Biopolymers: Biomedical and Environmental Applications

Edited by Susheel Kalia and Luc Avérous

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Preface

There is currently a tremendous interest in the latest information concerning polymer related topics. Experts predict the future availability of fossil resources (oil, natural gas and coal), which are not renewable, varies between one and three generations. Keeping in mind the deteriorating environmental conditions caused by many factors including advancements in science and technology, population expansion, global warming, etc, researchers all over the world have recently focused on biopolymers from renewable resources with much success.

This book focuses on different biopolymers and their applications in various fields. It highlights recent advances in technology in many areas from chemical synthesis and biosynthesis to end-user applications. These areas have not been covered in a single book before, and include information on biopolymers from chemical and biotechnological modifications, material structures, processing, characterization, properties, and applications.

Chapters cover nearly every conceivable topic related to polysaccharides, such as biofibers, bioplastics, biocomposites, natural rubbers, proteins, gums, and bacterial polymers. Given the global context it does not seem preposterous to consider the materials discussed as the polymers of the future.

The book distills recent research conducted by the scientific community. It is arranged in four parts. Part I, Polysaccharides, covers hyaluronic acid, chitin and chitosan, starch and other natural polysaccharides. Polysaccharides have received more attention due to their numerous advantages such as their renewability, non-toxicity, biodegradability and ready availability. This interest has resulted in a great revolution leading to polysaccharides becoming on par with, and even superior to, synthetic materials. That is why a plethora of research studies have been undertaken to understand the potential of these natural polymers.

Hyaluronic acid is a linear polysaccharide formed from disaccharide units containing N-acetyl-D-glucosamine and glucuronic acid. Since it is present in almost all biological fluids and tissues, hyaluronic acid-based materials are very useful in biomedical applications. After cellulose, chitin is the second most abundant natural polysaccharide resource on earth. Chitin and its de-acetylated derivative chitosan are natural polymers composed of N-acetylglucosamine and glucosamine. Both chitin and chitosan have excellent properties such as biodegradability, biocompatibility, non-toxicity, hemostatic activity and antimicrobial activity. Chitin and its derivatives are widely used in various fields of medicine.

Polysaccharides and their graft copolymers are finding extensive applications in diversified fields. The graft copolymerized and crosslinked polysaccharides are cost effective, biodegradable and quite efficient for use in technological processes. The end products obtained have improved properties that can be used in fields such as sustained drug delivery systems, controlled release of insecticides and pesticides to protect plants in agricultural and horticultural practices, release of water for plants during drought conditions, water treatment and membrane technology. Modified polysaccharides have found applications from permselective membranes to ionically conductive membranes for fuel cells.

Starch is the major carbohydrate reserve in higher plants and has been one of the materials of choice since the early days of human technology. Recently, starch gained new importance as a raw material in the production of bioplastics, in particular for use in the synthesis of monomers to produce polymers such as poly(lactic acid), and after chemical modification and thermomechanical processing, to produce the so-called thermoplastic starch.

Part II discusses bioplastics and biocomposites. One of the main environmental problems in industrial development is plastic waste and its disposal. An enormous part of scientific research has been directed towards environmentally benevolent bioplastics that can easily be degraded or bio-assimilated. High performance bio-based composites (biocomposites) are very economical and open up a wide range of applications.

Part III covers different biopolymers such as gums, proteins, natural rubbers and bacterial polymers and some of their applications. The genus *Cassia* has been the centre of attraction for many phytochemists throughout the world, especially in Asia. *Cassia* plants are a known source of seed gums which are usually galactomannans having close structural resemblance to many of the commercial seed gums, such as guar and locust bean gums, and are considered as non-conventional renewable reservoirs for the galactomannan seed gums. Thus, properties of *Cassia* seed gums in general can be tailored by chemical modification whereupon they can be exploited as useful dye flocculants and heavy metal adsorbents depending upon their solubility in water. Though galactomannans from *Cassia* seeds are nonionic polysaccharides, their adsorption performance is comparable with that of chitin and chitosan, and superior to other polysaccharides.

Gum Arabica is a natural plant gum that exudates a carbohydrate type and is an electroactive biopolymer. *Gum Arabica* and its complexes have potential applications in developing ionic devices such as batteries, sensors, bio-sensors, and other electronic applications, in addition to solar material, energy storage material and nanoscience. Biopolymers obtained from bacteria are rapidly emerging because they are biodegradable and available in abundance. Simple methods are being developed to grow and harvest the polymers to exploit them for numerous industrial and biomedical applications. Electronic structures and conduction properties of biopolymers are also discussed in Part III.

Part IV includes applications of various biopolymers such as seed coating to protect against biotic stress, biosorbent for the organic pollutant, pharmaceutical technology, drug delivery, and gene therapy.

Discussions in this book regarding the very important issues and topics related to biopolymers should be useful to those in the scientific community such as, scientists, academicians, research scholars, polymer engineers and specialists in other industries. The book also acts as a support for undergraduate and postgraduate students in the institutes of polymer and technology and other technical institutes. We hope it will be an exceptional book with important contributions from well-known experts from all over the world.

Both Editors would like to express their gratitude for all the excellent contributions made by the contributors to this book. We would also like to thank all who helped in the editorial work as well.

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April 2011

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