Stem cell fate and microenvironment

James T. Triffitt[1,*], *Qian Wang*[2,*]

1 Botnar Research Centre, Nuffield Department of Orthopaedics, Rheumatology and Musculoskeletal Sciences, University of Oxford, Nuffield Orthopaedic Centre, Oxford, UK; 2 Department of Chemistry and Biochemistry, University of South Carolina, Columbia, SC, USA.

***Corresponding authors:**
James T. Triffitt, james.triffitt@ndorms.ox.ac.uk;
Qian Wang, Wang263@mailbox.sc.edu.

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For successful translational use of stem cells in biomedicine, knowledge of the quality of the cells, the presence of bioactive factors, and the nature of the microenvironmental niches is paramount. They may be regarded as the *Three Musketeers* as they unite "All for one, one for all"[1] to control the trafficking, survival, proliferation, and differentiation of stem cells. In this second themed issue of *Biomaterials Translational*, entitled "*Application of Stem Cells in Translational Medicine: Stem Cells Part II*", we continue with a collection of high-quality review papers that cover this important topic.

The first review paper by Arora and Robey[2] discusses the nature of the heterogeneity of bone marrow stromal cells/skeletal stem cells and highlights the importance of distinguishing bone marrow stromal cells/skeletal stem cells from other types of mesenchymal stem/stromal cells. It also emphasises that the utilisation of an appropriate scaffolding compatible with the microenvironment contributes greatly to the success of any stem cell-based clinical application. This article is complemented by the Viewpoint article published in the first stem cell-themed issue of this journal[3] which gave an historic overview of the development of bone marrow stromal cells/skeletal stem cells. Benayahu's concise review[4] further discusses how the differentiation of mesenchymal stem cells relies on the cooperation of specific key molecular regulators and appropriate activation conditions. Consequently, knowledge of the molecular pathway and the main factors involved will provide effective tools to control the activation and regulation of a required specific lineage, which are pivotal for potential applications in therapeutics and food manufacture. Volponi and colleagues continue with a review of current developments in studies on the diverse populations of oral stem cells, focusing on the approaches to decode and map the different cell lineages, which are key steps for translational tissue engineering.[5]

The concept of a stem cell niche was first proposed by Schofield[6] in 1978 while investigating the nature of the haemopoietic stem cell. Now it is well known that stem cell fate is influenced by a microenvironmental niche which orchestrates the interactions of stem cells with key niche components including soluble factors, other cells, and extracellular matrices.[7] The review by Watt[8] reveals the complexity of the development of haematopoietic stem and progenitor cells and the existence of distinct microenvironmental niches for diverse subsets of haematopoietic stem and progenitor cells. The important roles played by mesenchymal stromal cells in these niches in relation to haematopoietic stem and progenitor cell fate-decisions under homeostatic conditions are emphasised. Cao and Yuan's review[9] summarises the fabrication, characterisation and impact on stem cell behaviour of the use of synthetic materials with specific nanotopographical surfaces, including static patterned surfaces, dynamic patterned surfaces, and roughness. Some representative examples of *in vitro* and *in vivo* studies are presented to demonstrate the potential of nanotopographical surfaces for directed modulation of stem cell fate. Finally, this issue is concluded by two articles, one by Steijvers et al.[10] and one by Hu et al.,[11] which highlight the major challenges in the development of artificial tissues using synthetic materials.

Although stem cell technology is not the 'Balm of Gilead' bringing magical, universal cures to all diseases, it is apparent that it plays a critical role in the future development of functional biomaterials for translational applications. In particular, for survival and for performance of normal functions *in vivo*, stem cells require localisation in precise, specific environmental niches. The creation of such microenvironmental niches is

an important direction for translational biomaterials research. Biomaterials Translational will continue to encourage authors to bring more research and review articles to this challenging and exciting research field.

Editor note: James T. Triffitt and Qian Wang are Editorial Board members of Biomaterials Translational. There were blinded from reviewing or making decisions on the manuscript. The article was subject to the journal's standard procedures, with peer review handled independently of these Editorial Board members and their research groups.

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