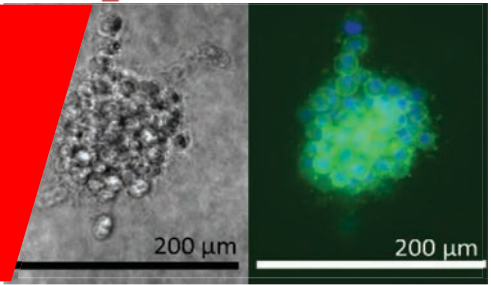


Cancer-on-a-Chip

MSc thesis theme



Background

Most cancer deaths are not caused by the primary tumor, but by secondary tumors formed through metastasis, a complex and poorly understood process. Metastasis consists of a number of sequential steps: (1) invasion, when tumor cells escape from the primary tumor and migrate through the surrounding tissue, (2) intravasation, when the cells enter a blood vessel; (3) survival in the blood circulation so the cells are transported throughout the body; (4) extravasation, i.e. cells moving out of a blood vessel; (5) establishment of a metastatic tumor (Figure 1A). This process is determined not only by cell-intrinsic properties, but also by the properties of the cell-extrinsic factors of the tumor microenvironment, such as (bio)chemical gradients, the mechanical properties and structure of the extracellular matrix (ECM) surrounding the tumor, or fluid flow, stresses or deformations (Figure 1B-E). [1]

In the Microsystems Research Section, we are developing microfluidic devices that make it possible to study these factors in a controlled manner, so that we obtain better understanding of metastasis. These “cancer-on-a-chip” devices may eventually be used to better diagnose cancer patients, or develop new cancer treatments.

Project topics

Our cancer-on-a-chip devices are cm-sized microfluidic chips that contain microchannels and microchambers in which we can culture cancer cells, integrate ECM materials with engineered mechanical properties and geometries, and control microfluidic flow for example to create biochemical gradients or mimic blood vessels. The cancer cell response to a change in these factors can be directly observed using microscopy. Figure 2 shows examples of Cancer-on-a-Chip devices we have developed before in our group. In this research, we closely collaborate with clinical research groups, biological researchers, and companies.

MSc projects in this research field mainly focus on the development of technology, for example chip design and fabrication, integration and engineering of ECM structures, control of microfluidic flow, or mechanical design. However, also cell culture and (biological) analysis are options.

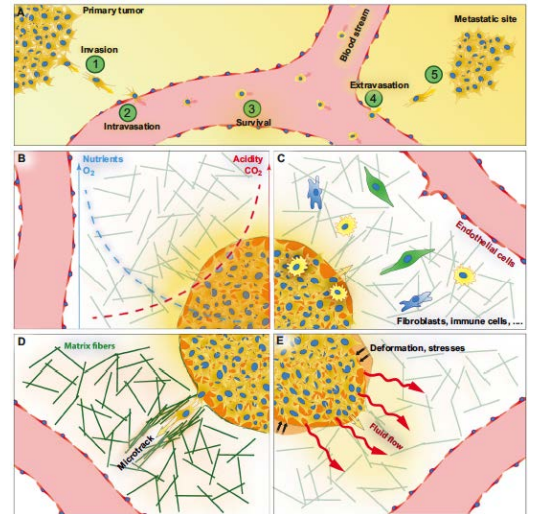


Fig. 1: (A) Schematic of the various steps of cancer metastasis, and the various factors in the tumor environment that play a role in these steps: (B) (bio)chemical gradients; (C) other cells present; (D) structure and mechanics of the ECM; (E) mechanical aspects (flow, stresses, deformations).

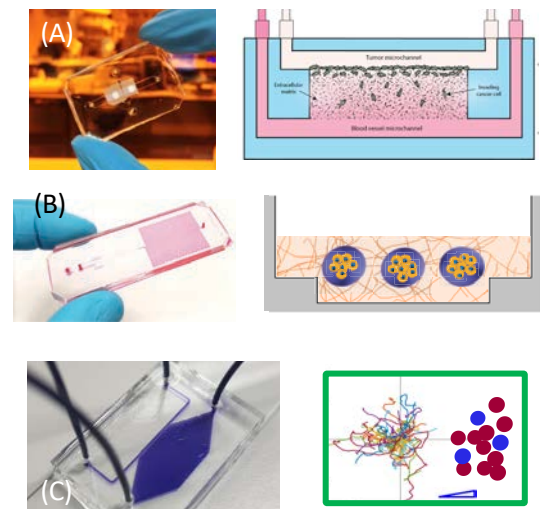


Fig. 2 Microfluidic Organ-on-Chip devices developed in our group. (A) tumor cell invasion & migration chip [2]; (B) 3D breast tumor invasion chip; (C) tumor oxygen gradient chip [3].

References

- [1] Sleeboom et al., Disease Models & Mechanisms, 2018
- [2] Amirabadi et al., Biomedical Microdevices, 2019
- [3] Sleeboom et al., Int. J. Mol. Sci., 2018

