John Innes Centre

Year in Industry Proposal for 2027/28

Title of Project	Delivering plastic degrading genes into contaminated soils using bacterial megaplasmids
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Project on Offer

Contamination with plastics and other long-lived pollutants is a major problem affecting natural environments such as soils. Pollutant biodegradation, by treatment with naturally occurring or bioengineered microorganisms that metabolise pollutants as a food source, has great potential as a cost-effective, environmentally friendly solution to soil contamination. Unfortunately, however, biodegradation bacteria are typically poorly adapted to the local environment and are quickly outcompeted by native microbiota. A potential solution is to introduce biodegradation genes into the contaminated environment by horizontal gene transfer (HGT), for example by encoding them on a plasmid, bypassing the requirement for externally added microbes to outcompete the existing microbial community. However, the stability and rate of HGT seen with currently available plasmids is insufficient for this to work effectively.

We recently discovered a class of plasmid-encoded regulatory genes with the curious ability to manipulate the behaviour of their host bacteria (1). These regulators increase host, and therefore plasmid fitness, and dramatically increase the rate of HGT between different bacteria. This project will explore the theoretical and practical steps necessary to combine plasmid regulators and bioremediation machinery to produce synthetic plasmids that can effectively drive beneficial bioremediation traits into contaminated soil communities.

The student will design and build synthetic bioremediation plasmids containing a xenobiotic bioremediation operon and plasmid regulatory genes identified in our ongoing research. We predict that these plasmids will exhibit enhanced abilities to spread within complex microbial communities, and to metabolise contaminating xenobiotics. We will use a combination of colony-counting, qPCR and FACS to track plasmid spread and the effectiveness of xenobiotic metabolism within model microbial communities. Finally, we will assess the impact of their synthetic plasmids on pollutant biodegradation efficiency in vitro, alongside the impacts of plasmid introduction on the microbial community in a contaminated soil environment.

The project will ultimately lead to a molecular-level understanding of plasmid regulation and its role in controlling plasmid spread and pollutant bioremediation in complex microbial communities. Plasmid regulatory genes are widespread among divergent plasmids in a wide variety of bacterial hosts, suggesting that these genes may control bacterial lifestyle, evolution and horizontal gene transfer in a range of different environmental and clinical environments.

(1) Plasmids manipulate bacterial behaviour through translational regulatory crosstalk
CMA Thompson, JPJ Hall, et al. *PLoS Biology* **21** (2), e3001988

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PERSON PROFILE *2 bullets max per box*	**Essential**	**Desirable**
Education *e.g. degree subject*	Biological sciences degree underway	2.1 or above in first year exams
Specialist knowledge and skills *e.g. course module*	Keen interest in microbiology	Interest in engineering biology and bioremediation
Relevant experience *e.g. lab/research work*		Any laboratory experience, especially molecular biology/microbiology/ biochemistry
Interpersonal and communication skills *e.g. teamwork and record-keeping*	Can work independently, as well as harmoniously as part of a team	Happy to present work to an audience
Additional requirements *e.g. outdoor working*	Enthusiastic Organised Hard-working	Punctual