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Meeting Proceedings ICBS2016—Translating the Power of Chemical Biology to Clinical Advances

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The annual ICBS meetings bring together cross-disciplinary scientists from academia, nonprofit organizations, government, and industry to communicate new research findings and approaches in chemical biology. *The Fifth Annual Conference of the International Chemical Biology Society (ICBS) was held in Madison, Wisconsin, USA (October 24–26, 2016)*. This gathering followed the annual meetings in 2011–2016 that were held in Boston,¹ Kyoto,² San Francisco,³ and Berlin.⁴ The 2016 Madison, Wisconsin meeting (Figure 1) had a record 248 participants from around the globe. This year's conference theme was *"Translational Chemical Biology."* In addition to three keynote lectures, 11 scientific sessions had a total of 37 podium speakers, complemented by over 100 poster presentations. The participants were welcomed by the cochairs Michael Hoffmann (University of Wisconsin—Madison) and Melvin Reichman (Lankenau Institute for Medical Research, Wynnwood, PA), the 2015–2016 President, and 2011–2016 Board Chairman of the ICBS.

DAY 1: SCIENCE AT THE INTERFACE OF CHEMISTRY AND BIOLOGY ACROSS THE GLOBE

The scientific sessions began with a plenary keynote lecture by **Laura Kiessling** (University of Wisconsin—Madison) on chemical glycobiology (Figure 2), sponsored by *ACS Chemical Biology*. The main themes of her talk were on how the sugars present on microbes have promise as targets for antibiotics and are used by the immune system. As an example of the former, UDP-galactopyranose mutase is an enzyme involved in galactofuranose incorporation into the mycobacteria cell wall, potentially representing

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a novel drug target. Dr. Kiessling described a high throughput screen that generated “hit” compounds, followed by structure—activity relationship studies that led to useful tool compounds with low micromolar to nanomolar activity.⁵ Proteins that recognize galactofuranose could mediate microbial cells and thereby distinguish self from nonself cells. Kiessling then detailed recent mechanistic studies on the galactofuranose-binding protein human intelectin-1 using lectin microarrays.⁶ A notable finding was the exquisite selectivity of human intelectin-1 for recognizing microbial over human glycans. Structural insights from X-ray crystallography revealed a molecular recognition motif with a lectin-bound calcium coordinated *via* the 1,2-diol moiety of not only galactofuranose but other microbial sugars. These findings suggest a novel biological sensing mechanism where human host tissue can effectively survey the surrounding microbiota. Kiessling’s talk provided a backdrop for the following four sessions on the first day covering chemical biology approaches targeting the human microbiome, natural products, infectious disease, and lipids.

Session I: Human Microbiome.

Federico Rey (University of Wisconsin—Madison) presented an overview on the bacterial metabolism of flavonoids, a “superclass” of natural dietary substances with many published health-promoting actions. He also introduced an opposite example, in which gut microbes transform otherwise beneficial dietary compounds into metabolites that are harmful to the host. He described his discovery that gut microbial metabolism of dietary choline results in the production of trimethylamine, which is absorbed by the host and further converted to trimethylamine *N*-oxide (TMAO). This metabolite may have deleterious cardiovascular actions. He described how TMAO alters host gene expression, lipid profiles, and host metabolomes⁷ to illustrate the importance of understanding how the host controls gut microbial composition and *vice versa* in ways that may be important in the underlying mechanisms of metabolic diseases. **Sean Brady (Rockefeller University)** next introduced a strategy for the discovery of bioactive microbiome-derived metabolites. A screening system was described using bacterial clones transformed with metagenomes to discover and characterize bioactive metabolites and their activities on target proteins.⁸ As one example, this approach successfully identified a novel metabolite, commendamide, as a GPCR G2A/132 agonist.

Session II: Natural Products.

Lixin Zhang (East China University of Science and Technology, incoming president of ICBS) summarized approaches used by his research group for the discovery of clinically important natural compounds from microbial natural product libraries.⁹ With avermectin given as an example,¹⁰ he highlighted the power of chemical biology for modifying certain metabolic pathways to improve efficiencies and lower costs in industrial-scale production of important natural-product drugs.

Elizabeth Sattely (Stanford University) described research on synthetic biology strategies deploying plant genome sequencing to reconstitute biosynthetic pathways. This led to the characterization of the enzymes from mayapple that complete the biosynthetic pathway

of the aglycone of etoposide, whose biosynthetic pathways had long been incompletely characterized, despite its clinical importance.¹¹

Marc Chevrette (University Wisconsin—Madison) described using a large database of genome sequences from diverse bacteria to study their evolutionary trends and to identify novel metabolites with therapeutic potential.

Sanjay Malhotra (Stanford University) talked about exploiting natural products chemistry to control protein–protein interactions (PPIs). He described several successful examples of structural modifications to azapodophyllotoxins¹² and chalcones¹³ for developing compounds that are effective in modulating PPIs implicated in antibiotic resistance.

Session III: Infectious Disease.

Eric Brown (McMaster University) described a new methodology to understand the nutrient and energy pathways required by infectious microorganisms.¹⁶ Panels of metabolism-modulating drugs were used to suppress various nutrients *via* “metabolite suppression profiling.” This revealed selective vulnerabilities in pathogenic signaling pathways essential to the survival of infectious microorganisms. The talk concluded by highlighting how differences in metabolic requirements between pathogens and the host can serve as a basis for designing novel antibiotics.

Deborah Hung (Massachusetts General Hospital) described how the problem of resistance can be approached from clinical and basic scientific viewpoints by introducing successful lines of experiments to understand and control host–pathogen interactions.

Christian Hackenberger (Leibniz-Institut für Molekulare Pharmakologie im Forschungsverbund Berlin, FMP Berlin) described novel, multivalent protein scaffolds to fight infectious diseases as well as the cellular delivery of functional proteins using cyclic cell penetrating peptides.¹⁷ Multivalent ligand–receptor binding events mediate key biological interactions. Aiming to inhibit viral binding and cellular entry, multivalent glycoconjugations were made to viral capsids, showing how the valency, spatial arrangement, and ligand specificity can be tuned. The fully functionalized virus particles inhibited hemagglutinin binding and had potent antiviral actions.

Masatoshi Hagiwara (Kyoto University) described novel biological and clinical aspects for targeting drug-resistant viruses by focusing on the signaling events of the host, not those of the pathogens. He described a strategy of targeting host proteins that are indispensable for viral replication, citing cyclin-dependent kinase (CDK) 9 as an example.¹⁹ His team developed the CDK9 inhibitor FIT-039, which successfully suppressed the replication of a broad spectrum of DNA viruses *in vitro* and *in vivo*, by inhibiting viral mRNA transcription. After the successful treatment of mice infected with ACV-resistant HSV-1, FIT-039 is advancing to clinical trials at the Kyoto University Hospital for skin warts induced by hepatitis B.

Session IV: Chemical Biology of Lipids.

Ulrike Eggert (King's College London) presented studies designed to understand how membranes and membrane trafficking participate in cytokinesis. By studying the lipidome changes in dividing cells, she discovered 11 lipids, including eight sphingolipids and ceramides, that specifically accumulate in dividing cells.²⁰ After characterizing their biosynthetic pathways and examining their contributions to the mechanical properties of dividing cells, she discussed possible links of her discoveries to the question of how lipid alterations contribute to the control of cell division.

Brent Martin (University of Michigan) described how *S*-palmitoylation directs the trafficking and membrane localization of hundreds of cellular proteins *via* the coordinated palmitoylation cycle, catalyzed by protein acyl transferases and acyl protein thioesterases.²¹ He discovered how expression of the epithelial-to-mesenchymal transcription factor Snail leads to reduced plasma membrane localization and *S*-palmitoylation of the tumor suppressor scribble.²² The mislocalization of scribble, which is often observed in aggressive cancers, provided emphasis for the importance of *S*-palmitoylation in cell polarity-mediated tumor suppression.

DAY 2: TO OBSERVE AND PERTURB IN CHEMICAL BIOLOGY

Junying Yuan (Shanghai Institute of Organic Chemistry, China/Harvard University) gave the second keynote talk summarizing past and new research on apoptosis and necroptosis. After her discovery of programmed cell death in *C. elegans*,²³ she showed that a blockade of mammalian interleukin-1 β converting enzyme (later named caspase-1) blocked neuronal cell death induced by trophic factor deprivation.²⁴ After detailed characterization of apoptosis in mammalian cells,²⁵ she discovered another form of cell death named necroptosis.²⁶ She found that TNF- α orchestrates a complex interplay of ubiquitination and phosphorylation, triggering apoptosis or necroptosis. Several factors that determine entry into the necroptotic pathway were characterized, including FADD proteins and RIPK1/RIPK3. The end of the talk described her recent finding that RIPK1/RIPK3 plays a critical role in mediating progressive axonal degeneration and suggested that inhibition of RIPK1 kinase might provide an axonal protective strategy for the treatment of amyotrophic lateral sclerosis (ALS) and other diseases involving axonal degeneration. From the viewpoint of chemical biology, it is noteworthy that the development of chemical tool compounds such as necrostatins^{26b} that modulate cell death phenotypes can lead to transformative new therapies for diseases with unmet medical need.

Session V and VI: Imaging and Biosensors.

Jin Zhang (University of California San Diego) described new biosensors to probe compartmentalized signaling activities. Specifically, by using fluorescent resonance energy transfer (FRET)-based biosensors for cAMP or protein kinase A, a local negative feedback mechanism where localized PKA controls cAMP gradients in order to ensure proper axon growth in developing neurons was characterized.²⁷ She also introduced her recent work on a novel biosensing system for superhigh resolution imaging to monitor signaling activities in

cellular microdomains. These biosensors will contribute to an understanding of temporally and spatially regulated cell signaling.

Dan Yang (University of Hong Kong) described the molecular design of highly selective fluorescent probes for individual reactive oxygen or nitrogen species (ROS or RNS) and their application for monitoring activities in live cells and tissues.²⁸ Very small changes of the probe structures led to high selectivity for individual ROS or RNS.

Bryan Dickinson (University of Chicago) introduced “activity-responsive RNA polymerases” (ARs). By combining rational protein design and phage-assisted continuous evolution, he developed protease-responsive ARs.²⁹ He described the expansion of input signals, such as protein–protein interaction, and output responses, such as protein expression, gene knockdown, and nanostructure production mediated by ARs.

Keith Wood (Promega Inc.) described two novel chemical approaches for identifying and evaluating target proteins of small molecules in live cells. One was the development of a cleavable version of the chloroalkane-based small molecule tag (Halo-tag), which can be attached to a protein without greatly affecting its potency and enabling highly selective enrichment and identification of the interacting targets by means of peptide mass fingerprinting. The other was a BRET-based system composed of the target protein–NanoLuc conjugate and a cell-permeable fluorophore-conjugated small molecule.³⁰ The system can be used to evaluate binding affinity or kinetics in live cells. He also reported a novel screening approach in live cells based on the combination of the target protein–NanoLuc conjugate and cellular thermal shift assay.³¹

Xing Chen (Peking University) described a liposome-assisted chemical reporter strategy for cell-selective and tissue-specific labeling and imaging of glycosylation *in vivo*. This strategy made use of ligand-targeted liposomes as a selective carrier of azidosugars. The transported azidosugars are metabolically incorporated into the targeted cellular glycans and can then be detected by copper-free click chemistry. With this technology, he successfully conducted not only fluorescent imaging but also glycoproteomics analysis in tumors³² and the mouse brain.³³

Krysten Jones (University of California, Irvine) described imaging tools to visualize cell–cell communications by developing “caged” luciferin that was uncaged by an enzyme such as β -galactosidase or nitroreductase.³⁴ The “caged” luciferin is uncaged within cells expressing the uncaging enzyme (activator cells) and then simply diffuses. Luciferase-expressing cells (reporter cells) located near the activator cells then exhibit bioluminescence, and the bioluminescence intensity corresponds to the distance between the activator cells and reporter cells.

Session VII: Cancer.

Phil Hierer (University of British Columbia) talked about chromosome instability and synthetic lethality. Data from a yeast system showed that synthetic lethal genes were highly connected with sets of genes for maintaining chromosome stability, which are conserved in eukaryotes and often mutated or overexpressed in cancer cells.³⁵ On the basis of these

findings, he described the search for the genes that cause chromosome instability (dCIN; dosage CIN), when overexpressed in yeast. He discovered 245 dCIN genes. Moreover, he succeeded in identifying the synthetic dosage lethal (SDL) partners of some dCIN genes by means of screening in yeast. These results raised the possibility that SDL partners of dCIN genes can be used as molecular targets for new classes of anticancer drugs with selective synthetic lethality.

Siddhartha Roy (Bose Institute, India) described the development of peptide-based synthetic transcription factors for regulation of gene expression. He showed that peptide mimics of oncogenic transcription factors such as Elk1³⁶ worked as highly specific gene regulators in cancer cell lines and primary cells. His approach could provide novel tools to manipulate the expression of targeted genes with high specificity.

Daniel Rauh (Technische Universität Dortmund, Germany) described the development of chemical tools such as inhibitors,³⁷ functional probes for target protein perturbation,³⁸ and key compounds for research and treatment of drug resistance.³⁹ His work involves collaboration between academia and industry, utilizing organic synthesis, biochemistry, and structural biology.

Scott Warder (AbbVie) discussed cancer cell line profiling for identifying new target opportunities. He tested the lethality of 120 000 small molecules on 30 cancer cell lines and profiled the hit compounds against their molecular targets. Gene expression profiling was used to generate mechanistic hypotheses of drug action. By this chemical genomics approach, he succeeded in discovering new pathways and proteins contributing to drug resistance, which could offer novel anticancer drug targets.

Session VIII: Young Chemical Biologist Rising Star Awards.

This session was sponsored by *ACS Chemical Biology* for showcasing the work of up-and-coming chemical biologists, selected by a “peer-review” panel comprised of past awardees.

William Pomerantz (University of Minnesota) presented his research in fragment-based small molecule discovery approaches for epigenetic proteins. A cornerstone of the approach was a metabolic labeling method for proteins using fluorinated amino acids. This approach enabled a protein-based ¹⁹F NMR method for small molecule screening (PrOF NMR),⁴⁰ analogous to the SAR by NMR⁴¹ studies of Steve Fesik and co-workers. His talk initially focused on method development to improve the screening efficiency and time demands for drug discovery against protein–protein interactions.⁴² The second part of his talk provided several vignettes on the uses of PrOF NMR for developing inhibitors for bromodomain-containing proteins, Brd4, BrdT, and BPTF.⁴³ The BPTF inhibitor⁴⁴ combined with recent studies⁴⁵ provides a potentially new mechanism for regulating c-myc, an oncogene dysregulated in 80% of cancers.

Yimon Aye (Cornell University) described a new methodology for tracking electrophile signaling in a target-dependent manner,⁴⁶ trademarked T-REX (targetable reactive electrophiles and oxidants).⁴⁷ She described a photocaged 4-hydroxynonenal appended to a chloroalkane for in-cell delivery to a HaloTag protein construct. Due to the availability of

over 20 000 HaloTag-protein constructs, the method is feasible for screening many proteins. A key insight was that upon in-cell irradiation, there is a stoichiometric release (rather than a large excess) of the nascent electrophile for protein adduct formation. Model studies were described with the antioxidant signaling protein Keap1, a current drug target for modulating antioxidant and inflammatory responses.⁴⁶ She concluded her talk by describing how T-REX could be used to screen for AKT modulators in live cells and zebrafish.⁴⁸

Ratmir Derda (University of Alberta) concluded the session, presenting an enhanced phage display methodology for developing post-translationally modified peptide libraries for challenging protein targets. Molecular evolution approaches using genetically encoded libraries⁴⁹ continue to gain traction in the field of ligand discovery. A variety of on-phage synthetic modifications were described, including oxime ligations,⁵⁰ cysteine mediated macrocyclizations,⁵¹ and 2-aminobenzamidoxime and aldehyde capture (ABAO) reactions.⁵² The utility of the expanded peptide phage library was demonstrated in several applications for ligand discovery against lectin concanavalin A⁵³ and glycopeptide antigens for tuberculosis-specific antibodies. He concluded his talk with a novel de-encoding step for deconvoluting multistep on-phage reactions.⁵⁴

DAY 3: CHEMICAL BIOLOGY BEYOND THE GENOME

Session IX: Epigenetics.

Tapas Kundu (Jawaharlal Nehru Centre) began with a historical perspective of his group's work on acetyltransferase inhibitors from natural products such as embelin⁵⁹ and the testing of their therapeutic potential as both anti-HIV and anticancer agents. He finished his talk, focusing on the p300/CBP HATs, disclosing a small molecule activator. Due the role of p300/CBP in neuroplasticity and long-term memory, he showed that the molecule could enhance neurogenesis.⁶⁰ The final discussion highlighted an interesting mechanism for treating Alzheimer's disease.

Jonathan Baell (Monash University) described a high-throughput screening campaign on the MYST family of HATs.⁶¹ Baell described extensive structure-activity-relationship and structural-biology data that led to a 4 nM inhibitor, WM-8014, with selectivity for KAT6A and KAT6B. Biological activity that correlates with H3K9 acetylation levels and KAT6A knockouts supports the potential for development of this new HAT-specific chemical probe as a therapeutic. However, Professor Baell again cautioned the community against promiscuous compound classes in synthetic and natural product libraries that are pan-assay interference compounds (PAINS), which can confound biological interpretations and medicinal chemistry campaigns. He recommended a series of steps that have been published by his group to avoid these medicinal-lead decoys.⁶²

Xiang David Li (University of Hong Kong) spoke on development of a photoaffinity proteomic method (CLASPI) for identifying the respective writers, readers, and erasers of new and established epigenetic modifications.⁶³ A new finding described was the identification of Sirt3, a decrotonylase,⁶⁴ complementing the discoveries of the YEATS domain reader⁶⁵ and p300 writer⁶⁶ of crotonylated lysine. He finished his talk describing the

development and application of photo-Lys,⁶⁷ a diazine photoaffinity reagent as a general tool for identifying novel epigenetic regulators.

Dong Wong (University of California—San Diego) discussed chemical and structural biology approaches to study transcriptional fidelity. The first part of the talk discussed the application of synthetic nucleic acids for assessing the structural and molecular requirements for Pol II-mediated transcription.⁶⁸ The second half of the talk explored the use of small molecule fluorescent probes to study the molecular mechanism of TET-dependent DNA methylation. These studies elucidated the role of Pol II in discriminating novel epigenetic marks, namely, 5-formyl cytosine and 5-carboxycytosine for modulating transcription.⁶⁹

Rong Huang (Virginia Commonwealth University) covered chemical biology approaches for studying the N-terminal methyl transferase (NTMT1). Biochemical characterization of unique substrates for NTMT1 were described that led to the establishment of the catalytic mechanism.⁷⁰ Subsequently, bisubstrate inhibitors were designed based on a modular construction of SAM analogs and peptide substrates with nanomolar potencies.⁷¹ A fluorescent photoaffinity probe was also designed, based on substrate recognition studies, for labeling NTMT1 and is a potential new tool to probe the cellular biology of this epigenetic regulatory enzyme.

Session X: Neurodegenerative and Neurological Disorders.

Rick Silverman (Northwestern University) described the development of two new lead-compound series from a high throughput screening campaign for the treatment of amyotrophic lateral sclerosis (ALS). Up to 20% of familial ALS diagnoses are associated with a mutation in Cu/Zn superoxide dismutase 1 (SOD1), leading to protein aggregation and cytotoxicity.⁷² Silverman detailed three compounds that disrupt SOD1 aggregation. These compounds provide cytoprotection *in vitro*, display promising *in vitro/in vivo* pharmacokinetics and high blood–brain barrier penetration, and extend life in mutant SOD1 mice models.⁷³ Silverman concluded with a description of a possible new paradigm for the treatment of ALS.

Lalit Sharma (St. Jude Children’s Research Hospital) described the design of probes to study coenzyme A (CoA) metabolism. The metabolism of CoA is regulated at the pantothenate kinase (PanK) step. The design of activators and inhibitors of this family of enzymes may provide opportunities to treat PanK-associated neurodegeneration (PKAN) and diabetes, respectively.⁷⁴ Sharma reported the discovery of inhibitors and activators of PanK in order to probe their potential therapeutic utilities.⁷⁵

Michael Finley (Merck and Co.) described a high throughput screen to discover selective inhibitors of Asc-1, a Na⁺-independent amino acid transporter localized to brain regions involved in cognition.⁷⁶ Asc-1 inhibition may lead to increased NMDAR function, which can be used as a novel, “negative cognitive symptom” treatment for schizophrenia. After developing a whole-cell uptake assay utilizing radiolabeled cysteine, 3 million compounds were screened, with the top performing compounds confirmed and assayed in a radiolabeled tyrosine counter-screen. They were then expanded and clustered into unique structural

groups, from which three series arose. Compounds were then optimized to submicromolar potency. Lead compounds are under consideration for schizophrenia therapeutics.

Kallie A. Mix (University of Wisconsin—Madison) described recent progress in bioorthogonal chemistry for protein modification with diazo compounds⁷⁷ as a means for promoting cellular delivery by attaching tunable diazo labels to the surface of proteins of interest. Parameters discussed included the kinetics of incorporation, the electronic characteristics and lipophilicity of the diazo reagent, as well as proof of concept studies in which GFP was delivered to the cytosol of cells. A potential future direction for this project is targeted delivery of therapeutic proteins.⁷⁸

Session XI: Regenerative Medicine.

Ellen Heber-Katz (Lankenau Institute for Medical Research and Thomas Jefferson University) described her characterization of the first mouse model of mammalian regeneration, the MRL auto-immune mouse.⁷⁹ Through genetic studies, p21cip1/waf1 and HIF-1 α were identified as two genes required for regenerative healing. She next described a small molecule, 1,4-DPCA, a proline hydroxylase domain inhibitor that by stabilizing HIF-1 α and inhibiting p21 levels elicited regeneration in the non-regenerative B6 murine strain, measured by punched ear-hole closures and other responses. The key point was the ability to regenerate completely all injured tissues *in situ* and to attain first dedifferentiation and then redifferentiation without the addition of any cells using this small molecule over a short period of time.

Shen Ding (University of California San Francisco) introduced his attempts to control cellular fate by the use of small molecules. One of the achievements described in his talk was the control of fibroblasts' fate, leading to pluripotency and differentiation of cardiomyocytes.⁸⁰ By using various combinations from among nine small molecules, he successfully induced cellular acquisition of pluripotency and differentiation.

Together, the talks in this session illustrated the potential power of simple compounds to elicit regenerative responses and control cellular fates, respectively.

The **third keynote speaker** and conference closer was **Kai Johnsson (École Polytechnique Fédérale de Lausanne)**. His achievements in establishing the novel protein-labeling technique using *O*⁶-alkylguanine alkyltransferase (AGT; or SNAP-tag) are well-known.⁸¹ He described more recent research for the design of semisynthetic biosensors, with both the high selectivity of protein sensors and the high functionality of small molecules.⁸² After reviewing some published examples,⁸³ he described the design of a novel semisynthetic sensor to measure cellular concentrations of the redox cofactors nicotinamide adenine dinucleotide (NAD⁺/NADH) and its 2-ribosyl-phosphate (NADP⁺/NADPH).⁸⁴ Application of the research for point-of-care drug monitoring was envisioned at the end of the talk.

CONCLUDING REMARKS AND OUTLOOK TOWARD SHANGHAI IN 2017

Student Poster Awards.

The meeting program also included 121 poster presentations, from which the following students were selected for an award by a committee comprised of several ICBS Board members. They winners were Michelle Boursier (UW Madison, “Non-Native Modulators of the RhlR Quorum Sensing Receptor in *P. Aeruginosa*”), Ryan Denu (UW Madison, “Chemical Genetics and Multiplex Proteomics Reveal Potential Substrates of Polo-like Kinase 4 (PLK4), the Master Regulator of Centriole Duplication”), Jordan Ho (UW Madison, “Manipulation and Inhibition of Mycobacterial Galactan Biosynthesis”), and Pei Liu (UC Berkeley, “Genomic Mining for New FtmOx1 Paralogs and Their Derived Natural Products”).

Post-Meeting Workshop.

Immediately following ICBS2016, an assay guidance workshop was held at Promega Inc.’s facility outside of Madison, Wisconsin. More than 40 participants discussed guidelines for the development of high quality assays for high-throughput screening and bioanalysis, including data analysis approaches.⁸⁵ The workshop was led by eight speakers: Nathan P. Coussens and G. Sitta Sittampalam (NIH/NCATS), Terry Riss (Promega Corp.), O. Joseph Trask, Jr. (PerkinElmer, Inc.), Jayme L. Dahlin (Brigham and Women’s Hospital), Thomas D. Y. Chung, (Mayo Clinic), and V. Devanarayan and Jeffrey R. Weidner (Abbvie).

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Figure 1.

Three important axes in current chemical biology. The annual ICBS meeting is designed to bridge disciplines and research segments that translate the power of chemical biology to clinical advances. Images from research described at the meeting in a clockwise direction include an in-cell and whole organismal image of redox-sensitive molecules from the Aye lab, a genetically encodable lysine mimetic for photo-cross-linking from the Li lab, bioorthogonal reaction discovery from the Raines lab, a new inhibitor for neurodegenerative disorders from the Silverman lab, and fragment-based screening using ^{19}F NMR from the Pomerantz lab and Eli Lilly.

Figure 2.

Keynote lecture by Laura Kiessling. The photo is reproduced with permission from the International Chemical Biology Society from the ICBS Web site (<http://www.chemical-biology.org/page/PictureGallery2016>). A ribbon diagram of human intelectin-1 in complex with allyl-beta-galactofuranose (PDB ID 4WMY) is shown at the top right, indicating an important mode of sugar molecular recognition with a structural calcium ion.

Figure 3. Board of Directors—ICBS. The photo was taken at the Annual Board Meeting held in Madison this year and is reproduced with permission from the International Chemical Biology Society from the ICBS Web site (<http://www.chemical-biology.org/page/PictureGallery2016>).