Studying Multiple Growth Phases of *E. coli* on Minimal Medium with Experiment and Therory

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Introduction

Escherichia coli (*E. coli*) produces cytotoxic acetate when fed with larger amounts of glucose as the only carbon/ energy source (batch growth, minimal medium) (Fig. 1). This is known as overflow metabolism. Initiated by the acetate switch, the excreted acetate can then be metabolized in a second growth phase, though biomass production is strongly reduced (Fig. 1).

We used optical online measurements, offline measurements, and modeling to elucidate the growth of strain W3110Z1 on glucose.

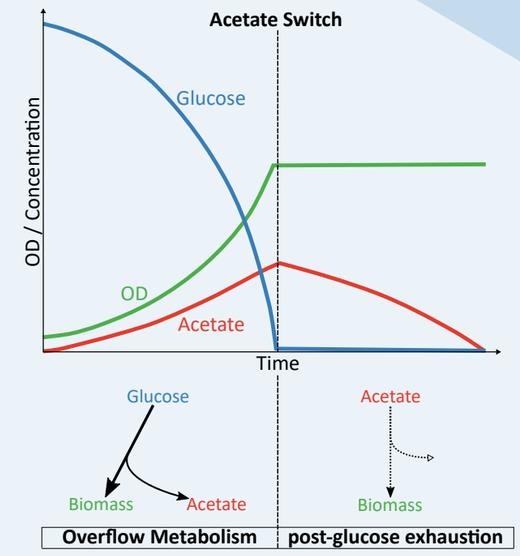


Fig. 1 **Schematic growth with glucose overflow metabolism.** Graph after Enjalbert, Brice et al. (2015)

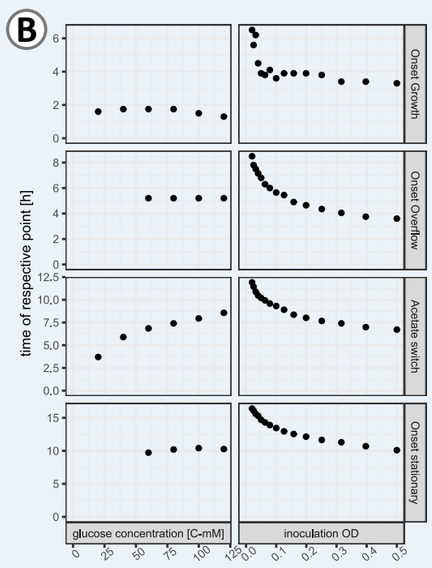
Enjalbert, Brice et al. (2015). "Acetate exposure determines the diauxic behavior of Escherichia coli during the glucose-acetate transition". In: Journal of Bacteriology 197.19, pp. 3173–3181. issn: 10985530. doi: 10.1128/JB.00128-15.

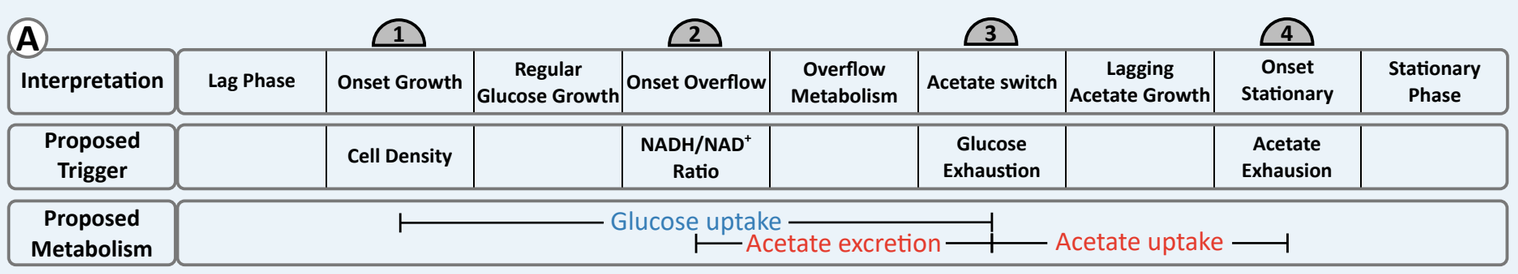
Experimental

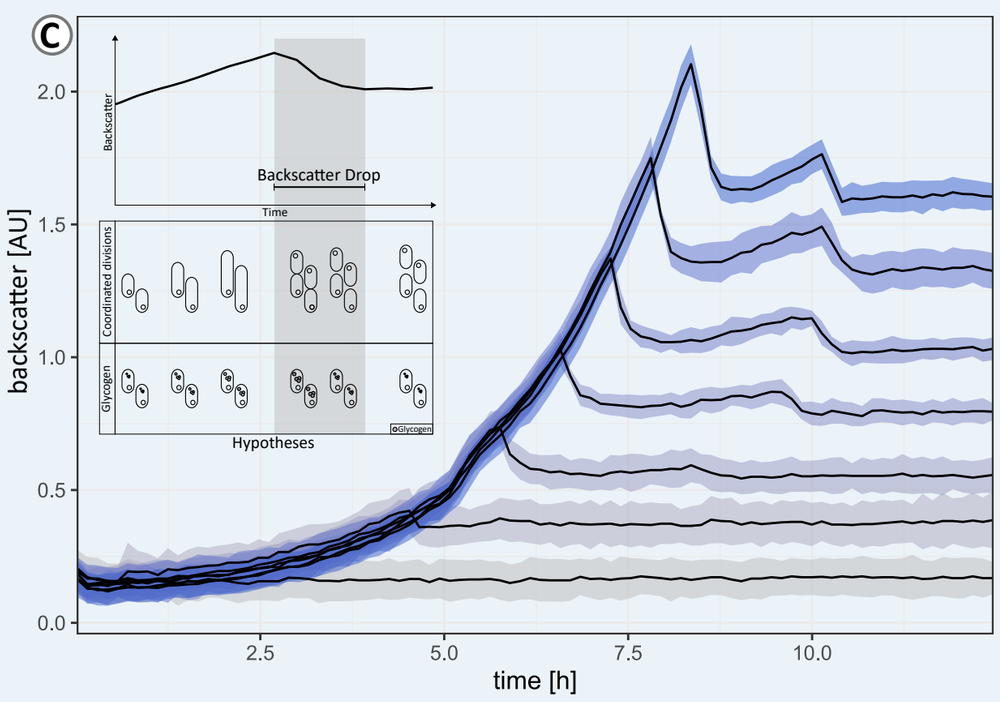
Multiple phases visible for growth with glucose.

Timings can be dependent on substrate concentration and inoculum.

Cells might induce overflow metabolism later during growth.







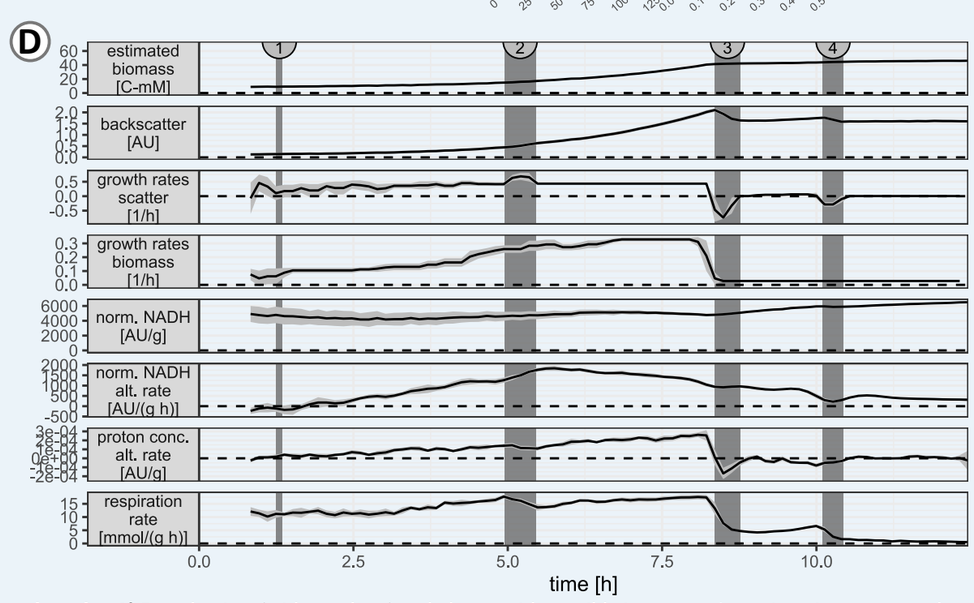


Fig. 2 Experimental results. A) Found points (with numbers) and phases with possible interpretation, triggering events and substrate metabolism. **B)** Changing timing of points with varying glucose concentration or initial cell density. **C)** Backscatter signal during growth with varying glucose concentrations. **Inset)** Hypothetical origins of backscatter-drops. **D)** Selected measurements during growth with 199.88 C-mM glucose, approximate times of points are annotated. Grey/ colored areas around curves mark 95% CI

Modeling

A Monod ODE model can produce a rough fit but misses the points and phases.

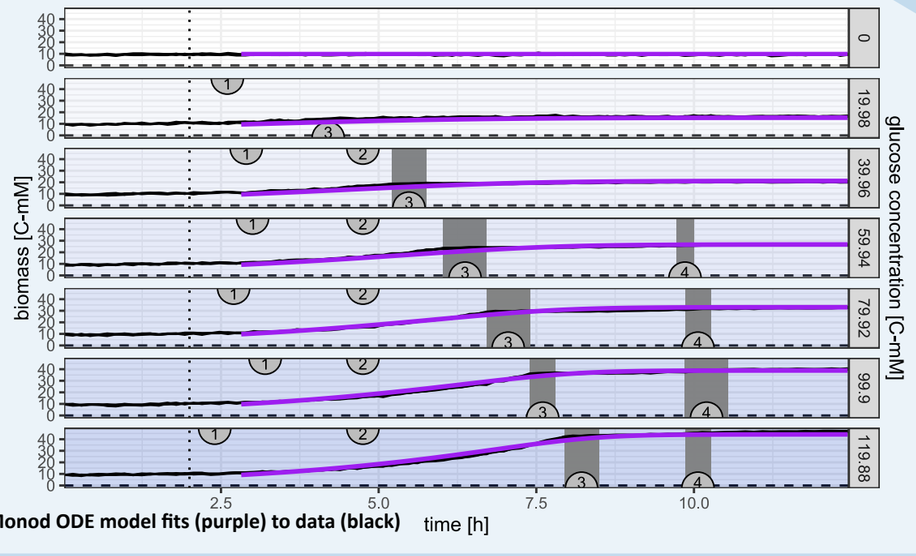


Fig. 3 Monod ODE model fits (purple) to data (black)

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