Engineering cell instructive materials: providing cells with commands at the nanoscale

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Engineered materials displaying patterns of biochemical and biophysical signals, proved to exert potent effects on cell behavior, ultimately dictating cell fate and functions [1]. In particular, nanoscale signals including topography, ligand density and availability, along with material stiffness finely control various aspects of cell functions including migration, orientation and differentiation. Material-based signals are transmitted within the cells through a common gate represented by focal adhesion and the cytoskeleton. Their dynamics and assembly ultimately affect gene expression and ultimately cell fate [2]. Here we report systematic evidences that biochemical-topographic-mechanical signals encoded on materials surfaces all affect cytoskeletal assembly and cell generated forces, thus altering the overall cellular and nuclear mechanics. Additionally, the guiding effects produced by material features are not limited to isolated cells as they guide supra cellular self-organization and trigger tissue-genetic events. Materials surfaces specifically engineered to control adhesive events may constitute the foundations of a new generation of biomaterials able to impart specific commands to control complex cell behavior through mechanotransduction pathways. Practical implementations of these findings might be enormous including surface functionalization of prosthesis, new culturing systems to affect stem cell behavior in vitro, in vitro generation of complex tissues for transplantations or drug discovery, development of lab-on-chip devices.

References:
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