10\textsuperscript{th} Annual
Midwest Carbohydrate and Glycobiology Symposium

at the University of Michigan

October 17\textsuperscript{th} - 18\textsuperscript{th}, 2014

Organized by: Dr. Pavel Nagorny
10th Annual Midwest Carbohydrate and Glycobiology Symposium
Schedule of Events

All talks will be held in the Chemistry building, 930 N. University Avenue, Ann Arbor MI 48109. Registration, poster sessions, lunch will take place in the atrium of the Chemistry building.

Friday, October 17th 2014:

5:30 - 6:00 pm: Registration and poster set-up.

6:00 - 6:10 pm: Introduction and welcome by Prof. Pavel Nagorny, University of Michigan

6:10 - 7:00 pm: Invited lecture by Prof. Jianglong Zhu, The University of Toledo

“Stereoselective Synthesis of Biologically Significant O- and S-linked 2-Deoxy Sugars”

7:00 - 7:15 pm: Oral presentation by Qian Qin, Michigan State University

“Glycopolymer Platform for Tumor-Associated Carbohydrate Antigen Presentation as Potential Anti-Cancer Vaccines”

7:15 - 7:30 pm: Oral presentation by Sri Kumar Veleti, The University of Toledo

“Synthesis and Inhibition Studies of Substrate Analog and Transition-State Inhibitors for Mycobacterium tuberculosis GlgE”

7:30 - 7:40 pm: Intermission

7:40 - 7:55 pm: Oral presentation by Jordan Walk, University of Michigan

“Sugar Silanes: Versatile Reagents for Stereocontrolled Glycosylation via Intramolecular Aglycone Delivery”

7:55 - 8:30 pm: Invited lecture by Prof. Benjamin Swarts, Central Michigan University
“Chemoenzymatic Synthesis of Trehalose Analogues: Rapid Access to Chemical Probes for Investigating Mycobacteria”

End of Friday’s scheduled events.

Saturday, October 18th, 2014:

8:00 - 8:45 am: Coffee and poster setup and viewing.

8:45 - 9:35 am: Invited lecture by Prof. Xiangqun Zeng, Oakland University

“Carbohydrate-Protein Interactions and their Biosensing Applications”

9:35 - 9:50 am: Oral presentation by Dan Wang, Cleveland State University

“Profiling Sialylation Status of Macrophage upon Cell Activation”

9:50 - 10:00 am: Intermission

10:00 - 10:15 am: Oral presentation by Herbert Kavunja, Michigan State University

“Identification, Profiling and Purification of Sugar-Binding Proteins from Cancer Cells using Magnetic Glyconanoparticles”

10:15 - 11:05 am: Invited lecture by Prof. Isaac J. Krauss, Brandeis University

“Combining Organic Synthesis and Directed Evolution to Design HIV Vaccine Candidates”

11:05 - 11:20 am: Oral presentation by Ross Mancini, University of Toronto

“Organoboron-Promoted Regioselective Glycosylations in Oligosaccharide Synthesis”

11:20 - 11:30 am: Intermission
11:30 - 11:45 am: Oral presentation by Ravi Sankar Loka, University of Iowa

“Synthesis of Heparin Sulfate Ligands via Nickel Catalysis and Chemoselective Sulfonation”

11:45 am - 12:40 pm: Lunch break and poster viewing

12:40 - 1:30 pm: Invited lecture by Prof. Mark S. Taylor, University of Toronto

“Organoboron Catalysts for Regioselective Activation of Carbohydrates”

1:30 - 1:45 pm: Oral presentation by Jeffrey Davidson, University of Guelph

“Comparative Study of Glycosylation at O-3 with N-Trichloroacetyl-D-Glucosamine and N-Acetyl-D-Glucosamine Derivatives”

1:45 - 2:35 pm: Invited lecture by Prof. Wenjun Du, Central Michigan University

“Efficient Syntheses of Polysaccharides and their Biomedical Applications”

2:35 - 2:50 pm: Oral presentation by Matthew McConnell, University of Iowa

“Carbohydrate-Functionalized Bivalent Polymers to Investigate the Predictable Tunability of Multivalent Interactions”

2:50 - 3:40 pm: Invited lecture by Prof. Peter Andreana, The University of Toledo

“Entirely Carbohydrate-Based Cancer Vaccines for Disease Prevention and Treatment”

3:40 - 4:40 pm: Poster Session

4:40 - 5:40 pm: Keynote Speaker Prof. Peng George Wang, Georgia State University

“Based on Current Chemical and Enzymatic Synthesis, So Close We are to a Commonly Existing Glycomic Library?”

5:40 - 6:00 pm: Meeting of the Principal Investigators
6:00 - 6:15 pm: Concluding remarks and awards ceremony

6:30 pm: Served dinner at The Original Cottage Inn

End of all scheduled events.

The rest of this program contains the abstracts of the work presented, beginning with the oral presentations, listed in order of time of talk, and concluding with poster titles, listed in alphabetical order of presenter name. Poster numbers are included to help locate the posters of most interest to you.

We hope you have enjoyed this year’s symposium. Thank you for visiting us at the University of Michigan. If you have any questions regarding this year’s event, please contact us at 10mcgs@gmail.com.
Invited Lectures and Oral Presentations:

**Stereoselective Synthesis of Biologically Significant O- and S-linked 2-Deoxy Sugars**

*Jianlong Zhu*
*The University of Toledo*

2-Deoxy sugars, especially 2,6-dideoxy and 2,3,6-trideoxy sugars are an important class of carbohydrates which exist in numerous biologically active natural products and clinical agents. These sugars have been found to play critical roles in their biological activity as well as stability and solubility. Although considerable synthetic studies have been reported, development of efficient tools for stereoselective preparation of 2-deoxy glycosides is of constant interest in the organic community. In this presentation, I will discuss new glycosylation methods for stereoselective synthesis of 2-deoxy sugars as well as “non-hydrolyzable” S-linked 2-deoxy sugars developed in our group. These O- and S-linked 2-deoxy sugars will be investigated for their structure and activity relationship (SAR) studies.

**Glycopolymer Platform for Tumor-Associated Carbohydrate Antigen Presentation as Potential Anti-Cancer Vaccines**

*Qian Qin, Zhaojun Yin, Philip Bentley, Xuefei Huang*
*Michigan State University*

Tumor-associated carbohydrate antigens (TACAs) are over expressed on tumor cells, which renders them attractive targets for anti-cancer vaccines. To overcome the poor immunogenicity of TACAs, we designed and synthesized a polymer platform via cyanoxyl-mediated free radical polymerization for antigen presentation by taking advantage of the polymeric backbone to incorporate both TACA and helper T (Th) cell epitopes on the same chain. Immunology studies were carried out to evaluate the efficacy of the glycopolymer as a potential cancer vaccine. The glycopolymer vaccine was able to elicit a robust T
cell-dependent immune response and the antibodies generated recognized Tn antigens on the tumor cell surface.

**Synthesis and Inhibition Studies of Substrate Analog and Transition-State Inhibitor for Mycobacterium tuberculosis GlgE**

*Sri Kumar Veleti, Jared J. Lindenberger, Sandeep Thanna, Donald R. Ronning, Steven J. Sucheck
The University of Toledo*

The appearance of extensively drug-resistant tuberculosis (XDR-TB) and multi drug -resistant tuberculosis (MDR-TB) demands the need to identify new anti-tuberculosis drug targets as well as to explore essential biosynthetic pathways. GlgE is a maltosyl transferase enzyme involved in α-glucan synthesis present in *Mycobacterium tuberculosis* (*Mtbt*). Mutating GlgE in *Mtbt* would accumulate maltose-1- phosphate (M1P) within cells leading to rapid death of the organism. To inhibit GlgE, a maltose-C-phosphonate (MCP) was designed to act as an isosteric, non-hydrolysable mimic of M1P a substrate for GlgE. On the other hand, we have designed 2,5-dideoxy-3-<sup>O</sup>-<sup>α</sup>-D-glucopyranosyl-2,5-imino-<sup>D</sup>-mannitol to act as a transition-state inhibitor of GlgE. The nitrogen atom present in the molecule has the ability to become protonated to maintain a positive charge at physiological pH that permits strong interactions with a carboxylate group found in the active site of this enzyme class. The carboxylate is predicted to stabilize the positive charge that develops in the transition state. MCP and 2,5-dideoxy-3-<sup>O</sup>-<sup>α</sup>-<sup>D</sup>-glucopyranosyl-2,5-imino-<sup>D</sup>-mannitol inhibited both Mtbt GlgE with an IC50 = 230 ± 24 μM and Ki = 237 ± 27 μM, respectively. We also tested inhibition on variant of *Streptomyces coelicolor* (Sco) GlgEI-V279S with 2,5-dideoxy-3-<sup>O</sup>-<sup>α</sup>-<sup>D</sup>-glucopyranosyl-2,5-imino-<sup>D</sup>-mannitol and observed Ki = 102 ± 7.52. The results confirm that a Sco GlgEI-V279S variant can be used as a model for Mtbt GlgE for which we designed a lead transition state inhibitor of GlgE.
Sugar Silanes: Versatile Reagents for Stereocontrolled Glycosylation via Intramolecular Aglycone Delivery

Jordan Walk
University of Michigan

Carbohydrates play many roles in the complex biological systems found within nature. An important goal in carbohydrate chemistry is the development of diastereoselective glycosylation methods to incorporate carbohydrates in an expedient and high yielding fashion. Intramolecular glycosylation is an approach whereby a glycosyl donor and acceptor are tethered together and subsequent activation of the donor results in diastereoselective transfer of the aglycone to the anomeric position. Previous work in the Montgomery group has focused on the development of carbohydrate-bearing silane reducing agents termed “sugar silanes.” Using these reagents, the direct reductive glycosylation of carbonyl substrates and the three-component assembly of glycosylated products via the catalytic union of aldehydes, alkynes, and sugar silanes is possible. We now describe a new method for the dehydrogenative silylation of alcohols using sugar silanes followed by intramolecular glycosylation. Appropriate combinations of silane position and protecting group allow highly selective access to β-manno, α-gluco, or β-gluco stereochemical relationships as well as β-2-azido and β-2-deoxyglycosides. Expanding upon the more traditional tethering at the 2-hydroxyl group of the donor, the 6-hydroxyl is utilized for tethering to give the first general method to obtain 1,2-trans glycosides via intramolecular aglycone delivery.

Chemoenzymatic Synthesis of Trehalose Analogues: Rapid Access to Chemical Probes for Investigating Mycobacteria

Benjamin Swarts
Central Michigan University

Trehalose analogues are emerging as valuable tools for investigating Mycobacterium tuberculosis, but progress in this area is slow due to the difficulty in synthesizing these compounds. Here, we report a chemoenzymatic synthesis
of trehalose analogues that employs the heat-stable enzyme trehalose synthase (TreT) from the hyperthermophile *Thermoproteus tenax*. Using TreT, various trehalose analogues were prepared quickly (1 h) in high yield (up to >99%) in a single step from readily available glucose analogues. To demonstrate the utility of this method in mycobacteria research, we performed a simple “one-pot metabolic labeling” experiment that accomplished probe synthesis, metabolic labeling, and imaging of *M. smegmatis* in a single day using only TreT and commercially available materials.

**Carbohydrate-Protein Interactions and their Biosensing Applications**

*Xiangqun Zeng, Fen Ma, Haiying Liu*

*Oakland University*

Bacterial cell surface carbohydrates (glycans) and adhesion molecules are major components of the outer surface of cells and are often characteristic of the cell types. Discrimination can be achieved by use of carbohydrate and lectin biosensor interfaces that monitor the presence of protein and carbohydrate biomarkers within the organism or on the bacterial cell surface. Bacteria detection using carbohydrate is a particularly promising approach to point-of-care applications because it offers greater flexibility to different strains of bacteria and is more stable, easier and cheaper to fabricate and store than antibody-based device. In spite of these compelling advantages, examples of carbohydrate being employed in the point of care biological detection systems are currently rare. The challenges of using carbohydrate recognition for detection mainly come from the weak affinity of carbohydrate-protein interaction, and the less developed high-information content, real-time and label-free assay technology.

In this presentation, we will give examples of label-free carbohydrate-based biosensors that allow for a multitude of discrete carbohydrate-protein interactions of bacterial cells to be observed simultaneously. Particularly, we will show glycosylated conductive polymer as a new biointerface to achieve the electrochemical signal transduction of carbohydrate-protein interactions. Glycosylated conductive polymers’ unique collective properties are very sensitive to very minor perturbations, which result in significant changes of
electrical conductivity and provide amplified sensitivity for quantifying carbohydrate-protein interactions. Very importantly, this new biointerface can be used for label free and reagentless detection, both by electrochemical and Quartz Crystal Microbalance (EQCM) transducers, and by using the direct fimbriae protein-carbohydrate binding as well as lectin mediated lipopolysaccharides (LPS)-carbohydrate binding. For example, glycosylation of quinone-fused polythiophene was shown to effectively transduce the binding of LPS-Con A-mannose or fimbriae protein binding with mannose into a current signal.

This integrated and orthogonal approach provided an enhanced sensitivity and limits of detection (e.g., 25 cell/mL for electrochemical sensor and 50 cell/mL for QCM sensor), a widened logarithmic range of detection (i.e., 3-7 for pili-mannose binding and 2-8 for Con A mediated binding), high specificity and selectivity, and an extraordinary reliability by a mechanism of internal validation. With these analytical performances, the described carbohydrate biosensor is envisaged for being capable of differentiating gram negative bacterial strain and species, for their use as a point of care diagnosis of bacterial infection using low cost and label free EQCM transducers.

Profiling Sialylation Status of Macrophage upon Cell Activation

Dan Wang, Huan Nie, Evgeny Ozhegov, Aimin Zhou, Xue-Long Sun
Cleveland State University

Sialic acids (SAs) are widely expressed on immune cells and their levels and linkages named as sialylation status may vary upon cell activation related to either physiological or pathological processes. In this study, we performed global profiling of sialylation status of macrophages upon activation including quantitation of the released SAs in the cell culture medium. Results of flow cytometry and confocal microscopy showed that cell surface α-2,3 linked SAs were predominant and changed slightly upon activation with atorvastatin for 24 hrs, while α-2,6 linked SAs were negligible in normal culture condition, but significantly increased upon activation. Meanwhile the amount of total cellular SAs increased from 369 ± 29 ng/mL to (1.08 ± 0.05) ×103 ng/mL after cell activation. However, there were no significant changes for secreted free SAs,
conjugated SAs, and total SAs in the medium as determined by LC-MS/MS method. These results indicate that cell surface sialylation status of macrophage changes distinctly after activation, which may reflect on the biological functions of the cells. Results of this work will contribute to a better understanding of the biological and pathological roles of SAs in immune system.

**Identification, Profiling and Purification of Sugar-Binding Proteins from Cancer Cells Using Magnetic Glyconanoparticles**

_Herbert Kavunja, Mohammad El-Dakdouki, John Wang, Xuefei Huang_

_Michigan State University_

Research has shown that the interactions between cancer cells and carbohydrates can play crucial roles in the survival, growth, invasion and metastasis of cancer cells making this interaction a target in cancer studies. Similarly, there is enough evidence supporting the fact that lectins (carbohydrate binding proteins) are over-expressed on cancer cells and the interactions between lectins and carbohydrates on the cell surface can contribute in cancer growth and development. However, studies to understand these interactions in finer details have been hampered by a lack of quantitative tools. In this presentation, magnetic iron oxide nanoparticle based technology immobilized with carbohydrates (glyco-nanoparticles) has been developed as a tool to isolated and purify endogenous lectins. Traditionally, proteins have been isolated using functionalized magnetic nanoparticle systems from cell lysates. However, the use of cell lysates possess limitations as some protein candidates might not be very stable in detergent additives present in buffers used in cell lysate preparation and therefore susceptible to lose of binding activity.

In this regard, we chose using whole cell incubated with glyco-nanoparticles as opposed to cell lysate. Good specificity has been achieved in endogenous lectin isolation from the cancer cells using glyco-nanoparticles raising the possibility of discovering novel lectins endogenous to cancer cells. This preliminary work indicates that carbohydrate functionalized magnetic iron oxide nanoparticles can be a new addition to the cancer research toolbox which could facilitate the further exploration of the role carbohydrate recognition plays in tumor development.
Combining Organic Synthesis and Directed Evolution to Design HIV Vaccine Candidates

Isaac J. Krauss, Satoru Horiya, Jennifer K. Bailey, Dung Nguyen, J. Sebastian Temme
Brandeis University

We will describe a new method for design of carbohydrate HIV vaccines, which combines organic synthesis and directed evolution techniques. This work originates from the observation that some HIV positive individuals produce antibodies which are broadly neutralizing and protective against HIV infection. One such antibody, 2G12, recognizes and binds to a cluster of carbohydrates on the viral envelope protein gp120. Our goal is to develop synthetic carbohydrate clusters which closely mimic the viral carbohydrate cluster, and which might thus elicit a 2G12-like antibody response when used as a vaccine. In order to design carbohydrate clusters which closely mimic gp120, we have developed evolution-based strategies, in which immobilized 2G12 is used to recognize and fish out the best glycocluster mimics of gp120 from amongst large libraries of ~10 trillion different glycosylated peptide- or DNA structures. The glycocluster structures obtained by these methods are recognized by antibody 2G12 as strongly as is the viral protein itself, and are thus of great interest for vaccine studies.

Organoboron-Promoted Regioselective Glycosylations in Oligosaccharide Synthesis

Ross Mancini, Stefi Anthonipillai, Corey McClary, Mark S. Taylor
The University of Toronto

Laboratory synthesis has become a vital tool for the production of well-defined oligosaccharides for biological study, but the requisite protection/deprotection of acceptor substrates can complicate their assembly. Regioselective functionalization of unprotected or minimally protected carbohydrates is an attractive alternative. Our group has developed a catalyst-controlled glycosylation method using diphenyl borinic acid that allows selective
functionalization of unprotected acceptor substrates, as well as a stoichiometric variant for challenging donor/acceptor combinations. Herein we describe the synthesis of the pentasaccharide component of a saponin natural product. Using our methodology we have completed this synthesis in 8 steps – the key steps involve organoboron-promoted regioselective glycosylation of rhamno- and arabinopyranosides, each bearing three hydroxyl groups. The disaccharide products are amenable to further regioselective functionalization, permitting rapid assembly of the remaining glycosidic linkages.

**Synthesis of Heparin Sulfate Ligands via Nickel Catalysis and Chemoselective Sulfation**

*Ravi Sankar Loka, Fei Yu, Matt McConnell, Hien Nguyen
University of Iowa*

Heparin, a sulfated glycosaminoglycan, isolated from mucosal tissues of bovine or porcine lungs and Intestine. It is used as anticoagulant drug, in renal dialysis or coronary thrombosis etc. Unfractionated or natural heparin is not homogenous and may have contaminants causing adverse effects. There are other forms of heparin such as Low Molecular Weight Heparin (LMWH with molecular weights of around 3-5 kDa) and Ultra Low Molecular Weight Heparin (ULMWH with molecular weights of 1.5 kDa). While LMWH is derived from heparin by chemical and/or enzymatic degradation, ULMWH (e.g. a pentasaccharide core) can be made synthetically. However, these processes are generally tedious, it’s hard to obtain homogenous LMWH where as ULMWH requires extensive protecting group manipulations and difficult to install 1,2-cis-2-amino glycosidic bonds that connect glucosamine to either glucuronic acid or iduronic acid to form heparin (1→4)-linked disaccharides. We successfully construct a number of heparin disaccharides in good yield and with excellent selectivity utilizing nickel catalysis. We have recently developed chemoselective sulfation strategy for further synthesis of heparin sulfate ligands, avoiding the use of extensive protecting groups to control chemoselectivity.
Organoboron Catalysts for Regioselective Activation of Carbohydrates

Mark S. Taylor
The University of Toronto

Progress towards developing and applying catalytic methods for selective functionalization of hydroxyl groups in carbohydrates is described. We have identified organoboron catalysts that enable regioselective activation of glycosyl acceptors, providing rapid access to di- and trisaccharides from unprotected or minimally protected pyranoside substrates. More recently, we have found that catalysts of this type can influence the stereochemical outcomes of glycosylations by changing the relative rates of $S_N2$- versus $S_N1$-type pathways. Applications to the stereocontrolled construction of challenging classes of glycosidic linkages will be presented. Catalyst-controlled activation of glycosyl acceptors offers interesting prospects for streamlined synthesis of oligosaccharides and selective glycosylation of polyol natural products. Our efforts along both of these lines will be discussed.

Comparative Study of Glycosylation at O-3 with N-Trichloroacetyl D-Glucosamine and N-Acetyl-D-Glucosamine Derivatives

Jeffrey Davidson, France Isabelle Auzanneau
University of Guelph

Previous members of the Auzanneau Research Group, M. Guillemineau and A Forman, have conducted studies on trisaccharides with a glucosamine unit at both the reducing and non-reducing end. These glucosamine units both had a free hydroxyl group at C-3 and differed by the trichloroacetamido and acetamido groups at C-2. These previous studies were unable to conclusively show the effects that the N-acetyl and N-trichloroacetyl protecting groups had on the reactivity towards glycosyl donors. This work provides the synthesis of two similar monosaccharide units, pentyl 2-acetamido-4,6-O-benzylidene-2-deoxy-β-D-glucopyranoside (henceforth referred to as the N-acetyl acceptor) and pentyl 4,6-O-benzylidene-2-deoxy-2-trichloroacetamido-β-D-
glucopyranoside (henceforth referred to as the \( N \)-trichloroacetyl acceptor) and examines their reactivity with 2,3,4,6-tetra-\( O \)-acetyl-\( \alpha \)-\( D \) galactopyranosyl bromide (henceforth referred to as bromide donor or galactosyl donor). Glycosylations were conducted in both Helfrich and Koenigs-Knorr conditions in which a single acceptor was glycosylated or the two glycosyl acceptors were in competition for the glycosyl donor. From the results of this study it can be concluded that the \( N \)-acetyl acceptor is more reactive to the galactosyl donor. Additionally, an orthoester will be formed in the glycosylation with the \( N \)-trichloroacetyl acceptor and the galactosyl donor if it is stabilized by a base.

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**Efficient Syntheses of Polysaccharides and their Biomedical Applications**

*Wenjun Du, Lingyao Li, Jun Wang, Melissa Obrinske, Lindsay Bitterman*

*Central Michigan University*

Carbohydrate-based polymers are ideal materials because of their favourable biocompatibility and biodegradability. However the access of carbohydrate-based polymers is limited. Natural polysaccharides are abundant but extensive purifications are needed to obtain sufficiently purity to meet the biomedical requirements. Synthetic approach has been explored but limited success has been achieved.

We reported herein efficient syntheses of polysaccharides using a variety of strategies including microwave-assisted polycondensation of di-functional AB-monomer, ring-opening polymerization of anhydro sugars, as well as our recent discovery of sugar poly(orthoesters). The syntheses of sugar poly(orthoesters) are especially attractive because the containing orthoester linkages are highly sensitive to acid-catalyzed hydrolysis, allowing for the construction of pH-responsive nanostructures. The synthesized poly(orthoesters) could be used to construct nanostructures through a self-assembly process or through an emulsion-evaporation process. The nanostructures could be an excellent
delivery system for selective and efficient delivery of drugs to cancer cells, wherein the cells are exposed to lower extracellular pH values.

**Carbohydrate-Functionalized Bivalent Polymers to Investigate the Predictable Tunability of Multivalent Interactions**

Matthew S. McConnell, Ravi Loka, Hien M. Nguyen  
*The University of Iowa*

Avidity can be defined as the overall binding affinity of a macromolecule to a protein that has multiple binding sites. Typical carbohydrate/protein binding interactions can be described in this way. The impact on avidity of the varying architectures of many synthetic sugar based macromolecules has been studied. The variables that have been studied, with respect to avidity, in glycopolymer systems include overall chain length, sugar density, length and flexibility of the linker, as well as the point of attachment to the sugar.

Concanavilin A (Con A)/mannose pairing represents a low cost, easy to use model system for further examination of these variables. We present the synthesis of a low polydispersity glycopolymer with α-mannose and β-glucose attached in an alternating fashion. The effect of this unique mannose/glucose bivalent architecture on the avidity of Con A will be compared to that of a bivalent mannose glycopolymer system as well as a monovalent mannose glycopolymer system utilizing isothermal titration calorimetry (ITC). We find that a mannose/glucose bivalent glycopolymer of similar size and structure to mannose/mannose bivalent glycopolymer have comparable avidities. We hypothesize that although β-glucose is a poor ligand on its own for Con A binding, our unique glycopolymer architecture forces β-glucose binding through the attachment of neighboring α-mannose units.
Entirely Carbohydrate-Based Cancer Vaccines for Disease Prevention and Treatment

Peter Andreana
The University of Toledo

Cancer is the second leading cause of death in the US. Various pharmaceutical-based chemotherapeutic and cancer immunotherapeutic agents are cell specific and therefore many types of tumors are not affected by treatment. A new approach to cancer vaccines utilizing a bacterial, capsular zwitterionic polysaccharide PS A1 and tumor associated carbohydrate antigens has rendered murine immune responses showing tumor selectivity, tumor specificity and tumor killing function.

This talk will focus on cancer vaccines of an entirely carbohydrate semi-synthetic construct, namely Tn-PS A1 and TF-PS B will be discussed. Processes for evaluating immunogenicity, specificity, and antibody function will include isolation, purification, chemical modification of PS A1 and subsequent in vivo mouse studies. ELISA, and FACS studies reveal that an immune response is specific for the conjugated Thomsen nouveau (Tn) and Thomsen-Friedenrich antigens. Our results argue for a novel carbohydrate vaccine construct highlighting cellular immune activation.

Keynote Address: Based on Current Chemical and Enzymatic Synthesis, So Close We Are to a Commonly Existing Glycomic Library?

Peng George Wang
Georgia State University
Poster Presentation Titles and Numbers

1. “Synthesis of BSA-MUC1 Conjugates for MUC1 Peptide Microarrays to Evaluate Serum Specificity”
   Allan Allmon, Michigan State University

2. “Virus-Like Particle QB as a Carrier in GM2 Specific Anti-Cancer Vaccines”
   Clair Baniel, Michigan State University

3. “Stereoselective Synthesis of S-linked Hexasaccharide of Landomycin A”
   Kedar N. Baryal, The University of Toledo

4. “Glycosylation at O-4 Position of Propyl Glycoside Glycosyl Acceptor with Galactosyl Trichloroacetimidate Donor”
   Jordana Bhimsingh, University of Guelph

5. “Synthesis of α-Glucan Substrate Analogs for the Characterization of Mycobacterium tuberculosis Enzyme GlgE”
   Samantha Bouhall, The University of Toledo

6. “Synthesis of the Globotriose Gb3 Antigen Conjugated to Zwitterionic Polysaccharides PS A1 for an entirely Carbohydrate Immunogen”
   Samir Ghosh, The University of Toledo

7. “Tyrosine-Targeted Protein Glycol-Modification with Carbohydrate Primary Arylamine Derivatives”
   Valentinas Gruzdys, Cleveland State University

8. “Studies Towards the Enantioselective Total Synthesis of Derhodinosylurdamycin A”
   Hem Raj Khatri, The University of Toledo

9. “To BBB or not to BBB: Aβ Detection via Delivering Glyco-Nanoparticles through BBB”
   Hovig Kouyoumdjian, Michigan State University

10. “Reverse Anomeric Effect-Mediated Synthesis of Sugar Poly(orthoesters) as pH-Responsive Nanoscopic Assemblies”
    Lingyao Li, Central Michigan University
11. “Synthesis and Immunological Studies of Linear Oligosaccharides of β-Glucan as Antigens for Anti-Fungal Vaccine Development”
Guochao Liao, Wayne State University

12. “Glycosylation of Quinone-Fused Polythiophene for Reagentless and Label-Free Detection of *E. Coli*”
Fen Ma, Oakland University

13. “Boron-Based Brønsted Acid Catalysis for Fischer Glycosidations”
Sanjay Manhas, University of Toronto

Seyedmehdi Hossaini Nasr, Michigan State University

15. “A Synthesis of Tetra- and Pentasaccharide Fragments of Dimeric Lewis X Tumor-Associated Carbohydrate Antigen”
Ali Nejatie, University of Guelph

Sharmeen Nishat, The University of Toledo

Krishnakant Patel, The University of Toledo

18. “Chemical Synthesis of Isotopically Labelled N- and O- Glycopeptides for Quantification of Tumor Associated Glycopeptides”
Sherif I Ramadan and Weizhun Yang, Michigan State University

19. “Selective Deprotection of Benzyl Ethers in the Presence of 4-Methoxybenzyl Ethers”
Zac Saleh and Ali Hourani, University of Michigan, Dearborn

20. “Synthetic Heterobivalent Glycopolymer Mimic of gp120 Glycan Shield”
Eric Sletten, University of Iowa

21. “Title of Poster to be Determined”
Suttipun Sungsuwan, Michigan State University
Sandeep Thanna, The University of Toledo

23. Investigation of Anti-Cancer Entirely Carbohydrate Constructs, Tn-PSA1 and Tf-PSB”
Kevin Trabbic, The University of Toledo

24. “Synthesis of Carbohydrate-Based Amphiphilic Block Polymers”
Jun Wang, Central Michigan University

25. “Synthesis Aided Structural Determination of Amyloid-β (1-15) Glycopeptide, a New Biomarker for Alzheimer’s Disease”
Peng Wang, Michigan State University

26. “Carbohydrate Permethylation Characteristics in the Presence of Boronic Acid”
Joshua N. Whited, Cleveland State University

27. “Developing Bacteriophage Qβ as Versatile Carrier for Anti-Carbohydrate Cancer Vaccine: Influence of Antigen Design on Antibody Responses”
Zhaojun Yin, Michigan State University

28. “Chemical Synthesis of Chondroitin Sulfate Oligosaccharides and Heparin Derivatives as Heparanase Inhibitors”
Zereng Zang and Jicheng Zhang

29. “Synthesis and Evaluation of Monophosphoryl Lipid A Derivatives as Fully Synthetic Self-Adjuvanting Glycoconjugate Cancer Vaccine Carriers”
Zhifang Zhou, Wayne State University

30. “Stereoselective Synthesis of α-Digitoxosides and α-Boivinosides via Chelation-Controlled Anomeric O-Alkylation”
Danyang Zhu, The University of Toledo
The 10th Annual Midwest Carbohydrate and Glycobiology Symposium would like to thank the following sponsors for helping us to host such a wonderful event:

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The Carl and Mary Johnson Family Foundation