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Cryogel based on polyelectrolyte complex for regenerative medicine

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Abstract

Bone regeneration is one of the most actively developing fields in regenerative medicine. Broken bones are the most common injuries of all large organs atituded to the older population. Large size defects require large-scale surgical interventions is the gold standard of treatment because of its osteogenic, osteoconductive and osteoinductive potentials. There are problems in recovery due to a shortage of allografts, rejection, and associated pain and morbidity from autografts demand the design of alternative tissue engineering methods which consists of the principles of engineering and biology to create biomaterials, which are able to mimic or regenerate functionally active tissues. In current inverstigation a number of natural polymer-based macroporous materials (biomaterials) were prepared. Macromolecular hydrogels consists of of chitosan(CS), hydroxyapatite(HydrApp), heparin(Hep) and polyvinyl alcohol(PVA) were prepared using different cross-linking agents, where unreacted aldehyde groups were blocked by glycine. Addition of PVA into the reaction mixture slowed down the formation of a polyelectrolyte complex(PEC) between CS and Hep, allowing proper mixing, and resulting in homogeneous solution. Freezing of the CS-HA-GA and PVA-Hep-GA mixture led to the formation of a non-stoichiometric PEC between opposite charged groups of CS and Hep, that allow further effective adsorption of bone morphogenic protein 2 (BMP-2) possible. It was exibited that the obtained cryogel matrix, loaded with BMP-2, stimulates the differentiation of rat BMSCs into the osteogenic lineage. Rat BMSCs immobilised to cryogel loaded with BMP-2 and express osteocalcin in vitro.

Conclusion & Significance: Obtained composite cryogel may have a high potential for bone regeneration applications. Currently we are working on optimisation of chemical composition of composite cryogel without of use of covalent crosslonking, in order to regulate biodegradation rate. We plan to show the clinical efficacy of prepared cryogel for bone regeneration in vivo. We will explore similar PEC systems and other biocompatible scaffolds for efficient attachment, migration and differentiation of BMSCs into chondrocytes for efficient regeneration of intervertebral disc.

Biography

Dr Dmitriy Berillo obtained 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 worked as a senior researcher in the Laboratory of Biosensors & Bioinstruments at Nazarbayev University(KZ). He was awarded a Marie Curie Research Individual Fellowship in 2016, and he had successfully accomplished the project at the School of Pharmacy & Biomolecular Sciences at the University of Brighton (UK) (Sept. 2016-2018). November 2018 October 2018 he has beed working as a senior researcher in Sensor Group at Aarhus University(Denmark). His research interests are the 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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