59. Nanotools

59.P01
Application of the nanoprobes derived from carbazole diiodide for detecting cell transformation

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The plastic nature renders cells to be changed by external stimuli. Multistep and multifocal processes are required for cell transformation. To establish a method for detecting cell transformation significantly benefits cell lineage tracing, cell identification, and cancer therapeutics. We developed a novel fluorescent nanoprobe, 3,6-bis(1-methyl-4-vinylpyridinium) carbazole diiodide (BMVC) to detect cell features of transformation and differentiation. BMVC probes can bind to quadruplex DNA structure and have been successfully used for differentiating cancer from normal cells. It can also distinguish stem cells from differentiated cells in various cellular types. It can be applied to living cells, and its signals are easily identified by conventional fluorescent microscopy. In this study, several cell transforming models were used to evaluate the utility of BMVC nanoprobes. These transformed cells demonstrated various alterations both in morphological phenotypes and subcellular organization. When BMVC probes were applied, the number of BMVC-positive cells increased in accordance with the changes of the transformed cells. The ratio of BMVC expression was correlated with the foci formation, increased cell motility, cell proliferation and apoptosis, anchorage-independent growth, and increased invasiveness. These results provide evidence of the potential of BMVC nanoprobes, and show the possibility of BMVC probes to be applied to monitor cell transformation.

59.P02
Self-assembled microcapsules with tunable and sustained release of macromolecules for tissue engineering

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Layer-by-layer (LbL) has been presented as a tool capable of constructing tunable and sustained release reservoirs for therapeutic and proliferation/differentiation agents. We report the conception of biocompatible stimuli-responsive microcapsules fabricated using LbL containing BSA as model protein. The capsules were constructed by the sequential adsorption of chitosan and a temperature-responsive elastin-like recombinamer (ELR) containing RGD into self-assembled layers and onto inorganic CaCO3 microparticle templates. By increasing the temperature (25–37°C), a considerable shrinking was observed (5.5–3.2 μm) as well as higher retention of the encapsulated BSA. Such variations were observed for the first time at a relevant physiological temperature, contrary to similar LbL systems requiring temperatures ranging 50–70°C. Different number of bilayers allowed tuning further the permeability: more layers resulted in a more effective barrier to the protein diffusion. Cell viability tests using L929 cells also demonstrated the non-cytotoxicity of these structures. The developed nanostructured reservoirs exhibited tunable and sustained permeability by simply varying the temperature and the number of layers. Exploiting both permeability mechanisms, it would be possible to control the release not only of a pharmaceutical in traditional drug delivery applications but also of agents in tissue engineering that influence the proliferation and differentiation of cells.

59.P03
Enhanced mesenchymal stem cell chondrogenesis using controlled nano-topography patterned on polycaprolactone scaffolds

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While previous reports have shown the importance of matrix materials and soluble factors on MSC chondrogenesis, the influence of nano-topography environment, which have been known to exert a critical effect on cell proliferation and differentiation in-vivo, have not been investigated in the chondrogenic differentiation of mesenchymal stem cells (MSC). In this study, we carried out a systematic study on the influence of nano-topographic matrix material (chondroitin sulfate) on MSC chondrogenesis. Distinct spatially-controlled nano-topography in the form of nano-pillar, nano-hole and nano-grill structures were directly patterned onto polycaprolactone (PCL) film acting as scaffold, followed by surface coating with chondroitin sulfate (CS). The effect of nano-topography on cell-proliferation, cell morphology, cell elasticity, F-actin distribution and chondrogenesis differentiation were studied and compared against non-patterned PCL film. Our results indicate that nano-topography, especially nano-pillar and nano-hole, exerted a significant enhancement on MSC chondrogenesis which corresponded to specific change in cell morphology and cytoskeleton reorganization and increased cell stiffness at early stage, compared to other topographic surfaces. This study indicates the sensitivity of MSC differentiation and development to surface topography and highlight the importance of incorporating topographical design in scaffolds for cartilage tissue engineering.

59.P04
Hepatocyte behaviors on single-walled carbon nanotubes

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Nanomaterials, such as nanoparticles, nanofibers, and nanotubes, advocated as useful material for cell scaffolding that mimics tissue architecture. Especially, carbon nanotubes (CNTs) have attracted attention as one of the most useful scaffolds for biological and medical applications due to their unique structural, electrical, and mechanical properties. In this study, we focus on the morphological and functional behaviors of

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