3D Bioprinting Soft Microrobotic "Niches" for Stem Cell Delivery

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Stem cell therapy holds tremendous promise for treating illnesses by regenerating damaged body tissues. However, no stem cell treatments for cardiovascular, pulmonary, neurological, or orthopedic diseases have obtained FDA approval due to the lack of safe and efficient delivery methods. To address these limitations, the Soft MicroRobotic “nichE” (SMORE) system was developed. This novel approach employs soft motile microbots that mimic the body’s stem cell reservoirs, known as stem cell niches, to precisely deliver high quantities of encapsulated stem cells while promoting cell survival and proper integration into host tissues without adverse effects. SMOREs were 3D-bioprinted from cell-laden ink containing a biocompatible polymer, photoinitiator, magnetic nanoparticles, stem cells, and niche components. Magnetometry determined that the nanoparticles had strong superparamagnetism. Scanning electron microscopy and uniaxial compression tests revealed suitable porosity and mechanical stiffness for supporting stem cells. Cell viability assays showed that both the SMORE material and the bioprinting process are biocompatible. Finally, SMOREs demonstrated injectability and responsivity in navigating through a real-size degenerated intervertebral disc model following external magnetic control. These capabilities allow successful delivery of stem cells to target sites, while the SMOREs’ porosity, elasticity, niche mimicry, and biocompatibility permit improved control over stem cell integration, proliferation, and differentiation. As such, the SMORE system exhibits significant potential for overcoming the primary obstacles to efficient cell delivery, offering a pathway towards highly effective stem cell therapies that can ultimately transform the treatment of countless diseases.

Awards Won:
China Association for Science and Technology (CAST): Award of $1,200