# Table of Contents

<table>
<thead>
<tr>
<th>Presenter</th>
<th>Title</th>
<th>Poster</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaley Annis &amp; Tracy Mulka</td>
<td>Novel Cloning Protocol for H3.3 Deletion Mutant Construction</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Stephanie Bean</td>
<td>Colorimetric Detection of Protein Amyloid</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Kishan Bellur</td>
<td>A New Method to Investigate Evaporation and Condensation of Cryogenic Propellants and Determine Accommodation Coefficients</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Daniel Blechschmidt</td>
<td>Catalytic Property Study of 1st and 2nd Generations of Supramolecular Catalysts</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Gemechis Degaga</td>
<td>The Potential of MgO (100) Surface for Increased and Stable Separation Application in Petroleum Refining Industries</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Ni Fan</td>
<td>Glycan-Dependent Mutual and Reversible Sequestration of Two Thyroid Cancer Biomarkers</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>Mingxi Fang</td>
<td>Unusual Fluorescent Responses of Morpholine-Functionalized Fluorescent Probes to pH Via Manipulation of BODIPY’s HOMO and LUMO Energy Orbitals for Intracellular pH Detection</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>Joseph R. Fedie</td>
<td>Exploiting Overactive Nutrient Transporters for Selective Targeting in MCF-7 Human Breast Carcinomas</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>McKensey Gariepy</td>
<td>Total Phenolic, Total Flavonoid, and Antioxidant Power of Thimbleberry Fruit Tissue (<em>Rubus parviflorus</em>)</td>
<td>31</td>
<td>16</td>
</tr>
<tr>
<td>Avik Ghosh</td>
<td>Mannose-based Water Soluble Near-Infrared Fluorescent Probes for Sensitive Detection of Lysosome pH</td>
<td>10</td>
<td>17</td>
</tr>
<tr>
<td>Author</td>
<td>Title</td>
<td>Pages</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>----------------------------------------------------------------------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>Sanaz Habibi</td>
<td>Do Faradaic Reactions Cause Hemolysis in Non-Uniform Alternating Current Electric Fields?</td>
<td>11 18</td>
<td></td>
</tr>
<tr>
<td>Bhaskar Halami</td>
<td>Non-Chromatographic Purification of Synthetic Oligodeoxynucleotides and Peptides</td>
<td>12 19</td>
<td></td>
</tr>
<tr>
<td>Shanshan Hou</td>
<td>Novel Courmarin-based Fluorescent pH Indicator Covering a Broad pH Range</td>
<td>13 20</td>
<td></td>
</tr>
<tr>
<td>Shanshan Hou</td>
<td>Lysosomal Targeting with Stable and Sensitive Fluorescent Probes (Superior LysoProbes): Applications for Lysosome Labeling and Tracking during Apoptosis</td>
<td>14 21</td>
<td></td>
</tr>
<tr>
<td>Grace Hubbell</td>
<td>Diastereoselective Formation of Bicyclic Annulation Products from the Interaction of Amino Acid Derivatives and 2-Imidazolines</td>
<td>15 22</td>
<td></td>
</tr>
<tr>
<td>Maryam Khaksari</td>
<td>Determination of Water-Soluble and Fat-Soluble Vitamins in Tears and Blood Serum of Infants and Parents by Liquid Chromatography/Mass Spectrometry</td>
<td>16 23</td>
<td></td>
</tr>
<tr>
<td>Sushant Kolipaka</td>
<td>Identification of the NO Generating Decomposition Product of Ascorbic Acid</td>
<td>17 24</td>
<td></td>
</tr>
<tr>
<td>June Kowalski</td>
<td>High Performance Liquid Chromatography Method Development for the Separation and Purification of Vanadium (IV) Oxide-Based MRI Contrast Agents</td>
<td>18 25</td>
<td></td>
</tr>
<tr>
<td>Elizabeth Kruppe</td>
<td>System of Nitric Oxide Release for Viral Inactivation</td>
<td>19 26</td>
<td></td>
</tr>
<tr>
<td>Maria Paula Kwesiga</td>
<td>Inhibition of Vascular Calcification in Smooth Muscle Cells by Nitric Oxide</td>
<td>20 27</td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>Title</td>
<td>Pages</td>
<td></td>
</tr>
<tr>
<td>-----------------------</td>
<td>------------------------------------------------------------------------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>Augustus J Lowry</td>
<td>Mass and Charge Transport in Pyrrolidinium Cation-based and Alkyltrimethylammonium Cation-based Ionic Liquids Using the Compensated Arrhenius Formalism</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td>Rachel Martin</td>
<td>Electrospinning Polymer Scaffolds for Use in Neural Tissue Engineering</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Cameron McKenzie</td>
<td>Treatment of MDA-MB-231 Cancer Cells with NO</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Nikhil Mittal</td>
<td>An Injectable Thermosensitive Biodegradable Hydrogel Embedded with SNAP Containing PLGA Microparticles for Sustained Nitric Oxide (NO) Release</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Ameya Narkar</td>
<td>Moisture Resistant Smart Hydrogel Adhesives Based on Reversible Catechol-Boronic Acid Complexation</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Jane Newman</td>
<td>Investigating the Viability of the Caur_1362 gene for the Production of Phytase</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Chelsea Nikula</td>
<td>An Innovative Way to Study Mutations Linked to Pediatric Brain Cancers</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Julie Osborne</td>
<td>Quantitative Streak Analysis of Bacterial Growth Inhibition with Nitric Oxide</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Kristine Parson</td>
<td>An Investigation into the Components of Little Bluestem Seed Exudate and Its Ability to Degrade Bisphenol A</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Julia D Peterson</td>
<td>The Effects of Plasma Derived from Lactobacillus johnsonii Supplemented Mice and DHA on RSV Infected Dendritic Cells</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Rattapol Pinnaratip</td>
<td>The Effects of Silica Nano/Micro Particle Incorporation on Mussel Inspired Poly(Ethylene Glycol) (PEG) Based Adhesive Hydrogel</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>Title</td>
<td>Pages</td>
<td></td>
</tr>
<tr>
<td>--------------------------</td>
<td>----------------------------------------------------------------------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>Zichen Qian</td>
<td>Response of Human Mesenchymal Stem Cells on ZIF-8 Particles Embedded Gelatin Hydrogel</td>
<td>30-39</td>
<td></td>
</tr>
<tr>
<td>Emily C. Ross</td>
<td>Identifying Thimbleberry Components with HPLC and GC-MS</td>
<td>32-40</td>
<td></td>
</tr>
<tr>
<td>Tristan A. Ruiz</td>
<td>Measuring the Antioxidant Content of Rubus parviflorus</td>
<td>33-41</td>
<td></td>
</tr>
<tr>
<td>Taylor A. Sharp</td>
<td>Solid-Phase Microextraction of Volatile Compounds in Rubus parviflorus</td>
<td>34-42</td>
<td></td>
</tr>
<tr>
<td>Angela Small</td>
<td>A Quantum Computational Study on the Effects of the Interaction between Magnesium Oxide Nanotubes and Active Pharmaceutical Ingredients on the Quality of Drinking Water</td>
<td>35-43</td>
<td></td>
</tr>
<tr>
<td>Melanie Talaga</td>
<td>A New Purification Method to Isolate a Human Cancer Associated Protein</td>
<td>36-44</td>
<td></td>
</tr>
<tr>
<td>Mikhail Trought</td>
<td>Lil' APOLLO: An Open Source Atmospheric Monitoring System</td>
<td>38-45</td>
<td></td>
</tr>
<tr>
<td>Soontorn Tuntithavornwat</td>
<td>Improving the Durability of Graphene Composite Sensors for Robust Biosensors</td>
<td>39-46</td>
<td></td>
</tr>
<tr>
<td>Christina Welch</td>
<td>Unveiling a New Hemolytic Lectin from a Previously Unexploited Higher Plant Species</td>
<td>40-47</td>
<td></td>
</tr>
<tr>
<td>Haihang Ye</td>
<td>Facile Synthesis of Ru Nanoframes with fcc Crystal Structure and Enhanced Catalytic Activities</td>
<td>41-48</td>
<td></td>
</tr>
</tbody>
</table>
Novel Cloning Protocol for H3.3 Deletion Mutant Construction

Kaley Annis, Tracy Mulka

Michigan Technological University

H3.3 is one of the eight variants of human histone protein H3, and found to be mutated in about 70% of pediatric glioblastoma (PGB) patients at specific residues. In order to investigate how this specific mutation leads to cancer development, it is important to create the mutant and compare its activity to wildtype H3.3 in gene regulation. The purpose of this study is to apply a novel cloning method to prepare a H3.3 deletion mutant. This novel cloning method provided the following advantages over traditional cloning with restriction enzymes and ligase. By employing this new protocol, total cloning time was shortened and loss of DNA during gel purification was avoided. Introduction of protease cleavage sequences allowed the removal of methionine, which will interfere with downstream application. The purified deletion mutant will be ligated to peptides with the desired modification/mutation via native chemical ligation, and the resultant full-length H3.3 mutant used to examine the consequences of mutation in PGB development. For this study, creation of a H3.3 deletion mutant in which the first 45 amino acids from a 136 full-length protein were removed is required. Primers were designed to anneal sequences flanking the coding sequences of residues 1 through 45. The primers also contained 1) coding sequence for Xa factor which removes methionine before ligation and 2) Phosphorothioate modification at the location to protect from exonuclease cleavage. Inverse Polymerase chain reaction (PCR) with H3.3 wildtype plasmid template was conducted and the PCR reaction mix was treated with an endonuclease DpnI to remove template DNA and with T7 gene 6 exonuclease to create 5'-overhangs. The treated DNA was directly transformed into expression Escherichia coli strain JM109(DE3) via heat shock method. Inverse PCR resulted in ~5600 bp fragments as designed. After transformation and selection, plasmids were isolated and sequenced to confirm the deletion. SDS-PAGE showed an overexpression of H3.3 deletion mutant.
Every 67 seconds someone in the United States develops Alzheimer's Disease (AD). AD is a neurodegenerative condition characterized by cognitive decline accompanied by memory loss. It is the only top ten cause of death in the United States which cannot be prevented, cured, or slowed. One of the proposed causes of AD is the formation of structures containing amyloid fibrils. Amyloid fibrils are insoluble fibrous protein aggregates sharing specific structural traits. Aside from AD, amyloid fibrils are associated with twenty other known human diseases, which arise from eighteen naturally occurring proteins or polypeptides which improperly fold to cause disease.

Most of the current detection methods for AD are post-symptomatic. This means that irreversible damage to the nervous system has already occurred before an official diagnosis has been made and therapy can begin. To improve abnormal protein accumulation detection and patient prognosis, gold nanoparticle aggregation, which has proven to be viable detection method because of the colorimetric shift that can be used to detect the formation of amyloid fibrils during the early stages of their development. Recent results from our lab indicate that osmolytes, which are natural compounds that regulate osmotic pressure in marine life, may enhance the detection of these misfolded proteins by inducing hydrophobic reactions.
A New Method to Investigate Evaporation and Condensation of Cryogenic Propellants and Determine Accommodation Coefficients

Kishan Bellur, Ezequiel Medici, Chang Kyoung Choi, Jeffrey Allen

Michigan Technological University

One of the major hurdles of long term space travel is the ability to store cryogenic propellants (liquid hydrogen, liquid methane, etc) for long durations without boil off. Even with the use of active and passive control of propellants, boil off in space is inevitable, leaving behind a liquid vapor mixture. Long-term CFD simulations of propellant behavior depend on accommodation coefficients which are in turn dependent upon the wetting characteristics and interface shape. Modeling efforts require the use of accommodation coefficients that have not yet been determined. In the present study, evaporation and condensation tests using hydrogen has been successfully completed at a range of pressures (15-30 psia) and temperatures (20-30 K). The liquid vapor interface is determined and the contact angle of hydrogen is found to be 0-8° with AL6061 and 0-2° with SS316. The interface curvature results in an anisotropy of stresses in the liquid. It has been shown that the evaporation flux is non-uniform and most of the evaporation occurs in the contact line region, close to the wall. A kinetic theory based evaporation model is built based on the classical Hertz-Knudsen-Schrage equation which has been expanded to include curvature and disjoining pressure effects. The model is evaluated in an iterative approach such that the curvature obtained from the model matches the curvature obtained from the experiments. The results of the experiments is used in conjunction with the kinetic phase change model, to extract the accommodation coefficients. The accommodation coefficient for a constant wall temperature using saturated hydrogen at 21K and a contact angle of 0° with Al6061 is found to be 0.76 ± 0.01.
Catalytic Property Study of 1st and 2nd Generations of Supramolecular Catalysts

Daniel Blechschmidt, Matt Woodhouse, Yu Liu

Northern Michigan University

In this research, two generations of Co(III)-salen complex containing aromatic electron acceptors have been synthesized. The two generations are different in the linker length and flexibility between the catalytic center and aromatic electron acceptors. The introduction of electron-rich aromatic compounds allows the assembly of the binuclear Co(III)-salen supramolecular catalyst, which in turn promotes the bimetallic mechanism based asymmetric ring opening reaction of epoxides. The two generations have been tested under a variety of activation and reaction conditions. Under optimized conditions, the second generation has shown much higher enantioselectivity and greater catalytic efficiency than both the first generation catalyst and the commercial Co(III)-salen catalyst.
Open metal–organic frameworks (MOFs) have been shown to have potential applications in catalysis, separation, gas storage, and sensing. Compared to conventionally used microporous inorganic materials such as zeolites, these organic structures have the potential for more flexible rational design, through the control and functionalization of the pores structure. One of the most prominent steps in petroleum refining is the separation of olefin from paraffin, an energetically and economically expensive task achieved via cryogenic distillation. Starting from recent experimental and computational studies that have shown the potential of the open metal site MOF-74 for selective adsorption in light hydrocarbons (C1-C4), the investigation proposed herein is two-fold. First, it aims at gaining a fundamental understanding of the chemical mechanism of the adsorption process occurring in MOF-74-Mg molecular cluster models, then to use such knowledge to engineer the resembling adsorption sites on MgO (100) surface to enhance the selectivity mechanism. Starting from its unmodified, relatively unselective topology, the MgO (100) surface will be modified to model structural features such as steps, edges, and kinks in a search for modifications that can reproduce most efficiently the separation capability observed in MOF-74-Mg. The choice of modeling MgO (100) surfaces is not only suggested by the resemblance that the open metal site in MOF-74-Mg has with respect to exposed metal sites on its surface, but is also driven by the need to find more efficient, less expensive, and more stable adsorbent materials to be used in practical applications such as in petroleum refining processes. In this study, Density Functional Theory (DFT) is applied to 2D MgO (100) surface to investigate the interaction between C₂H₆, C₃H₈, C₄H₁₀, C₂H₄, C₃H₆, and C₄H₈ (alkane and alkenes) molecules and the metal sites.
Thyroglobulin (Tg), a glycoprotein produced by thyroid glands, serves as an important pre- and post-operative biomarker of differentiated thyroid cancer (DTC). Tg plays crucial roles in the management of thyroid cancer patients, before and after their surgery. Thus, accurate determination of Tg level in patient samples is vital for appropriate decision making. We recently found that another common cancer biomarker, made exclusively by transformed thyroid cells, interacted with Tg and hid it in molecular clusters. Tg molecules trapped in such clusters will escape clinical detection, which could lead to flawed management of thyroid cancer patients. More importantly, since Tg plays a significant role in thyroid hormone secretion and Tg antibody production, masking Tg will have physiological and immunological consequences as well.
Unusual Fluorescent Responses of Morpholine-Functionalized Fluorescent Probes to pH Via Manipulation of BODIPY’s HOMO and LUMO Energy Orbitals for Intracellular pH Detection

Mingxi Fang

Michigan Technological University

Three uncommon morpholine-based fluorescent probes (A, B, and C) for pH were prepared by introducing morpholine residues to BODIPY dyes at 4,4′- and 2,6-positions, respectively. In contrast to morpholine-based fluorescent probes for pH reported in literature, these fluorescent probes display high fluorescence in a basic condition while they exhibit very weak fluorescence in an acidic condition. The theoretical calculation confirmed that morpholine is unable to function as either an electron donor or an electron acceptor to quench the BODIPY fluorescence in the neutral and basic condition via photoinduced electron transfer (PET) mechanism because the LUMO energy of morpholine is higher than those of the BODIPY dyes while its HOMO energy is lower than those of the BODIPY dyes. However, the protonation of tertiary amines of the morpholine residues in an acidic environment leads to fluorescence quenching of the BODIPY dyes via d-PET mechanism. The fluorescence quenching is because the protonation effectively decreases the LUMO energy which locates between the HOMO and LUMO energies of the BODIPY dyes. Fluorescent probe C with deep-red emission has been successfully used to detect pH changes in mammalian cells.
Exploiting Overactive Nutrient Transporters for Selective Targeting in MCF-7 Human Breast Carcinomas

Joseph R. Fedie

Michigan Technological University

Metabolic changes are typically accompanied by a change in cellular carbohydrate uptake, this alteration provides an opportunity for differentiation between cancerous and healthy cells. GLUTs are passive carbohydrate transporters that are responsible for the delivery of glucose, fructose, galactose and other carbohydrates into the cell. From 14 known GLUTs, the most studied GLUT1 is responsible for glucose uptake. GLUT1 has been a successful target for cancer imaging agents due to cancers increased carbohydrate consumption. Recent data identified that cancers have accelerated fructose uptake, and that uptake occurs primarily through fructose-specific GLUT5. In contrast to ubiquitous GLUT1, GLUT5 has high activity in cancer cells and minimal in normal cells. Hence, specific targeting of GLUT5 may provide a selective targeting of cancer cells. There is, however a massive gap in understanding what influences passage through GLUT5 transporters and what factors influence fructose-specificity. This research aims to identify GLUT5 tolerance towards fluorescent carbohydrate mimics as uptake probes. The uptake of the probe or lack thereof is measured by the fluorescence intensity after cancerous cells have been exposed to the probes. The structure-activity data, collected in these studies will provide a basis for designing GLUT5 targeting probes for various biochemical and biomedical applications.
The thimbleberry (*Rubus parviflorus*) is of cultural and economic significance throughout the Upper Peninsula of Michigan, though little of the chemistry of the berry exists in published literature. With no standard protocols on how to evaluate the fruit tissue in literature, comparisons can be difficult among varying fruits. Total phenolic acid content (TPC), total flavonoid content (TFC), and antioxidant power (FRAP) were used to evaluate and measure the thimbleberry fruit tissue samples. The results are presented here. For comparison, samples were collected from four distinct sites in Marquette, Michigan, and in three distinct harvests spanning two weeks of the peak ripening period. Samples were extracted with methanol. Fruit tissues from berries from varying species were extracted in methanol and identically prepared for analysis with the thimbleberries.
Mannose-based Water Soluble Near-Infrared Fluorescent Probes for Sensitive Detection of Lysosome pH

Avik Ghosh, Shuwei Zhang, Rachel Stites, Mingxi Fang, Haiying Liu, Feng Zhao

Michigan Technological University

Lysosome is one of the vital cell organelles in maintaining cellular homeostasis and mediation of various physiological processes, such as protein degradation and plasma membrane repair. Significant disruptive changes in the lysosomal pH can lead to damage in the lysosome which may in turn hinder the cellular functions and equilibrium. Spectroscopic analysis employing pH-sensitive fluorescent probes is becoming one of the most powerful tools for monitoring intracellular pH, due to their operational simplicity, high sensitivity, and excellent spatial and temporal resolution. Near-infrared (NIR) dyes are advantageous to bio-detection or imaging because of the minimal photo-damage to biological samples, deep tissue penetration, and minimal interference from background auto fluorescence in living systems. However, the NIR dyes often contain extended or elongated π-conjugated systems, which unfortunately lead to decreased photo stability, strong tendency to aggregate in aqueous solution, and poor cell permeability, thus limiting their biological applications. Mannose, as a sugar monomer of a series of carbohydrates, has drawn much attention in the fields of soft matter and materials science because of their excellent water-solubility, biocompatibility and the use for carbohydrate-protein interactions. In this study, we synthesized two water-soluble NIR probes with spiro-cyclic structures bearing mannose residues through a well-defined oligo(ethylene glycol) tethered spacer to detect and visualize the lysosomal pH changes in living cells. Both probes displayed extremely weak fluorescence at the extracellular pH of 7.5 through the closed form of the spirolactam ring, and become strongly fluorescent at the intracellular lysosomal pH of 4.5 through the opening of the spirolactam ring. The probes have advantages such as sensitive and selective near-infrared imaging of lysosomal pH changes over metal ions in living cells, potential intact in vivo imaging and deep tissue penetration without auto-fluorescence and unintended cellular damage issues.
Do Faradaic Reactions Cause Hemolysis in Non-Uniform Alternating Current Electric Fields?

Sanaz Habibi, Adrienne R. Minerick

Michigan Technological University

In microfluidic systems, electrode metal and electrolyte ions can participate in undesirable side reactions, including surface-faradaic reactions. These electrochemical reactions can have caustic byproducts that alter solution composition and thus changing solution biocompatibility. We hypothesize, based upon prior research evidence from our group of these Faradaic reactions in non-uniform alternating current electric fields, that the byproducts of the electrochemical reactions can cause cell deformation and cell lysis. This work investigates, human red blood cell lysis in non-uniform alternating current electric fields in the presence and absence of surface-faradaic reactions and the presence and absence of a surfactant. Planar orthogonal Cr/Au electrodes were employed to create a spatially non-uniform electric field. Experiments were conducted with and without a dielectric Hafnium Oxide (HfO₂) coating on the electrodes as well as with and without a surfactant, Triton X-100. The HfO₂ dielectric layer was deposited via electrosputtering to prevent contact between the metallic electrodes and electrolyte solution to minimize Faradaic reactions at the electrode surface and impede electron transfer. Experiments were run for 15 minutes at 1k Hz and 0.1 Vpp/micron field density, conditions at which the Faradaic Reactions had been previously characterized. Video microscopy images underwent intensity analysis to determine cell rupturing percentage. Comparison within uncoated and HfO₂ coated microdevices showed that overall cell lysis percentage was notably higher for uncoated microdevice which can be attributed to the cell lysis induced by surface-Faradaic reactions. In this study, the effect of Triton X-100 surfactant on cell lysis was also investigated to understand the molecules’ structural amphiphilic characteristic that influences either hemolysis or membrane stabilization. The results show that at low concentrations, Triton X-100 stabilizes red blood cells; while in the absence of this surfactant, hemolysis increases and a clear threshold exists for cell lysis. Thorough understanding of these molecular interactions will enable precise control of cell lysis within microdevices for subsequent subcellular molecular (DNA, protein, other) separations and analysis.
Non-Chromatographic Purification of Synthetic Oligodeoxynucleotides and Peptides

Bhaskar Halami, Durga Pokharel, Mingcui Zhang, Suntara Fueangfung, Shiyue Fang

Michigan Technological University

The new technique of purification of oligodeoxynucleotides and peptides is achieved using a catching by-polymerization approach. During automated synthesis, either failure sequences or full-length sequences are tagged with a polymerizable methacrylamide group. Purification is then achieved by subjecting crude products to the acrylamide polymerization conditions. Either failure sequences or full-length sequences are attached to the polymer leaving other in the solution. Impurities are simply removed by precipitation. Procedures do not involve in any chromatography. Purification is achieved with simple manipulations such as shaking and filtration. The technique is expected to be ideal for large scale purification of oligonucleotides and peptide drugs.
A new coumarin-based pH indicator was synthesized which is sensitive to pH in either weakly acidic or weakly basic solution. This indicator possesses moderate to high brightness, excellent photostability and compatibility with light-emitting diode. When this coumarin-based pH indicator is used, the membranes are capable of optical pH sensing over a very wide range comparable to the dynamic range of the glass electrode (pH 4–11).
Lysosomal Targeting with Stable and Sensitive Fluorescent Probes (Superior LysoProbes): Applications for Lysosome Labeling and Tracking during Apoptosis

Shanshan Hou, Xin Yan, Catherine Bammert, Lanrong Bi

Michigan Technological University

Intracellular pH plays an important role in the response to cancer invasion. We have designed and synthesized a series of new fluorescent probes (Superior LysoProbes) with the capacity to label acidic organelles and monitor lysosomal pH. Unlike commercially available fluorescent dyes, Superior LysoProbes are lysosome-specific and are highly stable. The use of Superior LysoProbes facilitates the direct visualization of the lysosomal response to lobaplatin elicited in human cholangiocarcinoma (CCA) RBE cells, using confocal laser scanning microscopy. Additionally, we have characterized the role of lysosomes in autophagy, the correlation between lysosome function and microtubule strength, and the alteration of lysosomal morphology during apoptosis. Our findings indicate that Superior LysoProbes offer numerous advantages over previous reagents to examine the intracellular activities of lysosomes.
Diastereoselective Formation of Bicyclic Annulation Products from the Interaction of Amino Acid Derivatives and 2-Imidazolines

Grace Hubbell, Grace E. Hubbell, Alyssa A. Ellsworth, Alexei Iretski, R. Adam Mosey

Lake Superior State University

2-Imidazolines are nitrogen-containing heterocycles that are desired for their antimicrobial, anti-inflammatory, antitubercular, analgesic, and anticancer activities. One concern during the development of bioactive molecules as prospective therapeutic agents is the potential for unintended reactions that can occur between small molecules and biomolecules. These reactions may lead to side effects, some of which can be very harmful. To determine the potential of side reactions between various 2-imidazolines and biomolecules, 1,2-disubstituted 2-imidazolines were exposed to amino acid derivatives, whereupon bicyclic annulation products were generated with a high degree of diastereoselectivity. The rate and yield of formation of such compounds was affected by electronic and steric features of the tested 2-imidazolines. Formation of these annulation compounds under the observed conditions indicates that 1,2-disubstituted 2-imidazoline compounds may potentially undergo similar reactions with amino acids when administered in clinical studies.
Determination of Water-Soluble and Fat-Soluble Vitamins in Tears and Blood Serum of Infants and Parents by Liquid Chromatography/Mass Spectrometry

Maryam Khaksari, Lynn R. Mazzoleni, Chunhai Ruan, Robert T. Kennedy, Adrienne R. Minerick

Michigan Technological University

Tears may serve as a viable diagnostic fluid with advantages such as less invasive sample collection and simplified sample preparation for analysis. Most water-soluble vitamins (WSVs) and fat-soluble vitamins (FSVs) were detected and quantified in human tears and compared with blood serum levels. Samples from 15 four-month-old infants and one parent were analyzed; vitamin levels were compared between tears and serum in a single subject, between infants and parents, and against self-reported dietary intakes. WSVs and FSVs were detected with a C18 column via two LC-ESI-MS/MS 16 and 18 min methods, respectively. Vitamins B1, B2, B3 (nicotinamide), B5, B9 and E (α-tocopherol) were routinely detected in tears and serum while A (retinol) was detected in serum. LODs determined in tears were 0.075-1.7 ng for WSVs and 0.24 ng for vitamin E. In contrast, LODs determined in serum were 0.057-0.66 ng for WSVs and 1.4 and 0.43 ng for FSVs A and E, respectively. The assay’s precision and accuracy were validated with %RSD of 2.2-10% and recoveries of 84.0-109% for all vitamins except for B5 and B9. Higher WSV levels were measured in tears compared to serum and also in infants compared to parents. FSV E levels were lower in tears than serum with no significant difference between infants and parents. Vitamin A was higher in parents than infants. Population trends were compiled and quantified via a cross correlation factor. Strong positive correlations were found between tear vs. serum for infant’s and parent’s E and parent’s B3, while slight positive correlations were detected for infant’s B3 and parent’s B1 and B2. Correlations between infant vs. parent were found for tear B1, B2, B3 and E, and serum B2, A and E. Significantly higher vitamin levels were observed in bottle-fed infants for serum vitamins B1 and B3 and more correlation was found between infants and parents in breast-fed infants. To the best of our knowledge, this work is the first to demonstrate vitamin detection and correlation between tears and blood serum levels. Results suggest that tears may be a viable biofluid to monitor nutritional health and speed deficiency diagnoses.
Nitric oxide (NO) has been shown to be a potent inhibitor of platelet adhesion and activation. Ascorbic acid which is naturally present in human body if present in greater than millimolar concentration, is known to react with S-nitrosothiols (RSNO) directly to reduce RSNO to NO and produce free thiol groups. The mode of action of ascorbic acid reacting directly with RSNOs is not known. We hypothesize that the high concentration of ascorbic acid is required because the reduction of RSNO is not caused by ascorbate but instead is caused by a decomposed product of ascorbic acid. S-Nitroso-N-Acetylpenicillamine is used as an NO donor. An HPLC method is under development for the identification of the ascorbic acid degradation product responsible for NO production from RSNO by the design, fabrication and validation of a novel HPLC-Chemiluminescence separation and detection scheme. Once the compound is identified it will be evaluated for potential medical use to produce NO. For example, the compound could provide a means that initiates RSNO decomposition in polymeric biomaterials, increasing the functionality of the medical device coated with biodegradable materials and preventing thrombus formation.
High Performance Liquid Chromatography Method Development for the Separation and Purification of Vanadium (IV) Oxide-Based MRI Contrast Agents

June Kowalski, Eugene Wickenheiser, Kathryn Kulju

Northern Michigan University

Vanadyl (VO$_2^+$) chelates used in magnetic resonance imaging (MRI) have been researched as cancer-specific contrast agents for the possible detection of early cancer. In this project, a reverse phase high performance liquid chromatography (HPLC) method was developed to separate and purify synthesized vanadyl chelates, specifically substituted VO(AcAc)$_2$ complexes. An Alltech C18 (150 X 4.6 mm) 3μ column and a methanol/formic acid/water mobile phase was used to achieve efficient baseline resolution and retention times for the vanadyl chelates. The wavelengths of maximum absorbance were obtained for each chelate by Ultra-Violet/Visible spectroscopy and were used for the detection of the purified chelates in the developed HPLC method. The optimized method was found to provide rapid and reproducible results for the separation of the vanadyl chelates. For further studies, the cancer-specific behavior of each purified vanadyl chelate will be analyzed by MRI methods.
System of Nitric Oxide Release for Viral Inactivation

Elizabeth Kruppe, Caryn Heldt, Megan Frost

Michigan Technological University

Nitric oxide (NO) is small signaling molecule of which plays numerous roles in the regulation of physiological processes. NO is known to play a significant role in immune responses. NO releasing materials have been demonstrated to have antibacterial effects. It also has been shown that NO has some effects on viruses through the use of S-nitroso-N-acetyl-D penicillamine. In order to study the inactivation of viruses using nitric oxide, a standard delivery system for NO from SNAP covalently linked to polydimethylsiloxane (PDMS) has been developed. Our system involves the photo-initiated release of NO from the SNAP-PDMS that has been cast into films on the bottom of glass vials. The glass vials will be used as the reaction vessels to deliver the NO into viral solutions. Herein we characterized the system in order to optimize conditions to store the polymer, the stability and reproducibility of the polymer/light configuration.
Inhibition of Vascular Calcification in Smooth Muscle Cells by Nitric Oxide

Maria Paula Kwesiga, Megan C. Frost

Michigan Technological University

Nitric oxide, a ubiquitous bioactive molecule produced by cells in the body is well known for its diverse roles such as aiding in vasodilation, neurotransmission and inhibition of thrombus formation. Recent findings suggest that it is in part responsible for inhibition of vascular calcification, a pathological process that is characterized by deposition of hydroxyapatite crystals in blood vessels and strongly correlates with high risk of cardiovascular events in patients with chronic kidney disease and diabetes. In vitro, calcification of primary smooth muscles was reported to be inhibited by the nitric oxide donor DETA-NONOate after 14 days in culture. Our study aims at understanding the role that nitric oxide plays in the progress of vascular calcification which could facilitate future therapeutic strategies targeted at improving cardiovascular health in patients.
Mass and Charge Transport in Pyrrolidinium Cation-based and Alkyltrimethylammonium Cation-based Ionic Liquids Using the Compensated Arrhenius Formalism

Augustus J Lowry, Allison M Fleshman

Lawrence University

Room-temp. ionic liquids (RTILs) offer great promise in the electrochemical industry. Application of these materials is limited, however, because the accepted empirical descriptions of mass and charge transport do not provide a molecular-level picture of the mechanism governing transport. An alternative model, the compensated Arrhenius formalism (CAF), successfully models mass and charge transport in RTILs providing this molecular-level picture. The CAF uses an Arrhenius-like expression to model transport as a thermally activated process by incorporating the dipole density into the exponential prefactor. The activation energy and exponential prefactor provide insight into the intermolecular interactions that govern transport. This work demonstrates the versatility of the CAF in describing temperature dependent self-diffusion, fluidity, and conductivity of pyrrolidinium cation-based RTILs and alkyltrimethylammonium cation-based RTILs and offers a comparison of the different systems.
Electrospinning Polymer Scaffolds for Use in Neural Tissue Engineering

Rachel Martin, Michael Mullins, Feng Zhao, Zichen Qian, Marie Wendling

Michigan Technological University

Polymer nanofiber scaffolds for use in neural tissue engineering have been fabricated via electrospinning of poly-L-lactic acid (PLLA) directly onto a 3D printed support. Previously, the investigators have shown success in promoting the directed growth of neural axons on highly aligned PLLA substrates both in vitro and in vivo. However, one criticism of the earlier in vitro studies is that by spinning fibers on a flat, two-dimensional surface, the growth of the axons is restricted to one plane. Thus the axon-to-fiber attachment may not be the sole mechanism for aligning the growth of the axons along the fibers, and the channels between the fibers and the substrate could contribute to the results. Using 3D-printing, elevated or “bridge” spinning stages were made with supports at varying heights, allowing the fibers to be suspending 2 to 5 mm above the substrate surface in many different configurations. This 3D structure promotes better access of in vitro cell cultures on the fibers to the growth media during incubation, reduces substrate effects, allows more degrees of freedom for axonal growth, and more closely simulates the growth environment found in vivo. Using these 3D stages, we have electrospun highly aligned fiber scaffolds of pure PLLA fibers. We have also begun exploring the spinning of coaxial fibers. Using methods and materials developed in the lab, fibers with a coaxial structure can be nominally spun using the existing electrospinning apparatus. Using these techniques, we are exploring spinning fibers with a PLLA sheath and a separate, independent core polymer. This new fibrous structure will give us the opportunities for many applications of the nanofibrous scaffolds for use in neural tissue engineering.
Cancer is one of the most researched diseases today. One area of interest in cancer research is the use of nitric oxide (NO) in treatment of cancer. In biological systems, macrophages produce large amounts of NO, which has been found to be cytotoxic to cancerous cells. To this end, a low amount of NO can actually be beneficial and aid cancer cell growth. With this in mind, determining exactly what levels of NO are required to efficiently kill cancer cells would be beneficial to cancer research. The MDA-MB-231 cell line, isolated from breast cancer, was the cell line chosen to deliver NO to cells grown in culture. The cells were grown on a specialized NO delivery device, which has a polymer membrane permeable to NO upon which cells are grown. Twenty-four hours after the cells were cultured in the device, NO was delivered to them by placing an NO donating polymer under the membrane the cells grew on. The level of NO the cells experienced was recorded using a chemiluminescence detector. Twenty-four hours later, the cells were imaged using fluorescence microscopy.

The data has been promising, with many deliveries killing more cells in the NO delivery region than in the surrounding areas. NO has also been found to enhance cancer cell growth at low levels in this research. More data will allow a more clear view of the effects of NO on cancer cells, though data so far has been positive.
Nitric oxide (NO) has been well known for its various biological attributes such as a potent smooth muscle cell inhibitor, anti-thrombogenic, antibacterial, anti-inflammatory and positive wound healing properties. Because of this wide range of biological functions, NO possesses great potential for use in the biomedical and therapeutical applications. In the current study, we have encapsulated S-nitroso-N-acetyl-penicillamine (SNAP) in biodegradable poly(lactic-co-glycolic acid (PLGA) (diameter 1-2.5 µm) microparticles which can release nitric oxide (NO) in a controlled manner. The amount of NO loading can be tuned by varying the amount of PLGA in the preparation. The duration, rate and amount of NO release from the microparticles can be initiated by varying light exposure or by the introduction of copper ions. Subsequently, the NO release profile of these stable SNAP incorporated microparticles were investigated when they were embedded in thermosensitive biodegradable chitosan-agarose hydrogel. The SNAP loaded PLGA microparticles were uniformly mixed in the hydrogel solution phase followed by the thermosensitive gelation. It is envisioned that this microparticle embedded thermosensitive hydrogel matrix can be used as an injectable system for controlled and continuous release of nitric oxide (NO).
Moisture Resistant Smart Hydrogel Adhesives Based on Reversible Catechol-Boronic Acid Complexation

Ameya Narkar, Brett Barker, Matthew Clisch, Jingfeng Jiang, Bruce P. Lee

Michigan Technological University

Smart adhesives that can bind to and debond from a substrate upon command are of great importance in the painless removal of wound dressings, separation of delicate organic components, repetitive surgical operations, etc. Existing smart adhesives have certain shortcomings like the need of high temperatures for debonding, irreversible adhesion, limited reversibility, weak or non-existent adhesion in a wet environment, etc. Hydrogel adhesives with up to 10 mol % each of dopamine methacrylamide (DMA) and 3-acrylamido phenylboronic acid (AAPBA) were developed. Dopamine mimics the catecholic moiety, 3-4 dihydroxyphenylalanine (dopa), found in mussel adhesive proteins. However, the catecholic groups form a strong complex with boronic acid at a basic pH, which promptly dissociate at an acidic pH. FTIR analysis demonstrated the formation of a new coordinate complex between DMA and AAPBA at 1489 cm⁻¹ for hydrogels equilibrated at pH 9, which was not observed at pH 3. Rheological analyses indicated that while the storage modulus (G¹) did not change with pH, there was more than an order of magnitude of increase in the loss modulus (G²”) at pH 9, which indicated the breaking of the coordinate complex under basic conditions. A total of 3 contacts was performed to probe the reversible interfacial binding capabilities of the hydrogel adhesive with a wetted glass substrate. High work of adhesion values of almost 2000 mJ/m² observed at the 1st contact reduced to 54.4% at the 2nd contact. However, the adhesive was able to recover almost 76% of its initial work of adhesion at the 3rd contact. The high adhesion at the 1st contact was due to DMA and AAPBA interacting with the glass substrate via H-bonds, electronic interactions, etc. The reduced adhesion was owed to the formation of the reversible coordinate complex at pH 9, which not only protected the catecholic groups from oxidation and irreversible crosslinking at pH 9, but also allowed the recovery of adhesive strength when the pH was changed to 3 at the 3rd contact. We were hence able to tune the adhesive properties of the hydrogel by employing AAPBA to control the redox properties of DMA and exploiting the pH dependent catechol-boronic acid complex to demonstrate reversible wet adhesion.
Investigating the Viability of the Caur_1362 gene for the Production of Phytase

Jane Newman, Steven Johnson

Lake Superior State University

Phytase is an enzyme capable of dephosphorylating phytic acid, which is abundant in livestock feed, commonly composed of soybean and corn. Phytase does not naturally occur in non-ruminant animals, such as pigs and chickens, and therefore the phytic acid is not broken down and tends to chelate biologically important cations. Not only are biologically vital cations lost through chelation, but phosphorus that could be obtained from phytic acid is also passed through the organism’s system and transferred to the environment. By allowing phosphates to be transferred to the environment, phosphorus pollution in soil and water has become a topic of interest. The gene of interest to this project, Caur_1362, was hypothesized to produce a viable phytase protein for potential agricultural applications. The gene Caur_1362 has been successfully cloned and expressed in the *E. coli* strain BL21, and then purified using immobilized metal chromatography.
An Innovative Way to Study Mutations Linked to Pediatric Brain Cancers

Chelsea Nikula, Momoko Tajiri, Martin Thompson

Michigan Technological University

There are four histone proteins that comprise the octameric histone core, a key component of DNA compaction into chromatin. The N-terminal tails of each histone protein is known to contain a variety of post-translational modifications, which can trigger both gene expression and gene silencing. Mutations are rare in these key proteins, but when they are found they are often connected to very serious and often lethal diseases. Three mutations in histone H3.3 have been tied to two types of pediatric brain cancer- diffuse intrinsic pontine glioma (DIPG) and pediatric glioblastoma (GBM). While there is a vast array of research linking these mutations to the cancers there has been little work examining the pathways of disease progression. Studying nucleosomes has proven to be challenging work and producing mutated histone proteins to incorporate into them has been difficult as well. In order to study how the mutations of histone H3.3 are tied to DIPG and GBM it is necessary to produce large quantities of homogenous, mutated H3.3. Our approach uses a novel ligation technique to attach a mutated peptide segment to a larger recombinant portion of the H3.3 protein. Past ligation techniques to produce mutated and modified proteins have utilized hazardous chemicals and problematic methodologies with a low yield, our method aims to overcome both of these. The ability to produce high quantities of specifically mutated or modified proteins and incorporate them into nucleosomes truly expands upon our capacity to study different diseases and cancers tied to aberrations in histone proteins. In addition, our method can be used to study a wide array of proteins with different modifications and mutations.
Bacterial infections are a prevalent concern to medical devices, and can ultimately lead to their failure. Over the years, various bacterial strains have evolved and developed resistances to a variety of antibiotics. There are many factors contributing to the growing number of antibiotic-resistant bacterial strains, but nevertheless there is a need for new approaches to fighting and preventing bacterial infections at the site of indwelling medical devices. Current literature revealed that nitric oxide (NO) possesses antibacterial properties and if appropriately utilized can inhibit bacterial growth and adhesion. With the use of S-Nitroso-N-acetyl-D-penicillamine covalently linked to polydimethysiloxane (SNAP-PDMS) as the NO releasing polymer, the inhibitory effects of NO against Staphylococcus epidermidis (S. epidermidis), Staphylococcus aureus (S. aureus), methicillin-resistant Staphylococcus aureus (MRSA), and Escherichia coli (E. coli) were quantified. The control material chosen for comparison was RTV3140, or surgical grade silicone rubber (PDMS), which is also the base material of the NO releasing polymer. The experimental setup was based on a combination of the Kirby-Bauer antibiotic disk susceptibility testing method and the urine streak—semi quantitative method. Results revealed that SNAP-PDMS does inhibit bacterial growth and prevent bacterial adhesion for all four strains of bacteria tested by greater than 1600% compared to RTV3140.
An Investigation into the Components of Little Bluestem Seed Exudate and Its Ability to Degrade Bisphenol A

Kristine Parson, Chris Nyland, Lesley Putman

Northern Michigan University

In previous studies results have shown that Little Bluestem seed exudate has degrading effects on Bisphenol A (BPA). This prompted further investigation into the seed exudate. Size exclusion chromatography with Sephadex G-75 yielded a clear and a brown fraction (Fraction I and Fraction II). Fractions I and II were subjected to SDS-PAGE gels, and Bradford protein assays. The protein content as determined by the Bradford protein assay was 25%, 29%, 19% (mass/mass) for the crude exudate and Fraction I and II respectively. SDS-PAGE analysis of the Fraction I showed proteins around 45 kDa and smaller. Fraction II, could not be analyzed with SDS-PAGE due to interference by brown substance. The brown substance was further isolated using solid phase extraction, the methanol eluant was analyzed with FT-IR and 1H NMR to determine structural features. ICP-OES analysis of the crude exudate confirmed the presence of iron, magnesium and calcium in the sample. To determine if these metal ions are critical for BPA degradation activity, the degradation was measured in the presence and absence of Ethylenediaminetetraacetic acid (EDTA). The presence of EDTA did not significantly decrease the degradation activity. However, increased binding interactions between the BPA and seed exudate was observed, by isothermal titration calorimetry (ITC). Further investigation into the role of EDTA is underway.
The Effects of Plasma Derived from *Lactobacillus johnsonii* Supplemented Mice and DHA on RSV Infected Dendritic Cells

Julia D Peterson, Wendy Fonseca, Nicholas W. Lukacs

Lake Superior State University

The emerging field of microbiome research has demonstrated the key role of microbial communities in the modulation of host immune responses. Previous studies in our group observed changes in the murine gut microbiome from allergen challenged mice gavaged with pet-associated house dust. Due to these previous studies and preceding interest in our laboratory, the effects of DHA on inflammasome and autophagy activity of RSV infected bone marrow dendritic cells was of interest. We tested the ability of DHA to suppress inflammasome activity upon RSV infection. The inflammasome serves as a central regulator of innate immunity and inflammation by inducing the maturation of cytokines and other processes for activation of an inflammation response. Following the exposure of cells to specific pathogens, a cytosolic protein complex assembles. This protein complex is essential for host defense against certain intracellular bacteria and virus. However, continuous activation can be detrimental for the body. The activation of NLRP3 inflammasome in response to pathogen-associated molecular patterns (PAMPs), such as lipopolysaccharides (LPS) or RSV, stimulates the caspase-1-dependent cleavage and secretion of IL-1β from stimulated cells. In this work we tested the activation of the inflammasome utilizing murine bone marrow dendritic cells (BMDC) that were treated with DHA and stimulated with RSV. After 2 hours of infection, cells were treated with adenosine triphosphate (ATP). ATP is shown to act as a potassium efflux agent, potentially triggering the activation of NLRP3 inflammasome in response to PAMPs. Samples were taken at different time points after treatment (2, 4, 6, 12, 24 hours). We observed a decreased expression of IL-1β and NLRP3 in cells that were treated with DHA and RSV infected, suggesting that DHA could be modulating the immune response in BMDC by suppressing inflammasome activity. This experiment was repeated at 4 and 6 hour harvests with similar data resulting, providing confidence in our results. The cDNA of the repeated 4 and 6 hour harvest was additionally used to look at the mRNA expression of two DHA receptors (GPR120 and PPARγ) and 3 proteins associated with autophagy (ATG5, ATG7, and BECN1). A decrease in mRNA expression of GRP120 and PPARγ was shown in DHA treated BMDCs, further supporting our hypothesis, and a slight increase in the expression of mRNA ATG5 and ATG7 was shown, however was not significant nor consistent. BECN1 illustrated a decrease upon DHA treatment. The experiment was repeated at 4 and 6 hour harvest, however GPR120 and PPARγ inhibitors were added to the samples, no difference was noticed when compared to untreated samples. Expression of IL1β, NLRP3, GPR120, ATG7, ATG5, and PPARγ were studied from BMDCs taken from mice gavaged with *Lactobacillus johnsonii*, previous experimental methods were followed, but DHA treatment was neglected. A significant decrease in the expression of IL1β, NLRP3, GPR120, and PPARγ relative to the control (PBS gavaged mice) was shown. No difference was noticed for ATG5 and ATG7 expression between PBS and *Lactobacillus johnsonii* gavaged mice. With this work we suggest an alternative way to modulated the immune response to RSV by microbiome modulatory metabolites.
Adhesives hydrogel is an interesting research topic as they could be used as substitute of surgical closures, fillers, and scaffolds. The main benefit of this type of material is that it can reduce complications, improve recovery, and function both ex vivo and in vivo. Ideal tissue regenerative bioadhesive and bioreactive hydrogels are required to have a set of combinations the following properties: 1) acceptable biocompatibility, 2) compatible mechanical property with surrounding tissues, and 3) allowing cellular adhesion and ingrowth, 4) specifically for this material, inducing collagenous extracellular matrix formation and proliferation of cells for accelerated wound healing. This purposed composite use poly(ethylene glycol) (PEG) as a backbone due to the polymer’s biocompatibility and availability. The hydrogel can be functionalized to integrate adhesive moiety, dopamine, inspired by blue mussels (Mytilus edulis), which can function in moist, ionic environments. However, the construct has bioinert nature and weak physical properties. To improve degradation, hydrolysable glutaric acid with ester linkage was incorporated. In addition, nano and micro silica particles have also been introduced into the hydrogel as a reinforcement to improve the hydrogel’s physical properties and bioactivity. The resulting composite shows promising changes in biological responses as well as improvements in general mechanical properties such as improved compressive strength, toughness, adhesiveness, and degradation profile.
Response of Human Mesenchymal Stem Cells on ZIF-8 Particles Embedded Gelatin Hydrogel

Zichen Qian, Lijun Zhang, Mitch Tahtinen, Avik Ghosh, Feng Zhao
Michigan Technological University

Metal organic frameworks have attracted much interest as a potential agent for drug delivery. Zn [(2-methylimidazole)2 (ZIF-8), which were synthesized from inorganic zinc ions and organic 2-methylimidazole, has low-density structure, high surface area, and tunable frameworks to serve as a suitable drug release vehicle. However, the external hydrophobic surface of ZIF-8 resulted in high cytotoxicity, which limited the biomedical applications of ZIF-8. Previous study on ball-milling ZIF-8 demonstrated a feasible method to decrease the cytotoxicity of the ZIF-8 by creating surface defects to expose the hydrophilic sites of the internal surface of ZIF-8. With the success of decreasing cytotoxicity, fundamental study of how defected ZIF-8 affect the cellular activities (survival, migration, and differentiation) was needed since the particle properties of the ZIF-8 was changed after ball-milling. Human mesenchymal stem cells (hMSCs) were widely accepted in regeneration therapy due to its multi-lineage differentiation ability and regenerative growth factors secretion. The objective of this study was to study the adhesion, proliferation, and differentiation of hMSCs on ZIF-8 immobilized gelatin hydrogel to investigate the potential of incorporating ZIF-8 into bio-scaffolds to design drug-releasing scaffolds. Results of the hydrogel characterization suggested that the swelling of the ZIF-8 embedded hydrogel was decreased with decreased particle size. N100 and N300 groups with lower particle size also released more Zn2+ before cell culture. After cell seeding, the hMSCs grown on Zif-8 included samples were more spread out and more elongated compared to those cultured on the pure gelatin hydrogel. Filopodium formation is increased when cells encountered the ZIF-8 particles. Osteogenic differentiation was observed to be highest in the smaller particle group at a lower dosage (N100 group). This study proved that ZIF-8 entrapped in hydrogel could modulate hMSC adhesion, growth, and osteogenic differentiation at controlled dosage and particle size. In summary, this study suggested that optimization of ZIF-8 particle dosage and size is required prior to design site specific regeneration therapies.
Identifying Thimbleberry Components with HPLC and GC-MS

Emily C. Ross, Brandon M. Canfield

Northern Michigan University

Thimbleberries are common in the Upper Peninsula but not sufficiently studied. The major focus of this research has been on the HPLC method development with fractional collection for additional analysis on GC-MS. A range of absorbance wavelengths have been measured to create a set of major components for identification. However, the major UV absorbance species do not appear to be volatile.
Measuring the Antioxidant Content of *Rubus parviflorus*

Tristan A. Ruiz, Brandon M. Canfield

Northern Michigan University

The thimbleberry plant (*Rubus parviflorus*) is native to two regions: the west coast of the United States and Michigan’s Upper Peninsula. The thimbleberry plant is important both to the contemporary locals and the native peoples who have historically made use of the leaf tissue for a variety of applications (in addition to the fruit tissue). However, there is not yet a lot of scientific literature on the subject of the antioxidant content of the leaves. In this study, the antioxidant content of wild thimbleberry leaves is tested using the Folin-Ciocalteu assay for total phenolic content, the aluminum chloride colorimetric assay for total flavonoid content, and the FRAP (ferric reducing ability of plasma) assay for antioxidant power. These results are additionally normalized to leaf size in order to explore growth cycle effects.
Solid-Phase Microextraction of Volatile Compounds in *Rubus parviflorus*

Taylor A. Sharp, Brandon M. Canfield

Northern Michigan University

Few studies have focused on the chemistry of Rubus parviflorus, also known as the thimbleberry, but there are currently no reports focusing on the volatile compounds of the berry. My research focuses on Solid-Phase Microextraction (SPME) of volatile compounds released from the tissue of the thimbleberry, using Gas Chromatography-Mass Spectrometry (GC-MS). The volatile compounds analyzed from the samples are responsible for comprising the complex bouquet of the berry. Reported volatile analysis of the raspberry, *Rubus Ideaus*, were utilized as a starting point for method development and analytical reference standards. Berries analyzed were harvested from different locations around Marquette, MI. Fresh and degradation thimbleberry products were examined, and compared to raspberry.
A Quantum Computational Study on the Effects of the Interaction between Magnesium Oxide Nanotubes and Active Pharmaceutical Ingredients on the Quality of Drinking Water

Angela Small, Loredana Valenzano

Michigan Technological University

The presence of molecules from active pharmaceutical ingredients (APIs) in drinking water and soil is currently a major environmental and medical concern. Materials and structures able to trap, separate, or inhibit the action of such APIs, in form of membranes for example, must be studied to mitigate this problem. The objective of this project is to address the nature of the interaction between metal oxide-based materials and the most common API molecules found in water such as acetaminophen, codeine, and ethinyl estradiol.

After a preliminary investigation of the relative stability of molecular monomers in a water solvated environment, the interaction with MgO(001) nanotubes is addressed. Results from this investigation show that water always stabilizes the structures by roughly 30 kJ/mol. The magnesium oxide nanotubes consist of forty atoms and have a diameter of approximately 7.0 Å.

Binding energies between the molecules and MgO(001) nanotubes are determined via single point calculations which are then used to find the zero point energy through a parabolic fit. The molecules are arranged with respect to the nanotube according to different geometrical configurations in the proximity of the base of the tube. This project will employ state-of-the-art electronic structure computational approaches based on density functional theory (DFT), which will allow for the understanding of the physicochemical properties of the interaction of acetaminophen, codeine, and ethinyl estradiol with the mentioned metal oxide species.
A New Purification Method to Isolate a Human Cancer Associated Protein

Melanie Talaga, Ni Fan, Purnima Bandyopadhyay, Chelsea Uganski, Ashli Fueri, Tarun K. Dam

Michigan Technological University

Galectin-3 (Gal-3) is a carbohydrate binding protein associated with many cancers including thyroid, colorectal, prostate, pancreatic, gastric, lung, ovarian, melanoma, breast, liver and multiple myeloma. Gal-3 is known to modulate cancer cell growth, apoptosis, metastasis and angiogenesis. The presence and secretion of Gal-3 is associated with the progression of many cancers, therefore this protein qualifies as a clinical cancer biomarker. The dynamic role that Gal-3 plays in the survival of cancer cells is poorly understood. We need to produce sufficient quantities of Gal-3 to study its diverse role in cancer biology. In this research, recombinant human Gal-3 from bacterial lysate was isolated using a new method developed in our lab known as “Capture and Release” or “CARE”. This method was first developed using plant materials. The successful purification of human Gal-3 expressed from E.coli further validates this method. This work demonstrates an inexpensive novel way to isolate Gal-3 to further investigate its crucial role in cancer. CARE is a cheaper alternative to isolate Gal-3 for its further application.
Lil' APOLLO: An Open Source Atmospheric Monitoring System

Mikhail Trought, Julia Jaglowski, David Jumes, Deanna Donohoue

Lawrence University

Scientific instrumentation is essential in any field of science. However, due to cost or mobility many instruments are not available to institutions or will not work for specific applications. Using electronic sensors along with a micro controller can solve these issues and allow instrumentation to be accessible to all, due to its low cost and size. Using these electronic components does not require any extensive background knowledge and a large community of users provides resources for troubleshooting. We have created an air quality device, which includes a temperature and relative humidity sensor, a CO₂ sensor, and a dust sensor that are controlled with an Arduino micro controller. This open source system was deployed around the Bakken-Williston Basin in the North Dakota area and was used to monitor the air quality at several different sites. Here we will compare the Arduino instrument with specialized instruments deployed on the same campaign to evaluate the quality of these sensors for air quality measurements.
Improving the Durability of Graphene Composite Sensors for Robust Biosensors

Soontorn Tuntithavornwat, Julia A. King, Caryn L. Heldt

Michigan Technological University

In spite of the great progress in medical technology in the last few decades, poor access to health care is still one of the challenges in developing countries. Biosensors are developing rapidly toward smaller devices with extremely sensitive detecting platforms to detect proteins and pathogens for quick and inexpensive disease diagnose and/or biological responses. Carbon based nanomaterials, in the form of carbon nanotubes (CNTs), graphene and graphene oxides, have shown that they can detect protein adsorption via the disruption of the electron-carrying crystalline network. In comparison to others derivative of carbon, such as graphite and carbon nanotubes, graphene shows the unique physical and chemical properties such as large surface area, excellent electrical conductivity, superior thermal conductivity and outstanding mechanical strength. In addition, the derived graphene oxide and reduced graphene oxide products are more hydrophilic, increasing their biocompatibility.

Our team is exploring graphene/cellulose based composite materials as a sensitive biosensor platform. Both graphene and cellulose are abundant and combined, they have unique properties for electrochemical detection.

Graphene/cellulose is a breakthrough innovation that supports graphene within natural polymer sheets. Cellulose moves the target solution through graphene layers by using capillary action, therefore creating a higher surface area for sensing applications and operating without external force to drive solution into the system. Graphene/cellulose paper is inexpensive and easily customized for porosity and surface chemistry. However, we have found that the graphene/cellulose composite, once exposed to a liquid environment, becomes fragile and brittle. Our proposed solution is to strengthen the paper with a combination of glutaraldehyde and poly(vinyl alcohol) (PVA). We have found improved wet and dry strength of the graphene/cellulose composite material. The interesting performance of this crosslinking system is the result from acetal and hemiacetal bonding from hydroxyl and aldehyde groups of PVA-glutaraldehyde-cellulose. On the contrary, adding PVA into the crosslinking system can also cause increasing of electrical resistivity which reduces sensing reliability of treated paper. Therefore, the result of strength and resistivity in graphene paper is needed to be investigated.
Unveiling a New Hemolytic Lectin from a Previously Unexploited Higher Plant Species

Christina Welch, Ni Fan, Melanie Talaga, Ramandeep Rekhi, Alexander Vizurraga, Tarun Dam

Michigan Technological University

Lectins are ubiquitously distributed carbohydrate-binding proteins that aid in numerous important biological functions. Most lectins clump (agglutinate) red blood cells or erythrocytes. Some lectins possess a cytotoxic function that enables the destruction of erythrocytes and other cells. These lectins are known as hemolytic lectins. Hemolytic lectins are carbohydrate-specific proteins that retain the ability to lyse or agglutinate these red blood cells. Two hemolytic lectins, CEL-III and LSL, have been widely researched and their binding properties and pore-formation mechanisms have been elucidated. The cytotoxic ability of these proteins has made them a novel tool for antimicrobial research. To our knowledge, a hemolytic lectin has never been found in a higher plant. In our lab, we have isolated a hemolytic lectin named Hemolysin X (HelyX) from a higher plant species and I am currently working to characterize this protein. We have found that HelyX is able to agglutinate and lyse rabbit erythrocytes. In other words, HelyX is unique in having properties like a lectin as well as a hemolytic protein. We have found that the lectin activity of HelyX could be inhibited by thyroglobulin, fetuin, asilofetuin and fibrinogen. Interestingly, the lytic activity of HelyX was also inhibited by thyroglobulin, fetuin and asilofetuin but not with fibrinogen. Currently, we have been further determining the macromolecular structure and hemolytic properties of HelyX.
Facile Synthesis of Ru Nanoframes with fcc Crystal Structure and Enhanced Catalytic Activities

Haihang Ye, Xiaohu Xia

Michigan Technological University

Nanoframes made of noble metals have received great interests in recent years owing to their superior performance in plasmonic, catalysis, and biomedicine. In this study, for the first time, we successfully synthesized Ru nanoframes using a two-step method. In the first step, Ru atoms were directed to selectively grow on the corners and edges of Pd truncated octahedra as the seeds, resulting in the formation of Pd-Ru core-frame octahedra. The key to the site-selective growth was careful manipulation of the reaction kinetics. In the second step, Ru nanoframes were produced from the Pd-Ru core-frame octahedra by removing the Pd cores through chemical etching. Importantly, the Ru nanoframes exhibited an fcc structure, replicating the crystal structure of initial Pd seeds. The fcc Ru nanoframes showed enhanced catalytic activities toward the reduction of p-nitrophenol and the dehydrogenation of ammonia borane compared to Ru nanowires with an hcp structure and roughly the same thickness.