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Investigating the Connection Between Surface Topography, Cell Membrane and Nucleus Deformation and its Impact on Chromatin Organization and Gene Expression

The field of mechanobiology explores how physical forces and mechanical properties of cells and tissues impact cell development and cell differentiation in health and disease. Physical forces acting on the cell can lead to perturbation of the cell membrane, causing remodeling of the cytoskeleton which can result in reorganization of the nuclear morphology. This is often associated with chromatin reorganization and changes in gene expression. Unraveling the mechanism of mechanical signaling is challenging because it is difficult to study in a controlled manner. Nanofabrication methods enable the generation of precisely engineered surfaces. When combined with advanced microscopy techniques, they can facilitate controlled and systematic studies of the relationships between mechanical forces, nuclear deformation, and chromatin organization. To achieve this we fabricate nanopillar arrays on glass cover slips using electron beam lithography. Through our design we can test three variations of the same parameter within a single experiment, alongside a flat control region for comparison. By seeding cells onto the substrate and allowing them to adhere, we can observe how their interaction with the nanopillars alters nuclear morphology and chromatin organization through advanced microscopy techniques. We will assess the changes in nuclear morphology and look at changes in HP1-α aggregates in the nucleus, which are proteins that are involved in compaction of the chromatin. For future work we aim to include alternative fabrication techniques, which may enable fabrication of more complex surface topography.

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