Heinrich Heine Universität Düsseldorf

Experimental master's thesis:

Elucidating the mechanisms that control the composition of minimal inter- and intraspecies synthetic bacterial communities

Project leader: St. Elmo Wilken
Institute: Synthetic Microbiology (Axmann Lab), Düsseldorf

Project outline

The overarching goal of this project is to experimentally investigate how metabolic features of minimal synthetic bacterial communities influence their structure and stability. We will investigate this question using already established inter- and intraspecies communities of engineered *Escherichia coli* and *Vibrio natriegens* that are coupled to each other through mutually complementary amino acid auxotrophies, as shown in Figure 1.

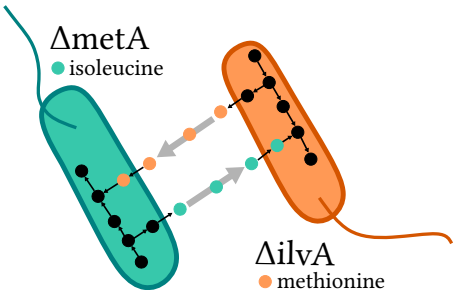

Figure 1: Mutually auxotrophic bacterial co-cultures simplify interaction analysis. ΔmetA cannot produce methionine, ΔilvA cannot produce isoleucine. Only when co-cultured can each strain grow.

Preliminary experimental work shows that the compositions of inter- and intraspecies communities with the same auxotrophic coupling are similar, and highly robust to perturbations. This raises several interesting questions. What factors control the observed composition of the communities? Why is the composition recalcitrant to change? Can we design larger communities using the auxotrophy coupling mechanism? Can this be exploited for biotechnological purposes? By focussing on tractable, minimal systems, quantitative experiments can be used to elucidate the mechanisms governing community dynamics.

In this project, you will learn advanced cloning techniques (Golden Gate cloning, including MoClo and MoCloFlex), genetic engineering using a CRISPR/Cas9 system, cytometry, metabolic engineering, and metabolomics (13C MFA, proteomics). In particular, a novel method will be used to separate the community members, allowing for the measurement of intracellular fluxes and enzyme concentrations in each member, revealing the regulatory basis for the observed community dynamics.

Qualifications

Formal requirements

- Enrolled student (m/f/d) in the Master's Biology or Master's Biochemistry program
- Project internship, project work, and Master's thesis should be completed in this project

Skills

- Basic microbial culturing techniques (yeast, bacteria, etc.)
- General wet lab experience (PCR, pipetting, etc.)
- Familiarity with cloning (advantageous)
- Literature research

Note: if you lack some of these skills, they can be taught during the internship.

Interested? Contact St. Elmo Wilken at wilkenst@hhu.de for questions, or send your CV to apply! Start date: May/June/July/August 2024, open to negotiation.