Functionalised graphene oxide substrates for directing neuroglial differentiation of adipose-derived mesenchymal stem cells

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Peripheral nerve regeneration is critical in the treatment of peripheral nerve injuries. Recently, significant focus has been placed on the use of biomaterial scaffolds which can deliver stem cells and lead the regeneration process at the injury site.

The aims of this study are:
1) to assess if the functionalisation of graphene oxide (GO) can direct the differentiation of adipose derived mesenchymal stem cells (ASCs) towards neuroglial lineages; and
2) to assess if Schwann-like differentiated adipose stem cells (dASCs) grown on graphene-based substrates have increased expression of neuroglial markers.

A comparison between GO, reduced GO, a peptide (IKVAV) functionalised GO and standard tissue culture glass is made. Atomic force microscopy (AFM), X-ray photo electron (XPS), Raman and Fourier-transform infrared (FT-IR) spectroscopies confirmed the uniform coverage of the substrates and successful functionalisation and reduction of GO. Gene expression studies by quantitative Real Time PCR on ASCs demonstrated increased neural gene expression in GO-IKVAV groups compared with the other substrates, while increased osteogenic and chondrogenic gene expression was demonstrated in GO and rGO substrates compared with GO-IKVAV and glass substrates. Quantitative Real Time PCR on dASCs demonstrated increased expression of glial markers such as neurotrophins and intermediate filament proteins.

We therefore conclude that it is possible to take advantage of the versatile chemical nature and biocompatibility of graphene to deterministically functionalise graphene to affect stem-cell differentiation towards a desired lineage, as well as promoting desirable gene expression.

Figures

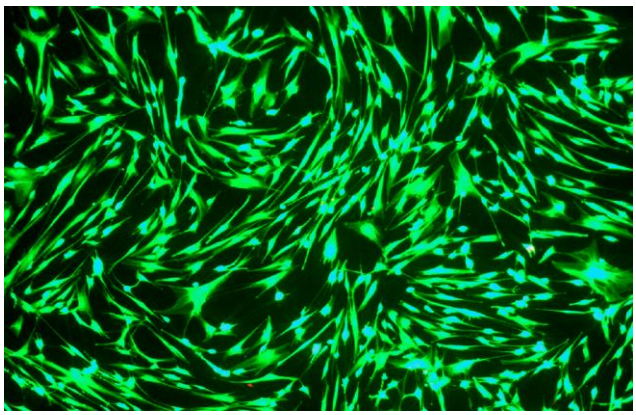

Figure 1: Live/Dead assay of dASCs after 48 hours on GO substrates