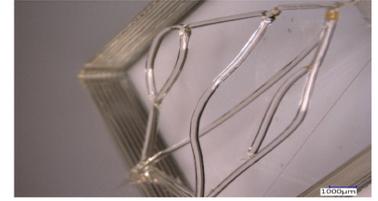


# Blood Vessels-on-a-Chip

MSc thesis theme



## Background

Our blood flows throughout our entire body through the interconnected network of blood vessels that constitutes our circulatory system. This transports oxygen and nutrients to all of our tissues, it provides the distribution system for our immune cells, and it forms a communication channel between organs. The circulatory system also plays a pivotal role in many diseases such as cancer, atherosclerosis, stroke, brain diseases, and so forth. It is, clearly, important to understand the biological, mechanical, and chemical aspects of blood vessels, as well as their interaction with surrounding tissues.

We therefore need good in-vitro models for blood vessel networks. Fig. 1 shows an impression of approaches used up to now, ranging from using engineering-based microfabrication methods to biological self-assembling cellular structures. Our ideal would be to be able to design and engineer the network in a completely controlled manner, but still retain the crucial properties of real blood vessels: their round shape, 3D network structure, diameters from centimeters down to microns, inclusion of actual cells, preferably organ-specific, as well as suitable extracellular matrix. Such a model does not exist yet.

## Project topics

In our group, we are developing methods to reach this ideal in-vitro model. We are focusing on two approaches. The first (illustrated in Fig. 2) uses 3D printing of networks of sugar fibers, which are subsequently embedded in extracellular matrix after which the sugar is dissolved, leaving a perfuseable microfluidic network. Finally, also cells may be seeded for biological relevance. The second method (see Fig. 3) uses a laser to write the perfuseable vessel network in a hydrogel that mimics the extracellular matrix; after this, cells may be seeded in the network. However, much work is still required to reach the ideal model.

MSc projects in this research field mainly focus on the refinement of the microfabrication technology (either sugar printing or laser writing) to enhance the controllability of network design, research into the best ECM mimicking materials, or control an characterization of microfluidic flow. However, also cell culture and (biological) analysis are options.

### References

- [1] Pollet & den Toonder (2020), *Bioengineering* 7, 17.
- [2] Pollet et al. (2020) *Micromachines* 11, 43.

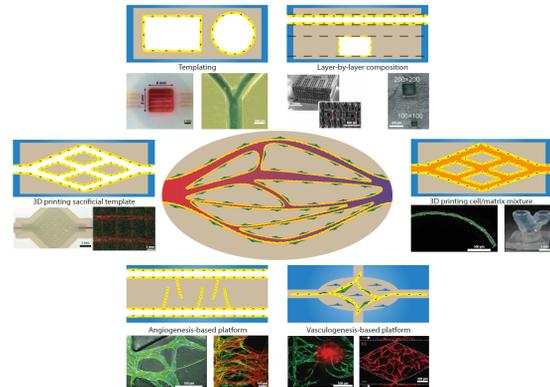


Fig. 1: An impression of different approaches to create an in-vitro model of blood vessel networks, "Vasculature-on-Chip". [1]

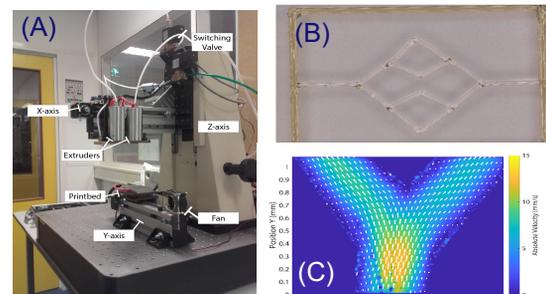


Fig. 2: Sugar printing of blood vessels-on-chip. (A) the sugar printer we specially seigned and built for this; (B) printed sugar glass fiber network; (C) flow measurement in the printed network. [2]

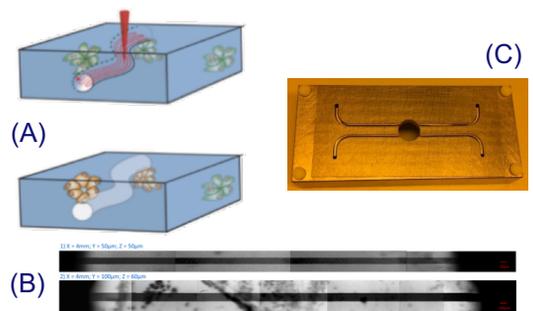


Fig. 3: Laser fabrication of blood vessels-on-chip. (A) The principle: a scanning laser locally ablates the matrix material. (B) We have written straight round vessels with a diameter down to 50 microns. (C) Microfluidic device in which we are going to integrate the written vessels..

