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

Establishment of a cultivation protocol: long-term cultivation of bacterial clusters in a microfluidic system to analyse growth behaviour under different cultivation conditions

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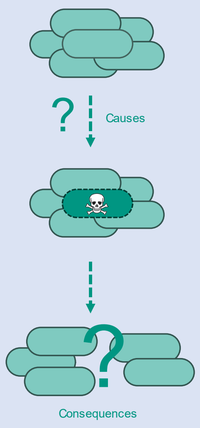
Overview and context of the bachelor or master project

About the overall project:

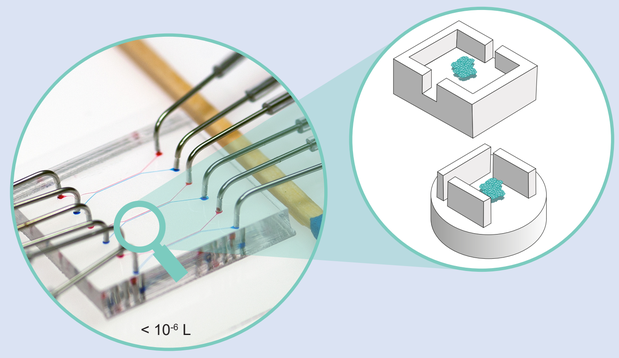
Motivation

The emergence of **multicellularity** was a significant event in the history of life, yet our understanding of it remains limited



- Crucial for the emergence is the **formation of groups** from previously single cells
- These exhibit behaviors such as the **altruistic suicide**
- The knowledge about the **causes and consequences** of this cell lysis are still rudimentary due to a lack of technology
- **Microfluidic platforms** offer promising solutions due to their precise environmental control and high temporal and spatial resolution

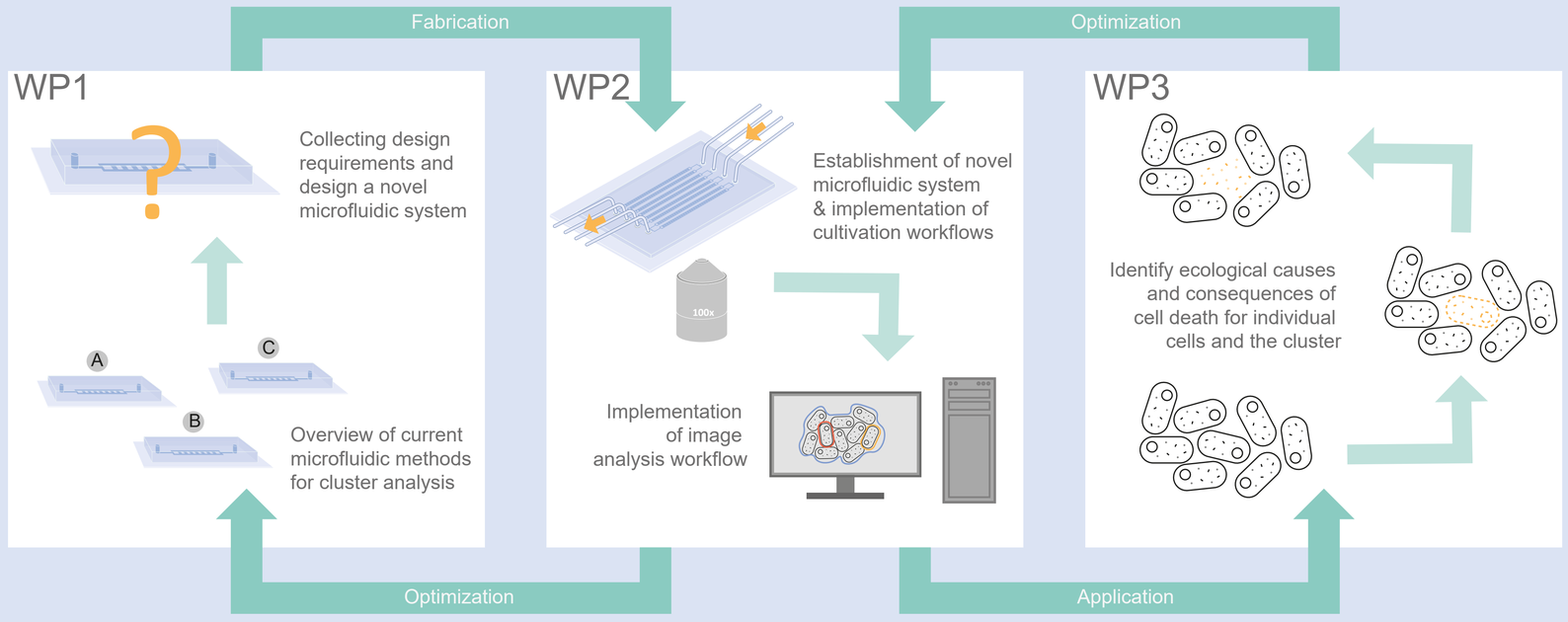
Aim



Development of the **microfluidic cultivation platform** and investigation of the **causes and consequences of the altruistic suicide** in bacterial multicellular groups

Work packages

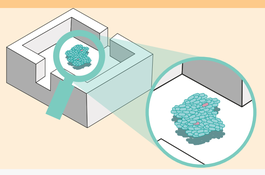
- WP1: **Development of a novel design for the microfluidic platform** to analyse bacteria cell clusters
- WP2: **Development and validation of the microfluidic platform** to quantify the growth and lysis of cells within clusters
- WP3: **Identify the causes and consequences of cell death** with the microfluidic cultivation platform



Positioning of the master‘s thesis in the project:

Further steps in WP1 and WP2

1. **Validation:** Pre-culture management
2. **Validation:** Cell cluster loading and trapping on chip
3. **Validation:** Cell cluster retention on chip
4. **Proof-of-concept:** Cell cluster cultivation on chip



Methods to learn during the master thesis:

Methods

Microfluidic platform
- Softlithography
- Handling and cultivation
- Design of new chips

Microscopy
- Phase-contrast and fluorescence microscopy
- Live cell imaging
- Parallelized and automated image capture

Microbiology
- Sterile cultivation of cluster forming bacteria
- Fundamental microbiological research

Analysis
- Image analysis of microscopic images
- Analysis of growth data

Application

- Apply now!
- Apply with: Curriculum vitae, transcript and proposal start date

Sent application to:
miriam.epping@kit.edu

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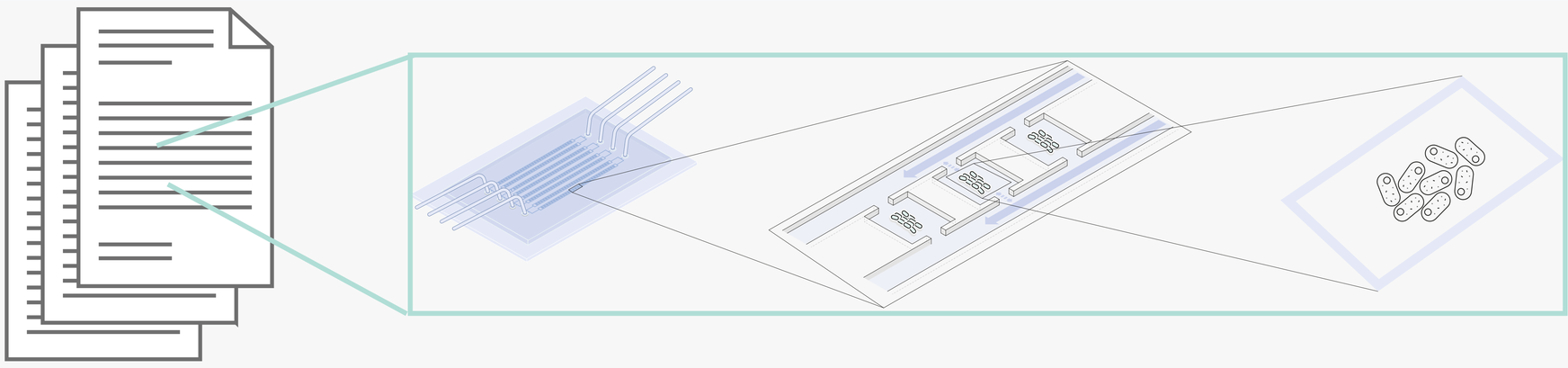
Concrete objectives and work packages of the master project (a bachelor project is less complex!)

Objective

The overall objective of this master's thesis is to develop and validate a reproducible cultivation protocol for bacterial clusters in a microfluidic system. The specific focus will be on pre-culture management, cell loading and cell retention in the microfluidic system. As a proof of concept, the bacterial clusters will also be cultivated under different cultivation conditions in the microfluidic system.



Work packages

Validation of preculture management:

Aim: Development of a reproducible cultivation protocol for the pre-culture management of bacterial clusters
- Ensure control of cluster size via pre-culture management
- Quantitative analysis of the reproducibility of the protocol

Validation of the cell loading of the microfluidic cultivation system:

Aim: To establish a detailed protocol for the successful loading of clusters of different sizes, linked to the cultivation protocol
- Investigation of the loading efficiency of clusters of different sizes
- Implementation of optimisations to increase the loading efficiency
- Quantitative analysis of the reproducibility of the protocol

Validation of cell retention in the microfluidic cultivation system:

Aim: Development of a protocol to ensure cell retention for clusters of different sizes, linked to the cultivation and loading protocol.
- Investigation of cell retention under different conditions.
- Identification and implementation of optimisations to increase cell retention.
- Quantitative analysis of the reproducibility of the protocol

„Proof of concept": Cultivation of the clusters in the microfluidic system:

Aim: Development of a comprehensive cultivation protocol for bacterial clusters in the microfluidic system. Consolidation of protocols for pre-cultivation, cultivation and retention.
- Carrying out cultivations under different and/or changing cultivation conditions.
- Evaluation of the growth behaviour of the clusters, taking into account varying cultivation parameters.
- Derivation of conclusions and identification of potential influencing factors on growth behaviour.
- Quantitative analysis of the reproducibility of the protocol

Expected results

The master thesis will provide a validated cultivation protocol for bacterial clusters in a microfluidic system. The results will provide insights into the growth behaviour of the clusters under different conditions and lay the foundation for future research in the field of microfluidic cultivation of bacterial clusters to investigate bacterial multicellularity.

Your Qualifications

- Background in bioengineering, biotechnology or similar
- Knowledge of microbiological methods
- Interest in multidisciplinary research
- Good written and spoken english skills
- Structured, independent and meticulous working method

Application

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