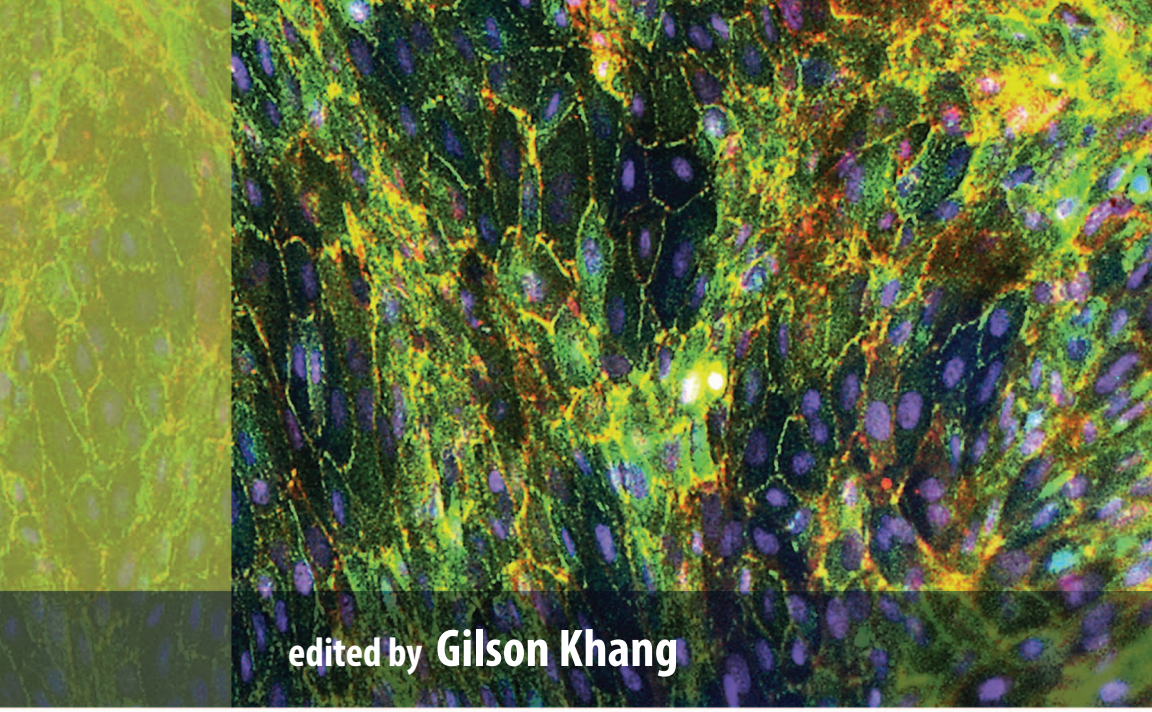

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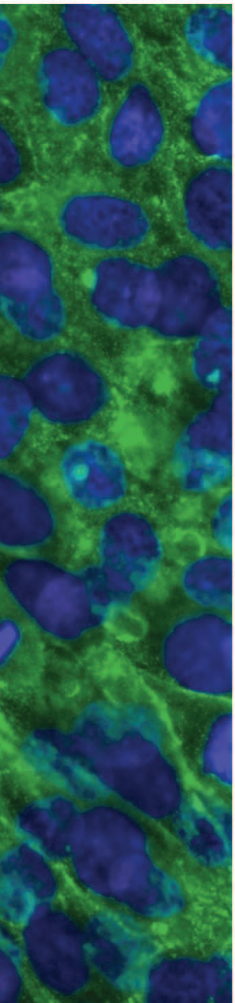

Handbook of

Intelligent Scaffolds for Tissue Engineering and Regenerative Medicine

Second Edition

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PAN STANFORD PUBLISHING

Published by

Pan Stanford Publishing Pte. Ltd.
Penthouse Level, Suntec Tower 3
8 Temasek Boulevard
Singapore 038988

Email: editorial@panstanford.com
Web: www.panstanford.com

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library.

Handbook of Intelligent Scaffolds for Tissue Engineering and Regenerative Medicine (2nd Edition)

ISBN 978-981-4745-12-3 (Hardcover)
ISBN 978-1-315-36469-8 (eBook)

Printed in the USA

I would like to dedicate this handbook to my wife,
Isabella Seong Hee Koh, my children,
Jerome Taeuk and Daniel Taehoon, and my mother.

Contents

Preface to the 2nd Edition

I edited the 1st edition of *Handbook of Intelligent Scaffolds for Tissue Engineering and Regenerative Medicine* in 2012, which comprised 45 chapters. The very recent environment of academia and industry in these areas has quickly and extensively changed in comparison to 4 years ago. For example, 19 regenerative medicine and tissue engineering, including cell therapy, products were launched in the Korean market. Among them, 4 stem cell products, approved by the Korea FDA, were launched in the Korean market in 2012. They are the world's first-time-reported autologous bone marrow–derived stem cells (BMSCs), autologous adipose-derived stem cells (ASCs), and allogenic umbilical cord–derived stem cells (UBSCs) for the treatment of myocardial infarction, ALS, Crohn's disease, and chondyle defects, respectively.

From the global point of view, four stem therapy products have been introduced. Additionally, over 100–200 clinical trial phases I, II, and III with a wide arena of scientific fields are under development throughout the world. This may be a burgeoning step toward the advancement of regenerative medicine compared to that of conventional medication therapy.

This handbook focuses on all aspects of scaffolds, especially intelligent scaffolds, from basic science to industries to clinical applications. It is organized into 10 major areas. Part I, "Introduction," reveals some of fundamentals of biomaterials, scaffolds, and manufacturing methods. Part II covers ceramic and metal scaffolds. Part III, "Intelligent Hydrogels," deals with the various types of hydrogels for tissue regeneration. In Part IV, scaffolds from electrospinning nanofibers have been covered. In Parts V and VI, 3D printing and nano-/bioconvergence technology for scaffolds have been introduced, respectively. Part VII covers the recent development of an acellular natural matrix for smart scaffolds. Part VIII of this handbook deals with the recent clinical trial on specific target organs using intelligent scaffolds. Part IX introduces the drug delivery system, and Part X deals with future enabling technology for scaffolds.

The authors have tried to cover the entire area of smart scaffolds for regenerative medicine and tissue engineering through the 44 chapters. I am indebted to the authors for willing acceptance, devotion, and contribution to each topic.

I express my thanks to my students, Mr. Jae Hoon Shin and others, and the editor, Archana Ziradkar, for editing all chapters. Especially, Ms. Ziradkar was fighting against 44 huge chapters and 1400 pages every day. Finally, I really appreciate our publisher, Pan Stanford Publishing, especially Mr. Stanford Chong. Without his trust and guidance, this huge work could not have been accomplished.

Gilson Khang, PhD

Preface to the 1st Edition

It has been recognized that regenerative medicine and tissue engineering offer an alternative technique to whole-organ and tissue transplantation for diseased, failed, or malfunctioning organs. Millions of patients suffer from end-stage organ failure or tissue loss annually. The only way to solve this problem might be organ transplantation and biomaterials transplantation. However, in order to avoid the shortage of donor organs and other problems caused by poor biocompatibility of biomaterials, a new hybridized method combined with cells and biomaterials had been introduced as regenerative medicine and tissue engineering around 20 years ago. The specialty of regenerative medicine and tissue engineering continues to grow and change rapidly. This area saw major advances in the past few years. This field for academic research and commercialization is needed in multidisciplinary areas such as adult, embryoinic, and induced pluripotent cells, genetic programming, nuclear transfer, cloning, genomics, proteomics, nanotechnology, biomaterials, etc. Thanks to the latest 20 years' endeavor, several tissue-engineered products (TEMPS) and regenerative medicinal products (RMP) are on the boundary of the translation of benchside discoveries to clinical therapies. For the reconstruction of a neotissue by regenerative medicine and tissue engineering, triad components such as (i) cells that are harvested and dissociated from the donor tissue, including nerve, liver, pancreas, cartilage, and bone, as well as embryonic stem cells, adult stem cells, induced pluripotent cells (iPS), or precursor cells; (ii) biomaterials as scaffold substrates whose cells are attached and cultured, resulting in the implantation at the desired site of the functioning tissue; and (iii) growth factors that are promoting and/or preventing cell adhesion, proliferation, migration, and differentiation by up-regulating or down-regulating the synthesis of protein, growth factors, and receptors are needed. This handbook has concentrated on all the things for scaffolds among triad components, especially intelligent scaffolds from basic science to industries to clinical applications. This textbook is organized into seven major areas.

Part I, "Introduction," reveals some of fundamentals of the biomaterials, scaffolds, and manufacturing methods. Part II covers ceramic and metal scaffolds. Part III, "Intelligent Hydrogels," deals with various types of hydrogels for tissue regenerations. In Part IV, topics of scaffolds from electrospinning nanofibers have been covered. In Part V, novel biomaterials for scaffolds have been introduced, especially to mimic Mother Nature. The sixth part covers the recent novel fabrication methods for smart scaffolds. The last part, Part VII, of this handbook deals with the recent clinical trial of specific target organs using intelligent scaffolds. The authors have tried to dedicate the 44 chapters to the whole area of the recent topic of smart scaffolds for regenerative medicine and tissue engineering. I am indebted to the authors for their willing acceptance, devotion, and contribution to each recent topic. I express my thanks to my students Mrs. Yong Ki Kim, Jung Bo Shim, and Young Un Kim for editing all manuscripts. Finally, I really appreciate our publisher, Mr. Stanford Chong. Without his trust and guidance, this huge work could not have been accomplished. Also, I would like to give special appreciation to Mr. Sarabjeet Garcha and Ms. Archana Ziradkar for their hard work.

Gilson Khang, PhD