Springer Series in Biomaterials Science and Engineering

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Aims and scope

The Springer Series in Biomaterials Science and Engineering addresses the manufacture, structure and properties, and applications of materials that are in contact with biological systems, temporarily or permanently. It deals with many aspects of modern biomaterials, from basic science to clinical applications, as well as host responses. It covers the whole spectrum of biomaterials – polymers, metals, glasses and ceramics, and composites/hybrids – and includes both biological materials (collagen, polysaccharides, biological apatites, etc.) and synthetic materials. The materials can be in different forms: single crystals, polycrystalline materials, particles, fibers/wires, coatings, non-porous materials, porous scaffolds, etc. New and developing areas of biomaterials, such as nano-biomaterials and diagnostic and therapeutic nanodevices, are also focuses in this series. Advanced analytical techniques that are applicable in R & D and theoretical methods and analyses for biomaterials are also important topics. Frontiers in nanomedicine, regenerative medicine and other rapidly advancing areas calling for great explorations are highly relevant.

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Functional Hydrogels as Biomaterials

Springer

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Preface

Polymeric hydrogels are an important class of functional soft materials made up of a large variety of neutral or charged hydrophilic macromolecules cross-linked chemically or physically in an aqueous environment. The water-rich nature of hydrogels resembles biological tissues, opening up many opportunities for hydrogels to be applied in biomedical areas such as contact lenses, wound dressings, drug delivery, and tissue engineering. Hydrogels, from both natural and synthetic origins, can be formed through cross-linking by either covalent bonds or physical cohesion forces between the polymer segments such as ionic bonding, hydrogen bonding, van der Waals forces, and hydrophobic interactions. In the last decades, hydrogels formed from water-soluble polymers through ionic interactions, polyelectrolyte complexation, thermally induced hydrophobic interactions, and host-guest supramolecular self-assemblies have received growing attention because of their easily tunable properties, making them broadly applicable to many promising and emerging biomedical applications.

This book is devoted to functional hydrogel biomaterials, which contains a collection of seven chapters, mainly focusing on the emerging areas of synthetic and biopolymer hydrogels formed through specially designed chemical or physical cross-linking, and the cyclodextrin-based host-guest supramolecular self-assembly, for cell encapsulation, cell expansion, cell differentiation and tissue repair, stem cell culture, and cellular therapy and drug delivery applications.

In Chap. 1, K. S. Lim, P. Martens, and L. Poole-Warren describe the advantages and disadvantages of hydrogels fabricated from various materials for cell encapsulation, with highlights on biosynthetic hydrogels, those designed to have the reproducible and tailorable physical properties of the base synthetic polymer as well as the desired biological attributes of the incorporated biological molecules. Chapter 2, authored by Y. M. Chen and Z. Q. Liu, introduces cell culture systems based on protein-free synthetic hydrogels for expansion of endothelial cells, with a focus on the negatively charged synthetic hydrogels, which can promote endothelial cell proliferation to form a monolayer as well as maintain the original functions of the expanded cells. In Chap. 3, C. Pradal and J. Cooper-White describe supramolecular hydrogels based on polyrotaxane, where many cyclodextrin rings are threaded by

linear polymer chains, for creating spatially flexible structures at the molecular scale in line with the current need for more tunable and dynamic hydrogel properties for directed stem cell differentiation and tissue repair application. Chapter 4 is authored by B. Joddar and Y. Ito, who describe the cross-linked biological components including polysaccharide, proteins, and cells as a three-dimensional tissue engineering scaffolds and culture matrices, which can be conveniently prepared and stably stored until utilization, for expansion and differentiation of various types of stem cells. Chapter 5 authored by S. T. Chua, X. Song, and J. Li is a review of cell encapsulation technologies based on hydrogel biomaterials, with a focus on stem cell encapsulation and some recent developments of such strategy for its use in treatment of diabetes, as well as a discussion on the challenges of the stem cell-based treatment of diabetes. In Chap. 6, J. H. Seo and N. Yui introduce the concept in designing the dynamic supramolecular surfaces based on polyrotaxane formed between cyclodextrins and block copolymers, with a description of the adsorption property of protein molecules, mobile property of cell-binding motif, and the following cell functions. In the last chapter, Chap. 7, X. Song and J. Li review the recent advances in polymer-cyclodextrin inclusion complex-based supramolecular hydrogels, as well as novel supramolecular structures based on pseudoblock copolymers formed by host-guest inclusion complexation with new stimuli-responsive properties, forming "smart" supramolecular hydrogels with desired and promising properties for controlled release applications.

The chapters in this book represent the recent advances in the emerging areas of hydrogels as biomaterials, collectively forming an important part of the foundations of the synthetic and biopolymeric, and supramolecular hydrogels used for cell and stem cell technologies, tissue engineering, regenerative medicine, and controlled drug delivery.

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