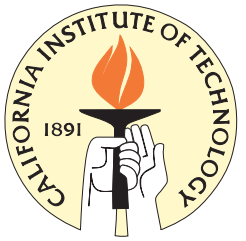
Analysis and Design of Biomolecular Feedback Systems



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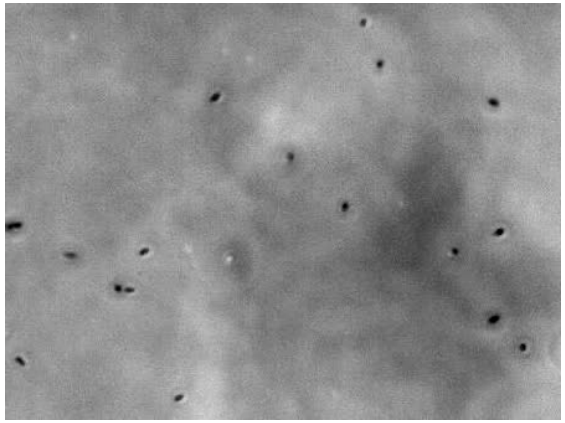
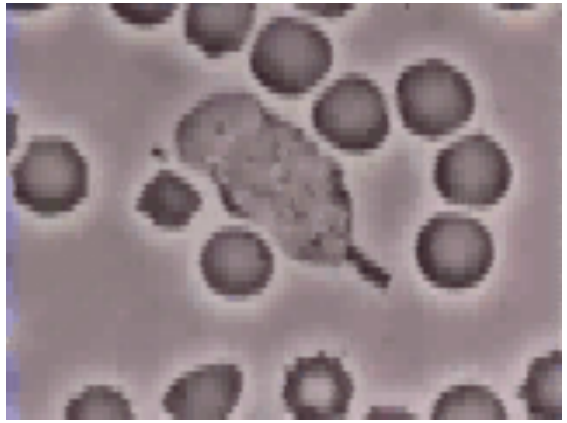
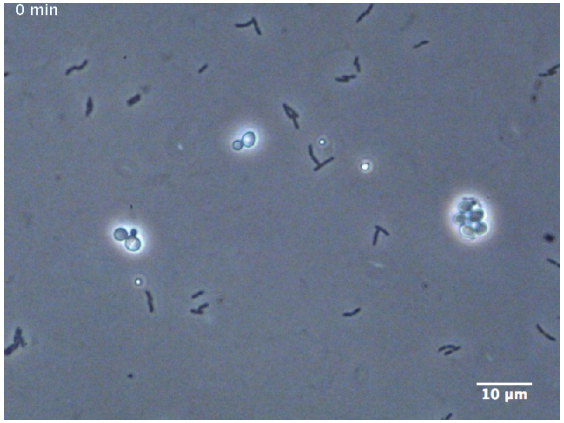
Goals for the workshop

- Introduction to emerging techniques for the analysis and design of biomolecular feedback systems, with applications in biology, biotechnology and nanoscale systems
- Intended for controls researchers who are interested in application of modeling, analysis and design techniques from control to natural and engineered biomolecular systems, as well as describing some of the open problems in this area.
- No prior knowledge of biology is required

Some Examples of Biological Dynamics and Feedback







Questions

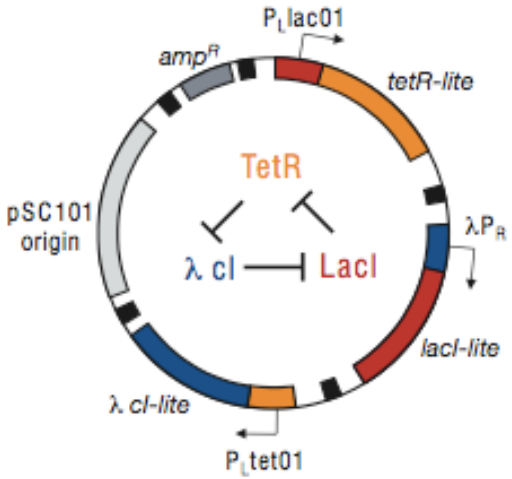
- How do bacteria “decide” which way to swim (run/tumble) to find food?
- How does a neutrophil “sense, compute and actuate” to control its motion?
- What controls the stages and rate of the cell cycle?

Morning lectures: develop tools for answering these types of questions through analysis of molecular scale dynamics and feedback

Approach

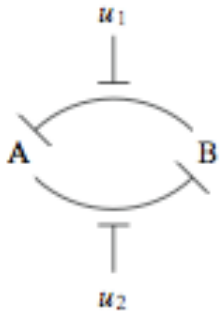
- Focus on common processes (transcription, phosphorylation, etc) in the cell
- Make use of tools from dynamical systems to quantify and classify dynamic behavior
- Balance of detail versus summary - more information available via references

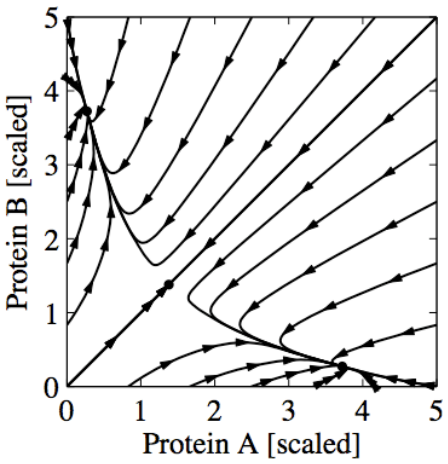
Biological Circuit Design (Synthetic Biology)



Represilator (Elowitz & Leibler)

- Ring oscillator with three repressors in a cycle
- Provides oscillations at frequency comparable to cell cycle





Genetic Switch (Collins and others)

- Interconnect two genes via cross-repression
- Resulting circuit has two states: “(1,0)”, “(0,1)”
- Can analyze robustness, speed of response

Workshop Schedule

Morning session: systems biology

9:00	Introduction and welcome
9:15	Biomolecular modeling (RMM)
10:30	Break
10:45	Feedback analysis techniques (RMM)
11:15	Examples: chemotaxis, heat shock, yeast mating response (RMM)

Lunch (12:30 - 2:00)

Afternoon session: synthetic biology

2:00	Overview, history and enabling technology (DDV)
2:15	Simple modules: oscillators, toggles, inverters (DDV)
3:00	Modularity: systems level challenges of composing modules (DDV)
3:45	Break
4:00	Modularity, continued
4:45	Implementation: constructing devices from component parts (DDV)

Wrap up: Q&A + discussion

5:15	Future challenges in synthetic and systems biology (RMM)
5:45	Adjourn