Carbohydrate-Based Vaccines

Methods and Protocols

Edited by

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Preface

Carbohydrates are the most abundant and structurally diverse molecules in nature. They are displayed on all cells in our body and form the so-called glycocalyx. However, carbohydrates are also present on pathogens such as viruses, bacteria, parasites, or fungi. These unique carbohydrate structures on the pathogen surface serve as “pathogen signatures” that are recognized as foreign by the host immune system and may finally induce a protective immune response. Since numerous glycan epitopes are highly pathogen-specific, they are promising candidates for carbohydrate-based vaccines.

The history of carbohydrate-based vaccines dates back to 1923 when Avery and Heidelberger identified the carbohydrate nature of the pneumococcal capsule derived from Streptococcus pneumoniae. Since then, tremendous progress has been made in the development of carbohydrate-based vaccines against infectious diseases as well as cancer. Some vaccines such as the Haemophilus influenzae type B, Neisseria meningitidis, or S. pneumoniae vaccine have already entered the clinic, while others are in the preclinical stage. This book aims to summarize the current status in this exciting field and details cutting-edge methods related to carbohydrate-based vaccines—from the identification of a suitable carbohydrate antigen via the preparation of glycoconjugate vaccines to the characterization of vaccine candidates for their use in preclinical and clinical studies.

In Chapter 1, Hütter and Lepenies give a historical overview on the development and success story of carbohydrate-based vaccines. Chapter 2 by Zimmermann and Lepenies discusses immunological aspects of polysaccharides and glycoconjugate vaccines and also highlights recent advances in the design of carbohydrate-based adjuvants. The central part of this book, the Methods section, starts with Chapter 3. A prerequisite for the preparation of carbohydrate-based vaccines is the identification of relevant pathogen-related glycans as described in Chapters 3 and 4. In Chapter 3, Xia and Gildersleeve present the glycan array platform to identify carbohydrate antigens including glycan microarray fabrication, microarray binding assays, and the analysis of microarray data. In Chapter 4, Ramsland, Turiel, and colleagues describe a protocol for the computational analysis of carbohydrate–protein interactions using the AutoMap software which might be a helpful tool for a rational selection of carbohydrate antigens. In Chapter 5, Anish, Seeberger, and colleagues provide a protocol for the generation of anti-carbohydrate monoclonal antibodies of high specificity, selectivity, and affinity that can be used for diagnostic and therapeutic purposes. The protocol given in Chapter 6 by Segura and colleagues details the opsonophagocytic assay as a correlate for protection to measure the functional capacities of vaccine candidate-raised antibodies.

The determination of pathogen-specific glycosylation patterns by suitable analytical tools and techniques is essential for carbohydrate antigen selection. Exemplary protocols are given in Chapters 7 and 8. In Chapter 7, Crispin and colleagues describe the glycan analysis of viral glycoproteins by ion mobility mass spectrometry, whereas in Chapter 8 Rapp and colleagues focus on the multiplexed capillary gel electrophoresis with laser-induced fluorescence detection technology (xCGE-LIF) for high-throughput glycan analysis.
The preparation of carbohydrate-based vaccines is the focus of Chapters 9 and 10. In Chapter 9, Lipinski and Bundle provide a strategy for the synthesis of glycoconjugate vaccines. In Chapter 10, Chiodo and Marradi present the preparation of gold nanoparticles as carriers for carbohydrate-based vaccines. In addition to the vaccine antigen, adjuvants are often crucial and impact vaccine efficacy. The protocol by Johannsen and Lepenies in Chapter 11 details the identification and characterization of carbohydrate-based adjuvants.

Chapters 12 and 13 deal with the characterization of carbohydrate-based vaccines. In Chapter 12, Berti and Ravenscroft focus on the characterization of carbohydrate vaccines by NMR spectroscopy whereas in Chapter 13 Harding and colleagues review the characterization of capsular polysaccharides and glycoconjugate vaccines by hydrodynamic methods. The final Chapter 14 by Jones reviews regulatory aspects of carbohydrate-based vaccines—a valuable and highly relevant addition to the book.

Although the present book is not an all-encompassing compendium of all methods related to carbohydrate-based vaccines and adjuvants, it contains a broad selection of relevant protocols. Thus, I expect this volume to be a valuable manual that will facilitate research in the field of carbohydrate-based vaccines.

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