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3D MULTI-SCALE SELF-ORGANIZED PATTERNS MADE OF HYDROXYAPATITE FOR CELL CULTURING

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Abstract. Understanding the formation mechanism of biomimetic hydroxyapatite under physiological conditions is very important for the insight into self-organization processes in nature and biomineralization. Hydroxyapatite is precipitated for the first time in the agar gel matrix via single-diffusion gel growth technique to aggregate inorganic Liesegang rings. The concentrations of the inner and outer electrolytes, as well as pH and temperature effects on the morphologies, periodicity, stability, and number of Liesegang rings (LRs) have been studied.

Introduction. Nowadays, developing of bioinspired functional materials made of molecular building blocks across length scales is of interest. There are numerous examples of periodic structures and materials displaying outstanding properties in nature. The unique properties and functionality of these materials arise from their specific hierarchical structure (i.e. nacre, bone, etc.) and possess distinct structural organization at different length scales. Therefore, understanding the formation mechanism of periodic structures is important for the insight into self-organization processes in nature and for fabricating natural mimetic materials with controlled periodic patterns.

Main part. We report a novel method of 3D multi-scale self-organized patterns made of biomimetic hydroxyapatite (HA), the main inorganic constituent of bones, in agar matrix. The biomimetic synthesis of HA with bone-like morphology occurred under physiological conditions using agar hydrogel matrix. Our model system involves gradual ion diffusion and phase transitions of calcium phosphates. The hydrogel network is an excellent system to study crystallization as agar gel prohibits sedimentation of the formed precipitates preventing the other hydrodynamic effects which could be induced by the sedimentation. The concentrations of the inner and outer electrolytes, as well as pH and temperature effects on the morphologies, periodicity, stability, and number of LRs have been studied. The biocompatibility of HA LRs obtained via the biomineralization-inspired crystallization process was studied by investigating its influence on C2C12 cell growth revealing a unique effect of cell tissue formation on the HA rings repeating the rings growth pattern. In addition, the cell density is about 30 times higher on the HA rings compared to the agar gel taken as a control. Besides, the cells prefer to attach and grow directly on HA patterns and around the LRs. Whereas cell density on agar and on the place between the rings is much lower.

Conclusions. This method can be prospective for generation of 3D gradient materials generation for studying the interface tissue engineering, systematic cell-biomaterial interaction, as well as for fabrication of the stimuli-responsive gradients to control/mimic migration of cells during the wound healing.

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