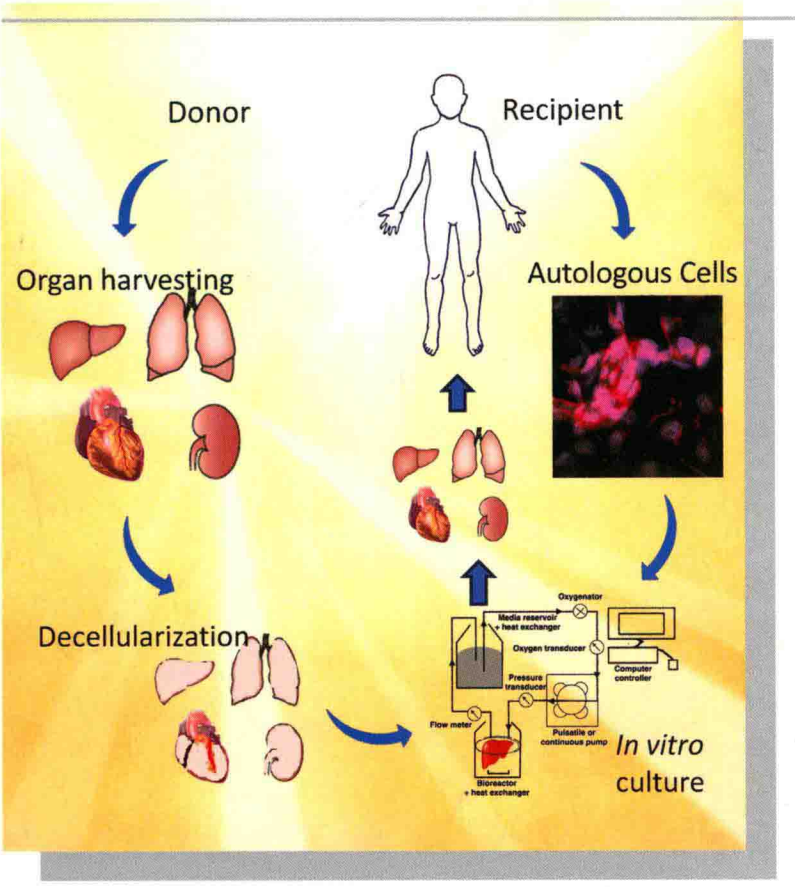
TISSUE REGENERATION

Where Nano-Structure Meets Biology

editors
Qing Liu
Hongjun Wang

Vol. 2
Frontiers in Nanobiomedical Research



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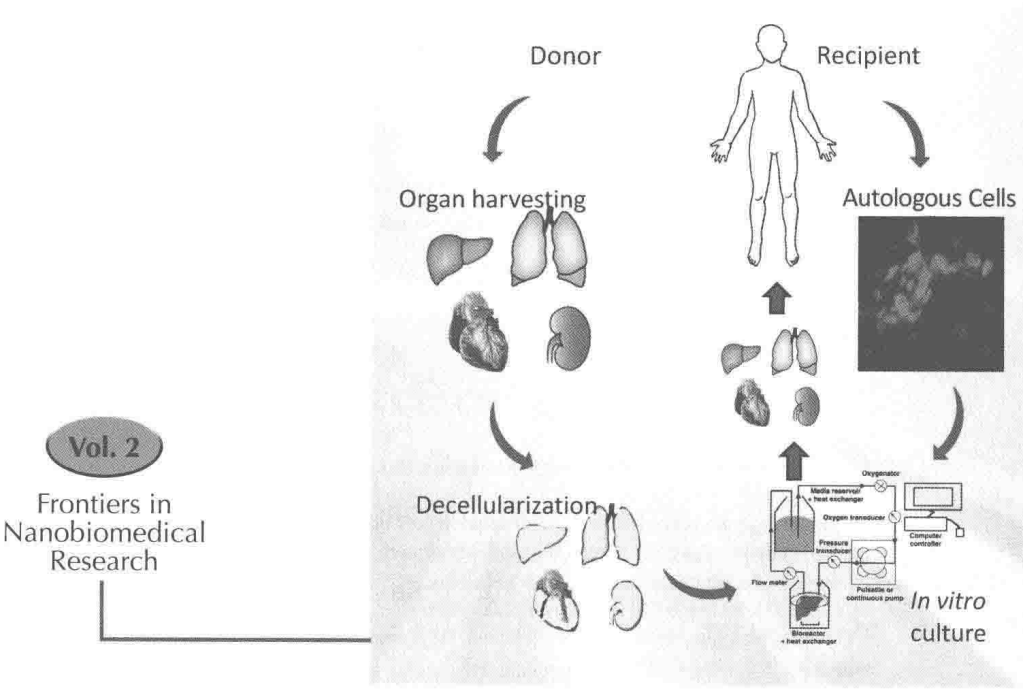

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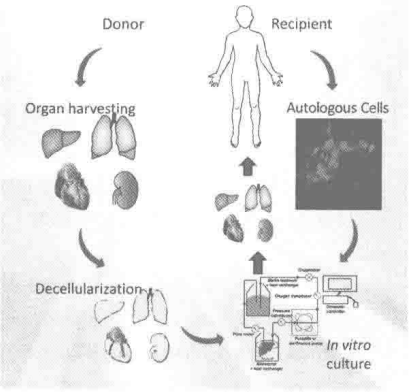

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Vol. 1: Handbook of Immunological Properties of Engineered Nanomaterials
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edited by Qing Liu (3D Biotek, USA and Tongji University, China) and Hongjun Wang (Stevens Institute of Technology, USA)

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Preface

Tissue loss and organ failure is one of the most devastating and costly problems in human healthcare. So far, Tissue and organ transplantation have been considered the most effective treatment option. In recent years, the need for tissue and organ has increased tremendously as a result of the significant increase in aging population and tissue loss caused by trauma or surgical removal of diseased tissue such as cancer. On the other hand, the availability of transplantable organs and tissues is very limited and the shortage issue will not be resolved in the near future. As a matter of fact it may become even worse. Therefore, vigorous ongoing efforts have been made to search for possible alternatives.

Tissue Engineering, an integrated science and engineering discipline aimed at creating functional tissues and organs for transplantation, has been evolving into one of the most promising therapies in regenerative medicine. As the essential elements of tissue engineering, cells, biomaterials and biological cues interplay and determine the size, shape and functionality of the resulting engineered tissues. Evolving from the original concept, *i.e.*, solely providing a primary structural support for cells to anchor, spread and proliferate, the design of biomaterial scaffolds has been involving the efforts to incorporate bioactive cues into scaffolds for biological modulation of the cellular behavior in the hope of obtaining desired tissue formation. In order to form functional tissues similar to native counterparts, it is appealing to recapture the key features of extracellular matrix (ECM). In human body, natural ECM plays important roles in regulating tissue and organ development. ECM, mainly composed of

nano-structured collagen fibrils and other glycoproteins, not only serves as scaffolding material for cells to attach, proliferate and differentiate, but also provides biological cues for guiding cell differentiation. In other words, the interactions between cells and nano-structured ECM biomaterials have played an important role in the process of tissue development.

Inspired by the process of natural tissue/organ development, scientists have invested tremendous efforts in developing nano-structured scaffolding biomaterials for better tissue regeneration. Among these nano-structured scaffolds, ECMs derived from *in vitro* cell culture and decellularized tissue matrix are of particular interest as they are inherently biologically relevant biomaterials.

Three-dimensional electrospun nanofiber scaffolds for tissue regeneration represent another type of nano-structured scaffolds, which represent a different approach to control cellular behavior for achieving tissue regeneration by mimicking both dimension and morphology of natural ECM. This approach provides a unique opportunity for the researchers to combine the material chemistry with nano-scale morphology of the scaffolds. Several chapters are particularly devoted to electrospun nanofiber scaffolds.

Of course, it will be incomplete without discussing nano-structured bioceramics. It is well-known that natural bone is mainly composed of nanosized bone mineral particles and collagen fibrils. In this regard, scaffolds made out of nano-structured bioceramics or the composite of nano-structured bioceramics with polymers have been frequently used for hard tissue regeneration. Latest research results, including those on nanosized bioceramic scaffolds, scaffolds with nanosize ceramic coatings and nano-structured composites, are presented in several chapters of this book.

This book has spanned a wide range of clinical applications. To make it easier for readers, the book has been further organized into the following research areas: *Stem cells for tissue regeneration*, *Nano-structured biomaterials for soft tissue regeneration*, *Nano-structured biomaterials for hard tissue regeneration* and *Cell interactions with nano-structured biomaterials.*

The authors of the book are all active researchers and leaders in their respective research fields. It was very time consuming to write the chapters after their busy daily research schedules. We are very grateful for their invaluable contributions to the book.

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