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Nanostructured electrically active scaffolds for neural and muscle regeneration

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Neural and muscle regeneration requires platforms that facilitate the guidance and maintenance of differentiated cells. Various laboratories have been investigating the use of micro and nanostructured polymer scaffolds for control of cell growth, cell guidance and tissue regeneration. In this presentation, we describe our investigations into the effects of orientated nanostructured conducting polymers on muscle and neural cell behavior, as well as the effects of electrical stimulation applied through these scaffolds.

Conducting nanostructured platforms were synthesized from aligned Multi Walled carbon NanoTube (MWNT) aerogel sheets deposited on gold coated mylar, as previously described. Conductive polypyrrole doped with para-toluenesulphonic acid (PPy-pTS) was deposited over the aligned carbon nanotube aerogel sheets, to create nanostructured PPy-pTS surfaces as required. DRG neural explants, PC12 cells or primary murine myoblasts were then grown on the scaffolds under differentiating conditions. Electrical stimulation (bipolar waveform) was applied for 8 hours per day for three days to analyse the effects of electrical stimulation on PC12 and myoblast behavior.

DRG neural explants and PC12s grown and differentiated on these substrates demonstrated a high degree of alignment, dependent on the thickness of the PPy-pTS overlay. Similarly, myoblasts and myotubes exhibited a high degree of alignment on nanostructured surfaces, this effect was also dissipated with increasing thickness of the PPy-pTS overlay. Electrical stimulation of myoblasts on the scaffolds resulted in a small but significant increase in myoblast fusion and cell density. In addition, PC12s electrically stimulated on these platforms exhibited an increased number of longer neurites, suggesting that electrical stimulation applied through conducting polymer platforms can increase neurite outgrowth, as previously observed in primary neural explants.

These studies demonstrate that nanostructured conducting polymer platforms can be used to influence neural and skeletal muscle differentiation *ex vivo*. In addition, these platforms can influence myofibre and neurite orientation in a manner reflecting the *in vivo* architecture of the parent tissue. Such platforms have applications in controlling the regeneration of skeletal muscle and neural tissues *in vivo* and for the integration of bionic devices designed to facilitate tissue regeneration and function.

Biography

Rob M. I. Kapsa completed his PhD in 1996 at the University of Melbourne Dept Medicine, St Vincent's Hospital (Melbourne). He is Program Director for the Bionics Platform of the ARC Centre for Electromaterials Science (ACES) and concurrent Principal Scientist and Head of Research Neurosciences at St Vincent's Hospital in Melbourne. He has published 85 peer-reviewed manuscripts including 2 book chapters and one book in the areas of muscle biochemistry, genetics, gene therapy and muscle and nerve engineering. His work is focused on the development of autologous cell-based regenerative therapies for hereditary nerve and muscle disease.

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