Functional and Structural Proteomics of Glycoproteins

Raymond J. Owens · Joanne E. Nettleship
Editors

Functional and Structural Proteomics of Glycoproteins

Springer

Editors
Raymond J. Owens
Oxford Protein Production Facility-UK
University of Oxford
The Research Complex at Harwell
R92 Rutherford Appleton Laboratory
Harwell Science and Innovation Campus
Oxfordshire
OX11 0FA
UK
ray@strubi.ox.ac.uk

Joanne E. Nettleship
Oxford Protein Production Facility-UK
University of Oxford
The Research Complex at Harwell
R92 Rutherford Appleton Laboratory
Harwell Science and Innovation Campus
Oxfordshire
OX11 0FA
UK
joanne@strubi.ox.ac.uk

ISBN 978-90-481-9354-7 e-ISBN 978-90-481-9355-4
DOI 10.1007/978-90-481-9355-4
Springer Dordrecht Heidelberg London New York

Preface

Large-scale sequencing of the human and other mammalian genomes has created an enormous database of protein sequences for functional and structural analyses. It has been predicted that nearly half of all human proteins are glycosylated indicating the functional importance of glycoproteins in human health and disease. However, the study of glycoproteins presents major challenges. Unlike nucleic acid and amino acid sequences, the glycans attached to proteins are not directly coded for by a template. Rather, they are the result of a complex processing mechanism which acts on proteins destined for the cell surface either to be secreted or retained in the membrane. The glycans attached to proteins are no longer regarded as a byproduct of biosynthesis but are functionally significant in their own right. Importantly, these glycans have emerged as biomarkers in the diagnosis of human diseases such as cancers and play a significant role in the mechanisms by which pathogenic viruses gain entry into human cells. Manipulation of the glycosylation patterns of therapeutic antibodies has led to improvements in their mechanism of action which may ultimately translate into increased clinical efficacy.

In the last few years, technology developments, in particular, advances in high throughput separation methods and detection techniques, have accelerated the characterization of the glycosylation patterns of cells and tissues. The use of lectin microarrays coupled to highly sensitive fluorescence-based detection systems has enabled the rapid profiling of glycan expression. Structural analysis is central to understanding the function of glycosylated proteins, though due to their heterogeneity, the attached glycans make glycoproteins difficult to crystallize for x-ray crystallography. The recent development of glyco-engineering techniques coupled to rapid protein production using transient expression in mammalian cells is facilitating the structural determination of glycoproteins. Key to exploiting the information generated by functional and structural studies of glycoproteins is the organization of the primary experimental data into public databases and the development of tools to search and analyse glycan structure and composition. In this volume, the state-of-the art in all these areas is reviewed by experts in the field of glycoproteomics. We are grateful to all the contributors to this book for sharing

their experience and knowledge. We also thank Springer Verlag for the opportunity of undertaking this project and for their assistance during the production of the book.

Oxford, UK

Raymond J. Owens
Joanne E. Nettleship

Contents

Contributors

Thomas A. Bowden The Division of Structural Biology, The Wellcome Trust Centre for Human Genetics, University of Oxford, Roosevelt Drive, Oxford, OX3 7BN, UK, tom@strubi.ox.ac.uk

Jennifer C. Byrne National Institute for Bioprocessing Research and Training, Dublin-Oxford Glycobiology Group, Conway Institute for Biomolecular and Biomedical Sciences, University College Dublin, Belfield, Dublin 4, Dublin, Ireland, jennifer.byrne@nibrt.ie

Eoin F.J. Cosgrave National Institute for Bioprocessing Research and Training, Dublin-Oxford Glycobiology Group, Conway Institute for Biomolecular and Biomedical Sciences, University College Dublin, Belfield, Dublin 4, Dublin, Ireland, eoin.cosgrave@nibrt.ie

Max Crispin Department of Biochemistry, Oxford Glycobiology Institute, University of Oxford, South Parks Road, Oxford, OX1 3QU, UK, max.crispin@bioch.ox.ac.uk

Simon J. Davis Nuffield Department of Clinical Medicine and MRC Human Immunology Unit, Weatherall Institute of Molecular Medicine, University of Oxford, John Radcliffe Hospital, Oxford OX3 9DS, UK, simon.davis@ndm.ox.ac.uk

Elizabeth E. Fry The Division of Structural Biology, The Wellcome Trust Centre for Human Genetics, University of Oxford, Roosevelt Drive, Oxford, OX3 7BN, UK, liz@strubi.ox.ac.uk

Robert E. Jordan Discovery Technology Research, Biologics Research, Centocor R&D Inc, 145 King of Prussia Road, Radnor, PA 19087, USA, BJordan@its.jnj.com

David M. Knight Discovery Technology Research, Biologics Research, Centocor R&D Inc, 145 King of Prussia Road, Radnor, PA 19087, USA, DKnight4@its.jnj.com

Lakshmi Krishnamoorthy Department of Chemistry, New York University, 100 Washington Square East, Room 1001, New York, NY 10003, USA, lkrishnamoorthy@nyu.edu

Thomas Lütteke Faculty of Veterinary Medicine, Institute of Biochemistry and Endocrinology, Justus-Liebig University Gießen, Frankfurter Str. 100, 35392 Gießen, Germany, thomas.luetteke@vetmed.uni-giessen.de

Kai Maaß Department of Chemistry, Institute of Inorganic and Analytical Chemistry, Justus-Liebig University Gießen, Schubertstrasse 60, Building 16, 35392 Glessen, Germany, kai.maass@anorg.chemie.uni-giessen.de

Lara K. Mahal Department of Chemistry, New York University, 100 Washington Square East, Room 1001, New York, NY 10003, USA, lkmahal@nyu.edu

T. Shantha Raju Discovery Technology Research, Biologics Research, Centocor R&D Inc, 145 King of Prussia Road, Radnor, PA 19087, USA, traju@its.jnj.com

René Ranzinger Complex Carbohydrate Research Center, The University of Georgia, 315 Riverbend Road, Athens, Georgia 30602, USA, rr@uga.edu

Pauline M. Rudd National Institute for Bioprocessing Research and Training, Dublin-Oxford Glycobiology Group, Conway Institute for Biomolecular and Biomedical Sciences, University College Dublin, Belfield, Dublin 4, Dublin, Ireland, pauline.rudd@nibrt.ie

Radka Saldova National Institute for Bioprocessing Research and Training, Dublin-Oxford Glycobiology Group, Conway Institute for Biomolecular and Biomedical Sciences, University College Dublin, Belfield, Dublin 4, Dublin, Ireland, radka.saldova@nibrt.ie

Sasha Singh Proteomics Center at Children's Hospital Boston, Boston, MA 02115, USA; Departments of Pathology, Harvard Medical School and Children's Hospital Boston, Boston, MA 02115, USA; F. M. Kirby Neurobiology Center, Children's Hospital Boston, Boston, MA 02115, USA, sasha.singh@childrens.harvard.edu

Judith Jebanathirajah Steen Proteomics Center at Children's Hospital Boston, Boston, MA 02115, USA; F. M. Kirby Neurobiology Center, Children's Hospital Boston, Boston, MA 02115, USA; Department of Neurobiology, Harvard Medical School, Boston, MA 02115, USA, judith.steen@childrens.harvard.edu

Weston B. Struwe National Institute for Bioprocessing Research and Training, Dublin-Oxford Glycobiology Group, Conway Institute for Biomolecular and Biomedical Sciences, University College Dublin, Belfield, Dublin 4, Dublin, Ireland, weston.struwe@nibrt.ie

Morten Thaysen Andersen Department of Biochemistry and Molecular Biology, University of Southern Denmark, DK-5230 Odense M, Denmark, mta@bmb.sdu.dk