
Preface

Glycans in proteins and lipids play key roles in modulating their structures and functions in living organisms. Functional glycomics is the study of structure–function relationships of glycans in a given biosystem. It requires the continuous development of rapid and sensitive methods for the identification of glycan structures and integration to structure–function relationships. In the recent years, a broad range of technologies is evolving rapidly to meet the needs of this field. These methods, including sample preparation, pre-fractionation, analytical separations, quantitation, mass spectrometry, microarray, bioinformatics, have advanced rapidly to support the explosive growth of application in functional glycomics. It is the aim of this book to provide new developments and emerging glycomics techniques to the researchers in the functional glycomics field. It is not solely a simple collection of methods; instead, detailed protocols have been written by world leaders in the field and demonstrated with respect to the fundamental challenges and novel applications.

A review on carbohydrate analysis is introduced at the beginning of this book (Chapters 1–3), including the nomenclatures, traditional analytical techniques, modern mass spectrometry strategies, NMR, and microarray techniques. Glycosphingolipids are the major components of the plasma membrane, which play key roles in cellular trafficking, signaling functions, and interactions with external agents. These glycolipids are important for the development of the nervous system. Lipopolysaccharides (LPS) and lipooligosaccharides (LOS), on the other hand, have important structural and functional roles in the life of a bacterial cell. In the context of functional glycomics, Chapter 4 is thus devoted to a review of human gangliosides and bacterial LOS in the development of autoimmune neuropathies. Chapter 5 introduces a synthetic approach to polyacrylamide-based glycoconjugates with biotin tag, with special emphasis on the development of carbohydrate biosensors and arrays. In general, permethylation increases the MS response by several orders of magnitude, and sequence information is readily obtained. Thus, Chapter 6 will discuss the details for using this approach to identify all isomeric glycoforms in very heterogeneous LPS preparations. In the past decade, much effort has been put into elucidating the biosynthetic pathway of O antigens. Chapter 7 deals with the development of technologies that will permit *in vitro* reconstitution of the O-repeating unit via glycosyltransferases. New strategies for the rapid determination of N-glycosylation sites and site heterogeneity are introduced in Chapters 8 and 9. These methods are rapid, reliable, and applicable to all organisms capable of producing N-linked glycans. The protein–carbohydrate interactions are discussed in Chapter 10, with an emphasis on a microarray strategy. This emerging technique presents an opportunity for high-throughput tools to speed research in glycomics. NMR spectroscopy has grown enormously in importance over the past decade in the field of functional glycomics. A highlight of its application is presented in Chapter 11. Glycosylation involves several multi-enzymatic pathways that generate a diverse and complex range of structures. One approach is the development of new enzymatic and analytical tools for structural characterization of carbohydrates and the integration with other functional “-omics”, e.g., metabolomics and lipidomics. Chapters 12 and 13, therefore, focus on new developments in the characterization of intermediates in biosynthesis

pathways. Glycans in serum are of particular interest as approximately half of all proteins are glycosylated. Chapter 14 will highlight the methods for profiling the glycans in human serum to identify glycan biomarkers. Chapter 15 describes a method for connective tissue glycosaminoglycan extraction, derivatization, and workup for subsequent capillary electrophoretic and/or mass spectrometric analysis. Mass spectrometry provides a rapid and reliable method for characterization of bacterial total glycomes. The comprehensive characterizations of bacterial protein glycosylation are presented in Chapter 16, while the direct analysis of bacterial cells allows for rapid analysis of cell surface polysaccharide antigens and provides a basis for serological typing and epidemiological surveillance studies of human and animal pathogens (Chapter 17). Finally, a case study against permethylation strategy, which has been widely used in glycomics community, is demonstrated with the analysis of fish serum N-glycans in Chapter 18. Given the importance of information integration in glycomics, the last chapter focuses on the bioinformatics platform to integrate the diverse data obtained from different technologies to allow a systems approach to glycan structure–function relationships.

Functional Glycomics: Methods and Protocols is aimed at both beginners and experienced researchers in the field of glycobiology, including biochemistry, molecular biology, cell biology, immunology, microbiology, and virology. Readers will find it very useful not just because of a variety of new techniques, but also the valuable success stories of the problem-resolving powers of a diverse set of analytical tools. This book then serves as a reference to guide researchers toward appropriate techniques and to design achievable research plans.

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