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Engineering stem cell differentiation: Building tissues with chemical glue and tweezers

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Developing new chemical- or cell-based therapies is a multi-stage and costly process. Attrition rates are high and failure often occurs in the latter and more expensive stages. Increasingly, it is now becoming accepted that a key reason contributing to failure of these therapies is linked to the early stages of their development and a reliance on *in vitro* cell models that fail to accurately represent the intended *in vivo* tissue target. In many examples, *in vitro* models involve basic 2D culture systems, with cells grown as a monolayer on a flat culture surface. While having the advantages of being relatively simple to perform, 2D cultures have the distinct disadvantage of failing to represent the complex 3D spatial organization and micro-environmental geometries encountered in the native tissue, involving specific cell-cell and cell-extracellular matrix interactions. This has an impact on how cells respond to various stimuli and can manifest as marked differences in activation and expression of genes and proteins and changes in cell function.

Here I will discuss chemical (cell surface modification) and physical approaches (holographic optical tweezers), to exert hitherto unattainable levels of control over the movements and positioning of live cells. With dynamic, precision control at the scale of the individual cell, we are working to manufacture definable and tuneable, 3D micro-tissues, which can be assembled together within minutes in a manner similar to building with 'cell LEGO'. With inherent control over manufacturing complexity we can deliver 'simple' 3D cell aggregates with applications in drug discovery and pharmaceutical testing.

Biography

Lee Buttery completed his PhD at Imperial College in 1996 and subsequently gained a lectureship position at Imperial College in 1998 before moving to the School of Pharmacy at the University of Nottingham in 2003. Lee's research has varied from work on the nitric oxide synthase family of enzymes in health and disease to stem cell biology and tissue engineering with a focus on bone tissue and 3D culture. Lee has published over 100 peer-reviewed papers and numerous book chapters.

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