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Micro- and nanoscale technologies for skeletal tissue regeneration

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Reconstruction of complex skeletal injuries due to trauma, infection, or tumor resection is a significant clinical problem. The superior regenerative capacity of autograft bone is related to the secretion of a mixture of cytokines from the autograft cells leading to the recruitment of osteoprogenitor and vasculogenic cells from the surrounding tissue to the injury site and induction of an anti-inflammatory immune response. Further, osteogenesis and vascularization during development are coupled by spatiotemporal regulation of paracrine signaling in which the invading vascular endothelial cells secrete osteogenic morphogens to stimulate cell differentiation and bone formation. I will present nanotechnologies for controlling polarization of macrophages in the process of bone regeneration and healing as well as controlling the spatiotemporal release of morphogens for coupling osteogenesis and vascularization in TE constructs. Degenerative joint disease affects millions of Americans with joint pain and disability. Current treatment methods such as autograft transfer or autologous chondrocyte transplantation rarely restore the tissue to its normal state. The stratified structure of articular cartilage is rooted in the spatiotemporal gradients of morphogens that direct the formation of morphologically distinct cartilage zones. I will present micro- and nanotechnologies for spatiotemporal release of morphogens to stimulate the formation of zonal organization of articular cartilage for a more effective clinical outcome.

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