Using Microfluidic Channels to Analyse the Effects of Intravasation and Extravasation on Dielectric Properties of Cancer Cells

Our research proposal aims to develop and utilize microfluidic channels to simulate cancer metastasis in vitro. By mimicking the intravasation and extravasation stages of metastasis, we will analyse the effects of intra- and extravasation on the dielectric properties of cancer cells using electrorotation.

Introduction

Metastasis is responsible for over 90% of cancer-related deaths. It is a complex process involving various cellular and microenvironmental factors. Here we propose a novel method to analyse the effects of intravasation and extravasation on the dielectric properties of cancer cells in microfluidic channels combining microfluidic design and electrorotation, a non-invasive method that probes the electrical properties of cells.

Research Objectives

Our research aims to:

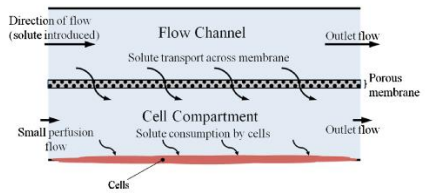
1- Mimic cancer metastasis in vitro using microfluidic channels by recreating the intravasation and extravasation stages of metastasis, we can study the behaviour and properties of cancer cells.
2- Analyse the effects of intra- and extravasation on dielectric properties of cancer cells. We will use electrorotation to measure the electrical properties of cancer cells during intravasation and extravasation.
3- Compare the electrical properties of cancer cells before and after simulated metastasis to understand the changes in the cancer cells' electrical properties and the underlying mechanisms.

Methods and Techniques

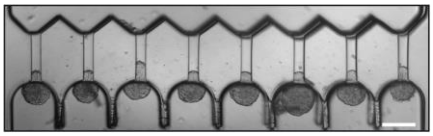
We will use a combination of microfluidic chamber designs and electrorotation to mimic cancer metastasis and measure the dielectric properties of cancer cells. The microfluidic channels will be designed to recreate the microenvironmental conditions of intravasation and extravasation.

Microfluidic Chamber Design

The microfluidic channels will have two compartments separated by a small porous membrane or small passages to mimic the blood-vessel wall.



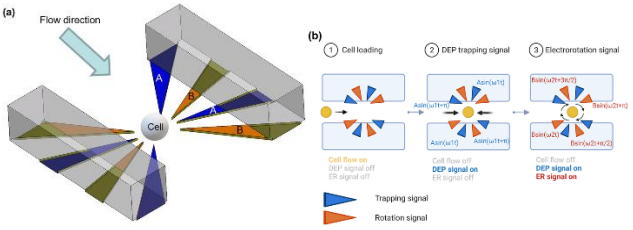
Inamdar et al. Biomicrofluidics 5, 022213 (2011).



Boot et al. Lab Chip, 2023, 23, 1768–1778.

Electrorotation

An eight electrodes system is planned to be used at the second compartment for trapping and rotating the cells.



Li, Y. et al. Biomed Microdevices 24, 23 (2022).

Expected Results

Based on previous studies, we expect to observe changes in the electrical properties of cancer cells during intravasation and extravasation. Specifically, we expect a decrease in dielectric permittivity and an increase in conductivity during these stages, indicating changes in cell membrane structure and the cytoplasmic contents.

References:

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3. Li Y, Huang C, Han SI, Han A. Measurement of dielectric properties of cells at single-cell resolution using electrorotation. Biomed Microdevices. 2022 Jun 30;24(2):23. doi: 10.1007/s10544-022-00621-3. PMID: 35771277.

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