Integrating 3D Bioprinting and Biologically Inspired Nanomaterials for Complex Tissue Regeneration

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Cells within the human body are in intimate contact with a 3D nanostructured extracellular matrix composed of numerous organic and inorganic components. As a result, one of the revolutionary changes in the field of biomaterials and tissue engineering is to develop biologically inspired nanomaterials and advanced 3D biofabrication techniques to create complex tissue construct mimicking native tissue. However, related studies are limited. As an emerging technique for custom fabricated tissue constructs, 3D bioprinting holds great potential to create highly functional tissues and organs with spatiotemporally organized bioactive cues, desirable patient-specific geometry, and well-controlled architecture. Therefore, the main objective of our research is to develop novel biologically inspired nanomaterials and advanced 3D bioprinting techniques to fabricate the next generation of nano tissue scaffolds for complex tissue regeneration (such as vascularized bone and osteochondral tissues). For this purpose, we designed and synthesized innovative biologically inspired nanomaterials (i.e., DNA based self-assembly nanotubes, nanocrystalline hydroxyapaptes and core-shell nanospheres with bioactive factors). Through 3D printing in our lab, a series of biomimetic tissue scaffolds with nano and micro features were fabricated. Our results show that these 3D printed nanocomposite scaffolds have not only improved mechanical properties but also excellent cytocompatibility properties for enhancing various cell growth and differentiation, thus promising for complex tissue regeneration.