Anthony Allen, 2018  From: Detroit, MI

Advisor: Thompson (Academic) Nee (Research)

Project: Cucurbituril Research and Synthesis

Description: Exploration of cucurbituril chemistry in an attempt to help synthesize the theoretical CB[9] molecule. I have been tasked with adding protecting groups to the glycoluril molecule that make up the "panels" of a cucurbituril. We are trying to synthesize 1,6-dibenzylglycouril. The 1,6-dibenzylglycouril will be attached to the end of a glycouril trimer. The benzyl groups will act as protecting groups and will later be removed after the trimer is attached to a glycouril hexamer. We hope that if we can attach the trimer to the hexamer and then remove the benzyl protecting groups from the end of the new 9 member oligomer that the molecule will fold into CB[9]. If the benzyl groups cannot be added to the glycouril, we anticipate using a different aromatic protecting group like o-xylylene.

Other Interests: Football, weightlifting, reading, philosophy, piano, chess

Eric Bell, 2017  From: Cincinnati, Ohio

Advisor: Ryno

Project: Insights into the Binding Behavior of Chaperone SurA using in silico methods

Description: The proper folding of many outer membrane proteins of E. coli depends on the chaperone activity of SurA, a protein located in the periplasmic space. The importance of SurA in maintaining the periplasmic proteome suggests small molecules that bind to and inhibit the function of SurA could also disrupt the viability of bacteria. Our lab’s focus is to understand the binding mechanism of not only small molecules but also the client proteins with SurA through a series of computational docking predictions. We used these docking predictions to find good drug candidates using a virtual screen involving the supercomputer, and plan to ultimately test these promising small molecules in competitive binding studies in vitro and on bacterial viability in vivo.

Other Interests: Video games, Music production, coding
Hannah Cook, 2018  From: Dartmouth, MA  
Advisor: Nee  
Project: Cucurbituril Synthesis and Chemical Analysis  
Description: Cucurbiturils are cyclic molecules that have been formed with 5, 6, 7, 8, 10, and 14 glycoluril pieces. They possess exciting attributes for further research in drug delivery. In an attempt to make the cucurbit[9]uril molecule, we are placing blocking groups, such as specific chelate molecules, onto the same side of a glycoluril unit that will hopefully lead to the formation of a trimer with removable blocked ends. In combination with the cucurbit[6]uril molecule, the goal is to combine these components to make a 9 membered ring, which has not been done before.  
Other Interests: Soccer, track, reading

Diego Cortes, 2018  From: Houston, TX  
Advisor: Elrod  
Project: Mechanism and Kinetics: Hydrolysis of beta pinene oxide  
Description: Very little research has been done for beta pinene oxide in the past. This compound was formed previously from beta pinene, which is a nature-made compound. Beta pinene oxide has an epoxide attached to a ring. The epoxide makes the compound reactive. This project's goals are to find what products form as a result of this compound's hydrolysis, under acidic conditions and without. The next steps are to compare the speeds at which these reactions undergo.  
Other Interests: Running. Guitar.
Will Dresser, 2019  From: Indianapolis, IN

Advisor: Elrod
Project: Kinetics and Reactions of Gaseous BVOC's
Other Interests: Hiking, Running, Reading, Video games, Backpacking

Chris Eckdahl, 2017  From: St. Joseph, Missouri

Advisor: Mehta
Project: Exploring tetrahedral packings
Description: Aristotle claimed that space could be tiled using tetrahedra of equal volume. This conjecture has since been disproven, but the realm of tetrahedral packing remains full of secrets. For instance, how close can you get to the perfectly dense packing envisioned by Aristotle? What symmetries are allowed in a structure made entirely of tetrahedra? What if the tetrahedra are magnetic? We investigate questions such as these using physical and computational models of tetrahedra. Besides addressing fundamental mathematical questions, we also hope to shed light on chemical systems such as colloids and nanoparticles.
Other Interests: Playing trumpet, chess, 3D printing, backpacking
Aidan Estelle, 2017  From: San Diego, CA

Advisor: Nee

Project: Fishing for Cucubiturils

Description: Cucubiturils are a class of cyclic polymers consisting of 5 to 10 glycouril units. Their unique, pocket-like shape results in a handful of interesting features, with a variety of possible applications including drug delivery and synthetic applications. However, cucubituril compounds are difficult and often costly to synthesize in reactions that produce a single size of polymer. Our work is aimed at building structures that rest selectively inside CB[8]. Once synthesized, the compound can be attached to a resin and be used in isolation of CB[8] from a mixture of variously sized cucubiturils.

Other Interests: Video games, Reading, cooking, Pottery

Erin Ford, 2018  From: Hockessin, DE

Advisor: Thompson

Project: Forensic Analytical Chemistry Experiments

Description: Equipment for testing of crime scene evidence is astronomically expensive and far out of reach for most college budgets. In an effort to make forensic science more accessible at the collegiate level, Professor Thompson wrote a lab manual for forensic science using novel techniques to circumvent the pricey equipment. This winter term, we will be beta testing Professor Thompson’s manual, elucidating any obstacles and learning lots all along the way!

Other Interests: Running, cooking, hiking, goofin around
Aaron Frederick, 2016 From: McLean, VA

Advisor: Mehta

Project: Thermodynamic Studies of Co-crystals

Description: Pharmaceutical co-crystals are a relatively new development that can potentially change the way new drugs are made. When studying these co-crystals, we found that they form spontaneously in the solid state. My studies are an attempt to quantify this spontaneous reaction in the form of Gibbs energy of formation for each of these co-crystals. This is done by subtracting the product of standard molar entropy and temperature from the enthalpy of formation. These two quantities (standard molar entropy and enthalpy of formation) are found with two different forms of calorimetry: differential scanning calorimetry (DSC) and bomb calorimetry. DSC measures the heat capacities of substances from temperatures as low as 120K to room temperature, and the standard molar entropy can be found from that data. Bomb calorimetry employs Hess' law and a knowledge of each element of a combustion reaction to solve for the enthalpy of formation of the sample.

Other Interests: Swimming, Music

Calvin Gang, From: Chicago, IL

Advisor: Oertel

Project: Synthesis of Single Crystals And Nanostructures of Lead Oxide Carboxylates with Halogenated Benzoate Ligands

Description: The solution processing of materials has been used in the top-down synthesis of nanostructures, which attract interest for properties that can differ from their bulk counterparts with the same chemical identity. Through hydrothermal synthesis, our lab has synthesized single crystals of lead benzoate and lead oxide benzoate compounds with halogenated ligands. Furthermore, we have synthesized nanowire structures from the ultrasonication of lead benzoates with fluorinated and chlorinated ligands. Powder X-ray diffraction suggests that the sonication process may involve a chemical conversion, in which the lead benzoate hydrate changes into a corresponding lead oxide benzoate. Electron diffraction used to analyze the individual nanowires suggests that the structures are low in crystallinity. Single crystal and powder X-ray diffraction as well as scanning electron microscopy will be utilized for analysis of the chemical conversion process and characterization of these nanowires.

Other Interests: break dancing, Avalon, The Walking Dead
Jingyan (Lulu) Huang, 2016  From: Beijing, China

Advisor: Nee

Project: Removal of dyes from industrial waste water with cucurbituril

Description: Cucurbiturils are pumpkin shaped cyclo-oligomer molecules built up of glycoluril units linked by methylene bridges. Cucurbiturils have demonstrated potentials in dye removal by forming inclusion complexes with different acidic, reactive and disperse dyes. Among the cucurbituril homologues synthesized in the laboratory, CB[8] is proposed to be the most efficient in forming inclusion complex with common dyes. The goal of the project is to study and optimize the interaction between CB[8] and industrial dyes

Other Interests: Whatever you catch me doing

Chris Husted, 2016  From: Armonk, NY

Advisor: Nee

Project: Cucurbituril Synthesis and Chemical Analysis

Description: The pumpkin-like or barrel-like molecules, cucurbiturils, are important in drug discovery and research. Many different variations have made such as 5, 6, 7, 8, 10, and 14. Currently, we are working on filling in the gaps and create cucurbit[9]uril using a trimer and hexamer. My partners are creating the trimer with removal blocking groups so I am working on creating the other reactant, which is Cb[6]. Hopefully, we will make the trimer and hexamer so we can begin working on the process of combining the two molecules to create the never created and sought after Cb[9].

Other Interests: Lacrosse, hockey, reading, netflix, reptile care
Canran (Polo) Ji, 2018  From:
Advisor: Mehta

**Project:** Spontaneous Co-crystal formations

**Description:** The mechanism of the formation of pharmaceutical co-crystals is still mostly a part of black art. During the experiment before, we found that the spontaneous co-crystal formation can be catalyzed under moist conditions which inspired us to use the organic vapor to take the place of the water in the experiment. It turned out last summer that the organic vapors like acetone and methanol have astonishing effects in catalyzing the formation of co-crystal. The main focus now is to figure out the relations between the organic vapors and their catalyzing effects.

**Other Interests:** Muscles, Poppin

Kallie Jiang, 2019  From: Grand Rapids, MI
Advisor: Elrod

**Project:** Oligomerization of lactones as a mechanism for the formation of 2-methyl glyceric acid (2-MG)-based oligomers

**Description:** The interaction between biogenic volatile organic compounds (BVOCs) and human introduced pollutants contributes to air pollution and climate change by forming potentially toxic components in aerosols. In this project, we will test one of the ways in which this might occur by studying the oligomerization mechanism for beta-propiolactone (BPL) and measure its relative nucleophilicity against water as a model for the lactone-driven oligomerization of 2-MG-like oligomers. 2-MG oligomers are known components of aerosol particles derived from the BVOC isoprene.

**Other Interests:** Figure skating, reading, drawing
Nigel Kidder-Wolff, 2016  From: West Hartford, CT

Advisor: Nee

Project: The Search for Cucurbit[9]uril

Description: The infamous molecular pumpkins known as cucurbiturils are built by connecting glycoluril units side to side and closing them into the pseudo-spherical supermolecule. Since their discovery over thirty years ago, cucurbiturils have been formed with 5, 6, 7, 8, 10, and even 14 glycoluril units, but nobody has yet isolated the 9 unit structure. By combining an open 6-membered glycoluril chain with an open 3-membered chain we hope to be the first.

Other Interests: Partner dancing, card games, sleeping

Jeff Levy, 2016  From: New Rochelle, NY

Advisor: Belitsky

Project: Synthesis of a Eumelanin Analog

Description: Eumelanin is the melanin pigment responsible for black and brown color in hair and skin. Eumelanin functions as a photoprotective agent, antioxidant, organic semiconductor and has specific molecular recognition properties. It’s formation is poorly understood, so we are interested in making a synthetic analog. Possible functions of such an analog include use in water purification and organic semiconductors. While eumelanin is an assembly of DHI (5,6 dihydroxyindole) oligomers, I am working to assemble DMICE (ethyl 5,6-Dimethoxyindole 2-carboxylate) oligomers due to more experimental success. Reactions we use include Iridium-catalyzed borylations, Suzuki-Miyaura cross couplings, and homocouplings. This work will provide insight on the biological formation of eumelanin.

Other Interests: Trombone, Piano, Guitar, Bicycling, Unicycling, Tricycling, Hiking, Backpacking
Sophie Lewandowski, 2016  From: Whitehouse Station, NJ

Advisor: Belitsky

Project: Synthesis and Characterization of Catechol-Coated Heavy Metal Sensors

Description: Eumelanin is a poorly understood pigment that is found in hair and skin. However, it is known that eumelanin has a strong affinity for heavy metals, such as lead and copper. In the past, our lab has taken advantage of this property and has developed a heavy metal sensor. This sensor consists of a synthetic analog of eumelanin, catechol, coated on a polyvinylidene fluoride disc. Upon addition to metals, the discs undergo a visible color change that can be quantified using colorimetry. In order to increase the color change at low concentrations of lead and copper, I am working on characterizing the coatings through UV-VIS spectroscopy and fluorimetry.

Other Interests: Running, baking, reading, content and copy editor for The Synapse

Sarel Loewus, 2016  From: Pullman, WA

Advisor: Ryno

Project: Investigating the Effect of the RpoH Transcription Factor on E.coli Biofilm Formation

Description: The rpoH gene encodes the σ32 factor, a transcription factor that controls the expression of more than thirty heat shock genes. In this project we are investigating how biofilm formation is effected by overexpression of rpoH in PHL628 E.coli, a K-12 E.coli strain (non-anterpopathogenic) with a mutation that enhances biofilm formation. Specifically we want to probe how the time of biofilm growth, biofilm morphology, and composition of the extracellular polymeric substance are affected by the overexpression of rpoH.

Other Interests: Running, Bicycling, Hiking
Liora Mael, 2016 From: Lexington, MA

Advisor: Elrod

**Project:** Atmospheric Oxidation: Mechanism and Kinetics of the Reactions of Monoterpenes

**Description:** Monoterpenes are compounds produced by coniferous trees. In concert with human introduced pollutants, these monoterpenes can impact air quality. We are interested in studying the kinetics and mechanisms for the oxidation of the various compounds. These reactions are studied using flow tube chemical ionization mass spectrometric technique (FT-ICMS). Knowledge of the details of these oxidation pathways is important for understanding how these systems work.

**Other Interests:** Papermaking, hiking

Daniel Markus, 2018 From: Rockville, MD

Advisor: Belitsky

**Project:** Synthetic Melanin Filtration Agents

**Description:** Melanins are far less understood on a chemical level than biomolecules such as proteins and DNA, but they have a range of interesting properties that make them potentially beneficial as water purification agents. Working in collaboration with a local company, Nanotech Innovations, we are exploring synthetic melanin in combination with a variety of other materials, including carbon nanotubes, alumina nanoparticles, and activated carbon, as filtration agents for heavy metals and organic dyes. This Winter Term, we are exploring the synthesis of melanin-containing composite materials and testing their binding and filtration properties.

**Other Interests:** Guitar, songwriting, photography, political debate, reading, Netflix binging
Lele Mathis, 2018  From: Chevy Chase, MD

Advisor: Oertel

Project: Synthesis of Organic-Inorganic Crystals of Lead Oxide Phosphonates

Description: The study of the corrosion of lead-tin alloys led to the synthesis of the organic-inorganic hybrids from lead oxide and various carboxylic acids, which were discovered to be made up of a helix made of lead oxide tetrahedra attached to carboxylate ligands. These materials were found to be noncentrosymmetric, giving them useful properties such as optical activity. We are now synthesizing organic-inorganic hybrids with lead oxide using phosphonic acids instead of carboxylic acids, and examining their structures using single-crystal and powder X-ray diffraction in order to find more varieties of these interesting materials and to understand how a different organic ligand changes the crystal structure.

Other Interests: Dancing, videogames, board games

Kepler Mears, 2017  From: Brookline, MA

Advisor: Whelan

Project: Selection of Aptamers for Ovarian Cancer Biomarkers

Description: Aptamers are short nucleotide sequences that have been selected to bind to target molecule. In our lab we use a selection method called SELEX (Systematic Evolution of Ligands by Exponential Enrichment) to develop aptamers to be used in diagnostics and therapeutics for the ovarian cancer biomarkers HE4 and CA125. My project is optimizing our selection method and incorporating a technique called emulsion Polymerase Chain Reaction (ePCR). ePCR has been demonstrated to be a more effective way of amplifying DNA than traditional PCR, we believe the incorporation of this method will lead to the development of stronger binding aptamers.

Other Interests: Rap music and beer
Karstan Minanov, 2018 From: Grosse Pointe Farms, MI

Advisor: Nee

Project: Organic Synthesis Study

Description: Prilocaine and benzocaine are two commonly used anesthetics that can be synthesized in several different ways. An anesthetic is used to disrupt the propagation of nerve impulses in tissues in a reversible but lasting way. My research involved the study of a newly proposed mechanism that can create both prilocaine hydrochloride and benzocaine by starting with a toluene ring. This toluene ring can be transformed into mononitrotoluene and then the ortho, para, and meta versions of the mononitrotoluene can be separated by creating o-toluidine hydrochloride and p-methylacetanilide. The o-toluidine takes on an aqueous nature and can be extracted and the p-methylacetanilide can remain in an independent aqueous layer. The two products are then treated separately to create benzocaine from the p-methylacetanilide from a mechanism that has been known since the 1950s and the o-toluidine can be transformed into prilocaine hydrochloride by using the newly discovered mechanistic steps. My goal in my research was to replicate this experiment in order to test the validity of the experiment and to find various ways to improve upon it so it was run several times in hopes of finding the best possible way to carry it out. This new synthesis pathway was discovered by Partricia Demare and Ignacio Regla at Universidad Nacional Autónoma de México.

Other Interests: Lacrosse, video games, hockey, cooking

Won Hee (Harry) Ryu, 2016 From: Seoul, South Korea

Advisor: Matlin

Project: Investigation on organocatalyzed Nazarov cyclization reaction

Description: Traditionally, the Nazarov Cyclization involves the acid-catalyzed cyclization of divinyl ketones. The Matlin lab has discovered that this reaction can also be catalyzed by hydroxylamine hydrochloride. Current work is directed at developing a chiral variant of hydroxylamine with the hope of inducing enantioselectivity in the cyclized products. A second area we are investigating is adding dienes to the reaction in order to capture the reactive hydroxyallyl cation intermediate in an enantioselective reaction.

Other Interests: Food Instagram, cooking, vodka, Winning Nobel Prize
Andrew Santiago, 2019  From: Evanston, IL

**Advisor:** Oertel

**Project:** Synthesis of Hybrid Organic-Inorganic Molecules

**Description:** Previous research on the corrosion of lead and lead-tin alloy based historical artifacts by carboxylic acids resulted in the synthesis of hybrid Organic-Inorganic (O-I) crystals of lead oxide tetrahedra bonded to organic ligands. Hybrid O-I molecules are a rather new and developing field, and these materials have a wide variety of physical properties. The lead oxide and carboxylic acid crystals formed in a myriad of constructions, including lead oxide double helices. Current research is now investigating other hybrid O-I crystals based on lead oxide with new ligands.

**Other Interests:** Mahjong, other tabletop games, baking

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Delia Scoville, 2016  From: China, ME

**Advisor:** Whelan

**Project:** Characterization of Aptamer Binding Affinity to the Cancer Biomarker CA125

**Description:** I am focusing on characterizing the binding affinity for short DNA sequences called aptamers to an ovarian cancer protein biomarker, CA125. CA125 has been chosen as the protein of interest due to the recent development of an algorithm (ROCA) that relates CA125 levels over a woman's lifetime to her likelihood of developing ovarian cancer. Based on previous work done in the Whelan lab, certain aptamers have been selected via the one-pot method as potential candidates for use in improved early stage ovarian cancer detection techniques. I will be using a variety of analytical methods including fluorescence anisotropy and capillary electrophoresis to further examine the binding between CA125 and its aptamer candidates in order to select the best aptamer to use as a cancer detector.

**Other Interests:** Running, cooking, reading
Santino Stropoli, 2018  From: Manhattan

Advisor: Elrod

Project: Oligomerization Reactions of Isoprene-Derived Epoxides

Description: Isoprene is a volatile organic compound released in relatively large volumes by plants. In the atmosphere, it undergoes reactions that produce various epoxides that are observed in aerosols. We study these epoxides, particularly 2,3-epoxy-2-methyl-1,4-butanediol, via NMR to determine what further reactions they are likely to undergo.

Other Interests: I am a double degree student in chemistry/music. I study violin in the conservatory, but I am also very interested in jazz guitar and flamenco ukulele.

Alejandro Vera, 2017  From: Chicago, IL

Advisor: Belitsky

Project: Synthetic Melanin Filtration Agents

Description: Melanins are far less understood on a chemical level than biomolecules such as proteins and DNA, but they have a range of interesting properties that make them potentially beneficial as water purification agents. Working in collaboration with a local company, Nanotech Innovations, we are exploring synthetic melanin in combination with a variety of other materials, including carbon nanotubes, alumina nanoparticles, and activated carbon, as filtration agents for heavy metals and organic dyes. This Winter Term, we are exploring the synthesis of melanin-containing composite materials and testing their binding and filtration properties.

Other Interests: Guitar, basketball, drawing, video games
Yinuo Zhang, 2017 From: Ningbo, China

Advisor: Thompson

Project: Forensic Analytical Chemistry Experiments

Description: We will proceed one crime case selected from professor Thompson's forensic analytical chemistry lab manual and practice knowledge & skills learned from Analytical Chemistry lab meanwhile improving my lab skills.

Erica Zheng, 2017 From: Ottawa, Canada

Advisor: Ryno

Project: Discovering Inhibitors of the Periplasmic Chaperone SurA for Novel Antibiotic Development

Description: Our lab will focus on the direct inhibition of the protein SurA, a protein found in the periplasmic space of Gram-negative bacteria. SurA acts as a gatekeeper between the interior of a bacterium and the external environment. It is responsible for the proper folding of secreted proteins and toxins as well as the overall maintenance of the cell membrane. We will express this protein in E. coli, and purify it using an intein tag-based approach. Through the development of a fluorescence anisotropy-based assay, we will discover new types of small molecule antibiotics that specifically inhibit this chaperone and disrupt bacterial homeostasis.

Other Interests: Flute, reading, old movies, dogs