Bioactive Polymeric Systems

An Overview

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Preface

The vast array of libraries in the world bear mute witness to the truth of the 3000-year-old observation of King Solomon who stated ". . . of making many books there is no end, and much study is a weariness of the flesh." Yet books are an essential written record of our lives and the progress of science and humanity. Here is another book to add to this huge collection, but, hopefully, not just another collection of pages, but rather a book with a specific purpose to aid in alleviating the "weariness of the flesh" that could arise from much studying of other journals and books in order to obtain the basic information contained herein.

This book is about polymeric materials and biological activity, as the title notes. Polymeric materials, in the broad view taken here, would include not only synthetic polymers (e.g., polyethylene, polyvinyl chloride, polyesters, polyamides, etc.), but also the natural macromolecules (e.g., proteins, nucleic acids, polysaccharides) which compose natural tissues in humans, animals and plants. In the broad sense used here, biological activity is any type of such action whether it be in medication, pest control, plant-growth regulation, and so on. In short, this book attempts to consider, briefly, the use of any type of polymeric material system with essentially any kind of biological activity.

Many books have been written about various segments of the vast spectrum of biological activity and polymers. This book is, however, unique in its conception in that what exists in the 22 chapters are brief, introductory reviews of a wide variety of bioactive polymeric systems which are written by experts in their fields for a scientist who is *not* an expert in this specific field. The purpose of these chapters is to provide a scientist with some interest in a particular bioactive polymeric system with the basic, and relevant, information available in fields other than his or her own specialty. This will enable a specialist to examine how someone in a different field might attack a problem relevant to their own and rapidly assess how these other techniques, materials, or approaches might apply to their own research or development problems. The resulting cross-fertilization should help advance all of the various types of bioactive polymeric materials. These 22 chapters contain an aggregate of about 3000 references to other reviews and more detailed papers in the area of bioactive polymeric systems which will enable the reader to obtain further background in any desired area.

The organization of this book is centered mainly around the category of the polymeric system used to achieve the biological activity result, rather than on the end usage. The book is organized in the following manner:

Overview	Chapter 1
Controlled-Release Systems	Chapters 2–8
Special Experimental Techniques	Chapters 9 and 10
Natural Polymer Systems	Chapters 11–15
Pseudonatural Polymer Systems	Chapters 16 and 17
Synthetic Polymer Systems	Chapters 18–22

By far, the largest emphasis in this book is on medically related biological activity and various aspects of this topic can be found in Chapters 1, 2, 4, 6, 7, 12–15, and 18–22. Chapters 3, 5, 8–11, and 16–17 are mainly concerned with nonmedical applications. In actual fact, information relating to either medical or nonmedical applications can be found in nearly all the chapters and the various approaches and/or techniques delineated are often usable in either of these main areas. This is to be expected since the desired end result can often be achieved in several ways. While this theme is developed more fully in Chapter 1, the following three examples illustrate the interrelationships between the bioactive polymeric systems considered in this book.

Enzymes are obviously a biologically active system which is macromolecular. Several diseases (e.g., phenylketonuria, tyrosinosis, etc.) arise from the lack of a specific enzyme and can be treated by the administration of the appropriate enzyme. Sometimes an enzyme can be used medically in other types of disease treatment. For example, the enzyme L-asparaginase has been shown to suppress the growth of certain tumors. The catalytic activity of enzymes is not, however, limited to medical applications. Enzymes are used in various industrial processes, such as fermentation, and in laundry detergents. Some of these above applications might be done more effectively by a bound enzyme. However, since an enzyme normally contains a specific site on the macromolecule which gives rise to the bioactivity, might not this same end result be achievable with a completely synthetic polymer with the same type of site – a pseudoenzyme or an enzyme-mimetic polymer? Could the same result, potentially, be achieved by an apparently unrelated polymer structure or system?

While cancer is actually a multiplicity of diseases, we can generalize and note that the treatment of this disease often includes chemical means – the chemotherapy approach. Obviously, these agents can be enclosed in a polymeric matrix to control the release of the drug agent to the cancer and possibly make the treatment more effective. A given anticancer agent could also be readily bound to a polymer and either be released to the body or be active in the bound form. The polymeric material in either case could be a synthetic one or a natural material. Carrying this approach one step further, one could attach the anticancer agent to a bioactive polymer (natural or synthetic), such as an enzyme or an antibody, and possibly enhance the drug activity. The possibilities seem endless. Only time will reveal what approach might prove best for cancer treatment. It may well be that various kinds of cancer will respond better to different approaches.

Finally, consider the problem of the control of algae growth in a pond. The end goal is merely to prevent algae buildup in any way possible, at a reasonable expense (including labor) and considering the effect of the chemical agent on the total ecosystem. In that light, it would hardly matter whether the system was the controlled release of an algicide, an antialgae synthetic polymer, or an enzyme that destroyed the algae. The problem is how to find a method of control that would be more efficient than the periodic hand addition of an algicide.

The chapters in this book will, hopefully, bring these interrelationships into clearer focus and aid in the solution of numerous apparently unrelated problems. We especially encourage the reader to consider the use of the other more unfamiliar techniques in their own problems, where appropriate, and also to consider the use of their own approaches to other areas as might be suggested by this book.

The editors wish to thank each author for their excellent chapters. We also thank our families for their special form of assistance with this book. It would have been nearly impossible to complete this volume without their encouragement and warm smiles.

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