Karlsruhe Institute of Technology

Bachelor / Master Thesis

Microsystems in Bioprocess Engineering, Institute of Process Engineering in Life Sciences
Karlsruhe Institute of Technology, Fritz-Haber-Weg 2, 76131 Karlsruhe, Germany

Single-cell analysis of growth kinetics in precisely controlled environments

About Us: The "Microsystems in Bioprocess Engineering" group is situated within the Chemical Engineering (CIW) Faculty of the KIT. Our goal is to bridge the gap between microfluidic technologies and bioprocess development. We develop novel microfluidic tools (*e.g.*, single-cell cultivation systems) and apply them to investigate research questions relevant to bioprocessing. Utilizing the acquired knowledge, our aim is to pioneer the development and establishment of new bioprocesses.

Background: Microorganisms live in structured, multi-species networks where interactions and metabolic specialization shape their function. Understanding these interactions is key to optimizing biotechnological processes. Co-cultures and the division of metabolic tasks offer great potential for biotechnological applications, but their efficiency depends on a comprehensive understanding of key performance indicators. To explore these interactions, a synthetic co-culture of *Corynebacterium glutamicum* strains with complementary amino acid auxotrophies is used. Studying their growth behavior under varying environmental conditions, can provide valuable insights into their full biotechnological potential.

Project aim: This project focuses on single-cell growth dynamics, investigating how auxotrophic *C. glutamicum* strains respond to nutrient and pH fluctuations under industrially relevant conditions. Cells are cultivated in femtoliter-sized cultivation channels, enabling to observe single-cell growth under highly defined conditions. The project aim is to explore the influence of process parameters with high spatio-temporal control, revealing microbial growth responses that remain undetected by bulk measurements. The results will enhance the understanding of growth dynamics between partner strains in different microenvironments and their relevance at larger production scales.

Your tasks

- Fabrication of microfluidic cultivation devices
- Sterile cultivation of auxotrophic bacteria
- Microfluidic single-cell cultivation under different cultivation conditions combined with time-lapse imaging
- Analysis, evaluation and interpretation of single-cell imaging data
- For a master project: Image analysis with cell segmentation and single-cell tracking

Your qualification:

- Background in bioengineering, bioinformatics, biotechnology or similar
- Knowledge of microbiological methods, sterile working
- Interest in multidisciplinary research
- Structured, independent and meticulous working method

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