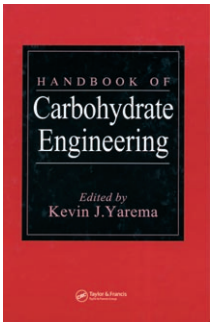
Handbook of Carbohydrate Engineering



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Carbohydrates, from simple monosaccharides to large polysaccharides, have many biomedical, nutritional, and industrial applications in modern daily life. Uses that involve the simplest sugars were developed long ago, for obvious reasons. However, recent advances in the knowledge of complex carbohydrates and their functions are focusing attention on new potential uses of carbohydrates. For example, it is now widely recognized that glycoconjugates (glycoproteins, proteoglycans, and glycolipids) have a crucial role as partners in many biochemical processes that are mediated by molecular-recognition events (development, intercellular communication, cell and tissue differentiation, etc.). In this context, even though modern glycosciences are still at an early stage, carbohydrate engineering has a great potential for the development of new biochemical and biomedical applications. This book discusses recent trends in carbohydrate engineering from that perspective.

Carbohydrate engineering, defined as the study and manipulation of carbohydrates for practical applications, has been understood in this volume in a general sense, to include not only true engineering topics concerned with the modification of these materials to exploit a particular property or application, but also basic aspects of carbohydrate science (biology, chemistry, and biochemistry). This broad perspective, as well as the inherently multidisciplinary nature of the study of carbohydrates, implies that a very broad range of subjects and techniques must be covered. Therefore, this book includes background, theories, methods, techniques, and applications that start from basic carbohydrate chemistry (such as the isolation and structural characterization of carbohydrates), or from glycobiology (such as glycosylation mechanisms or the role of oligosaccharides in diseases), and end with the applications of engineered carbohydrates as therapeutic products and with applications of a more industrial kind, such as environmental protection measures. Although such a large field cannot be treated exhaustively in a single work, the book has succeeded in presenting a comprehensive overview of potential applications of carbohydrates.

The book contains 29 chapters by 77 authors, which focus on different independent topics. Each chapter can be considered as a review in itself and read independently; some chapters include detailed experimental procedures. The diversity of the topics and the self-contained character of the chapters means that a logical straightforward organization of the chapters under general subjects is not possible. The individual table of contents for each chapter is complemented by an extensive introduction, which is a useful guide through the book, helping one to find information on specific topics.

The book places much emphasis on new methods and tools for the production of carbohydrates. The limited availability of carbohydrates with well-defined chemical structures and of tools to modify them is, without doubt, one of the bottlenecks that hinder the development of more sophisticated potential applications of carbohydrates. This obstacle is particularly severe for progress in the applications of glycoconjugates in medicine. Although it is recognized that glycans play an essential role in some glycoprotein functions, the problem of characterizing and controlling the diverse glycoforms that are produced naturally is a considerable challenge for achieving progress on potential applications of glycoconjugates. In that respect, this collection of articles provides a useful overview of the use of living cell systems (bacteria, yeast or more complex plants, insect or mammalian cells) and cell-free enzymatic methods for the preparation of complex oligo- and polysaccharides. Classical organic synthesis of carbohydrates is less important in this context, but is included in some chapters that deal with specific carbohydrate structures. The book also includes chapters describing the basic glycosylation machinery of the cell, and detailed descriptions of biosynthetic pathways for various types of carbohydrates, including both oligo- and polysaccharides. In particular, there is an extensive treatment of the application of modern genetic engineering techniques to the modification of cells or enzymes for the production of carbohydrates or recombinant glycoproteins.

The description of practical applications of carbohydrates is mainly focused on their use in biomedicine and human health, but some examples of applications in environmental protection are also discussed. This volume reviews the biological functions of some carbohydrates, such as N-glycans, glycosaminoglycans, sialic acid, or glycolipids, as potential sources of biomedical uses. Some chapters also cover carbohydrate applications in antibody engineering, vaccine development, or the use of mimetics as therapeutic products. This survey of biomedical applications of carbohydrates is completed by a description of the use of polysaccharides in tissue engineering. Two chapters are devoted to the applications of polysaccharides as vectors for drug transport or as nonviral gene delivery devices, an area of growing interest in the field of nanomedicine, with examples of their uses and future perspectives.

The book is undoubtedly intended for researchers. Although it is mainly focused on the chemical engineering area, it is also interesting for glycoscience researchers, as it includes much background knowledge on basic carbohydrate chemistry and biochemistry. In general, it provides an overview of modern applications of carbohydrates, which is attractive for anyone interested in their potential uses, from research scientists to engineers.

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