The Nakanishi Symposium

on Natural Products & Bioorganic Chemistry

March 17, 2026

Sponsored by
The Chemical Society of Japan
&
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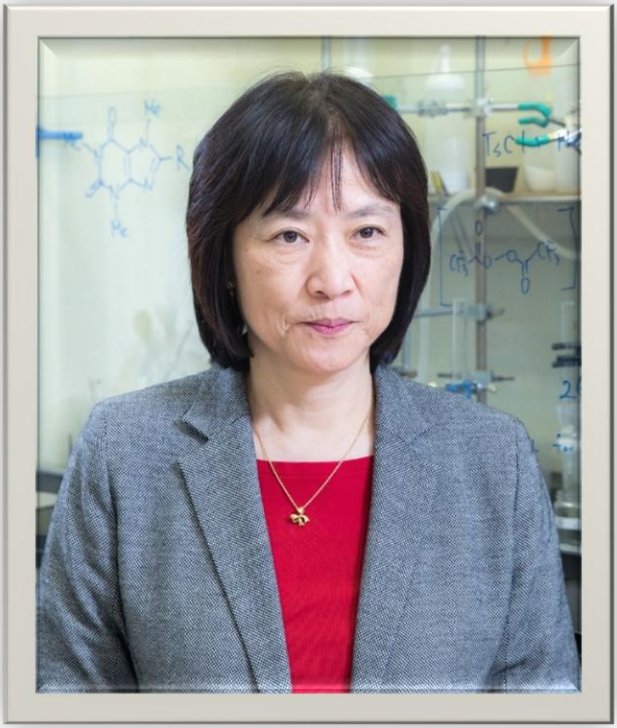

Dr. Mikiko Sodeoka

Director
RIKEN Center for Sustainable Resource Science

Mikiko Sodeoka: born in Fukuoka, Japan, and graduated from Chiba University (B. 1981, M. 1983), Researcher, Sagami Chemical Research Center (1983-1986), Research Associate, Hokkaido University (1986-1990, Prof. M. Shibasaki), D.Pharm, Chiba Univversity, 1989, Postdoctoral Fellow, Harvard University (1990-1992, Prof. E. J. Corey, G. L. Verdine), Assistant Professor, The University of Tokyo (1992-1995), Group Leader, Sagami Chemical Research Center (1996-1999), Associate Professor, The University of Tokyo (1999-2000), Professor, Tohoku University (2000-2006), Chief Scientist, RIKEN (2006-2024), Group Director, Catalysis and Integrated Research Group, RIKEN Center for Sustainable Resource Science (2013-present). Director, RIKEN Center for Sustainable Resource Science (2025-present).

Representative Awards

The Chemical Society of Japan Award for Creative Work (2004)
Nagoya Medal Prize (Silver Medal) (2007)
Fellow of American Association for the Advancement of Science (2014)
The Synthetic Organic Chemistry Award, Japan (2017)
Arthur C. Cope Scholar Award (2017)
The Pharmaceutical Society of Japan Award (2021)
IUPAC Distinguished Woman in Chemistry or Chemical Engineering (2023)
Medal with Purple Ribbon (2024)
Ryoji Noyori ACES Award, Asian Chemical Editorial Society (2025).

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Nakanishi Symposium 2026

Organized by: Nakanishi Symposium Organizing Committee

Co-organized by: The Chemical Society of Japan,
Division of Natural Products Chemistry & Biological Science

Date: Tuesday, March 17, 2026, 13:00–15:40

Venue: Funabashi Campus, CST, Nihon University

Program

13:00-13:20 **Award Ceremony of Nakanishi Prize 2026**

Congratulatory Address: Prof. Keiji Maruoka;
President, The Chemical Society of Japan

Prize Winner of the Nakanishi Prize 2026: Dr. Mikiko Sodeoka;
Director, RIKEN Center for Sustainable Resource Science,
Group Director of Catalysis and Integrated Research Group

Report on the Nakanishi Prize Selection: Chairman Minoru Ueda

13:20-15:40 **Nakanishi Symposium**

13:20- Opening Remarks
Prof. Hirokazu Arimoto *(Tohoku University)*

Presider Prof. Hiroki Oguri *(The University of Tokyo)*

13:25- "*Unlocking the Potential of Glycan Analogs via Linkage-Editing Strategy*"
Prof. Go Hirai *(Kyushu University)*

Presider Prof. Hirokazu Arimoto *(Tohoku University)*

13:50- "*Chemoproteomic Solutions for Biological Problems*"
Prof. Motonari Uesugi *(Kyoto University)*

Presider Prof. Eriko Nango *(Tohoku University)*

14:15- "*Covalent chemistry under multi-molecular crowding bio-systems for chemical biology study*"
Prof. Itaru Hamachi *(Kyoto University)*

Presider Dr. Keiko Shimamoto *(Suntory Foundation for Life Sciences)*

14:40- **Award Lecture** "*Raman Spectroscopy for Chemical Biology Research*"
Dr. Mikiko Sodeoka *(RIKEN)*

15:35- Closing Remarks
Dr. Keiko Shimamoto *(Suntory Foundation for Life Sciences)*

Unlocking the Potential of Glycan Analogs via Linkage-Editing Strategy

Go Hirai

Graduate School of Pharmaceutical Sciences, Kyushu University

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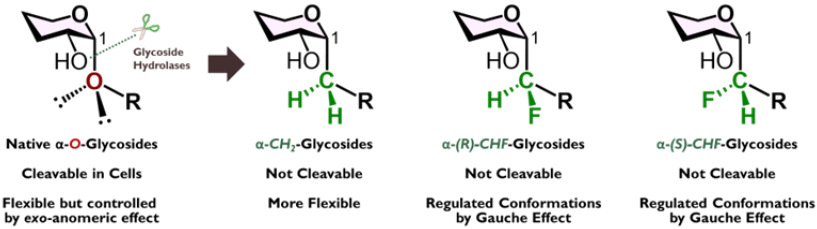
Glycans play critical roles in numerous biological processes through their interactions with proteins, including lectins and immune receptors. Unlike proteins and nucleic acids, glycans are conformationally flexible due to the nature of their glycosidic linkages, which lack strong intramolecular constraints such as hydrogen bonding or π-stacking. These flexible linkages define not only the connectivity of monosaccharide units but also the conformational distributions and motions of glycans—features that are believed to influence biological function, although experimental evidence directly linking glycan flexibility to specific biological outcomes remains limited.

On the other hand, when aiming to utilize glycans as biologically active molecules, the development of analogs with improved metabolic stability is essential. However, such efforts have significantly lagged behind due to the inherent complexity of glycan synthesis. We have developed a Linkage-Editing Strategy that systematically replaces the native O-glycosidic bond with C-based linkages, such as CH_2- and CHF-linkages, and related structures. These C-glycosidic linkages are hydrolytically stable and resistant to cleavage by glycosidases, making them attractive for biological studies and therapeutic applications. Importantly, these linkages are not mere bioisosteres of the O-glycoside—they introduce distinct steric and stereoelectronic features. Thus, linkage editing offers a dual advantage: enhancing chemical stability and altering conformational distribution, and thereby changing the biological activity.

In this lecture, I will present the conceptual basis and synthetic methodology of our Linkage-Editing Strategy, along with representative examples that demonstrate how small changes at the glycosidic linkage can unlock new biological potential. I will also discuss how this approach can be applied more broadly to the design of stable, bioactive glycan mimetics for use in chemical biology, immunology, and drug discovery. By precisely editing the connectivity and conformation of glycans, we can not only overcome limitations of natural glycosides but also create novel molecular entities that probe or control complex biological systems.



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Chemoproteomic Solutions for Biological Problems

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Our laboratory applies chemoproteomic technologies to address fundamental and medical challenges in biology. This lecture will briefly showcase three recent studies that exemplify this approach. More recent chemoproteomic approaches from our laboratory may also be discussed.

The first example is a collaboration with the group of Dr. Sodeoka, the recipient of this year's Nakanishi prize. We developed a chemoproteomic strategy to map blue-light-induced protein oxidation in live cells (1). Taking advantage of a simple alkyne probe and proteomic analysis, we identified cell surface proteins, particularly integrins, as highly susceptible to blue-light damage. Oxidized integrin beta 1 lost its adhesive and proliferative functions, providing molecular insight into blue-light-induced cellular dysfunction and aging.

Second, we created a spermidine-based chemoproteomic probe to identify spermidine-binding proteins and screen for functional analogs (2). This revealed over 140 targets, including key mitochondrial FAO enzymes such as HADHA. Guided by these insights, we discovered "spermimic," a synthetic spermidine mimic that restores mitochondrial function and augments PD-1 immunotherapy in aged mice.

Third, our combination of natural product screening and chemoproteomic analysis uncovered a plant natural product (arvenin I) as the first covalent activator of a protein kinase (3). This

unexpected mechanism enhanced antitumor immunity, establishing covalent activation as a new paradigm in kinase activation.

These studies illustrate how chemoproteomics provides molecular maps, identifies unconventional drug mechanisms, and enables the design of small molecules to solve pressing biological and medical problems.

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Covalent chemistry under multi-molecular crowding bio-systems for chemical biology study

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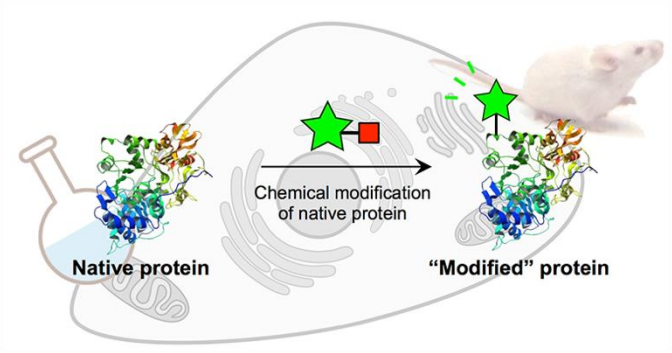
Understanding behaviors of biological molecules including proteins, DNA/RNA, various metabolites and metals under biologically relevant conditions is critically important for chemical biology study. However, it is generally difficult because these molecules function under multi-molecular and crowding environments. Various methods based on chemistry and genetic engineering have been developed to data, which contribute a lot to their analyses in molecular details. Indeed powerful, most of them are insufficient in the spatial resolution for *in vivo* dynamic systems.

There is now a strong demand for valuable methods that can analyze dynamic changes of biological molecules at high spatial resolution within the structurally delicate 3D environment (ideally genetics free) such as the live brain. It is now conceivable that converting such dynamic biological events into permanent detection signals aids their precise analysis. Activity-based labeling may be a powerful strategy used to transform transient analyte activities into chemical bond formation (or cleavage), thereby enabling later in-depth analyses such as imaging and immunohistochemistry. The utility of such labeling has been demonstrated in studies of intracellular dynamics of reactive oxygen species, calcium and transient metal ions. A recording strategy based on covalent chemistry for capturing transient/dynamic events could serve as an even more powerful methodology for analyses *in*

vivo, including those performed in the brain, where structural complexity poses substantial challenges. Here, I would like to briefly discuss recent progress of my group in covalent chemistry-driven chemical biology.



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Raman Spectroscopy for Chemical Biology Research

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We have conducted diverse research primarily focused on bioactive molecules. We have developed a variety of reactions that are useful for the synthesis of bioactive molecules. These reactions include catalytic asymmetric C-C and C-F bond-forming reactions that proceed via transition metal enolates.[1] In addition, we have been engaged in the development of molecules that demonstrate novel bioactivity and selectivity. Key achievements include the development of molecules capable of regulating chemical modifications of proteins such as phosphorylation[2] and methylation,[3] and molecules that selectively inhibit or induce a specific type of necrotic cell death.[4] We have also pursued chemical biology research aimed at elucidating the mechanisms of action of these bioactive molecules.[5] Furthermore, we have developed novel methodologies to address these objectives.

The Nakanishi Prize has been awarded for research work that extends chemical and spectroscopic methods to the study of important biological phenomena. Thus, at this symposium, I will focus on Raman spectroscopy for chemical biology research among our long-standing studies on biomolecules.

At present, fluorescence imaging is regarded as the gold standard in biological research, and the localization of a specific protein is easily visualized by fusion with a fluorescent protein. Furthermore, fluorescent probes that detect small biomolecules such as metal ions and reactive oxygen species, as well as organelle markers, are also

widely used. Nevertheless, there are problems associated with the use of fluorescence imaging in the study of small bioactive molecules. The common problem is that when a large fluorophore is introduced to a small bioactive molecule, the molecule's biological activity often decreases significantly due to the reduced affinity for the target protein and/or reduced cell permeability. To solve these problems, we had the idea to use small vibrational tags instead of large fluorescent tags.

A tiny alkyne shows a distinctive Raman signal that does not overlap with major Raman signals of endogenous biomolecules such as lipid and proteins. Therefore, alkyne-tag Raman imaging (ATRI) was anticipated to be a powerful approach for visualizing small molecules in live cells. As a proof of concept, we first succeeded in imaging of 5-ethynyl-2'-deoxyuridine (EdU) that had accumulated in the nucleus of living cells.[6] Examination of structure-Raman shift/intensity relationships revealed that alkynes conjugated to an aromatic ring and/or to a second alkyne (conjugated diynes) exhibit strong Raman signals.[7] In addition, we demonstrated that nitrile and deuterium can also serve as Raman tags for imaging.[8] Based on the basic imformation, we applied ATRI to the imaging of various small molecules.[9] We also developed a method called alkyne-tag Raman screening (ATRaS), to identify the small molecule-binding sites in its target proteins.[10]

These research achievements were made possible through collaborative studies with experts from various fields.[11] In particular, none of the research result would be produced without the groundbreaking Raman microscope developed by Professors Katsumasa Fujita and Satoshi Kawata of Osaka University, and their insights into Raman imaging. Key applications of ATRI were proposed by Professors Michio Murata of Osaka University (imaging of sphingomyelin accumulation in lipid raft-like structures), Minoru Ueda of Tohoku University (elucidation of the mechanism of action of a plant toxin), and Motonari Uesugi of Kyoto University (imaging of

chemical probes to identify photodamaged proteins). All these studies were made possible by the contributions of many coworkers, including Drs. Kosuke Dodo, Hiroyuki Yamakoshi, Jun, Ando, Shusuke Egoshi, and many others. I would like to take this opportunity to express my deepest gratitude to them.

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Go Hirai: born in 1975 and received his B.S. degree from Tohoku University, Faculty of Science in 1997, and his Ph.D. from Tohoku University, Graduate School of Science in 2002 (Prof. Masahiro Hirama). He served as an Assistant Professor at the Institute of Multidisciplinary Research for Advanced Materials (IMRAM), Tohoku University (2002–2004), followed by appointments as Research Scientist (2004–2010) and Senior Research Scientist (2010–2016) at RIKEN (Prof. Mikiko Sodeoka). In 2016, he was appointed Professor at the Graduate School of Pharmaceutical Sciences, Kyushu University, where he is currently based. He has received several awards, including the Incentive Award in Synthetic Organic Chemistry, Japan (2013), and the Thieme Chemistry Journal Award (2015).

Montanari Uesugi: born in Osaka,1967, and graduated from Kyoto University (BS 1990, PhD 1995 under the supervision of Prof. Yukio Sugiura). Dr. Uesugi is currently serving as Director & Professor, WPI-iCeMS and ICR, Kyoto University. After completing postdoctoral training in the Harvard Chemistry Department, Dr. Uesugi began his independent career at Baylor College of Medicine in Houston, where he established an interdisciplinary laboratory in the field of chemical biology. He was tenured at Baylor and moved to Kyoto University as a full professor in 2005. He is a recipient of Tokyo Techno Forum 21 Gold Medal Award (2006), German Innovation Award (2011), and Ichimura Award (2017). Dr. Uesugi and his co-workers aim to gain a fundamental understanding of biological

events through the study of small molecules. He provided the first edX course from Japan, "The Chemistry of Life," to create a new educational path for millions of learners worldwide.

Itaru Hamachi: born in 1960 and graduated from Kyoto University (B. 1979) PhD, Kyoto University (Prof. Iwao Tabushi and Teruo Matsuura) 1988, Assistant Professor, Department of Synthetic Chemistry, Kyushu University (Prof. Toyoki Kunitake: 1988-1992), Associate Professor, Department of Synthetic Chemistry, Kyushu University (Prof. Seiji Shinkai: 1992-2001), Professor, Institute of Fundamental Organic Chemistry, Kyushu University (2001-2005), Professor of Synthetic Chemistry and Biological Chemistry, Kyoto University (2005-), PREST Researcher of JST (1999-2007), CREST Researcher of JST (2008-2018), ERATO Research Director of JST (2018-2024). Nagoya Silver Medal, Chemical Society of Japan Award, UC Berkeley BASF lectureship, Peking U Xing Da lectureship

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2001 John D. Roberts
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2019 Lewis E. Kay
2020 Yoshito Kishi*
2021 Mei Hong
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2024 Minoru Isobe*
2025 Steven G. Boxer
2026 Mikiko Sodeoka*

*Selection and presentation made by the Chemical Society of Japan.

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