Quantitative analysis of growth arrest variability in bacteria

Nathalie Q. Balaban

Racah Institute of Physics, Hebrew University, Jerusalem, 91904, Israel

MOST bacteria in the wild are in the growth arrested state. Even strains that have the ability to replicate rapidly eventually exhaust available nutrients and enter growth arrest. However, most microbiological studies are performed on rapidly growing bacteria. Here we present simple experimental tools to study the effect of noise on the growth arrest properties of bacteria, based on single cell analysis in microfluidic devices and automated screening setups. The results are analyzed using simple mathematical models of the cellular processes at work. Using this approach, we found that simple genetic modules, known as toxin-antitoxin motifs, exploit noise to generate a variability of growth arrest in bacterial populations, leading to enhanced survival under antibiotic treatments. Toxin-antitoxin modules provide a natural molecular design for exploiting the noise and generating variability of growth arrest at the population level, which increases the survival probability under stress.