Phenotypic Variability in Chromatic Adaptation of Cyanobacteria

Project Outline:

Phenotypic variability is observed in clonal bacterial populations, whereby individuals display significantly different phenotypes under a given environmental condition and despite having the same genetic make-up [1]. From an evolutionary stand point, phenotypic variability presents a paradox as only one phentoype is expected to be fit under a specific environment. This paradox is resolved by considering evolution under environmental conditions. In other words, phenotypic variability can be beneficial (at the population level) if populations are experiencing environmental fluctuations [2]. Using computer simulations, we have recently shown that simple genetic circuits enabling phenotypic variability at population level evolve under fluctuating selection (i.e. environmental fluctuations) [3]. A more generalized theoretical model suggest that any bacterial trait responding to fluctuating environmental conditions should display phenotypic variability in accordance with environmental fluctuation rates [4].

To further develop the theoretical modeling of phenotypic variability and understand its molecular basis, this project will focus on the chromatic adaptation response from cyanobacteria as a model system. Chromatic adaptation (CA) is the ability to cyanobacteria to regulate the expression of different light absorbing phycobilins so to improve their light harvesting capacity under a given light condition [5]. Using time lapse microscopy, we will investigate CA in individual cells across a population. The resulting single cell dynamics of CA will inform a theoretical model of this process and its heterogeneity. Subsequently, we will endevaour to evolve cyanobacteria under specific, fluctuating light conditions to test the capacity of the underlying regulatory mechanisms to adapt the level of heterogeneity in CA response.

The specific aims of this mini project will be;

- Develop a robust time laps image acquisition of cyanobacteria under different light conditions using a inverted fluorescent microscope available in the Soyer lab.
- Complement and verify chromatic adaptation measurements with molecular quantification of phycobilin levels.
- Develop appropriate algorithms for image analysis of acquired data to measure single cell level chromatic adaptation dynamics.
- Build mathematical models of increasing molecular complexity to explain the acquired data.

References: **1.** Science 305:5690 (2004): 1622. **2.** Genetics 169:4 (2005). **3.** Molecular systems biology 8 (2012). **4.** Science 309:5743 (2005). **5.** Annu Rev Plant Biol 57 (2006):.

OSS Lab: We are based in the School of Life Sciences and are part of the Warwick Centre for Integrative Synthetic Biology (WISB, http://wisb.warwick.ac.uk). We work on diverse research questions at the interface of systems, evolutionary and synthetic biology. Members of the group have diverse backgrounds including microbial biology, engineering, mathematics and computer science and employ both experimental and theoretical approaches.

Required Skills (Selection Criteria): This project is best suited to candidates with an interest and/or experience in microscopy, image analysis, molecular biology and mathematical modeling. Familiarity with molecular techniques for handling cyanobacteria would be a plus.