

"What is the key challenge in constructing and engineering microbiomes?"

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Robustness in uncertain environments

Our desire to construct new microbial communities, and manipulate existing microbiomes, has exploded over the last decade. This desire has coincided with, and perhaps been facilitated by, two great strides in science: metagenomics has allowed us to better understand the ubiquity and complexities of microbiomes, and synthetic biology has turbo-charged our ability to engineer biological systems. Advances in both of these areas are needed to make microbiome engineering routine. We need methods that can cheaply elucidate microbiome dynamics over short timescales alongside more comprehensive libraries for engineering community interactions. These challenges are technical and, with some effort, will be overcome.

There is, however, a more complex challenge in microbiome engineering. Whether we want to treat disease with live bio-therapeutics, produce valuable chemicals in a bio-reactor, or bio-remediate polluted ecosystems; the environment is uncertain, yet it is fundamental. Resources flow in and out, are produced and consumed, modified and degraded. Competitors come and go, grow and move and adapt and die. Temperatures change, forces are applied, gases diffuse, and liquids evaporate. While some of this may be predictably periodic, much of it will occur unpredictably in time and space. Although these same challenges are present for monocultures, the environment is an intrinsic part of a microbiome – it is after all the arena within which all interactions are mediated. This uncertainty requires us to adapt our thinking when working with microbial communities. Our designs must be able to bend to external pressures – within reason – and to fail safely and predictably when those pressures are too great.

Declaration of interests

The author declares no competing interests.