Metabolic Heterogeneity in Clonal Microbial Populations

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Diauxic growth is a widely observed phenomenon where, under certain conditions, heterotrophic microbial populations undergo separate phases of exponential growth when provided with multiple substrates. Though first described in the 1940s, the phenotypic response at the level of individual cells remains unclear [1].

In the traditional interpretation, all cells within a population make a synchronous shift in substrate specialisation via the regulation of pathway-specific enzymes [1]. However, in recent years a number of competing hypotheses have emerged to describe behaviour at the single-cell level that may manifest as diauxic growth at the population level [2]. These include metabolic heterogeneity, where distinct subpopulations specialize early and deplete substrates at different rates [3], and "bet hedging" where a small subset of the population maintains the ability to metabolize alternative substrates when required [4].

Using two bacterial species (*E. coli* and *M. extorquens*) as model organisms, we employ secondary ion mass spectrometry (SIMS) to analyse individual cells grown on a mixture of isotopically labelled substrates, enabling a direct measurement of substrate specialisation and growth rate. We are able to detect metabolic phenotype of single-cells throughout the period of growth, and in each scenario, resolve the nature of the diauxic shift.

References

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