

Foreword

Carbohydrates are important biomolecules of the living world. By virtue of their diverse and complex structures, they are involved in specific cell-cell interactions and thereby participate in a variety of vital life processes. Over past twenty years carbohydrates have acquired immense importance as more and more information about their biological roles is revealed. As a result, the scientific fraternity is exploring various facets of sugars in a variety of applications in human life. For example, carbohydrate conjugation improves the solubility and specificity of the drug molecules. Likewise, carbohydrate based nanoparticles, glycoconjugates and gels offer important medical applications. In this premise, the book edited by Prof. Vinod Kumar Tiwari and Dr. Bubun Banerjee titled *"Carbohydrates in Chemistry and Biology: Decorated Compounds, Bioconjugates and Catalysts"* covers a vast canvas of carbohydrate related studies indicating that future belongs to carbohydrates. The book provides detailed information about the green synthesis, biological importance and catalytic applications of carbohydrate derivatives. This comprehensive book contains twenty chapters and I am confident that it will prove to be a good reference for researchers aspiring to venture into the fascinating field of glycans.

Chapter 1 of the book gives a brief introduction to carbohydrate-designed drugs which are revolutionizing the field of therapeutics by improving drug targeting, pharmacokinetics, and reducing side effects. This chapter delineates their applications in anticancer, antiviral, antibiotic, and anti-inflammatory treatments, highlighting their potential for precise drug delivery. Chapter 2 focuses on the structure and physico-chemical properties of different carbohydrates in pharmaceutical applications, with particular attention to their biocompatibility and biodegradability in drug delivery systems. The examples include hyaluronic acid, alginate, chitosan, dextran, cellulose, gellan, cyclodextrin, pullulan, and starch. The chapter also talks about how the modifications to their functional groups can improve drug loading and facilitate targeted release. Due to their low cost, ease of modification, and strong clinical potential, carbohydrate-based polymers present a great promise for advancing drug delivery systems in future research.

Chapter 3 covers the importance of carbohydrate based nanoparticles (CBNPs) with respect to their potential for enhancing therapeutic and diagnostic applications, owing to their unique features such as better targeting, improved bioavailability, and fewer side effects. Despite being nontoxic, biodegradable, and water-soluble, challenges in large-scale production and regulatory approvals still exist. Continued research into their synthesis and functionalization is expected to reveal new and innovative uses in medicine and biotechnology. Chapter 4 narrates how bioactive carbohydrates play crucial roles in drug discovery and development. This chapter focuses on the total synthesis of carbohydrate-decorated bioactive compounds, showcasing how these chiral molecules, originated from plants, animals, and microorganisms, can be used to create novel drugs with therapeutic potential. Chapter 5 entails chemistry of carbohydrate-decorated

O-heterocycles which show potential in drug development due to their structural diversity and enhanced biological activity. Recent advances in radical chemistry and copper-catalyzed glycosylation as well as use of deep eutectic solvents (DES) have enabled efficient synthesis of these complex molecules. Chapter 6 discusses the importance of sustainable practices in carbohydrate synthesis, highlighting the use of green solvents such as water, ionic liquids, and DES which offer a more environmentally friendly alternative to traditional organic solvents. These solvents provide advantages including stereoselectivity, high yield, and reduced reaction time.

Chapter 7 describes the role of coupling reactions in carbohydrate chemistry for enabling the formation of glycosidic bonds and the synthesis of complex carbohydrate structures. Various coupling reactions including enzymatic glycosylation, click chemistry, and transition metal catalyst leading to stereoselective installation of C-O and C-C bonds are covered. Chapter 8 focuses on triazole-based carbohydrate molecules, synthesized via click chemistry. The Cu-catalyzed azide-alkyne cycloaddition (CuAAC) click reaction has emerged as a powerful tool for creating novel therapeutic and diagnostic entities. This method has opened up new avenues for the creation of glycoconjugates with potential medicinal applications. Chapter 9 is devoted to synthesis of isothiocyanates (ITCs) which are carbohydrate based heterocycles endowed with biological properties. Chapter 10 and 11 cover ultrasound-assisted and microwave-assisted synthesis of carbohydrate derivatives, respectively.

Chapter 12 discusses how natural carbohydrate feedstocks can offer a sustainable solution for industrial preparation of bioactive compounds. Chapter 13 talks about the applications of carbohydrate-based gel forming substances (gelators) as antibacterial agents, in drug delivery, as anticancer agents, in tissue engineering and in the development of soft-optical devices, nanomaterials, and structuring agents. Chapter 14 explores the inherent potential of manufacturing ionic liquids (ILs) from abundant, renewable carbohydrates, offering a sustainable alternative to traditional chemical production methods. It highlights the unique characteristics of carbohydrate-derived ILs, such as their hydrogen-bond-rich structure, biodegradability, and low toxicity, which make them ideal candidates for applications in catalysis, biomedicine, and environmental technologies. Chapter 15 highlights the advances made in the field of carbohydrate-supported nanostructured materials used in organic transformations. Chapter 16 discusses the bioconjugation of carbohydrates including the commonly adopted strategies and the bioconjugates of carbohydrates with biomolecules such as proteins and nucleic acids. Chapter 17 describes carbohydrate polymers and their diverse applications. It covers different types of carbohydrate-based polymers, including starch, cellulose, chitin, and pectin, highlighting their structural properties and functions. The chapter also explores their industrial applications in food, pharmaceuticals, biodegradable materials, and biomedical fields, emphasizing their role in sustainable and eco-friendly solutions. Chapter 18 explores the preparation of biofuels from carbohydrates, providing an overview of their production and classification. It highlights different types of biofuels, including furan-based biofuels derived from car-

bohydrate biomass. The chapter discusses key conversion processes and their significance in sustainable energy solutions. Chapter 19 details the industrial applications of carbohydrates across various sectors, including food, pharmaceuticals, agriculture, textiles, emulsions, and the paper industry. It highlights the functional roles of carbohydrates in these industries, such as thickening agents, stabilizers, bioactive compounds, and biodegradable materials, emphasizing their importance in sustainable and innovative applications. The last chapter, i.e., Chapter 20 describes advances in carbohydrates-based metal-organic frameworks and highlights their limitations and potentials.

Overall, the book encompasses diverse areas of carbohydrate research and gives an overall perspective of the field to the readers.

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