Designer Gels for Cell Culture & Bioprinting Applications

Biogelx is a biomaterials company that designs tuneable peptide hydrogels, offering artificial tissue environments for a range of cell culture applications. These highly tuneable, cell-matched biomaterials are three dimensional (3D), 99% water and have the same nanoscale matrix structure as human tissue, tuned to meet the needs of any given cell type. The ability to precisely control the mechanical & chemical properties of these hydrogels is creating new opportunities in the fields of 3D cell culture, cell-based assays, cancer cell research, regenerative medicine, and bioprinting.

Hydrogels Tuned to Match Tissue Environments

The chemical and physical properties of the hydrogels can be tailored to meet the needs of specific cell types, thereby enabling the study and manipulation of cells in a more realistic (in vivo-like) 3D environment that is simple, fully defined and tuneable. The products unique cell-matching capabilities clearly provide academic users, medical researchers and pharmaceutical companies with a serious alternative to competing 3D cell culture products.

The Technology – Self-assembling Peptides

Biogelx’s hydrogels are based on the combination of Fmoc-diphenylalanine (Fmoc-FF) and Fmoc-Serine (Fmoc-S) peptides. Fmoc-FF alone self-assembles to form fibers in aqueous environments (gelator peptide), whilst Fmoc-S would form micellar structures by comparison (surfactant peptide). By combining the two peptides, it produces fibers of Fmoc-FF coated with Fmoc-S, which presents hydroxyl functionality on the surface of the fibers (‘core-shell’ assembly), and thus presenting a suitable surface chemistry for cell adhesion (Figure 2).

Flexible Handling

The gels are applicable across a range of cell-based applications. Gelation is triggered through addition of cell culture media (Figure 3), offering a flexible approach, where cells can be cultured inside the gel (3D culture) or on top (2D culture).

Dictating Stem Cell Differentiation using Hydrogel Stiffness

Specifically, these hydrogels have been shown to aid stem cell migration, differentiation, survival and integration. Figure 4 presents results from growing mesenchymal stem cells on three Fmoc-FF/S hydrogels of varying stiffness, but identical peptide chemistry. Each hydrogel was found to direct differentiation of the cells into specific lineages, as they presented bone (rigid gel), cartilage (stiff gel), or neural (soft gel) cell phenotypes in the absence of differentiation media, matrix proteins or bioactive motifs.

This data highlights the influence a highly tuned 3D environment can have, in the context of stem cell differentiation.

3D Bioprinting

Biogelx are optimising protocols that adapt these hydrogels for use in 3D bioprinting. It is known that salts in the cell media are the trigger for gelation in standard cell culture methods, as such this concept can be applied to control gelation to suit 3D Bioprinting methods.

Early experiments have shown that even at relatively low pre-gel and salt concentrations constructs of good strength can be generated. Figure 6 shows a ring structure created by printing Biogelx pre-gel into a gelatin support material formulated with a 1X DPBS.

Acknowledgements

Biogelx would like to thank Prof. Matt Dalby and his research group at the University of Glasgow, who undertook the cell-based work associated with evaluation of the gels with MSCs.

References