Heterogeneous cell population models uncover "rules of life", inform experimental design, and enable control of cell population dynamics

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Computational models are essential tools that can be used to simultaneously explain and guide biological intuition. My lab employs machine learning, dynamical systems, and agent-based modeling strategies to explain biological observations and uncover fundamental principles that drive both individual cellular decisions and cell population dynamics. We are interested in the inherent multiscale nature of biology, with a specific focus on system-level dynamics that emerge from interactions of simpler individual-level modules.

In this presentation, I introduce a multiscale agent-based model of a cell population that integrates subcellular signaling and metabolism, cellular level decision processes, and dynamic vascular architecture and function to interrogate multilateral regulation among heterogeneous cell agents. I also introduce a reduced phase model of heterogeneous circadian oscillators and use this model to control phase resetting. Both modeling frameworks are flexible and can be adapted to represent, analyze, and control a wide variety of biological systems.

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