

## Preface

IT IS SAID THAT “THIRD TIME’S A CHARM,” and we hope this third summary of the quickly evolving field of glycobiology is a significant improvement over previous editions. For historical reasons, the emphasis of the field was initially vertebrate-centric, with the broader focus mostly on glycans of multicellular animals. But glycans are major components of cell-surface and extracellular compartments in all domains of life. Rich in complexity, they are the versatile interface of cells in a hydrophilic environment. In addition, glycans appear intracellularly as modifications of other biomolecules or as energy-storing polymers. Indeed, an apparently universal rule of nature is that all cells and extracellular matrices of all species studied to date include a dense, diverse, and complex array of glycans. Evidently, natural selection repeatedly preferred organisms with major expression of glycans at cell surfaces and extracellular spaces. Thus, the glycosciences are relevant to exploring all lineages of life, and this book has been expanded accordingly. Meanwhile, material sciences, biofuels, and energy production also prominently involve glycan biopolymers and their biochemistry, biology, and structure. Expanding coverage to all these new arenas required an increase in number of editors and involvement of a broader range of expert authors. But to stay within our goal of a textbook aimed at the advanced undergraduate or early graduate student, the editors agreed to shorten most preexisting chapters—ensuring that those who buy a print copy will not strain themselves lifting it!

An emerging theme in the prior edition was that glycosylation pathway mutations in cultured cells that caused no grossly obvious defects under normal growth conditions often resulted in serious consequences for intact organisms. In keeping with these observations, many acquired human diseases have since been found to be associated with altered glycosylation. In addition, there has been an explosion in the discovery of congenital disorders arising from mutations in genes associated with glycosylation, typically with multiorgan consequences. Genome-wide and exome sequencing will likely continue to identify novel disorders of glycosylation of increasing subtlety arising from hypomorphic mutations.

One disappointment since the last edition is that the hoped-for integration of glycomics with other “omics,” and the corresponding centralization of glycan structural databases with gene and protein databases at long-term repositories like the National Center for Biotechnology Information (NCBI; at the National Library of Medicine), has not yet materialized. However, current efforts in this direction are encouraging. In this regard, another feature of this edition is the introduction of a greatly expanded symbol nomenclature for graphical representation of glycans, housed at the NCBI (see inside front cover). As with the previous edition, the editors chose to maximize utility to the community by releasing this nomenclature ahead of the book publication, after consulting with a broad range of stakeholders in the field, including experts in glyco-bioinformatics, curators of extant databases, and the IUPAC Carbohydrate Nomenclature Committee. A new feature is the linkage of glycan symbols to corresponding entries in PubChem, the NCBI database of chemical entities. Thus, a novice entering the field who wonders what a green circle represents can hover a pointer over it at the NCBI website and reveal “D-mannose,” or click on the symbol and link directly to the corresponding PubChem entry. Symbols can either be downloaded as a palette or copy/pasted, carrying along the PubChem link into some applications. A sobering realization was that expanding the nomenclature to include all monosaccharides to be mentioned in the book required a total of more than 70

symbols, and there are likely more to be added in the future! With regard to an acronym for this nomenclature, the editors agreed on the generic name, Symbol Nomenclature For Glycans (SNFG) as opposed to “Essentials of Glycobiology Nomenclature.” An SNFG discussion group will decide future changes, and will morph into a more formal steering committee, once the book is completed. As another old adage goes, “If you love something, let it go.”

This edition of the book continues a fruitful collaboration among the Editors, NCBI, and Cold Spring Harbor Laboratory (CSHL) Press that makes an online version of the book available, without charge, at the same time the print version is published. By opening online access to the book in this way, as we did with the previous edition, everyone—from the layperson to a high school student to the graduate student in a developing country—has free access to the knowledge it contains. The three partners in this initiative are extremely grateful to an anonymous benefactor who made this approach to publication possible by underwriting the publication costs to help CSHL Press avoid a financial loss on the project.

In the same spirit, the Editors of this edition agreed not to accept personally the generous share of income from sales of the book offered by CSHL Press. Instead, such funds will be devoted to the goal of furthering the impact of the book in the glycoscience community. Editors of the previous edition agreed to assign residual royalties for the same purpose. These choices allow the editors to more actively promote the book, because we have no personal financial conflict of interest in so doing. If you are reading these words in a print copy of the book that is not your own, please consider buying one and support a good cause!

A major attempt has been made to harmonize the artwork style throughout the book and very special thanks are owed to “Artwork Editor” Rick Cummings for working with everyone involved to ensure the success of this goal. Among the other Editors, special thanks are also owed to Jerry Hart, who joined me in a final read of most chapters. The contributions of the many coauthors and consultants were invaluable, and the unwavering support of leaders at the NCBI (David Lipman) and CSHL Press (John Inglis) was crucial to the success of this venture. Many individuals at the NCBI (Evan Bolton, Paul Thiessen, Marilu Hoepfner, and the NCBI Books team) and at CSHL Press (Inez Sialiano, Kathleen Bubbeo, Denise Weiss, and Jan Argentine) contributed major efforts. We are also deeply grateful to several experts and many trainees in our laboratories (see listing of names under Consultant Reviewers), who enthusiastically reviewed draft chapters and provided invaluable comments.

Absent a designated budget for the executive editor’s office, I took full advantage of the administrative support infrastructure of the Programs of Excellence in Glycosciences (Rita Sarkar, NHLBI Program Officer) and of the Glycobiology Research and Training Center (GRTC) at UC San Diego. We also used the Open Science Framework (OSF; a free, open-source web application resource) to coordinate the sharing of draft chapters among authors and editors. Special thanks are due to Susan Korosy and Tracy Gilstrap for coordinating the workflow from my office under the moniker `glycobookadmin@ucsd.edu`. This e-mail address will remain open for readers to send in bouquets, brickbats, or blunders discovered.

The knowledge base regarding the chemistry, evolution, biology, medicine, biotechnology, materials science, and energy potential of glycans has undergone a further vast expansion since the last edition of this book was published. We hope that both novice and expert readers will find this a valuable resource for exploring the fascinating world of glycans and their numerous roles in all life-forms on the planet.

Ajit Varki