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Role of Micro-Patterning on Stem Cell-Material Interaction Modulation and Cell Fate

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Abstract : Micro-contact printing is a form of soft lithography that uses the relief patterns on a master polydimethylsiloxane (PDMS) stamp to form patterns of self-assembled monolayers (SAMs) of ink on the surface of a substrate through conformal contact technique. Here, we adopt this method to print proteins of different dimensions on our biodegradable polymer substrates. We started off with printing 20-500 μm scale lanes of fibronectin to engineer the shape of bone marrow derived human mesenchymal stem cell (hMSCs). After 8 hours of culture, the hMSCs adopted elongated shapes, and upon analysis of the gene expressions, genes commonly associated with myogenesis (GATA-4, MyoD1, cTnT and β-MHC) and neurogenesis (NeuroD, Nestin, GFAP, and MAP2) were up-regulated but gene expression associated to osteogenesis (ALPL, RUNX2, and SPARC) were either down modulated or remained at the nominal level. This is the first evidence that cellular morphology control via micropatterning could be used to modulate stem cell fate without external biochemical stimuli. We further our studies to modulate the focal adhesion (FA) instead of the macro shape of cells. Micro-contact printed islands of different smaller dimensions were investigated. We successfully regulated the FAs into dense FAs and elongated FAs by micropatterning. Additionally, the combined effects of hard (40.4 kPa), and intermediate (10.6 kPa) PA gel and FAs patterning on hMSCs differentiation were studied. Results showed that FA and matrix compliance plays an important role in hMSCs differentiation, and there is a cross-talk between different physical stimulants and the significance of these stimuli can only be realized if they are combined at the optimum level.

Keywords : micro-contact printing, polymer substrate, cell-material interaction, stem cell differentiation
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