Curr Synthetic Sys Biol 2016, 4:2(Suppl)
http://dx.doi.org/10.4172/2332-0737.C1.006

Transcriptional rewiring of plant defense responses

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Plant defense responses are modulated by substantial transcriptional reprogramming; up to 40% of the genome can be differentially expressed following pathogen challenge. This indicates that transcriptional factors play an important role in the defence response. Previously, we have shown that a technique known as genetic rewiring, where the open reading frames of selected transcription factors are fused to different promoters altering the natural expression of the regulator, can be used to synthetically evolve novel phenotypic diversity. As a transcription factor can potentially regulate thousands of target genes alteration of its natural expression has the potential to generate radically new phenotypes. We have shown through this approach in yeast that heterologous protein expression can be significantly enhanced using this rewiring approach. Furthermore, network analysis reveals that rewired open reading frames and promoters possess characteristic topological network features that can serve as predictive features for future rewiring endeavors. As such in conjunction with a presentation of our work on rewiring the yeast transcriptome I will briefly discuss how we are using a combined systems and synthetic biology approach to first construct large scale transcriptional networks responding to pathogen challenge in plants. Secondly I will show how through a process of topological network analysis how we are now selecting promoters and open reading frames which we will use to rewire the plant defense transcriptome. This novel transciptome diversity will be used to help reveal key regulatory points and potential weaknesses in these networks as well as revealing potential solutions to help improve tolerance to plant pathogens.

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Development of tools for mammalian gene circuit design and performance control

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Synthetic biology aims at developing and applying engineering tools to sense and process endogenous information and to implement robust responses to intracellular conditions. Mammalian synthetic networks build on the conjugation of efforts to increase the number of DNA parts for genetic circuit assembly with minimal counteractive effect with the intracellular context with the ability to design circuits that are activated when specific endogenous molecules are sensed within the cells. I will show our results on designing new genetic parts such as transcriptional activators and repressor in mammalian cells and circuits based on RNA binding proteins as a new potential platform of gene delivery and genetic circuit regulation. Finally I will describe the design of protein sensors as mean to trigger cell-selective circuit activation.

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