

# From Stereocontrolled Glycosylation to Automated Chemical Synthesis

Alexei V. Demchenko, PhD

*Department of Chemistry, Saint Louis University*  
3501 Laclede Ave, St. Louis, Missouri 63103, USA  
E-mail: alexei.demchenko@slu.edu; www.glyco-world.com; @glycoworld

From the building blocks of nature to disease-battling pharmaceuticals, carbohydrates have had a profound impact on evolution, society, economy, and human health. Numerous applications of these essential biomolecules in many areas of science and technology exist, most of which can be found at the forefront of therapeutic agent and diagnostic platform development. Although carbohydrates are desirable for the pharmaceutical and biomedical communities, these molecules are very challenging targets for chemists because of the need for functionalization, protecting and leaving group manipulations, controlling anomeric stereoselectivity, separation, and analysis. The development of practical methods for the synthesis of building blocks,<sup>1</sup> chemical glycosylation,<sup>2, 3</sup> and glycan assembly<sup>4</sup> represent demanding areas of research.

At the core of this presentation is the development of new methods, strategies, and technologies for the chemical synthesis of glycans. These tools will be discussed in light of recent results related to the development of new glycosylation reactions,<sup>5-7</sup> methods for controlling the stereoselectivity,<sup>8, 9</sup> and HPLC-based automated synthesis.<sup>10-12</sup> The effectiveness of methods developed will be illustrated by the synthesis of glycopharmaceuticals.<sup>13</sup> This work has been generously supported by the National Institutes of Health and the National Science Foundation.

## References

- (1) Wang, T.; Demchenko, A. V. *Org. Biomol. Chem.* **2019**, *17*, 4934-4950.
- (2) Nigudkar, S. S.; Demchenko, A. V. *Chem. Sci.* **2015**, *6*, 2687-2704.
- (3) Singh, Y.; Geringer, S.; Demchenko, A. V. *Chem. Rev.* **2022**, *122*, 11701-11758.
- (4) Panza, M.; Pistorio, S. G.; Stine, K. J.; Demchenko, A. V. *Chem. Rev.* **2018**, *118*, 8105-8150.
- (5) Singh, Y.; Demchenko, A. V. *Chem. Eur. J.* **2019**, *25*, 1461-1465.
- (6) Escopy, S.; Singh, Y.; Stine, K. J.; Demchenko, A. V. *Chem. Eur. J.* **2021**, *27*, 354-361.
- (7) Dent, A.; Escopy, S.; Demchenko, A. V. *Chem. Eur. J.* **2023**, *29*, e202300873.
- (8) Mannino, M. P.; Demchenko, A. V. *Chem. Eur. J.* **2020**, *26*, 2927-2937.
- (9) Mannino, M. P.; Demchenko, A. V. *Chem. Eur. J.* **2020**, *26*, 2938-2946.
- (10) Panza, M.; Stine, K. J.; Demchenko, A. V. *Chem. Commun.* **2020**, *56*, 1333-1336.
- (11) Escopy, S.; Singh, Y.; Stine, K. J.; Demchenko, A. V. *Chem. Eur. J.* **2022**, *28*, e202201180.
- (12) Kashiwagi, G. A.; Petrosilli, L.; Escopy, S.; Lay, L.; Stine, K. J.; Meo, C. D.; Demchenko, A. V. *Chem. Eur. J.* **2024**, *30*, e202401214.
- (13) Singh, Y.; Escopy, S.; Shadrack, M.; Bandara, M. D.; Stine, K. J.; Demchenko, A. V. *Chem. Eur. J.* **2023**, *29*, e202302288.



Department of Chemistry  
School of Science and Engineering  
Saint Louis University  
126 Monsanto Hall (Office)  
130 Monsanto Hall (Lab)  
3501 Laclede Ave.  
St. Louis, MO 63103, USA  
[alexei.demchenko@slu.edu](mailto:alexei.demchenko@slu.edu) (e-mail)  
+1 (314) 977 2898 (office)  
+1 (314) 583 3571 (cell)  
<https://www.glyco-world.com> (www)  
<http://www.twitter.com/glycoworld> (@glycoworld)  
<https://slu.zoom.us/my/glycoworld>



---

## BIOGRAPHICAL SKETCH



Alexei Demchenko was born (1965), raised, and educated in Moscow, Russia. He graduated from the Mendeleev University of Chemical Technology of Russia with a Diploma (M.S.) in Chemical Engineering (1988) before joining the laboratory of the late Professor Kochetkov at the Zelinsky Institute of Organic Chemistry in Moscow. In 1993, he was awarded a Ph.D. in organic chemistry by the Russian Academy of Sciences for his work on the development of thiocyanate methodology for glycosylation. After two post-doctoral years under Kochetkov, he joined Professor Boons' group at the University of Birmingham (UK) as a BBSRC post-doctoral research fellow. In 1998, he moved to the Complex Carbohydrate Research Center, University of Georgia (USA) as a research associate. In 2001, he joined the faculty at the University of Missouri - St. Louis (UMSL) as an Assistant Professor where he was promoted to the rank of Associate Professor with tenure (2007) and Professor (2011). In 2014, Demchenko was appointed Curators' Distinguished Professor of Chemistry and Biochemistry. In 2021, Demchenko joined the faculty at Saint Louis University as Professor and Department Chair.

Professor Demchenko received a number of professional recognitions and awards including a CAREER award by the National Science Foundation (2005), the New Investigator Award by the Division of Carbohydrate Chemistry of the American Chemical Society (ACS, 2007), the UMSL Chancellor's Award for Excellence in Research and Creativity (2013), the ACS St. Louis Award (2014), the UMSL Senior Investigator of the Year Award (2017), Fellows Award by the Academy of Science – St. Louis (2020), the UMSL Co-Investigators of the Year Award (with Keith Stine, 2020), the Melville L. Wolfrom Award by the Division of Carbohydrate Chemistry and Chemical Glycobiology of the ACS (2024), and the ACS Midwest Award (2024).

With participation of 175 trainees, Professor Demchenko has co-authored 235 articles (Scopus *H*-index 49, Scholar *H*-index 53) and has given 185 invited lectures and seminars. His research interests are in the area of synthetic carbohydrate chemistry that include: streamlined synthesis of carbohydrate building blocks; novel glycosylation reactions; methods for stereocontrolling the glycosidic bond formation; strategies for expeditious assembly of complex glycans and glycoconjugates; synthetic vaccines and glycopharmaceuticals; human milk oligosaccharides and other food additives and ingredients; solid phase and automated synthesis; modification and conjugation of glycans to protein carriers, surfaces, and nanoparticles. His research program has been funded by grants from a variety of sources totaling \$13.3M.

Professor Demchenko has served in many editorial roles and organized several international conferences including the 2015 Gordon Research Conference on Carbohydrates. From 2019, he has served as President of the U.S. Advisory Committee for the International Carbohydrate Symposia. Professor Demchenko was the 2020-2021 Chair of the Division of Carbohydrate Chemistry of the ACS. Demchenko is the National Representative of the USA for the International Carbohydrate Organization.

## PROFESSIONAL EXPERIENCE AND APPOINTMENTS

- 2021 - Professor and Chair, Department of Chemistry, Saint Louis University, USA**  
2014 - 2021 Curators' Distinguished Professor of Chemistry and Biochemistry, UM – St. Louis, USA  
2011 - 2014 Professor of Chemistry and Biochemistry, UM – St. Louis, USA  
2007 - 2011 Associate Professor and Director of Graduate Studies, UM – St. Louis, USA  
2001 - 2007 Assistant Professor of Chemistry and Biochemistry, UM – St. Louis, USA  
1998 - 2001 Research Associate (Boons), Complex Carbohydrate Research Center, Georgia, USA  
1995 - 1998 BBSRC Post-Doctoral Research Fellow (Boons), University of Birmingham, UK  
1993 - 1995 Research Associate (Kochetkov), Zelinsky Institute of Organic Chemistry, Moscow, Russia

## EDUCATION, DEGREES

- 1988 - 1993 Ph.D. in Organic Chemistry (Kochetkov), Zelinsky Institute of Organic Chemistry, Russia  
1982 - 1988 M.S. in Chemical Engineering, Mendeleev University of Chemical Technology of Russia

## RESEARCH INTERESTS

- Streamlined synthesis of regioselectively protected carbohydrate building blocks
- Novel glycosylation reactions. Stereocontrol and mechanism of chemical glycosylation
- Expedient strategies for the synthesis of complex oligosaccharides and glycoconjugates
- Synthetic glycoproteins (anti-cancer, anti-bacterial, anti-septic, etc.)
- Human milk oligosaccharides and other food additives and ingredients
- Solid phase and surface chemistry: application to automated glycan synthesis

## SELECTED AWARDS

- 2024 The Midwest Award, American Chemical Society, St. Louis Section  
2024 The Melville L. Wolfrom Award, American Chemical Society, CARB Division  
2020 Co-Investigators of the Year Award (with K. J. Stine), UM – St. Louis Office of Research  
2020 Outstanding Scientists Awards - Fellows Award, Academy of Science - St. Louis  
2017 Senior Investigator of the Year Award, UM – St. Louis Office of Research  
2014 St. Louis Award, American Chemical Society, St. Louis Section  
2013 Chancellor's Award for Excellence in Research and Creativity, UM – St. Louis  
2007 New Investigator Award, American Chemical Society, CARB Division  
2005 CAREER Award, National Science Foundation

## SELECTED PROFESSIONAL ACTIVITIES AND HONORS

- 2022 - Fellow of the Saint Louis University Research Institute  
2020 - Fellow of the Academy of Science – St. Louis  
2020 - 2021 Chair, Division of Carbohydrate Chemistry, American Chemical Society  
2019 - The National Representative of the USA for the International Carbohydrate Organization  
2019 - President of the U.S. Advisory Committee for the International Carbohydrate Symposia  
2015 Chair, Gordon Research Conference on Carbohydrates  
2012 - 2021 Associate Editor, Journal of Carbohydrate Chemistry

## SELECTED RESEARCH SUPPORT

- 2006 - 2027 National Science Foundation (CHE-0547566, 1058112, 1800350, 2147156, **2350461**)  
2006 - 2028 National Institutes of Health, NIGMS (R15 GM077170, R21 GM072693, R03 AI067494, R01 GM090254, R01 GM111835, U01 GM120673, **R35 GM152125**)

## RECENT PUBLICATIONS (SELECTED FROM 230; SCOPUS H-INDEX 49, SCHOLAR H-INDEX 53)

- G. A. Kashiwagi, L. Petrosilli, S. Escopy, et. al., *Chem. Eur. J.* **2024**, 30, e202401214 (Front cover)
- Y. Singh, S. Escopy, M. Shadrack, et. al. *Chem. Eur. J.*, **2023**, 29, e202302288
- A. Dent, S. Escopy, A. V. Demchenko. *Chem. Eur. J.*, **2023**, 29, e202300873
- Y. Singh, S. A. Geringer, and A. V. Demchenko. *Chem. Rev.*, **2022**, 122, 11701-11758
- S. Escopy, A. V. Demchenko. *Chem. Eur. J.*, **2022**, 28, e202103747 and e202201180
- S. Escopy, Y. Singh, K. J. Stine, A. V. Demchenko. *Chem. Eur. J.*, **2021**, 27, 354-361 (Hot paper)
- S. A. Geringer, Y. Singh, D. J. Hoard, A. V. Demchenko. *Chem. Eur. J.*, **2020**, 26, 8053-8063
- M. P. Mannino, A. V. Demchenko. *Chem. Eur. J.*, **2020**, 26, 2927-2937 and 2938-2946 (Hot papers)
- Y. Singh, A. V. Demchenko. *Chem. Eur. J.*, **2020**, 26, 1042-1051 (Hot paper, front cover)
- Y. Singh, A. V. Demchenko. *Chem. Eur. J.*, **2019**, 25, 1461-1465 (Top downloaded paper 2018-19)

## BOOKS EDITED

- Handbook of Chemical Glycosylation*, A. V. Demchenko Ed., Wiley-VCH, **2008**  
*Frontiers in Modern Carbohydrate Chemistry*, A. V. Demchenko Ed., ACS Symp. Ser., 960, **2007**