Table of Contents

Preface
List of Contributors
Introduction to Hydrogels
  Kinam Park
Crosslinked Polymers
Hydrogels Synthesis
Expansion of a Hydrogels Structure
Swelling Forces in Hydrogels
Swelling Mechanism
Water in Hydrogels
Hydrogels Properties
Hydrogels Characterization
Hydrogels Applications
Summary
References

Part I. Stimuli-Sensitive Hydrogels

Stimuli-Responsive Hydrogels and Their Application to Functional Materials
  Teruo Okano
Introduction
Stimuli-Responsive Gels as Functional Materials
Function of Mechanical Motion
Function of Information Transmission and Transformation
Function of Mass Transport
Cell-Sheet Engineering Using an Intelligent Surface
Cell-Sheet Engineering
Intelligent Surfaces
Design of Network Structure for Functional Gels
Topological Gels, Double Network Structure Gels, Nanocomposite Gels
Graft Gels
Microfabrication of Gels
Self-Oscillating Gels as Novel Biomimetic Materials
Design of Self-Oscillating Gels
Self-Oscillating Behaviors of the Gels
Self-Oscillating Behaviors of the Gels
Control of Oscillation Period and Amplitude
On-Off Regulation of Self-Beating Motion
Peristaltic Motion of Gels with Propagation of Chemical Wave
Design of Biomimetic Micro-/Nanoactuator Using Self-Oscillating Polymer and Gels
Self-Walking Gels
Microfabrication of the Gels by Lithography
Control of Chemical Wave Propagation in Self-Oscillating Gels Array
Self-Oscillating Polymer Chains as "Nanooscillator"
Self-Flocculating/Dispersing Oscillation of Microgels
Fabrication of Microgel Beads Monolayer
Self-Oscillation Under Physiological Conditions
References

Feedback Control Systems Using Environmentally and Enzymatically Sensitive Hydrogels
  Nicholas A. Peppas
Hydrogels as Basic Functional Elements of a Control System
Hydrogels in Sensors
Optical Transduction
Mechanical Transduction
Electric Transduction
Limitation of Enzyme Secondary Substrate
Preservation of Enzyme Activity
Hydrogels as Actuators
Magnetically Controlled Systems
Biodegradable Hydrogels for Controlled Drug Release
Julio San Roman

Introduction
The Nature of Biodegradable Hydrogels
Physical Hydrogels
Hydrophobic Interactions Hydrogels
Ionic Interaction Hydrogels
Hydrogen Bonded Hydrogels
Chemically Bonded Hydrogels
Summary
References

Thermo-Responsive Biodegradable Hydrogels from Stereocomplexed Poly(lactide)s
Yoshiharu Kimura

Introduction
Micelles and Hydrogels with Various Block, Graft, and Armed PLA Copolymers
Stereocomplexation of Enantiomeric PLAs, and the Hydrogels Applications
Hydrogels Study on Enantiomeric PLA-PEG Linear Block Copolymers
Motivation of the Study on Stereocomplexed Micellar Hydrogels
Copolymer Synthesis and Gels Formation
Hydrogels from Micellar Solutions of ABA Triblock Copolymers
Hydrogels from BAB Triblock Copolymers
Hydrogels from AB Diblock Copolymers
Hydrogels Properties and Applications
Summary
References

Hydrogels-Based Drug Delivery System with Molecular Imaging
Soon Hong Yuk

Introduction
Hydrogels Polymers for Imaging Probes
Poly(Ethylene Glycol) (PEG) and Its Copolymers
Poly(N-isopropylacrylamide) (PNIPAM)
Molecular Probes for Imaging
Gold Nanoparticles
Magnetic Nanoparticles
Fluorescence Dyes
Microbubbles
Quantum Dots
Molecular Probe/Polymer Composite Systems
Iron Oxide Nanoparticles/Polymer Composite Systems
Quantum Dot/Polymer Composite Systems
Microbubble/Polymer Composite Systems
Drug Delivery System with Molecular Imaging Capability
Summary
References

Part III. Hydrogels for Tissue Engineering
Hydrogels for Tissue Engineering Applications
Pieter J. Dijkstra

Introduction
Hydrogels Designs for Tissue Engineering
Crosslinking Methods to Form Hydrogels
Chemical Crosslinking by Radical Polymerization
Crosslinking Functional Groups
Crosslinking by Enzymatic Reactions
Crosslinking by Stereocomplexation
Hydrogels by Thermo-Gelation
Crosslinking by Self Assembly
Crosslinking by Inclusion Complexation
Combining Physical and Chemical Crosslinking
Naturally Derived Hydrogels
Protein-Based Polymers
Polysaccharides
Synthetic Hydrogels
Hydrogels Based on PEG-PLA and PEG-PGA Copolymers
Fumaric Acid-Based Hydrogels
Hybrid Hydrogels
Tissue Engineering Applications
Bone Graft Substitutes
Cartilage Regeneration
Conclusions
References
Composite Hydrogels for Scaffold Design, Tissue Engineering, and Prostheses
L. Ambrosio
Introduction
Basic Concepts and Properties
Scaffolds for Tissue Regeneration
Summary
References
Hydrogels for Cartilage Tissue Engineering
Claire Vinatier
Introduction
Characterization of Hydrogels
Theory of Viscoelastic Behavior
Cartilage Morphology, Properties and Diseases
Composition of Articular Cartilage
Chondrocyte
Histological Organization of Articular Cartilage
Extracellular Matrix (ECM)
Pathology of Articular Cartilage
Cartilage Repair
Cartilage Regeneration
Tissue Engineering (TE)
Hydrogels Polymers
In Situ Crosslinkable Hydrogels
Polymer Associations
Physical and Mechanical Behavior
Summary
References
Gelatin-Based Hydrogels for Controlled Cell Assembly
Renji Zhang
Introduction
Gelatin-Based Hydrogels for the Controlled Hepatocyte Assembly
Establishing a Multicellular Model by 3D Cell Assembly for Metabolic Syndrome
Cryopreservation of 3D Constructs Based on Controlled Cell Assembly
Conclusions
References
Double Network Hydrogels as Tough, Durable Tissue Substitutes
Jian Ping Gong
Introduction
Robust Gels with High Elasticity
DN Gels from Synthetic Polymers
Necking Phenomenon of DN Gels
Local Damage Zone Model for the Toughening Mechanism of DN Gels
Robust Gels from Bacterial Cellulose
Sliding Friction of Gels
Frictional Behavior of Gels
Dependence on Load
Sample Area Dependence
Substrate Effect
Extremely Low Friction Gels
Template Effect on Gels Surface Structure and Its Friction
Robust Hydrogels with Low Friction as Candidates for Artificial Cartilage
Wear Properties of Robust DN Gels
Biocompatibility of Robust DN Hydrogels
Evaluation of Robust Gels
Summary
References
Hydrogels Contact Lenses
Miroslava Duskova
Introduction
Contact Lens Terminology
Materials Used for Hydrogels Contact Lenses
HEMA
Other Glycol Methacrylates
Dihydroxy Methacrylates
Methacrylic Acid
Acrylamides