Control of environmental context to fine-tune genetic performance

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Abstract

A small change in the extra-cellular environment can cause big behavioural fluctuations intracellularly—a *butterfly effect* that challenges our ability to design robust genetic networks. Here we analyse how the presence of octanoate in the growth media of the soil bacteria *Pseudomonas putida* promotes the accumulation of intra-cellular polyhydroxyalkanoates (PHAs) which, in turn, modify the regulatory machinery [1]. PHAs act as non-permeable capsules that occupy the volume of the cell, changing from transcription/translation regimes to diffusion rates. We tested the impact of octanoate on a simple regulatory node where the source of regulators and their target promoter are placed in a plasmid and in the chromosome, respectively [2]. Results show that the presence of octanoate correlates to fluctuations in promoter activity. Mathematical modelling suggests we can use such environmental parameter to rationally fine-tune genetic performance without having to modify DNA sequences. Along with our recent findings on the impact of intra-cellular contextual dependencies [3], we advocate for characterising the impact of environmental conditions for the sake of harnessing biological complexity.

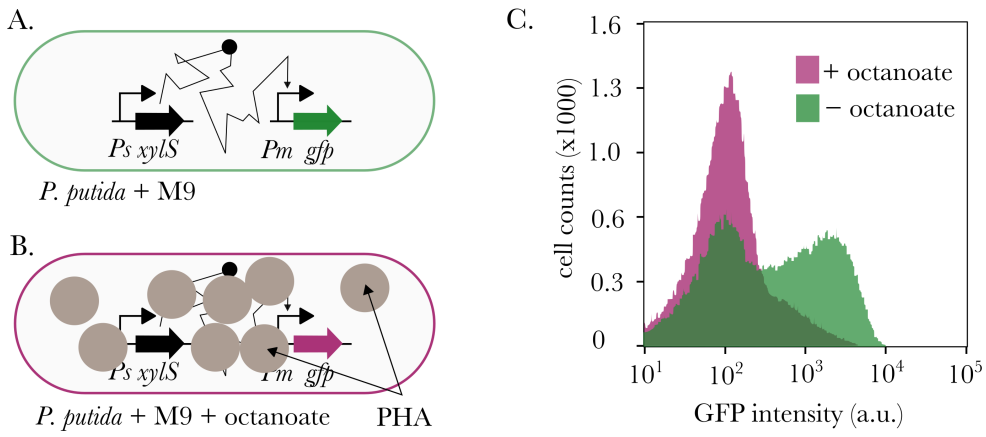

Figure 1. Promoter activity can be rationally adjusted by designing the environmental context. **A.** Regulatory node tested, where regulator source and target are engineered at distance. **B.** By adding octanoate to the environment, the intracellular space is filled with PHAs, which impacts on the mobility of regulators. **C.** Regulator mobility is translated into regulator availability; less regulators reach their target in the +octanoate scenario, thus promoter activity decreases.

References

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