Engineered nano bioactive materials for directed multi-dimensional cell alignment and differentiation

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Background: The design and development of novel biomaterials scaffolds for regenerative medicine is the key and hot topic in the field of materials engineering. Smart biodegradable scaffolds as bioactive extracellular matrix (ECM)-mimetic environments can significantly improve cell behavior and promote tissue repair and reconstruction. Micro/nano-scale topographical cue is one of major influencing factors on cell/tissue regeneration since the topographical structure is highly organized and can guide cell alignment and elongation.

Methods: Based on the understanding of tissue engineering principle the present paper reports a novel bioactive and absorbable surface: 3D nano pattern using poly(L-lactide-co-glycolide)/collagen by nano imprinting technique. In order to compare the influence and bioeffects of scaffold surface on cell behavior, PC 12 nerve cells were seeded on nano patterned topographical scaffolds (various size parameters: depth, and width).

Results: AFM and SEM images show topographical nano patterned surface and neuron grows on the scaffolds . MST assays demonstrate a increase in the proliferation rate during 5 days cell culture. Moreover, the morphology of PC 12 and orientation and elongation is significantly different on patterned or non-patterned surface. Cells distribute randomly on flat film/non-patterned surface, while on the aligned/patterned scaffolds, more than 70% of PC 12 cells disperse ± 20° of the topographical orientation.

Conclusions: Bioactive physiologically aligned architectures were designed and developed to achieve successful regulation and differentiation of nerve cells in vitro. We studied favorable environments that induce cell alignment and elongation for neuron by combining nano-scale patterns. The fabricated system can serve as a novel multi-dimensional scaffolds for tissue engineering and regenerative medicine. In particular, it is also a platform to provide suitable topographical cues in cell culture systems for cellular orientation control and study cell behaviors in vitro.

Keywords:, biomaterials, engineering, topographical cue, neuron, nano pattern