Organosilica nanoparticles for real-time monitoring of oxygen and pH in biological systems

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Traditional cell culture techniques involve the use of flat, two-dimensional (2D) stiff substates (i.e., polystyrene, glass), which provide insight into the fundamental basis of cell interaction and cell fate. However, these methods poorly misrepresent the native tissue environment, where there are stark differences between in vitro and in vivo interactions – stemming from the differences in the local microenvironment.[1] The emergence of three-dimensional (3D) cell culture systems as a mimic for the native tissue environment has been able to provide further a clearer insight into key biological interactions, such as cell fate and interactions, drug efficacy, and disease progression. However, the differences between the transport and distribution of metabolites, such as oxygen and nutrient diffusion, and waste removal within 3D systems, compared to 2D cell monolayers, can also influence cell fate. Therefore, spatio-temporal monitoring within 3D cell constructs will enable better understanding on how cell fate changes over time within the complex and heterogenous microenvironment. Nanosensors are an alternative approach to electrodes and fluorescent stains, which provide both temporal and spatial resolution for analyte sensing.[2] A grand challenge in this area is to then translate such systems into animals and humans to realise real-time spatio-temporal monitoring *in vivo*.[3]

To visualize spatio-temporal changes within the complex microenvironment, we have developed nanosensors for real-time monitoring in situ, using fluorescence and ultrasound as detection modalities.[4],[5] Organosilica is a promising material for developing nanosensors as it is biocompatible, with tuneable surface chemistry and easily controlled particle size. These nanosensors can be easily dispersed within a 3D cell construct, and employed as non-invasive, continuous nanosensors. In this presentation, we will showcase the development our organosilica nanosensors for monitoring oxygen and pH dynamics in real time.

References:

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