



Department of Biomedical Engineering

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# Decoding Biological Dynamics in Bacteria: From Gene Circuits to Imaging Methodology

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Venue: YEUNG-B5208, 5/F

Yeung Kin Man Academic Building

### Abstract

Temporal dynamics constitutes an important layer of regulation in bacterial physiology. Many biomedically or industrially relevant cellular processes—such as transitions to alternative growth states and heterogeneous responses to external stimuli—are governed by the dynamic behaviors of the underlying gene circuits. Gaining insights into the biological origins, functions, and tunability of these dynamic phenomena in bacterial cells is of fundamental importance for both microbiology and synthetic biology research.

To demonstrate the richness and complexity of dynamic processes in bacteria, I will begin by discussing my work on a canonical bacterial gene circuit which modulates the spatial fidelity of cell division via dynamic patterning. When cells were subjected to environmental stress, this circuit revealed a striking and previously unrecognized role in division control, resonating with the general idea that gene circuits with dynamic outputs have often evolved to cope with fluctuations in the external environment.

In the second part of the seminar, I will introduce a high-throughput imaging platform we developed to systematically profile dynamic phenotypes in single bacterial cells. By integrating microfluidics with in situ genotyping, this platform enables massively parallel, time-resolved measurements across hundreds of bacterial strains grown under defined growth conditions. This capability opens the door to large-scale, unbiased investigations of cellular dynamics, phenotypic variability, and gene circuit behavior in bacteria.

Together, these studies underscore the remarkable complexity of bacterial behavior and highlight the pressing need for advanced, high-resolution tools capable of capturing and interpreting the temporal dimension of microbial life at the single-cell level.

### Biography

Yi Liao is currently an Assistant Professor from the Division of Life Science at the Hong Kong University of Science and Technology (HKUST). Previously, Yi completed his postdoctoral training in the field of quantitative systems biology with Prof. Michael J. Rust at the University of Chicago, and obtained his Ph.D. in Chemistry under Prof. Julie S. Biteen at the University of Michigan. His current research group at HKUST combines quantitative optical microscopy, microfluidics and mathematical modeling to investigate how bacterial cells encode, generate and process complex temporal signals to drive advanced cellular functions, such as phenotypic memory, noise filtering, bet-hedging, and adaptation.