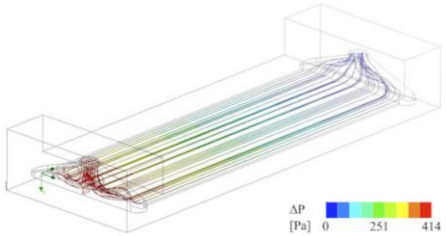
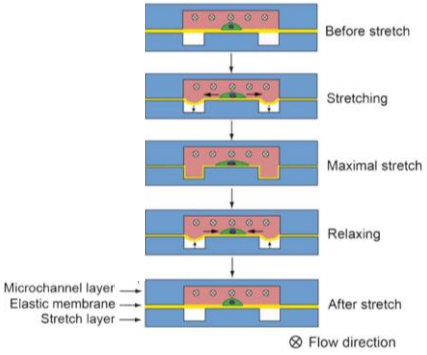
Master Thesis Proposal
CFD Analysis of a Novel Flow-Stretch Bioreactor



Steady Flow in a Flow-Chamber [1]



Envisioned setup of bioreactor [2]

Background
Many cells in the human body show mechanosensitive behavior, reacting e.g. to changes in pressure, shear stress or strain. To investigate responses to shear stress in-vitro, cells are often cultured in flow-chambers that provide distinct wall shear stress (WSS) at certain flow rates, following the law of Hagen-Poiseuille for steady flows.
We want to investigate the response of endothelial cells (EC) to unsteady, pulsatile flows as well as combined flow and stretch. The latter will be realized with a flow-stretch bioreactor similar to the design of Zheng et al. [2]. As the pulsatile flow and, in case of the flow-stretch bioreactor, the moving membrane will change the flow inside the flow-chamber to the point that WSS cannot be estimated analytically anymore, an extensive computational fluid dynamics (CFD) study of these novel conditions is necessary.

Project Goal
In this project, the magnitude and distribution of WSS inside two flow-chamber designs for cell culture is to be investigated via CFD. First, the impact of pulsatile flow in comparison to steady flow should be studied for a common, rigid flow-chamber. Second, the flow and resulting WSS inside the described flow-stretch bioreactor is to be investigated. Both tasks include the setup of a suitable CFD model and analysis of the results. Possible design-iterations to improve the uniformity of the WSS distribution might become part of the project if they prove to be necessary.

You will
- experience the entire process of a CFD design study
- have access to state-of-the-art CFD software and ETH's HPC cluster (Euler)
- benefit from the collaboration within an interdisciplinary project

You bring
- basic knowledge of fluid dynamics
- basic experience with CFD (ideally Star-CCM+)
- the ability to work independently and reliably
- a systematic and methodical approach to problem solving

https://interfacegroup.ch/

Universität Zürich[UZH]

The Interface Group

About us
The Interface Group addresses clinical needs through the convergence of engineering, biological, and medical research. The interdisciplinarity of our projects is reflected in our team and approach to problem solving.
We regard the link between research and education as the key to excellence in training.

Facts
Type: Master Thesis
Start: as of now
Duration: 6 months

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References:
[1] Kriesi, C., et al. (2019). Front. Bioeng. Biotechnol., 7(91)
[2] Zheng, W. ,et al. (2012). Lab Chip, 12, 3441-3450