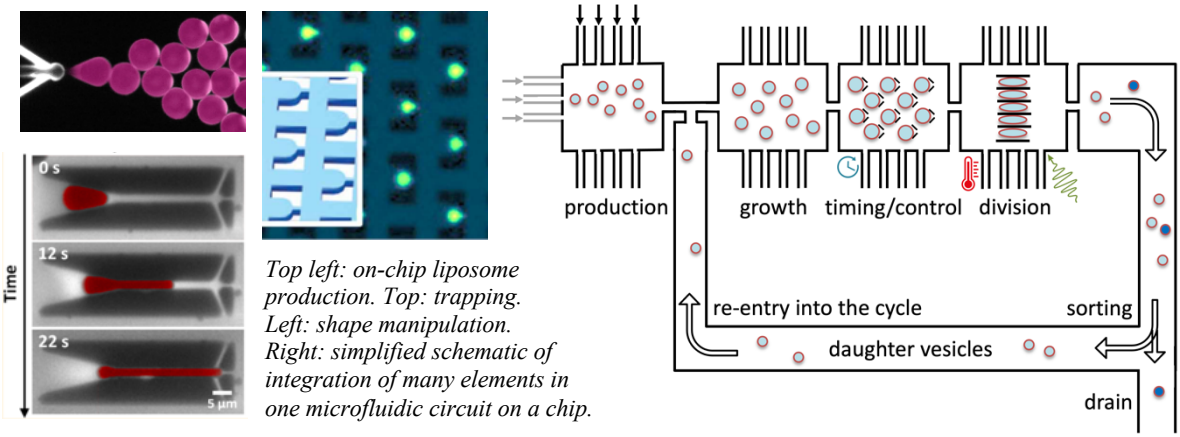
PhD (4 years): Microfluidics for synthetic cells: 'Life on a chip'

Job description:
Can one build a living cell from individual lifeless components? A cell is an extremely complex system made of countless components. We do not know how these interact to form a living cell that sustains itself, grows and divides. The Basyc initiative is an ambitious, collaborative 10-year research program that aims to build an autonomous self-reproducing synthetic cell from the bottom up in order to understand 'how life works'. As a container, we use giant unilamellar vesicles (GUVs), which are cell-sized, lipid bilayer-enclosed reaction compartments that can be visualized by real-time microscopy and directly manipulated using biophysical tools.

This experimental PhD project will focus on the development of an integrated micro/nanofluidics lab-on-chip system that will allow us to engineer the entire life cycle of synthetic cells on chip, from interphase to division. Our ultimate ambition is a cyclic microfluidic circuit, where viable daughter vesicles are selected and fed back into the system for renewed rounds of processing – thus allowing for evolutionary cycles of improvement.



Top left: on-chip liposome production. Top: trapping. Left: shape manipulation. Right: simplified schematic of integration of many elements in one microfluidic circuit on a chip.

Different microfluidic manipulation steps of synthetic cells have already been tested individually, but until now there has been no effort to integrate them in one integrated chip. Integrating different modalities onto one chip will provide new opportuinities but also calls for new approaches to ensure that microfluidic manipulation is matched to the internal timing of the different phases of the cell cycle. Moreover, for automated operation, it will be necessary to incorporate control and decision mechanisms like active valves. You will study microfluidic approaches that will allow us to cycle liposomes from spot to spot across the chip, where at various locations different actions are pursued, such as growth, fusion, mechanical manipulation by shapers or splitters, and temperature- or light-triggered events to trigger shape changes or fission. The device should allow massively parallel imaging of the vesicles during these processes. In the first half of the project, the focus will be on implementing and boosting the technology while in later years the technology will be used in experiments in collaboration with many other PhD students across the Basyc consortium who are developing different biological modalities.

The research environment: You will be co-supervised by Cees Dekker and Gijsje Koenderink and will be embedded in both teams, which are conveniently located in the same department. The Dekker lab is an experimental biophysics lab that explores a range of subjects from nanopore sequencing to chromosome biology, including microfluidics research. The Koenderink lab is an experimental biophysics lab that studies how cellular shape changes during cell migration and division are driven by the cytoskeleton and how cell morphogenesis is influenced by mechanochemical interactions with the extracellular matrix. Both labs are embedded in the TU Delft Department of Bionanoscience, which

focuses on the fundamental understanding of biological processes from molecule to cell. The department features an inspiring and supportive international environment with access to state-of-the art facilities for microfluidics and nanofabrication (Kavli Nanolab), advanced imaging, molecular/cell biology, biochemistry, and high-performance computing for image processing.

Qualifications: We seek an outstanding experimental scientist with a strong affinity for research at the interface of physics, biology and chemistry and with relevant research experience in fields such as microfluidics, device fabrication, fluid dynamics, biophysics, or nanoscience. We are looking for a candidate with skills in microfabrication but also a high level of intellectual creativity and genuine interest in fundamental research. You have a hands-on mentality, demonstrated ability to work in a strongly multi-disciplinary environment, enjoy collaborations, and easily communicate with scientists from different disciplines.

Applications: For submitting your application, please contact Cees Dekker, c.dekker[at]tudelft.nl and Gijsje Koenderink, g.h.koenderink[at]tudelft.nl.
With your application, please send:

- A motivation letter that briefly describes why you apply for this position, your research interests, and your fit to the group.
- A detailed CV.
- Names and email addresses from at least 2 references.

Your application will be reviewed as soon as it is received.