THE PHYSICS OF BACTERIAL CELL SHAPE AND SIZE



All living cells are bounded by envelopes that protect them from the environment and confer their sizes and shapes. These shapes help cells to spatially organize their internal biological processes, allowing them to divide and faithfully segregate genetic material to each daughter. Yet, we still know very little about how cells obtain and control cell shape despite rapidly changing intra- and extra-cellular conditions, even in the arguably simplest and best understood organism: Escherichia coli. The problem is complex as it requires bridging scales between nanoscopic protein behavior and macroscopic cell shape and cell-cycle progression; this is where approaches from physics are required.

Here, I will present three vignettes that illustrate how my lab combines high-precision microscopy, microfluidics, physical modeling, and well-defined perturbations to reveal design principles and the relevant players of bacterial morphogenesis: 1) Cells constantly convert metabolites into biopolymers, notably protein, RNA, and DNA, which are densly packed inside the cell. To maintain the density of macromolecules within a permissive range, cells must increase their volumes in coordination with the rate of biomass growth. We developed accurate label-free phase microscopy to measure cell mass and cell shape independently, which then allowed us to constrain and reveal design principles underlying this coordination. 2) Second, I will discuss how rod-shaped bacteria such as E. coli control rod-like geometry. Using single-molecule tracking and applying physical forces, we could show that different processes responsible for cell-envelope remodeling respond to different mechanical and geometric cues, which provide mechanical feedback for cell-shape control. 3) Finally, if time permits, I will discuss how bacteria decide when to divide into two. By following single-cell lineages in microfluidic chips over multiple generations, we could study temporal correlations between different processes during their division cycle. Those correlations then allowed us to build a stochastic model of cell-cycle control.

Colloquium Seminar Series

Wednesday, March 23, 2022

Join us on Zoom at 3:10pm

https://utoronto.zoom.us/j/88646928603

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