Characterization of Growth Rate of Closely Related *Escherichia coli* Strains

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Introduction

Growth rate of bacteria depends on temperature and growth media but also sensitively on the genetic make-up of the strains. To investigate the effect of small genetic variations on different *E.coli* K12 sub strains, we measured the growth rate of two parental strains, MG1655 and BW25113; the differences are seen in Figure 1. Cells were grown overnight in liquid culture consisting of M9 minimal media enriched with either 0.5% glucose or 0.2% glycerol, and at 28 °C and 37 °C. The growth rate was measured using the optical density (OD_{600}) with a spectrophotometer every 30 mins.

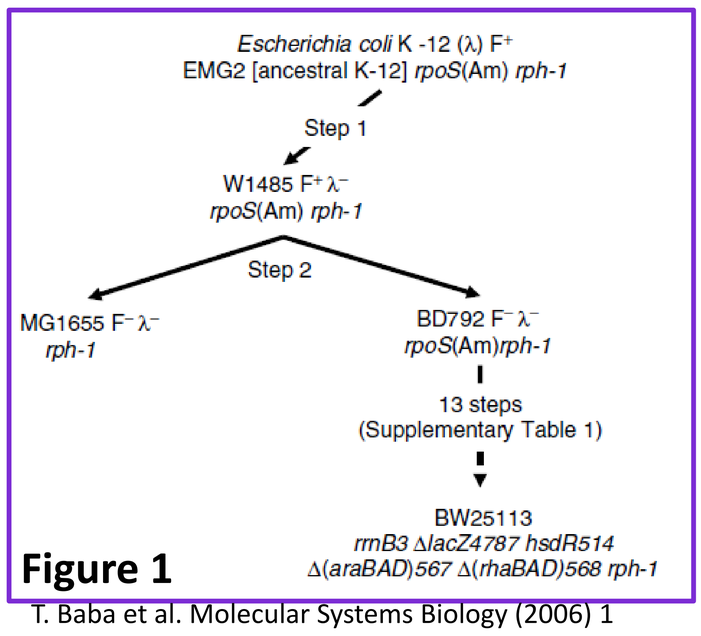

Figure 1

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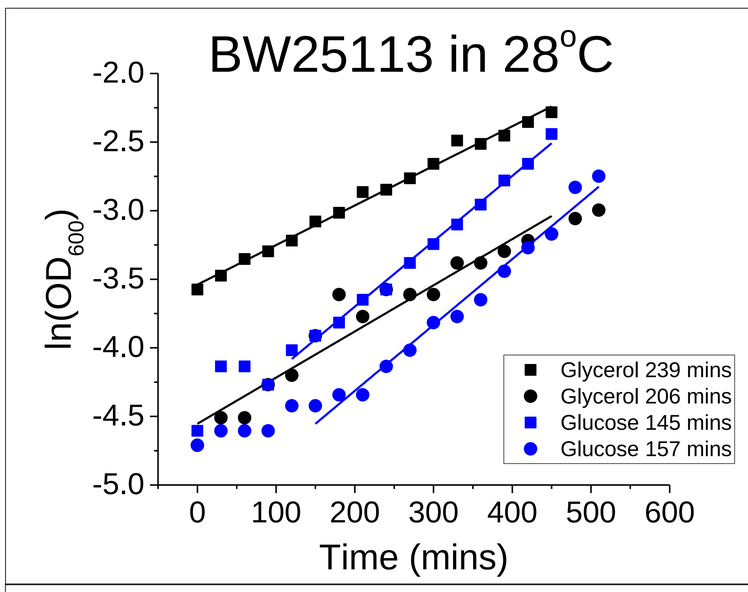
Theory

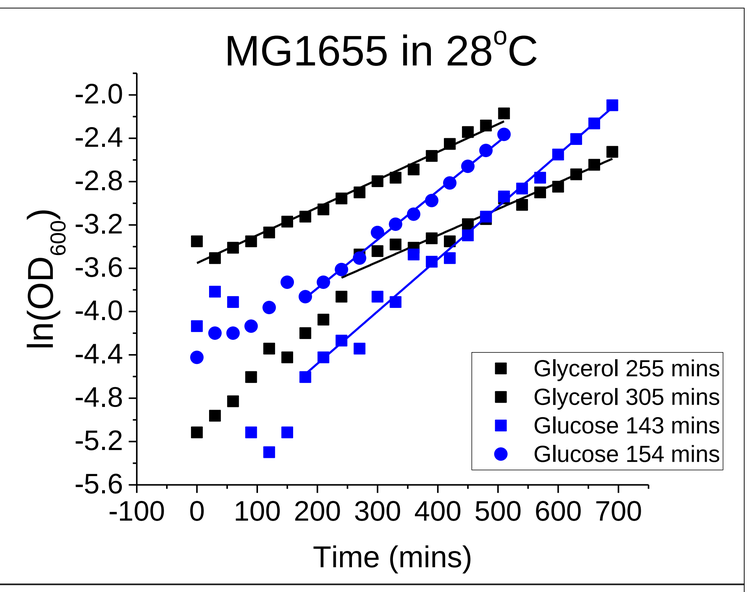
The optical density of cell culture, OD, is approximately proportional to the number of cells, *N,* in the solution. *E. coli* growth follows typically three phases called the lag, log, and stationary phase. Lag phase is when the growth rate is null, log phase corresponds to exponential increase in cell numbers, and stationary phase is when cell division stops. These stages can be seen on standard growth curves. To determine the doubling time of the cells, the natural log of the OD curve is found and is fit to a linear curve. The slope defines the growth rate, μ [$mins^{-1}$]. Equation 1 is the exponential growth rate where N_0 is the initial number of cells and t is the time. Equation 2 is the doubling time, τ_d.

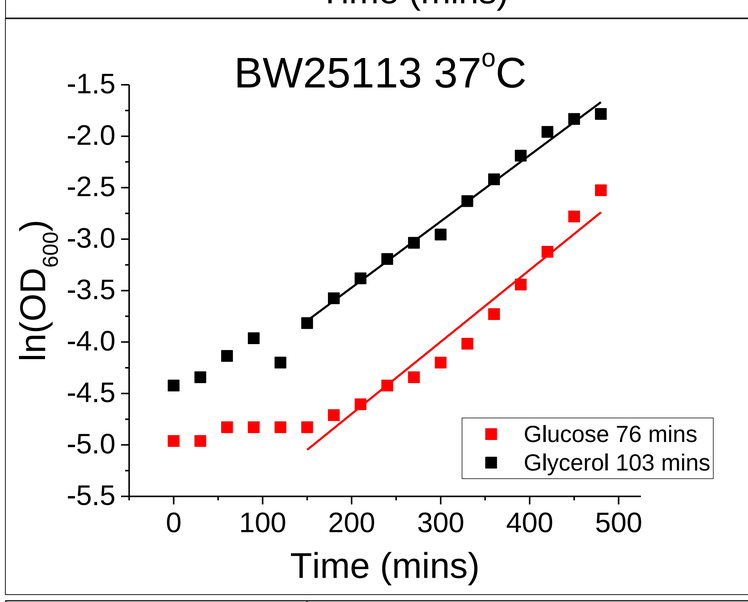
$$N(t) = N_0 e^{\mu t}, \mu = \frac{\ln(\frac{N}{N_0})}{t} \text{ (Eq. 1)}$$

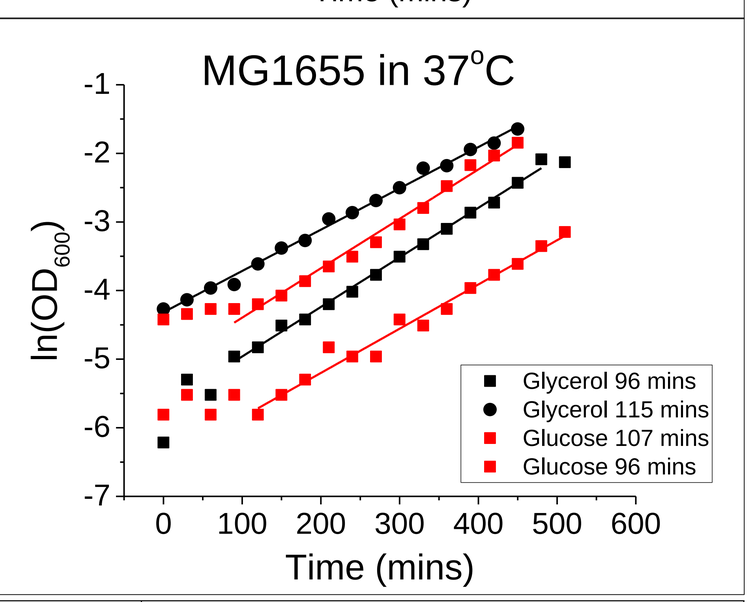
$$\tau_d = \frac{\ln(2)}{\mu} \text{ (Eq. 2)}$$

Results









Average doubling time	Glucose		Glycerol	
	28°C	37°C	28°C	37°C
MG1655	148 ± 7.78 *mins*	101.5 ± 7.78 *mins*	280 ± 35.4 *mins*	105.5 ± 13.4 *mins*
BW25113	151 ± 8.49 *mins*	76 *mins*	222.5 ± 23. 3*mins*	103 mins

Conclusion

We investigated what effect small genetic variations in two *E. coli* K12 sub strains have on their growth rates. Glycerol is an energy-poor carbon source, causing the cell's metabolism to act at a slower rate. Therefore, the cells double at a slower rate compared to their growth in glucose, the preferred energy source for bacteria. The increase in temperature speeds up the metabolism of the cells, which in turn increases their growth rate giving a faster doubling time. Our measurements show that BW25113 despite harboring additional genetic deletions grow faster than its parental strain MG1655 in minimal medium. One needs to be aware of these differences when comparing published results from these two sub strains.

Acknowledgements

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References

Martínez-Gómez, K., et al. (2012). "New insights into Escherichia coli metabolism: carbon scavenging, acetate metabolism and carbon recycling responses during growth on glycerol." Microbial Cell Factories **11**(1): 46.