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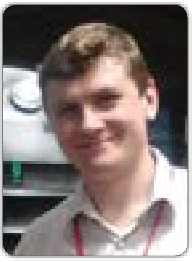

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Cryogel based on polyelectrolyte complex for growth factor delivery

Bone regeneration is one of the most actively researched fields of regenerative medicine and bone fractures are the most common injuries of all large organs, especially in the aging population. Critical size defects require large-scale surgical interventions and auto-grafting is accepted as the gold standard treatment due to its osteogenic, osteoconductive and osteoinductive potentials. Issues such as a shortage of allografts, rejection issues and associated pain and morbidity from autografts require the development of alternative tissue engineering approaches that combine the principles of engineering and biology to create biomaterials, which are able to mimic or regenerate functionally active tissues. In this study a variety of natural polymer-based macroporous materials (biomaterials) were developed. Cryogels composed of chitosan (CHI), hydroxyapatite (HA), heparin (Hep) and polyvinyl alcohol (PVA) were prepared cross-linked by glutaraldehyde (GA) and treated with glycine. Addition of PVA into the reaction mixture slowed down the formation of a polyelectrolyte complex (PEC) between chitosan and heparin, allowing proper mixing, and producing to homogeneous preparation. Freezing of the CHI-HA-GA and PVA-Hep-GA mixture led to the formation of a non-stoichiometric PEC between opposite charged groups of CHI and Hep, which makes further efficient immobilization of bone morphogenic protein 2 (BMP-2) possible, due to electrostatic interactions. It was shown that the obtained cryogel matrix, loaded with BMP-2, stimulates the differentiation of rat BMSCs into the osteogenic lineage. Rat BMSCs attach to cryogel loaded with BMP-2 and express osteocalcin *in vitro*. Obtained composite cryogel with PEC may have a high potential for bone regeneration applications. In our future work, we plan to demonstrate the clinical efficacy of prepared cryogel for bone regeneration in an animal model. The following work is devoted to exploration of similar PEC and other biocompatible scaffolds for efficient attachment, migration and differentiation of BMSCs into chondrocytes for efficient regeneration of intervertebral disc.

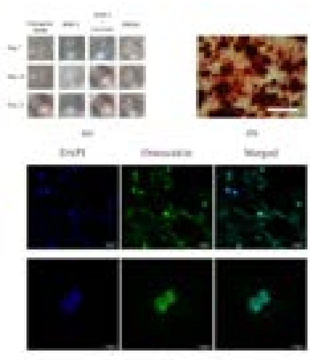

Figure: CLSM micro images of Rat BMSCs growing on cryogel stained with DAPI (blue) and anti-osteocalcin antibodies (green).

Recent Publications

1. Ahsan S M, Thomas M, Reddy K K, Sooraparaju S G, Asthana A and Bhatnagar I (2018) Chitosan as biomaterial in drug delivery and tissue engineering. International Journal of Biological Macromolecules 110: 97-109.
2. Akilbekova D, Shaimerdenova M, Adilov S and Berillo D (2018) Biocompatible scaffolds for regenerative medicine. International Journal of Biological Macromolecules 114:324-333.
3. Garcia-Gareta E, Coathup M J and Blunn G W (2015) Osteoinduction of bone grafting materials for bone repair and regeneration. Bone 81:112-121.
4. Berillo D, Elowsson L and Kirsebom H (2012) Oxidized dextran as crosslinker for chitosan cryogel scaffolds and formation of polyelectrolyte complexes between chitosan and gelatin. Macromolecular Bioscience 12(8): 1090-1099.

Biography

Berillo Dmitriy has completed his PhD in organic chemistry at KazNU al Farabi (Almaty, KZ) in 2010. He was a visiting PhD student and then postdoctoral researcher at the Biomaterials and Biosensors groups at Lund University (Sweden) in 2008-2009 and 2010-2014, respectively. He has worked as a Senior Researcher in the Laboratory of Biosensors and Bioinstruments at Nazarbayev University (KZ). He was awarded Marie Curie Research Individual Fellowship in 2016, and he had successfully accomplished the project at the School of Pharmacy and Biomolecular Sciences at the University of Brighton (UK) from 2016 to 2018. Since 2018 he is a Senior Researcher in Sensor Group at Aarhus University (Denmark). His research interest in preparation of scaffolds for water purification from toxic pollutants and for regenerative medicine for example the study the differentiation of stem cells into osteoblasts within a novel biocompatible scaffold with immobilized growth factor. He designed cryogels preparation based on noncovalent interactions: Polyelectrolyte complexes; self-assembly of Fmoc-diphenylalanine under cryoconditions; scaffolds based on non-covalent interactions such as metal-polymer coordinated complexes etc.; enzymatically cross-linked proteins under cryoconditions, stimuli-responsive cryogels.

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