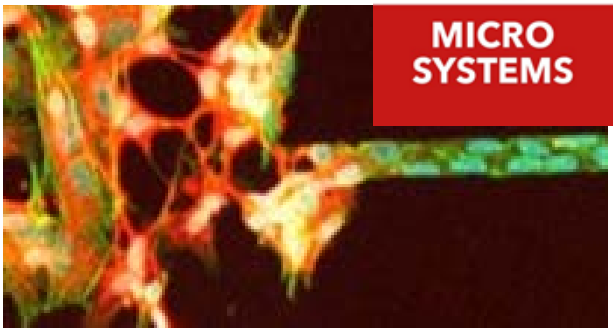
Exploring synergy between design processes in Mechanical Engineering and novel tools in pharmaceutical drug testing industry



Graduation project | Neuro-Nanoscale Engineering

Introduction | neuro-nanoscale engineering

Neuro-Nanoscale Engineering investigates neuro-cellular micro-environments enabled by nano- and microfabrication methods. We invent unique microsystems implementing our novel technologies in so called Brain-on-Chips. The understanding of critical design rules in meeting requirements of *in vivo*-like (neuro) bio-hybrid systems is therefore our focus. One important tangible application area of our research results can be found in the creation of (micro)physiological and clinically relevant drug testing devices for the prevention, relief and cure of neurodegenerative diseases. Beyond such specific solutions for microsystems in biology and medicine, we work on emerging technologies combining Brain-on-Chip (BoC) and Artificial Intelligence (AI).

Fundamental to the design of a BoC is the 4D control (structure & time) at the material interfaces intertwining with the biological processes led by functionality. Neuro-Nanoscale Engineering projects aim to contribute to this field of research by designing, realizing and testing model systems of such microenvironments to observe and elucidate these processes experimentally.

Project | synergies in design processes

Our currently investigated Brain-on-Chips are microsieves, microbioreactors, microtunnel devices and actuator chips (Fig 1a-d) [1-4]. These all contain microfluidic functionals but require different means of handling. To implement these devices in a pharmaceutical drug screening workflow unification of these handling procedures would be an interesting approach in gaining traction in industry. However, our current knowledge of the pharmaceutical design workflows when using design structure matrices is quite limited and it would be helpful to find synergies in the design processes by a careful analysis of the user's requested RPCs for BoC devices to be come the number-one tool to be applied in early stage (neuro)pharmaceutical drug testing applications.

Goal | milestones and achievements

The goals of this project are:

1. Overview of equipment and handling workflows.
2. Analysis of the workflows for BoCs by Design Structure Matrices.
3. Identification of unifying modes of fluidic operation between the different devices and provide advice on the main bottelnecks.

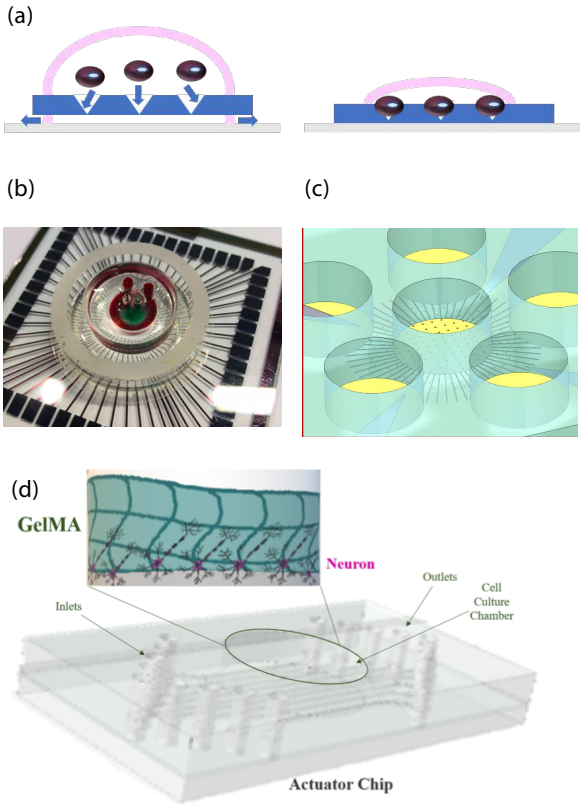


Fig. 1. Overview of BoCs in Neuro-Nanoscale Engineering. **(a)** Microsieve, **(b)** microbioreactor, **(c)** microtunnel device and **(d)** actuator chip

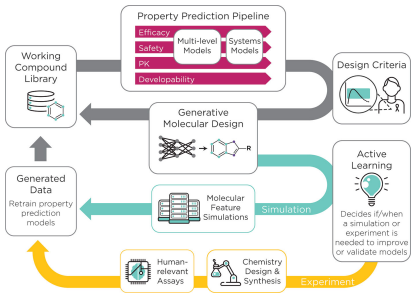


Fig. 2. A preclinical drug discovery workflow

References

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