Mechanical phenotyping of single cells using shear and inertial microfluidics

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Disease can alter the biological constituents of cells and as such, whole cell deformability can be a marker of disease state. Microfluidics is an appealing technique for mechano-phenotyping due to being high-throughput. Cell viscoelasticity results in a mechano-response dependent on stress, strain-rate and technique. Typically, microfluidics hydrodynamically deforms cells under inertia or shear-dominant stress. Where inertia-dominant regimes show sensitivity to cytoplasmic and nuclear changes [1], shear regimes show more sensitivity to cytoskeletal changes [2]. Here, cells were deformed in a microfluidic extensional flow using both inertial and shear flows, measuring their maximum stretch at a stagnation point. HL60 cells showed different mechano-responses dependent on flow regime [3]. Microfilaments were disrupted using LatA, which showed cell softening in a low-strain shear-dominant regime. Assays were also done using the microtubule disruptor CA4 and chromatin decondenser TSA. Overall, actin had a larger effect on deformability, and nuclear changes were only detectable in a high-strain and inertia-dominant regime. Colorectal cancer cell lines: SW480, HT29 and SW620, were studied as a model for disease progression. Multiparameter analysis was used to classify cells by tracking deformation and recovery, with elastic moduli found using the Kelvin-Voigt model. Results showed that the cells become softer with disease progression. HT29 and SW620 showed incomplete shape recovery, indicating increased plasticity.

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