Tuning cell adhesion and migration via photoactive surfaces

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Abstract

Cells are not only constantly probing chemical and mechanical signals induced by their surrounding matrix, but are also able to respond and adapt to changes in the adhesive environment. Attempts to tailor cellular environments to specific biological and medical functions (scaffolds for tissue regeneration and biocompability of implants) depend on mechanistic understanding of the signalling cues of these cell-matrix interactions.

We have developed and used novel 2D adhesive scaffolds of diverse geometries and tunable adhesiveness to investigate cell adhesion and migration. A unique property of these surfaces is their chemical "switchability"; namely, the capacity to functionalize the surface, at high temporal and spatial resolution using optical de-passivation approach. These "switchable" scaffolds consist of precisely micro-patterned surfaces with "passivated" and gradually "functionalized" regions. After cell plating and in tandem with microscopy-based monitoring, passivated areas can be optically "switched on" and become adhesive, thus enabling local cell adaptation.

Using such experimental tools, we study how cells integrate information of spatially controlled adhesive gradients and how they adapt to them. With the cells exposed to different adhesive patterns we quantify the cells' response, including their migration and polarization. Additionally, we study the hierarchical assembly of adhesion-mediating proteins within the cells, and determine their interactions with the cytoskeleton. We discuss the potential of this new approach to provide new insight into the spatial regulation of cell polarization and migration.