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Synthetic Gene Circuits

-Engineering synthetic gene circuits allows scientists to design cells to perform any number of tasks such as biosensing, therapeutic or commodity production or bioremediation to name a few. An important design principle when engineering sophisticated synthetic gene circuits is modularity as it breaks the system down into small modules, thereby reducing complexity. However, even with rigorous rounds of design-build-test iterations, the whole circuit often does not function as anticipated. Resource competition has been suggested as a reason for such performance failures; limited resources may result in undesired competition between the modules within one gene circuit. Understanding how the modules in a circuit are unintentionally coupled is essential to mitigate resource competition and modularity loss.

Researchers at Arizona State University have created a synthetic cascading bistable switches (Syn-CBS) circuit system that addresses the obstacle of resource competition in designing synthetic gene circuits. These Syn-CBS systems manage resource competition between the modules of the synthetic gene circuit. The Syn-CBS system comprises two modules that may be expressed in one cell/the same kind of cell (single strain), or each expressed in different kinds of cells (two-strain). Testing with both the single- and two-strain Syn-CBS circuits show corrections in micro-organism consortia of deviated cell fate transitions due to resource competition. The effect of the resource competition on the circuit is minimized through a division of labor using microbial consortia.

This circuit system builds synthetic cascading bistable switches circuits to achieve successful cell fate transitions.

Potential Applications

- Single-strain Syn-CBS circuits can be used to test the other controlling strategies of resource competition
- Two-strain Syn-CBS circuits can be used for studying the multiple cell fate transition and delivery of multiple drugs
- Engineering multicellular synthetic systems and metabolic pathways

- Biomedicine
- Environmental science
- Applied life science

Benefits and Advantages

- The Syn-CBS circuits can be utilized to coordinate multiple cell fate decisions.
- Deviated cell fate transitions due to resource competition were corrected in micro-organism consortia
- Reduces or eliminates unfavorable circuit-host interactions
  - Increases performance for making machinery for transcriptional and translational purposes when using microbial consortia

For more information about this opportunity, please see

Zhang et al - Nature Communications - 2021

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

Dr. Tian's departmental webpage

Dr. Wang’s departmental webpage