Emerging materials for tissue engineering and regenerative medicine: themed issue for *Journal of Materials Chemistry* and *Soft Matter*

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Materials are playing an increasing role in a variety of medical applications encompassed by the fields of regenerative medicine and tissue engineering.[1] Although materials have been used for various types of medical applications for thousands of years, the field of biomaterials has evolved greatly in the past few decades.[2,3] Traditionally, one of the key considerations in selecting biomaterials has been their biocompatibility. In most cases such behaviour was defined by the ability to minimise cell–host interactions, such that the material would ideally be inert to the tissue. With advances in our understanding of biological phenomena, as well as new developments in materials sciences and engineering, a new generation of biomaterials is emerging that are bioinstructive rather than passive.

In this joint issue of *Journal of Materials Chemistry* and *Soft Matter*, recent advances in the area of biomaterials engineering for tissue fabrication and regenerative medicine are highlighted. Engineered materials can now be fabricated with unique biochemical and biophysical properties that can be used to direct the interaction of biological systems with the engineered materials through the activation of specific biological signaling mechanisms. Many of the new biomaterials presented in this joint issue involve innovations in terms of polymer design, biofunctionalisation and patterning as well as the development of new bioceramic based materials. In particular we focus on how design and control of materials chemistry can provide enhanced functionality. Exploiting materials chemistry can take many different forms including the tailoring of surface chemistry, the addition of signaling cues such as conjugated peptides, degradable linkers or controlled release of proteins, that can enable cell adhesion, migration, proliferation, differentiation and tissue growth. In addition, engineered materials including new composite materials are emerging with the aim of providing multiplexed functionality. Examples presented in this issue include degradable nanocomposite materials with mechanical properties amenable to load-bearing, and bioactive polymer mixtures that direct cell function and/or exhibit specific mechanical properties as well as chemo-, bio- or thermo-responsive properties. Given the versatility of methods with which the chemistry of hydrogels can be modified, it is no surprise that a number of papers in this issue focus on engineering bioinstructive hydrogels.[4,5] For example, self-assembled peptides, photocrosslinkable poly(ethylene glycol) and polysaccharides are all reported as biomaterial platforms that can be further decorated with biological cues.

Biophysical properties, such as mechanical properties, are also now well known to be important mediators of cell behaviour.[6] A number of papers in this joint issue are focused on the development of novel materials with tunable mechanical properties and the analysis of the resulting changes in substratum mechanics on cell responses. In addition, we include reports on the tailoring of other biophysical features such as the micro- and nanoarchitecture of materials using various techniques such as photolithography, electrospinning and molding. These incorporated topographical and architectural features can be used to direct tissue vasculature or multicellular organization.

Equipped with this array of emerging instructive biomaterials, significant advances are being made in generating tissue-like structures and directing cell fate decisions. The applications in engineering tissues range from hard tissues (such as bone) to softer tissues (such as vocal cords), and include metabolically active tissues (such as the liver) and electrically functional tissues (such as heart). Furthermore, we should not forget that a range of cellular behaviour from adhesion to more complex differentiation processes can be modulated by changes in relatively simple materials properties such as hydrophilicity and surface charge. As can be seen from the articles within this joint issue, these new biomaterials are not simply bystanders but are active participants in directing potentially life-saving biology.

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