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Poster #82: Too Early or Too Late? Trade-Offs in the Timing and Specificity of Bacterial Defence Systems Against Mobile Genetic Elements

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Horizontal Gene Transfer (HGT) is a key element of bacterial adaptation and evolution, enabling the acquisition of genes that influence critical traits, such as antibiotic resistance. HGT is mediated by Mobile Genetic Elements (MGEs) like plasmids, transposons and bacteriophages. While MGEs can be beneficial, some, such as bacteriophages, are harmful, prompting bacteria to evolve diverse anti-phage defence systems (DSs). To date over two hundred DSs have been identified, and a single cell, on average, has five DSs. This remarkable diversity has sparked an interest in trade-offs associated with DSs, such as the balance between effective protection and associated costs.

Here we focus on a trade-off involving the timing of activation of a DS and the ability to discriminate between MGEs. DSs that sense early infection signals, such as foreign DNA, can neutralise MGEs before they harm the host. However, these signals are often shared among diverse MGEs, making it difficult to distinguish between beneficial and harmful elements. On the other hand, DSs that detect later-stage signals, such as phage proteins, enable more acute discrimination but may activate too late to prevent cellular damage.

Using an Individual Based Model (IBM), we explore how ecological and evolutionary factors influence the fitness of early-acting versus late-acting DSs. We examine conditions under which one strategy outcompetes the other, and whether mixed strategies emerge. Our results offer insights into the evolutionary pressures that shape DS diversity, elucidating how bacteria navigate the complex landscape of HGT, and its implications in bacterial adaptation and evolution.

Reference #1

Reference #2

Reference #3

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