Engineering complex tissues that can mimics or stimulates native tissue functions hold enormous promise in treating organ failures resulting from injuries, ageing, and diseases. Our inability to mimicking the complex tissue architecture, providing necessary cellular microenvironment, and communicating with biological entities, are some of the challenges that need to be addressed to control the formation of functional tissues. Designing advanced biomaterials with controlled physical, chemical and biological properties can be beneficial to facilitate the formation of specific functional tissues. Recently, different types of scaffolds are used to control the cell-matrix interactions. Among them, nanocomposite scaffolds are one of the promising candidates as it can mimic physical, chemical and biological properties of most of the tissues. Our lab is developing a range of bioactive and responsive nanocomposites from synthetic silicates and natural/synthetic polymers to promote in vitro differentiation of human mesenchymal stem cells (hMSCs). By controlling the interactions between polymer and nanoparticles, elastomeric soft and mechanically stiff scaffolds can be fabricated to mimic native tissue properties. Moreover, synthetic silicates are highly bioactive and can promote in vitro osteogenic differentiation of human mesenchymal stem cells (hMSCs) in the absence of any osteoinductive factor such as bone morphogenetic proteins-2 (BMP-2) or dexamethasone in 2D and 3D microenvironment. The impetus for introducing this silicate-based nanocomposites for biological applications is due to the urgent unmet needs for bioactive materials for therapeutic applications, in the field of regenerative medicine. We believe that these highly bioactive nanoplatelets may be utilized to develop devices such as injectable tissue repair matrixes, bioactive fillers, or therapeutic agents for stimulating specific cellular responses in bone-related tissue engineering.

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