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Case ID:M20-191L^
Published: 5/5/2021

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A Mutually Inhibitory Network with Positive Autoregulation and Communications (MINPAC)

Biological pattern formation requires complex gene regulation networks and accurate cell-cell coordination. The reaction-diffusion (RD) based clock and wavefront model has been proposed as a mechanism involved in biological pattern formation of repeated and segmented structures. While RD driven pattern formation has been demonstrated in many systems, its role in multicellular pattern formation has not been sufficiently studied, primarily due to the lack of suitable experimental systems.

Researchers at Arizona State University have designed a bottom up synthetic gene network capable of directing engineered single cells to form self-organized tunable patterns. This gene network, designated mutually inhibitory network with positive autoregulation and communications (MINPAC), is a synthetic biology approach to generate complex spatial patterns arising from a reaction diffusion circuit motif. E. coli cells were transformed with MINPAC and results showed that pattern formation was observable within a couple days.

MINPAC provides a synthetic biology approach for complex spatial pattern generation and represents a paradigm for future design of pattern-forming circuits.

Potential Applications

- Gene network to generate complex spatial patterns in transformed single cells
  - Developmental biology, i.e. somitogenesis
  - Biological pattern formation
  - Engineering of synthetic tissues
- Generation of an expression pattern of a gene with a synthetic gene circuit

Benefits and Advantages

- Self-organized and tunable

- A single PDE model can recapitulate and predict all the MINPAC-directed biological patterns

- Complete motif with intracellular transcriptional network and intercellular communication modules which cross-regulate each other to direct pattern formation

o Coordinates molecular gene expression, cellular population response and positional information interpretation

- Guides cells to self-organize into patterns at both microscopic and colony scales

- Can be modulated by external inducers to generate diverse patterns including multiple-stripe patterns, target-like patterns and ring patterns

For more information about this opportunity, please see

Wu et al - BioRxiv - 2019

For more information about the inventor(s) and their research, please see

Dr. Kuang's departmental webpage

Dr. Wang’s laboratory webpage