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Protein Engineering of Multi-functional Biomaterials for Regenerative Medicine

Stem cell transplantation is a promising therapy for a myriad of debilitating diseases and injuries; however, current expansion and transplantation protocols are inadequate. My lab designs biomaterials to overcome these challenges using biomimetic, protein-engineering technology. By integrating protein science methodologies with simple polymer physics models, we manipulate the polypeptide chain interactions and demonstrate the direct ability to tune the material properties including hydrogel mechanics, cell-adhesion, and biodegradation. These materials have allowed us to identify matrix remodeling as a previously unknown requirement for maintenance of stemness in neural progenitor cells within 3D expansion systems. Through a series of *in vitro* and *in vivo* studies, we demonstrate that protein-engineered hydrogels may significantly improve transplanted stem cell retention and regenerative function. Furthermore, many of the lessons learned about designing injectable biomaterials can be extended to design new bio-inks for 3D printing applications. While 3D printing has enormous potential for tissue engineering, few bio-inks are currently available to facilitate the printing of complex, cell-laden constructs. We demonstrate the design of customizable bio-inks that enable the printing of multiple cell types into distinct geometric forms.