

**MICRO AND
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IN ENGINEERING STEM
CELLS AND TISSUES**

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MICRO AND NANOTECHNOLOGIES IN ENGINEERING STEM CELLS AND TISSUES

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PREFACE

More than a million people worldwide are in need of an organ transplant while only 100,000 transplants are performed each year. More than 100,000 Americans need a transplant each year but only 25,000 transplants are performed. Tissue engineering has become increasingly important as an unlimited source of bioengineered tissues to replace diseased organs. Tissue engineering attempts to build body parts by assembling from the basic components of biological tissues, namely, the matrix, cells, and tissue morphogenetic growth factors. As tissue-specific cells are limited in quantity, stem cells with their ability for self-renewal and pluripotency are becoming increasingly important as a cell source in regenerative medicine. These cell sources include but are not limited to bone marrow-derived stromal cells and hematopoietic cells, umbilical cord-derived stem cells, and induced pluripotent stem cells. Top-down approaches utilizing porous scaffolds with random or well-defined pore structures, seeded with cells and growth factors, have been used, in some cases successfully, as cellular constructs in the clinically relevant length scale in regenerative medicine. However, top-down approaches cannot recreate the intricate structural characteristics of native tissues at multiple nano- and microscales, leading to the formation of less than optimal composition and distribution of the extracellular matrix. It should be emphasized that the hierarchical organization of native biological tissues is optimized by evolution to balance strength, cell-cell and cell-matrix interactions, growth factor presentation, and transport of nutrients. Consequently, bottom-up approaches to build a single modular unit to mimic the structural features of native tissues and to serve as a building block for assembly to a larger tissue scale have received more attention in recent years. The processes of cell adhesion, migration, differentiation, extracellular matrix formation, and cell maturation depend on interactions at multiple length scales between the cell surface receptors

and their corresponding ligands in the matrix. The success of engineered tissues as an unlimited source for replacement of damaged organs depends on our depth of understanding of those interactions and our ability to mimic those interactions using enabling nano- and microscale technologies and to build modular scalable units for implantation. This book provides an overview of enabling micro- and nanoscale technologies in designing novel materials to elucidate the complex cell–cell and cell–matrix interactions, leading to engineered stem cells and tissues for applications in regenerative medicine. The editors, Murugan Ramalingam, Esmail Jabbari, Seeram Ramakrishna, and Ali Khademhosseini, thank the authors for their contribution to this timely book.

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