Sayantani Basu

KU THE UNIVERSITY OF KANSAS
Chemical & Petroleum Engineering

Comprehensive Exam Presentation

Ph.D. Chemical and Petroleum Engineering

"Injectable hydrogels based on in vitro derived extracellular matrix for bone regeneration"

Abstract

Stem cell adhesion, proliferation and differentiation are strictly regulated by the surrounding extracellular matrix (ECM), which is a complex and dynamic microenvironment enriched with bioactive molecules and proteins. Decellularization of tissues and organs is one of the most common routes to generate ECM based materials for tissue engineering applications. Despite its immense potential, strategies based on organ derived ECM display limited control over the final ECM composition with poor reproducibility from batch to batch. This issue is caused by the inherent variability of the native tissue source or the specific method of decellularization used to obtain the ECM.

A more promising alternative is represented by ECM from in vitro cultured cells, where stem cells are cultured in controlled media conditions to obtain ECM with defined chemical and biological properties. Based on this concept, we propose the development of in vitro ECM derived injectable hydrogels with osteogenic and angiogenic properties to promote bone regeneration. Our hypothesis is that the combination of both types of ECM will support the osteogenic differentiation of stem cells while promoting endothelial cell proliferation and their organization into blood vessels. The ECM will be obtained in vitro by culturing and decellularizing human bone marrow derived stem cells (hBMSCs) undergoing osteogenic and angiogenic differentiation. The ECM based injectable hydrogel will be fabricated by forming reversible imine linkages between the aldehyde groups of oxidized alginate, which will act as a multifunctional crosslinker, and the amine groups present in the ECM proteins. The dynamic nature of these bonds will provide shear thinning as well as self-healing properties to the crosslinked hydrogel network. The physical and rheological properties of the hydrogel will be thoroughly investigated to identify the optimal concentration of oxidized alginate required to form shear-thinning hydrogels that can be injected in a bone defect site while maintaining their structure upon removal of the applied stress. Similarly, we will test the potential of the hydrogels to induce in vitro osteogenic and angiogenic differentiation by assessing the expression of osteogenic and angiogenic markers in hBMSCs cultured in the presence of the ECM based hydrogels. Finally, we will evaluate the in vivo osteogenic potential of the formulated hydrogels by delivering them in rat cranial defects to promote bone regeneration. Assessment of the inflammatory response, bone regeneration and blood vessel formation will be necessary to validate their use in bone tissue engineering. Ideally, the presence of both osteogenic and angiogenic factors in the ECM should lead to a complete bone healing response with sufficient vascularization in the defect region. If successful, this type of ECM based injectable hydrogels could be used for bone tissue engineering applications and be a valid replacement to existing therapies based on bone allografts.

Date/Time

Tuesday, May 14th

Starts at 2:00PM

(Stay for the 20-30 minute presentation, but you will be asked to leave during committee questions)

Committee Chair:

Arghya Paul

Location

G535 LEEP2