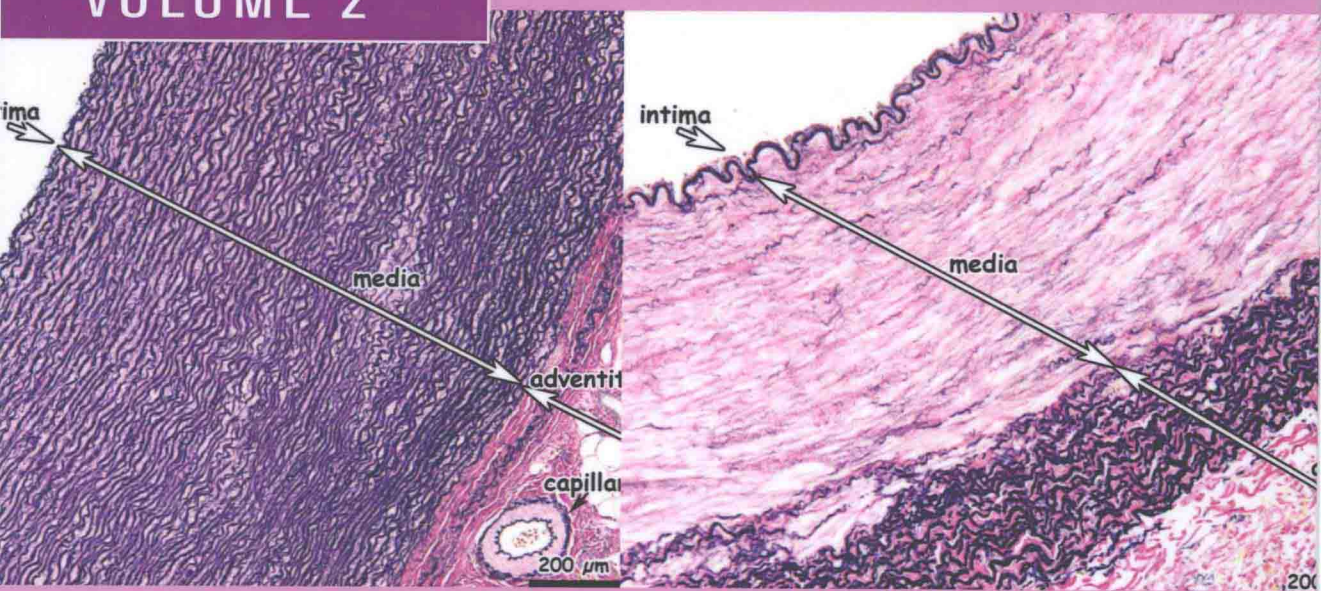


Biomaterials 2-Volume Set, Third Edition

# POLYMERIC BIOMATERIALS

Medicinal and Pharmaceutical Applications

VOLUME 2



Founding Editor  
**Severian Dumitriu**

Editor  
**Valentin Popa**



CRC Press  
Taylor & Francis Group

# POLYMERIC BIOMATERIALS

## Medicinal and Pharmaceutical Applications

### VOLUME 2

Biomaterials have had a major impact on the practice of contemporary medicine and patient care. Growing into a major interdisciplinary effort involving chemists, biologists, engineers, and physicians, biomaterials development has enabled the creation of high-quality devices, implants, and drug carriers with greater biocompatibility and biofunctionality. The fast-paced research and increasing interest in finding new and improved biocompatible or biodegradable polymers have provided a wealth of new information, transforming this edition of **Polymeric Biomaterials** into a 2-volume set.

This volume, **Polymeric Biomaterials: Medicinal and Pharmaceutical Applications**, contains 28 authoritative chapters written by experts from around the world. Contributors cover the following topics:

- Processing polymeric biomaterials into specific forms that ensure biocompatibility and biodegradability for use in various applications in the medical and pharmaceutical arenas
- Use of biomaterials to address medical issues such as pulmonary disease, cancer, heart disease, tissue damage, and bone disease
- Applications including a variety of drug delivery systems, medical devices, anticancer therapies, biological uses for hydrogels, nanotechnology, bioartificial organs, and tissue engineering

Completely revised and expanded, this state-of-the-art reference presents recent developments in polymeric biomaterials and the most up-to-date applications of biomaterials in medicine.



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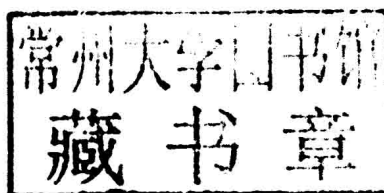
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# **POLYMERIC BIOMATERIALS**

**Medicinal and Pharmaceutical Applications**

**VOLUME 2**

## Polymeric Biomaterials

*Polymeric Biomaterials: Structure and Function, Volume 1*

*Polymeric Biomaterials: Medicinal and Pharmaceutical Applications, Volume 2*

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# Preface

The field of biomaterials has developed rapidly because of the continuous and ever-expanding practical needs of medicine and health-care practice. There are currently thousands of medical devices, diagnostic products, and disposables on the market, and the range of applications continues to grow. In addition to traditional medical devices, diagnostic products, pharmaceutical preparations, and health-care disposables, the list of biomaterials applications includes smart delivery systems for drugs, tissue cultures, engineered tissues, and hybrid organs.

Undoubtedly, biomaterials have had a major impact on the practice of contemporary medicine and patient care, resulting in both saving and improving the quality of lives of humans and animals. Modern biomaterials practice is continuing to develop into a major interdisciplinary effort involving chemists, biologists, engineers, and physicians. It also takes advantage of developments in the traditional, nonmedical materials field, and much progress has been made since the beginning of the research in biomaterials that made possible the creation of a high-quality and much improved variety of devices, implants (permanent or temporary), and drug carrier devices. All of these now display a greater than ever biocompatibility and biofunctionality. The variety of chemical substances used in these materials is currently very broad, and most biomedical applications are associated with various polymers and materials based on them.

The pace of research in the field of polymeric biomaterials is so fast that two editions of *Polymeric Biomaterials* have already been edited by Severian Dumitriu. Due to the interest generated and the success of these books, Severian was working on a third edition. Unfortunately, he passed away before this could be finalized. Many of the scientists who accepted his invitation to cooperate for this new edition agreed to contribute to the book in memory of the contribution that Severian made to the field of polymeric biomaterials. Together with Daniela, his beloved daughter, and Barbara Glunn and Jessika Vakili from Taylor & Francis Group, we decided to continue the work and finalize this book.

This book is organized in two volumes consisting of 53 chapters that systematically provide the latest developments in different aspects of polymeric biomaterials. Thus, we can mention contributions to the field of synthesis and applications of polymers such as polyesters, poly(vinyl alcohol), polyphosphazenes, elastomers, bioceramics, blends or composites, enzymatic synthesis, along with natural ones such as mucoadhesives, chitin, chitosan, lignin, carbohydrates derivatives, heparin, etc.

Drugs carriers and delivery systems, gene and nucleic acids delivery represent other subjects of some chapters, dealing with both supports (biodegradable and biocompatible) and techniques (nanoparticles, electrospinning, photo- and pH responsive polymers, hydrogels, lipid-core micelles, biomimetic systems, medical devices) aspects. In some cases, biomaterials can be synthesized, modified, and processed by different methods to ensure biocompatibility and biodegradability to be used as membranes, composites, scaffolds, and implants. Some examples of specific utilizations of polymeric biomaterials are presented, such as orthopedic surgery, bone regeneration, wound healing, dental and maxillofacial surgery applications, artificial joints, diabetes, anticancer agents and cancer therapy, modification of living cells, myocardial tissue engineering—repair and reconstruction, and bioartificial organs.

Publishing this book was accomplished with the contributions of renowned scientists from all over the world. They are all experts in their particular field of biomaterials research and have made high-level contributions to various fields of research. We are very grateful to these scientists for their willingness to contribute to this reference work as well as for their engagement. Without their commitment and enthusiasm, it would not have been possible to compile such a book.



I am also grateful to the publisher for recognizing the demand for such a book, for taking the risk to bring out such a book, and for realizing the excellent quality of the publication.

I would like to thank Daniela for her inestimable help and assistance. I dedicate this book to memory of Severian, one of my best friends.

Last but not least, I would like to thank my family for their patience. I sincerely apologize for the many hours I spent in the preparation of this book, which kept me away from them.

This book is a very useful tool for many scientists, physicians, pharmacists, engineers, and other experts in a variety of disciplines, both in academe and industry. It may not only be useful for research and development but may also be suitable for teaching.

This book has a companion CD that contains color figures as noted at the applicable text figures.

**Valentin I. Popa**

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# Acknowledgments

My father was passionate about polymeric biomaterials. He was very happy when this project was planned with Taylor & Francis Group. He had worked tirelessly toward this. He would have loved to have seen this book published, but destiny willed otherwise.

I am extremely grateful to Professor Popa for accepting to serve as the editor, to all the authors for their precious contributions, and to the staff at Taylor & Francis Group.

The positive response from the authors to pursue their contribution to this book was amazing and is testimony of their appreciation for the scientific contribution that my father made to the field of polymeric biomaterials.

I trust the book is of great quality and reflects the efforts and dedication that have been put into it by my father and all the contributors.

My small contribution to this book is dedicated to the memory of my parents, Severian and Maria, for their unconditional love and for being the best teachers ever. And to finish on a positive note, I want to cite one quote of Dr. Seuss that I particularly like:

“Don’t cry because it’s over. Smile because it happened”.

**Daniela Dumitriu**



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# Editors

**Severian Dumitriu** (deceased) was a research professor, Department of Chemical Engineering, University of Sherbrooke, Quebec, Canada. He edited several books, including *Polymeric Biomaterials*, second edition, *Polysaccharides in Medicinal Applications*, and *Polysaccharides: Structural Diversity and Functional Versatility* (all three titles were published by Taylor & Francis Group [previously Marcel Dekker]), and authored or coauthored over 190 professional papers and book chapters in the fields of polymer and cellulose chemistry, polyfunctional initiators, and bioactive polymers. He also held 15 international patents. Professor Dumitriu received his BSc (1959) and MS (1961) in chemical engineering and his PhD (1971) in macromolecular chemistry from the Polytechnic Institute of Jassy, Romania. Upon completing his doctorate, he worked with Professor G. Smets at the Catholic University of Louvain, Belgium, and was a research associate at the University of Pisa, Italy; the Hebrew University Medical School, Jerusalem, Israel; and the University of Paris, South France.

**Valentin I. Popa** earned his BSc and MSc in chemical engineering (1969) and PhD in the field of polysaccharide chemistry (1976) from Polytechnic Institute of Iasi, Romania. He was awarded the Romanian Academy Prize for his contributions in the field of seaweed chemistry (1976). He has published more than 500 papers in the following fields: wood chemistry and biotechnology, biomass complex processing, biosynthesis and biodegradation of natural compounds, allelochemicals, bioadhesives, and bioremediation. He is also the author or coauthor of 37 books or book chapters. Dr. Popa holds six patents and has been involved in many Romanian and European research projects as scientific manager. He was visiting scientist or visiting professor at Academy of Sciences (Seoul, Korea, 1972), Technical University of Helsinki (Finland, 1978), Institute of Biotechnology (Vienna, Austria, 1995), Research Institute for Pulp and Paper (Braila, Romania, 1976), “Petru Poni” Institute of Macromolecular Chemistry (Iasi, Romania, 1985, 1986), Université de Sherbrooke and University McGill (Canada, 2003), STFI-Packforsk (now known as Innventia, Stockholm, Sweden, 2008), and Institute of Wood Chemistry (Riga, Latvia, 2009). Dr. Popa is a member of the International Lignin Institute, International Association of Scientific Papermakers, International Academy of Wood Science, Romanian Academy for Technical Sciences, and American Chemical Society. He is also a professor of wood chemistry and biotechnology in “Gheorghe Asachi” Technical University of Iasi, PhD supervisor (30 students defended their theses), and editor-in-chief of *Cellulose Chemistry and Technology*.



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