University of Basel
Department of Biomedical Engineering

BIROMED-Lab
Medical Robotics and Mechatronics

# Master Thesis: Machine learning approach for automated assessment of organoid vasculature

**Context:** Organoids are "in vitro miniaturized and simplified model systems of organs [which] self-organize into complex structures" usually derived from stem cells [1]. Since 2009, the organ-on-a-chip approach to synthesising viable non-vascularized small organoids progressed significantly and is currently the most used approach. The method of choice is to grow an organ or organoid in a gel. Most organoid engineering in academic research is carried out manually and is, therefore, labour intensive. The vascularization is critical to nourish cells with nutriments and transport drugs. Methods to generate vascularized organoids have been discovered but the vasculature creation is uncontrolled, manual and poorly understood. Research is currently getting both non-vascularized and vascularized organoid synthesis automated.

This Master Thesis is your opportunity to work on an exciting project, which has an impact on research as well as the pharmaceutical industry.

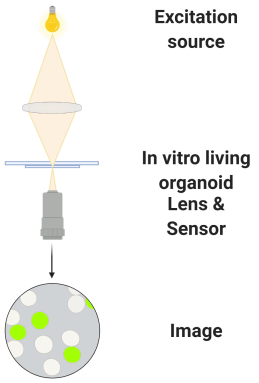


**Figure 1:** Schematic of the fluorescence microscopy principle

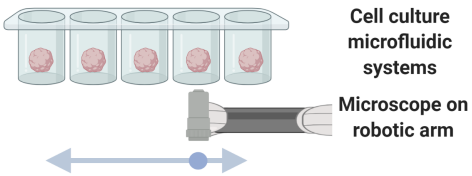


**Figure 2:** Schematic of the microscope robotic-mounted

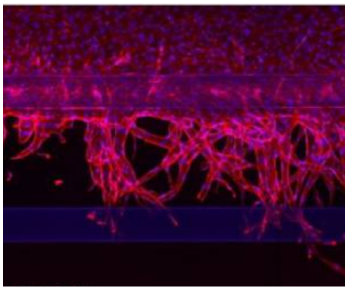

**Figure 3:** Digital microscope image of angiogenesis

**Task description:** We currently perform research with the aim to build a fully-automated organoid synthesis robotic system that takes care of organoids 24/7 and gathers data without disturbing organoids. The robot system includes miniature digital microscope(s) (fig. 1, fig. 2) to allow automating the organoid health assessment.

In this context, you will be responsible for the Machine Learning (ML) package of the vasculature image analysis (fig. 3). You will be provided with sets of unlabelled images from other academic projects and/or unlabelled images from the lab organoids.

**Workpackages:**

- Review the relevant literature on concepts for vasculature analysis (30%)
- Design and test ML algorithm to provide vascularization formation start and completion time detection, vascularisation topology and assessment of perfusability.(70%)

Start: FS 2022 or upon agreement with the student
Duration: 6 months

**Supervision:**
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`https://biromed.dbe.unibas.ch`

[1] M. Hofer and M. P. Lutolf, "Engineering organoids," Nature Reviews Materials, vol. 6, pp. 402–420, feb 2021
fig. 3: V. van Duinen, D. Zhu, C. Ramakers, A. J. van Zonneveld, P. Vulto, and T. Hankemeier, "Perfused 3d angiogenic sprouting in a high-throughput in vitro platform," Angiogenesis, vol. 22, pp. 157–165, 2019.