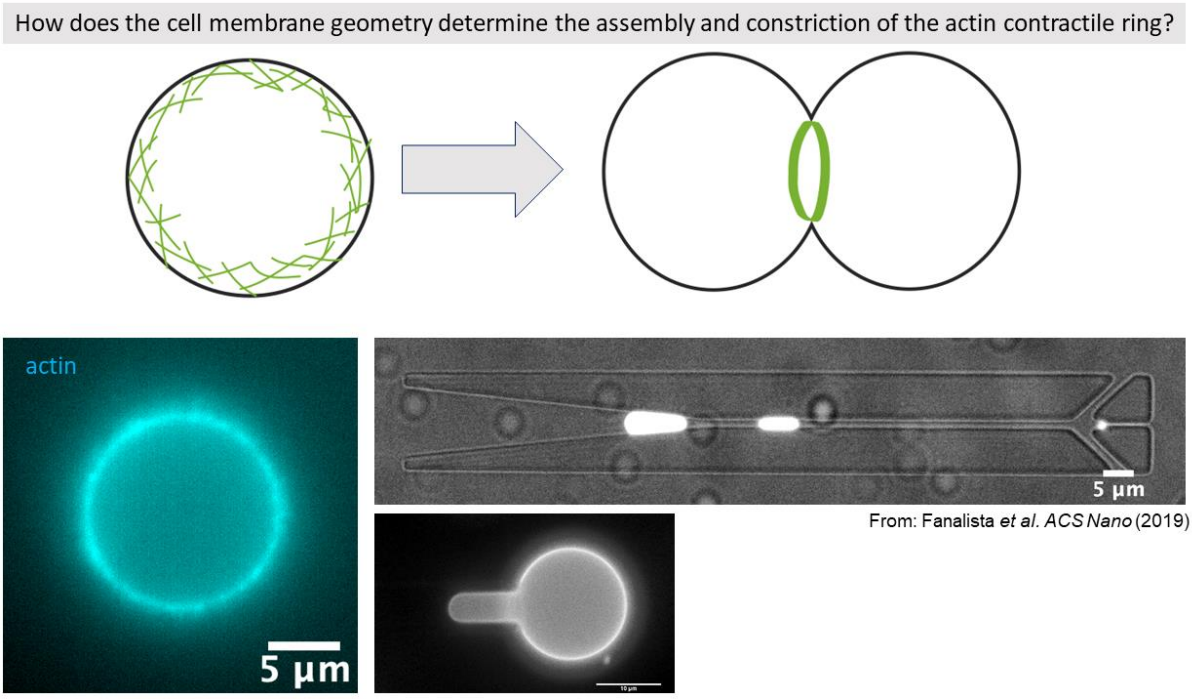
PD position (2 yr): The physics of cell division studied through synthetic cells

Job description:
Cells are the smallest autonomous building blocks of our body. Their shape and mechanics are governed by a delicate force balance between the **plasma membrane** and the **cytoskeleton**, an elastic scaffold of stiff protein filaments. The cytoskeleton mechanically stabilizes the thin and fragile lipid bilayer membrane but also actively drives changes in membrane shape by exerting pushing and pulling forces. A paradigmatic example of this mechanical interplay is the process of **cell division**, which is driven by a contractile ring of actin filaments that constricts the membrane mid-cell. The key structural component is a cross-linked network of actin filaments that is tightly anchored to the plasma membrane and constriction is driven by myosin motor molecules that utilize ATP to slide the actin filaments. Most research till now has focused on the question how force generation by the actin cytoskeleton changes membrane shape.

The aim of this project is to ask the reverse question: **how does the membrane geometry determine the assembly and constriction of the actin ring?** Models suggest that actomyosin ring formation and furrow ingression sensitively depend on the cell geometry and the balance between cortical tension at the cell equator and the poles. Some models predict that contractile ring initiation furthermore requires cooperation with lipids and proteins that promote membrane curvature. To experimentally test these ideas, you will reconstitute **synthetic cells** by encapsulating a minimal machinery required for actin ring assembly inside lipid vesicles and use **microfluidic devices, optical tweezers, and curvature-inducing proteins** to impose a controlled membrane geometry. To measure the dynamic response of the actin and the membrane, you will make extensive use of **confocal fluorescence imaging, FCS, FRAP, and single-molecule imaging**. This project is part of a large Dutch research initiative (Basyc) aimed at building an autonomous self-reproducing synthetic cell. Our team's contribution focuses on the mechanical machinery needed to achieve cell cleavage. Within the team, you will closely collaborate with three PhD students that work on several different aspects of the actin-based cell division machinery.



From: Fanalista *et al. ACS Nano* (2019)

The research environment: We offer an inspiring, supportive and collegial environment. The **Koenderink lab** is an experimental biophysics lab studying the physical principles that underlie the self-organization and dynamics of living cells. We use quantitative physics-based methods that combine advanced microscopy (optical microscopy, EM and AFM) and mechanical probing. We study 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. Our work addresses both fundamental biological questions on cell and tissue morphogenesis and physics questions on the 'active soft matter' properties of living matter. The Koenderink lab is 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, international environment with access to state-of-the art facilities for nanofabrication, imaging, molecular/cell biology, biochemistry, and high-performance computing for image processing. Within the department, we closely collaborate with several other groups on the Basyc project.

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 biophysics, soft matter science, single-molecule techniques, optical microscopy, nanoscience, and/or quantitative cell biology. We are looking for a candidate with 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, and you can easily and effectively communicate with scientists from different disciplines. Candidates who want to seek independent funding for their own research agenda are encouraged to discuss possible options. There are many options, which we can explore together, and the Research Funding team of the TU Delft Valorisation centre can offer support.

Info: contact Gijsje Koenderink, g.h.koenderink[at]tudelft.nl
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https://www.tudelft.nl/over-tu-delft/werken-bij-tu-delft/vacatures/details?jobId=2331&jobTitle=Postdoc%20The%20physics%20of%20cell%20division%20studied%20through%20synthetic%20cells