IFJPAN – NTNU

Biomechanical heterogeneity of cancer cells as a parameter for high throughput detectability

Altered deformability of cancer cells is one of the manifestations of oncogenic changes showing its potential to be nanomechanical fingerprints of various diseases. Currently applied techniques working at the single cell level lack of reliable, high-throughput technologies that qualitatively and reliably can detect and evaluate mechanically altered individual cells, in particular in samples characterized by a large degree of heterogeneity as it is in the case of cancer.

The idea of the project is to combine microfluidic approach with selective capturing of cells for enhanced identification of specific population of cells characterized via specific mechanical and adhesive properties. Custom designed microfluidic devices will be used to sort cells floating through the channels choosing cells with defined mechanical properties. Next, these cells will be captured on modified microarray supports, those surface will be coated with specific molecules (lectins or antibodies) characteristic for give cancer stage. Furthermore, their mechanical and microrheological properties will be measured by AFM. As the understanding of the relation between mechanics of suspended, floating and adherent cells require the application of theoretical model developed within our project, the properties of cells will be compared with a model system composed of hydrogel beads of various, tunable mechanical properties. Although AFM-based elasticity measurements have already demonstrated larger deformability of cancerous cells, it should be noted here that their mechanical properties are determined at the steady state conditions, for a flat, nicely spread cells. In microfluidics, floating cells are round, therefore, it is essential to understand the relation between mechanical properties of adherent cells and cells in suspension. So far, there is no direct proof showing to what extent initially larger cellular deformability is preserved in floating cancer cells. Understanding this relation is essential for enhancing the identification of cells by microfluidic devices.

To test the effectiveness of the developed microfluidic device, a few groups of cancer cell lines will be applied, namely human bladder cancer cells characterized by a large deformability, human melanoma cells with smaller deformability differences and pancreatic cancer cells of unknown mechanical relation. Based on the obtained results, we expect that already reported limitations in quantification of cellular deformability, helpful in the comparison of healthy and pathologically altered cells, will be overcome. Through this, a developed microfluidic device will be capable to differentiate/separate specific cancer cell populations in suspension composed of cells characterized by a small deformability difference, thus could be translated and applied in cancer diagnosis, delivering a tool for high throughput and quantitative identification of mechanically altered cells.