Title: IMAGINE BioSecurity: Mesocosm based methods to evaluate biocontainment strategies and impact of industrial microbes upon native ecosystems.

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Project Goals: This SFA project task seeks to develop a methodological pipeline that utilizes lab mesocosms to evaluate the integrity of novel biocontainment designs and assess the impact of industrial microbes on native environments. Additionally, we are designing the mesocosms with the aim of simulating the complexity of an environmental escape while still being streamlined and reproducible enough that they can be used to broadly evaluate biocontainment strategies in diverse microbes from different trophic regimes. Findings from these systems will be used to elucidate fundamental principles that drive engineered biosystems in their natural and non-native environments.

Abstract Text: Industrial production microbes and their associated bioproducts have emerged as an integral component of a sustainable bioeconomy. However, the rapid development of these innovative technologies raises biosecurity concerns, namely, the risk of environmental escape. Thus, the realization of a bioeconomy hinges not only on the development and deployment of microbial production hosts, but also on novel biocontainment designs to reduce risk associated with environmental escape. To date, most biocontainment strategies have been largely evaluated in the lab, often in monocultures and under tightly regulated conditions, thus their escape potential has never been thoroughly evaluated under conditions that even begin to recapitulate an environmental escape, where they would face complex microbial communities, a diverse array of resources and metabolites that may influence escape frequency, as well as increased probability of horizonal gene transfer[1]. Here, we are developing methods that utilize soil mesocosms to evaluate the efficacy of novel biocontainment strategies and to assess the impact of production systems upon terrestrial soil microbiome dynamics. This methodological pipeline will allow us to screen a broad range of biocontainment modules in diverse microbes from different trophic regimes via a down-selection strategy that allows for detection of rare escapees, effect of associated bio-products, and impact on native ecologies. To our knowledge these efforts represent a first in-kind testing pipeline of this rigor and will allow for the establishment of a national standard for the assessment of the safety of industrial microbes and their associated bioproducts, accelerating the realization of a secure bioeconomy.

References/Publications

1. Arnolds, K. L. *et al.* Biotechnology for secure biocontainment designs in an emerging bioeconomy. *Curr. Opin. Biotechnol.* **71**, 25–31 (2021).

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