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Monitoring single-cell bacterial growth using drop-based microfluidics

Drop-based microfluidics is a technology by which monodisperse water-in-oil emulsions are created through the manipulation of fluids in a microfluidic device. The resulting drops act as individual, contained environments that can carry biological cargo; in the case of this study, the cargo is single Pseudomonas aeruginosa bacterial cells. Here, the growth of two strains of P. aeruginosa, wild type and a mutant hibernation promotion factor knockout strain, Δhpf, was monitored using specially developed microfluidic drop incubation technology. The Δhpf gene helps cells to successfully enter dormancy when undergoing starvation. Here we have developed an incubation technique that utilizes a uniquely engineered microfluidic device to hold drops in a set position and prevent drop evaporation for the duration of a 24 hr growth period. This technique allows for the growth of individual cells to be monitored, meaning that insights such as the heterogeneity of cell growth are lost to bulk data. During the growth period, drops are continually imaged through confocal technology to determine changes in fluorescence output, which reflects cell growth. This technique demonstrates the ability to monitor the growth of single cells to produce growth curves for each individual cell. In this study the developed microfluidic incubation technology facilitates a deeper investigation of the demographics of growth between the two strains explored, and allows for probing the heterogeneity of bacterial populations at a single cell level.

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