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Synthetic Eukaryotic Cells / Stem Cells

Engineering Bioactive Niches to Control Stem Cell Function

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Abstract:
Stem cells have been isolated from a number of natural niches, ranging from embryos to a variety of adult tissues. Furthermore, these stem cells have been demonstrated to have the capability to differentiate into numerous cell types. However, the environmental signals that control stem cell self-renewal and differentiation must be better understood before these cells can be harnessed for therapeutic application. We have identified numerous signals that regulate the proliferation and differentiation of stem cells of the adult nervous system, which continually divide and generate new neurons throughout human life. Furthermore, we have made progress in developing a quantitative, molecular understanding of the mechanisms by which these signals exert control over stem cell function. The next goal is to apply this basic biological information to develop systems to optimally control stem cell function, since the robust and reproducible isolation, culture, and control of viable, multipotent stem cells is a major challenge in regenerative medicine. In an effort to design synthetic equivalents of endogenous regulatory signaling molecules, we have attempted to control stem cell proliferation and function by developing biomimetic polymer scaffolds. These synthetic scaffolds are decorated with bioactive motifs that we have successfully engineered to control the self-renewal and/or differentiation of stem cells in vitro and potentially in vivo. The development of such synthetic, bioactive stem cell niches has significant promise for the development of controllable therapies for numerous diseases, including Parkinson's and Alzheimer's therapy.