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Engineering chondrogenic niches for tissue engineering applications

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Mature articular cartilage has very limited ability to self-repair after injury or disease. The cellular microenvironment plays a crucial role in directing proliferation, adhesion, metabolic and catabolic activities of cells. Cells interact with their microenvironment via membrane receptors that recognize changes in the extracellular matrix, oxygen levels, mechanical stimuli and small molecules. The aim of this work was to engineer 3-dimensional (3D) niches which will improve conditions for cartilage tissue engineering applications such as autologous chondrocyte implantation (ACI). To achieve this goal we designed microenvironments that mimic the proteoglycan or the type II collagen component of cartilage. The proteoglycan mimetic 3D microenvironment was achieved using sulfated alginate hydrogels while collagen was mimicked by incorporating GFOGER peptides in a polyethylene glycol (PEG) hydrogel. We observed that sulfation of alginate induced cell proliferation while maintaining the chondrogenic phenotype of 3D encapsulated chondrocytes. Moreover, interactions of human mesenchymal stem cells with the triple helical collagen mimetic, GPC(GPP)5-GFOGER-(GPP)5GPC-NH2, and the fibronectin adhesion peptide, RGD, were studied in degradable or non-degradable PEG gels. GFOGER-modified degradable gels induced the highest cell proliferation and were the most chondrogenic of the investigated conditions. To conclude, the cell microenvironment can be engineered to induce cell proliferation, maintain the cartilage phenotype of chondrocytes and promote chondrogenic differentiation of stem cells. The results of this work provide insight into several crucial aspects of the microenvironment and should lead the way to the discovery and application of novel promising materials, for repair and regeneration of cartilage lesions.

Biography

Rami Mhanna received his BE in Computer and Communications Engineering from Notre Dame University (Zouk Mosbeh, Lebanon) in 2006 and his MSc in Biomedical Engineering from The University of Melbourne (Melbourne, Australia) in 2008. He pursued his Doctoral studies in the Biosensors and Bioelectronics and the Cartilage Engineering and Regeneration labs at the Swiss Federal Institute of Technology (ETH Zurich, Switzerland). He defended his PhD in 2013 and is currently a Postdoctoral fellow in the 3B's group. His research is focused in the fields of tissue engineering and drug delivery where he utilizes biomimetic microenvironments for tissue engineering applications.

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