WILLIAM PATERSON UNIVERSITY OF NEW JERSEY

COLLEGE OF SCIENCE AND HEALTH

RESEARCH

INTERNSHIPS AND EXTERNSHIPS

GARDEN STATE- LOUIS STOKES ALLIANCE FOR MINORITY AND PARTICIPATION

CELEBRATING STUDENT RESEARCH ACTIVITIES 2021
TWELFTH EDITION

EDITED BY: DR. DANIELLE DESROCHES, COVER BY BRIANA E. LAWTON AND STARR-MADISON NESBITT-SMITH

RESEARCH
INTERNSHIPS, EXTERNSHIPS

WILLIAM PATERSON UNIVERSITY

COLLEGE OF SCIENCE AND HEALTH
BIOLOGY DEPARTMENT
Garden State-Louis Stokes Alliance for Minority Participation (GS-LSAMP)
&
Minority Association of Pre-medical Students (MAPS)
&
College of Science and Health Student Research (CSHSR)

Celebrating Student Research Activities
2021
12th Annual Edition

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William Paterson University, Chemistry Department

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William Paterson University, Mathematics Department

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Introduction

This is the 12th year the Garden State Louis Stokes Alliance for Minority Participation (GS-LSAMP) program and the College of Science and Health Student Research (CSHSR) has published this report of the research efforts and successes of William Paterson University's science majors.

As in previous years, Summer Research Internships and Externships have provided underrepresented minority students (URM) and non URM science students with the opportunity to work on or off campus, in a laboratory or in their field of interest, under the supervision of faculty. This opportunity has allowed them to experience firsthand "how scientists work" and how to conduct scientific research. Many students actively participated in specific projects in which they learned new techniques, including the use of elaborate laboratory equipment, computer -assisted analyses, animal husbandry and handling. Other students have spent their summers volunteering or shadowing physicians in Hospitals and Health Clinics. These internships have proven to be a valuable asset for students applying to Graduate or Professional school, or in job placement or career selection following graduation.

All the summer interns have presented their summer experience at one of our monthly, well attended, meetings in the Fall 2019 and Spring 2020 semesters. Many interns have also gone to the GS-LSAMP Annual STEM meeting at Rutgers University, October 2019. Four of our students won top prizes for their posters at this meeting! The abstracts in this manuscript, which were written by these students, provide an honest and candid account of their work with their mentor. Unfortunately, this past spring (2020) they were not able to present their work in other regional and national meetings due to the COVID19 Pandemic.

These summer internships would not have been possible without the support of the Biology, Chemistry and Environmental Sciences faculty who have volunteered to mentor our students. Others have provided contacts for off campus opportunities.

This summer 2020, in spite of the Pandemic, GS-LSAMP and the COSH were able to continue to provide students with the opportunity to remain engaged and motivated, while the campus and laboratories were closed. With funds from NSF for URM students, as well as additional funds from the Provost office, an Alumni Association grant, the Science Enrichment Center, and the Dean of COSH, 37 students were kept engaged in research remotely with our COSH faculty. The usual stipend of $1500/student was increased to $2000/student.

This 2021 publication showcases the work of our students during a very difficult and challenging period. This work would not be possible without the support of Dr. Venkat Sharma, Dean of the COSH, who funded 10 more students, and Dr. Jean Fuller-Stanley, Associate Dean of CSH and LSAMP's recently retired project director at WPUNJ. A grant submitted by the GS-LSAMP coordinator to the WP Alumni Association provided funds to support 4 more students. Dr. Donnar Rennar-Potacco of the the Science Enrichment Center added funding for 2 more interns. Many thanks to Provost, Dr. Joshua Powers, for the additional funding of 5 more interns. As a result of these cumulative efforts, **a total of 34 students** were included in one of our largest groups since the start of the GS-LSAMP program and associated COSH student research

A huge and grateful thank you as well to Rita Levine for assisting in all matters related to GS-LSAMP, updating and recording applications, keeping rosters, creating a virtual meeting room, and for her technical and graphic support with this manuscript.

Ideally, next year's publication will include many more interns and mentors.

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Research Internships Abstracts

William Paterson University,

BIOLOGY DEPARTMENT

Investigation of pathways and genes in *Candida glabrata* that influence tolerance to echinocandin antifungals

Christal Rolling, Cassie Girardin, Kelley R. Healey PhD (mentor), William Paterson University

Candida glabrata is a commensal organism that can cause invasive infections in immunocompromised patients and demonstrates elevated rates of resistance to antifungal drugs, including echinocandins. Upon exposure to stress, such as an antifungal, yeast cells activate multiple cellular mechanisms that can allow survival until resistance mutations are acquired. These adaptive, or tolerance, mechanisms can be targeted in order to enhance the activity of antifungals and/or possibly mitigate acquired resistance. We performed an extensive literature search of cellular factors that influence antifungal tolerance in *C. glabrata* or other related yeasts. Our focus converged on genes and regulators within the cell wall integrity and calcineurin pathways and specific histone acetyltransferases, histone deacetylases, geranylgeranyl transferases, and vacuolar ATPase assembly factors. We then designed experiments that include gene disruption, gene cloning, and drug susceptibility assays to investigate the effects of our most promising cellular factors on echinocandin susceptibility and resistance in *C. glabrata*.

Cassie Girardin

A Bioinformatic Investigation of *Marinobacter adhaerens* and *Alteromonas mediterranea,* two Bacterial Members of the *Karenia brevis* Marine Community

Collin DeMan, Dr. Emily A. Monroe, and Dr. Carey Waldburger (mentor), Department of Biology, William Paterson University

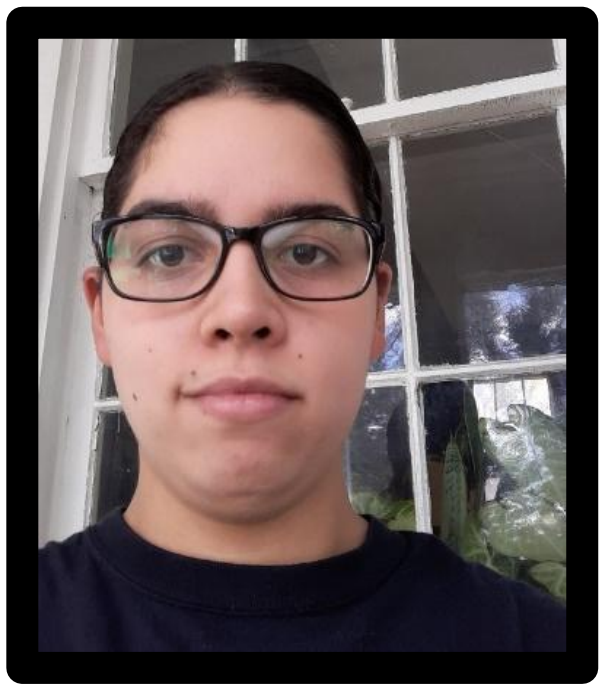
Karenia brevis is a toxic dinoflagellate that forms blooms in the Gulf of Mexico, harming the surrounding ecosystem. *Marinobacter adhaerens* and *Alteromonas mediterranea* are two gamma-proteobacteria that were isolated from laboratory cultures of *K. brevis*. In this study we have used a bioinformatic approach to examine their genomes for features with potential impact on bloom formation. Each of these bacteria showed a high content of sodium and iron transport clusters of orthologous groups (COGs) and additional analysis of the sodium transport-related COGs revealed that genes encoding the Mrp (multi resistance and pH) family of proteins were present in *Marinobacter adhaerens* yet absent in *Alteromonas mediterranea*. Mrp genes are found in a wide variety of bacteria where they play roles in sodium and pH homeostasis. It will be interesting to ascertain whether the Mrp gene cluster in *M. adhaerens* confers a degree of sodium tolerance not displayed by *A. mediterranea*.

Insect Biodiversity in Riverside Park, Bergen County

Fernanda Marques and Dr. Joseph Spagna (mentor)

Insects are the most abundant and varied animals, with very diverse habitats and conditions in which they survive. For this research, we have surveyed the insects around Riverside Park in Bergen County, New Jersey. When performing a survey, each insect collected contributed to our understanding of the environment. For this work, we collected insects with three different kinds of nets. These nets were used for about 30 minutes every couple of days between the time of 8 pm to 8:30 pm in park, primarily in the bushes along the river's edge, where most of the insects were located. Of the insect orders we collected more than one of, Orthoptera were 43%, Coleoptera 33%, Homoptera 14%, and lastly Hymenoptera and Hemiptera both were 5%. The three most abundant groups- crickets and grasshoppers, beetles, and planthoppers, reflect the dominant vegetation but show surprisingly few species with a life stage in the river, such as dragonflies or caddisflies.

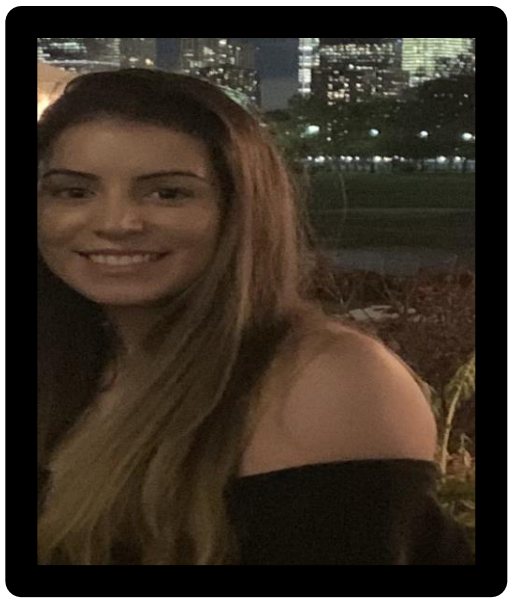
Using Niche Modeling to Assess the Roles of Competition and Climate in Distributions of North American Agelenid Spiders



Nikki Gaffney, Dr. Joseph Spagna (mentor)

The Agelenidae are a family of North American spiders that are comprised of many species, defined by strikingly similar behavior patterns and physical builds (Chamerlain and Ivie). The American continent is expansive, with many geographic breaks that may have produced the highly-branched phylogenetic tree. I used GIS mapping software and niche modeling of North American Agelenid spiders to determine whether the species distributions were determined primarily by presence of other species, or by geographic and climatic limits. I am using locality data for the map and assigning coordinates from Google Maps to type localities without coordinates. I will then analyze whether the species distributions match their fundamental geological and climatic limits, and what factors could influence the spiders to not do so, all via the GIS mapping software. Results may support that the species distribution is primarily determined by competition or by varying environments.

Identifying potential PCR primer sites for distinguishing subgroups of Myxococcales in agricultural soils.



Melanie Araujo, Fathima Muhammad, Dr Kendall Martin (mentor), William Paterson University, Dr. Carolee Bull, The Pennsylvania State University.

Myxobacteria are soil bacteria that use social behavior to hunt as “wolfpacks” and prey on other bacterial species, decreasing their numbers. We began the process of primer development to help identify and monitor subgroups of Myxobacteria that prey on bacteria that harm our crops. We downloaded all the 16S sequence for Myxococcales, from the international ribosomal database project, and ran a sequence-analysis to group them by similarity and produce a sequence alignment. We organized the multiple-alignment in a spreadsheet with these similar types together and searched for sequences that distinguished different subgroups of Myxococcales. Potential primer-sites were selected and characterized in the multiple-alignment that might be used for specific PCR-detection of subgroups of Myxococcales. By identifying and monitoring subgroups of Myxobacteria that prey on important soil-borne pathogens, we can track how these subgroups of Myxococcales respond to changes in soil conditions. This could allow us to better manage crop disease.

A Bioinformatic Study of Karenia brevis Bacterial Community Members Reveals an Important Role in the Nitrogen Cycle for Mamiella atlantica and Maliponia aquimaris.

Kate LaVallee, Dr. Emily A. Monroe, and Dr. Carey Waldburger (mentor), Department of Biology, William Paterson University

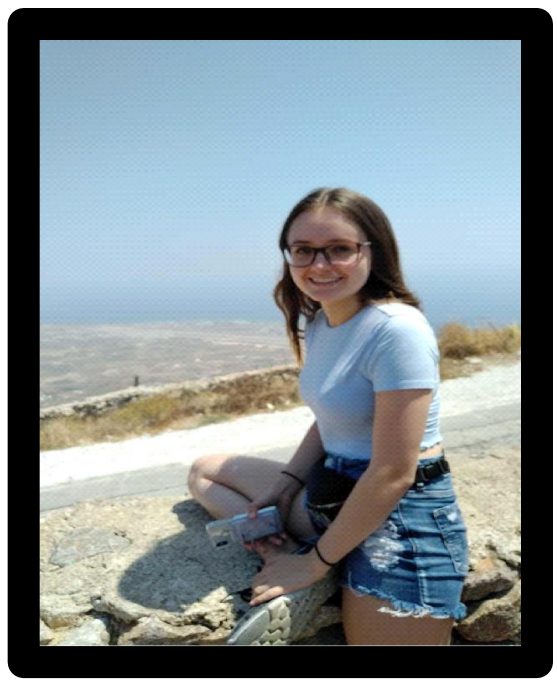
The dinoflagellate *Karenia brevis* forms toxic blooms that have wreaked havoc on the marine life of the gulf coast of Florida for decades. In this study, we used a bioinformatic approach to examine the genomes of two bacterial members of the marine microbial community that *K. brevis* inhabits to identify potential roles in bloom formation and community health. Our analysis of *Mameliella atlantica* and *Maliponia aquimaris*, two alpha-proteobacteria isolated from a *K. brevis* mixed culture, revealed a high content of genes involved in nitrogen cycling. Nitrogen metabolism is a critical biological process due to the importance of nitrogen as constituent of proteins and nucleic acids and a role in energy generation via anaerobic respiration. These included genes in the denitrification and assimilatory nitrogen reduction pathways. Interestingly, neither bacterium contained the entire denitrification pathway but both bacteria together could fully convert nitrate to nitrogen, suggesting a communal approach to denitrification.

Teaching Strategies and Developing Online Material for Anatomy and Physiology Courses

Andrew Garcia, Briana Lawton, Dr. Danielle Desroches (mentor), William Paterson University

The purpose of this research is to find external resources that are beneficial to the learning experience of Anatomy and Physiology students. This is essential as the human population is currently battling a pandemic, causing us to rely on online learning. It is important to acknowledge that there are a variety of methods from which students can learn, mainly visually and/or auditorily. This can be achieved through YouTube channels as well as other sites with a target audience of science/medical students. To confirm the effectiveness of providing external material, a brief survey was conducted for an Anatomy and Physiology I course of Summer 2020. Although less than half of the class submitted a complete survey, each response was quite helpful. From the data collected, the majority of the students utilized the external learning material provided by the researchers and professor of the course, which as a result demonstrated increased confidence and effort in understanding the course material, according to their rating of what they feel they deserve as a final grade. In addition to searching external resources, updated knowledge of the COVID-19 pandemic has been implemented into specific topics of the course to better help students' understanding by providing a real life example.

Characterizing Polyketide Synthase Genes in *Karenia brevis*



Cameron Litterini and Dr. Emily A. Monroe (mentor), Department of Biology, William Paterson University

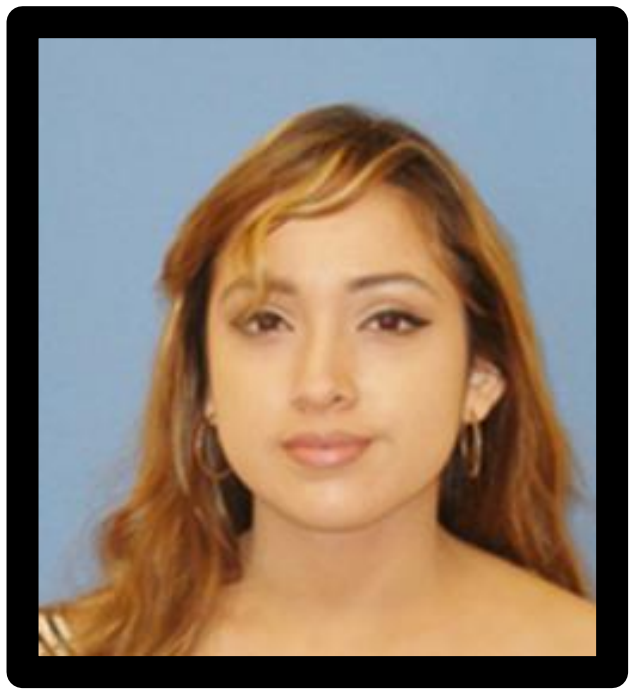
The causative organism for the Florida red tide, *Karenia brevis*, produces brevetoxins that cause death of mammals and fish and illness in humans. No genes have been linked to brevetoxin biosynthesis, but new multi-modular polyketide synthases (PKS) were recently identified. The purpose of the study was to determine if *K. brevis* sequences, contigs 28414 and 54805, are unique to *K. brevis* or conserved amongst other organisms. Homologous sequences were identified using BLASTp. The Conserved Domain Database and P-fam were used to compare the protein domain organization of *K. brevis* sequences and their homologs. Domain structures of contig 28414 and its homologs are similar, suggesting this PKS is conserved in both organisms. Domain structure of contig 54805 and its homologs are not similar, suggesting this PKS is not conserved and possibly unique to *K. brevis.* Contig 54805 may be a better candidate for brevetoxin biosynthesis and will be investigated further.

***Karenia brevis*, a toxic dinoflagellate**

Jannat Begum and Dr. Emily A. Monroe (mentor), Department of Biology, William Paterson University

Karenia brevis is a marine dinoflagellate that produces brevetoxins (PbTx), potent neurotoxins resulting in detrimental marine and human health impacts. Brevetoxins are synthesized by polyketide synthase (PKS) enzymes. The objective of this study is to better understand secondary metabolite biosynthesis in *K. brevis* and similar species through a bioinformatics analysis. Recently published sequences for three multi-domain *trans*-AT PKS contigs - 10709, 15957, and 78360 - were studied and compared to homologous sequences. Primary analysis found that the sequence similarity between the *K. brevis* PKSs and those found in other species is low. Further, analysis of the domain structures using the Conserved Domain Database (CDD) and Pfam indicate that the domain structures of the *K. brevis* sequences are unique suggesting they are involved in a process unique to *K. brevis*. Further studies aim to gain a deeper understanding of which sequences may be responsible for brevetoxin production in *K. brevis*.

Effects of Dehydration on Beta-amyloid Aggregation



Jaimie Pasmino, Sonya M. Bierbower, PhD (mentor)., William Paterson University

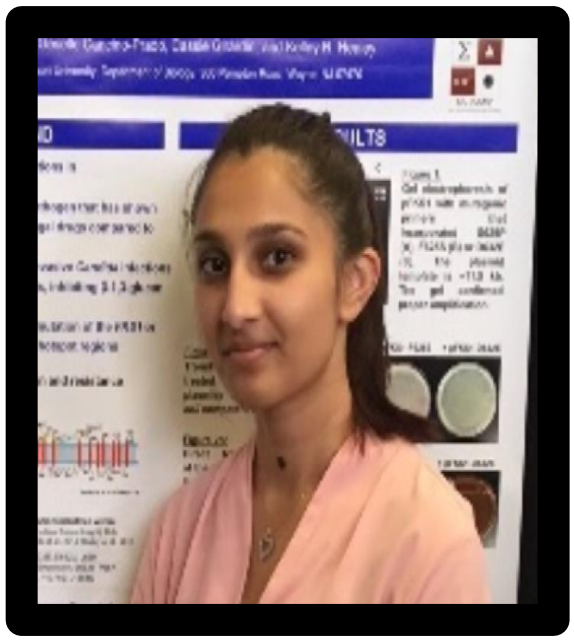
Alzheimer's disease is a common form of dementia, it causes an irreversible, progressive brain disorder that slowly destroys memory and thinking skills with the potential to seriously interfere with everyday tasks. One of the hallmark proteins that characterize Alzheimer's is abnormally cleaved APP resulting in beta-amyloid, it is insoluble and sticky, causing these proteins to aggregate. These plaques become problematic to neurons, blocking neuron synapses, and rendering them unable to communicate. Because of memory complications that arise with Alzheimer's, people experience short-term memory loss and forget to hydrate frequently. Due to constant dehydration, thirst signals are suppressed through neural adaptation, combined with the fact that aging already brings about a significant lack of thirst recognition, all this to say that people with Alzheimer's are normally chronically dehydrated. It is well known that water plays a crucial role in the folding, dynamics, and function of proteins. This study intends to further investigate the correlation between dehydration and the aggregation of beta-amyloid.

Computer science frameworks as a basis for models of neural hardware

J
amie Carolyn Reulbach, Sonya M. Bierbower PhD (mentor), Dr. David Freestone (Co-mentor)* William Paterson University

Modern computers were designed in the 1940s taking heavy inspiration from neuroscience. Advances in computer science and computational neuroscience have allowed for innovative algorithms to simulate tractable models of memory, such as A.I. neural networks used in everyday programs. Many computer data structures were not made with neuroscience in mind, but rather efficiently storing and retrieving data from a programming standpoint. Scientists have begun taking these concepts designed for efficiency to form new models of how animal neural structures may function. Theoretical research suggests that brain regions may act as Bloom filters, binary trees, stacks, etc. using numbers generated within the brain (numerons), units of entrained cognitive information (engrams), and computations enacted using these values (operators). The goal of this work is to show how computer data structures may be used by animals to solve problems and to encourage biologists, psychologists, and neuroscientists to rethink memory using computer science frameworks.

Investigation of *Candida auris* triazole resistance mechanisms and bioinformatic analysis to identify relevant genes for future research



Indira Sawh, Geselle Cancino-Prado, Kelley R. Healey PhD (mentor), William Paterson University

Candida auris is an emerging fungal pathogen that causes healthcare center outbreaks and is resistant to several antifungal drugs, including triazoles. While recent research by our lab characterized triazole target (*ERG11*) mutations, additional mechanisms of triazole resistance are not fully understood. We performed a literature search to summarize various resistance mechanisms in *Candida* species, with particular focus on *C. albicans* due to its phylogenetic relatedness to *C. auris*. Other significant mechanisms include the overexpression of *ERG11* or of drug-efflux pumps (Cdr1, Cdr2, Mdr1), often caused by mutations within specific transcription factors (Tac1, Mrr1, Upc2). Therefore, we performed BLAST and PFAM analyses on these cellular factors and identified *C. auris* homologs, some of which were already characterized and others were hypothetical/uncharacterized. The predicted, homologous transcription factors contained conserved zinc cluster domains. We propose future experiments, including sequencing and gene expression analyses, to determine if these homologs influence *C. auris* triazole susceptibility.

William Paterson University,
CHEMISTRY DEPARTMENT

Decarboxylative coupling reactions for the synthesis of organic scaffolds

Courtnee Aristil, Dr. Kaur Parminder (mentor), William Paterson University

Decarboxylative coupling refers to a reaction in which organic halide reacts with carboxylic acid, forming a new carbon-carbon bond, and CO_2 is lost. The reaction requires base, oxidant and a metal catalyst. Developments in this research area have recently established the frequent use of carboxylic acids, generally benzoic acid derivatives, as they are readily available and non-toxic, with a stable nature. Most of the research in the area has been done using the precious metals, which limits the scope of these reactions due to their limited availability, cost, and impact on the environment. Copper, on the other hand is relatively cheap and non-toxic, has been found as an efficient catalyst in recent years. During the initial phase of my project, I have focused on the detailed study of these published reports to develop an outline of my project. My ultimate goal in the current research is to understand and explore the use of non-precious metals (such as Ni, Mn, Zn) as catalysts for the decarboxylative coupling reactions.

Assembly of Zinc Amino Acid Complexes and Their Applications

Melisa Buken[1], Gurjeet Longia [1], Bhanu P. S. Chauhan (mentor) [1]

Zinc (II) and its complexes have a variety of uses in catalytic, medical and biological uses. Zinc (II) has taken attention of researchers because of its antimicrobial and anti-inflammatory properties which makes it one of the most important trace elements in the human body, it is also incorporated in the active center of many enzymes. Zinc (II) also has a great advantage in biological application and chemical reactivity in ligands and amino acids. Amino Acids are essential in many biological functions, the side chain groups aid in the formation of metal center and help with the catalytic action. The different side chains on the amino acids are involved in metal binding and this has been found to yield different morphologies that are obtained under different reaction conditions. Rhodanine is known to possess antimicrobial, antibacterial, and antiviral advantages and can be used in many different applications.

In this research zinc has been analyzed for its medicinal applications, catalysis, as nonlinear optics and nanomaterial structures as zinc (II) complexes with amino acids and rhodanine. Zinc (II) complexes with rhodanine and Zinc (II) complexes with amino acids have shown to be important in antibacterial, and antifungal uses. Zinc (II) complexes are very functional in applications such as UV light emitters, gas sensors, and acoustic wave devices. The data is analyzed and monitored by NMR, FTIR, X-Ray diffraction, SEM, TEM, FESEM, and UV-Vis.

Acknowledgment:

Danielle Desroches, Department of Biology, William Paterson University; Bhanu P. S. Chauhan, Department of Chemistry, Engineered Nanomaterials Laboratory, William Paterson University; Funded by the Louis Stokes Alliances for Minority Participation.

Fundamental Methods for the Phase Transfer of Nanoparticles

Elijah Cook, B.P.S Chauhan (mentor), Sanaa Gokeh

The utilization of nanoparticles for a variety of applications has raised much interest in the past years as new knowledge has emerged in nanochemistry. New and diverse methods for synthesis, characterization, and application of these particles have been discovered with differing degrees of ease and reproducibility. Post-synthetic modification of nanoparticles is often a required step to facilitate their use in applications. The reaction conditions and chemical environment for the nanoparticle synthesis may not support or may conflict with further reactions. For this reason, it is beneficial to have phase transfer methods for nanoparticles to allow for dispersion of colloidal solutions in a variety of solvents. Phase transfer methods are often limited in the types and sizes of particles that can be effectively dispersed in an immiscible solvent. Currently, general transfer methods for wide varieties of nanoparticles have not been identified. New routes for phase transfer allow for utilization of a larger range of particles in applications which were previously limited by solubility and reactivity issues. In this work, we will describe the fundamental methods for the phase transfer of metallic nanoparticles. We will look at the major problems and pitfalls of these methods. The applications of phase transfer will also be reviewed, mainly focusing on catalysis and drug delivery.

Acknowledgement: Funded by the Louis Stokes Alliances for Minority Participation.

Utilizing Eosin-Y as a Photocatalyst and Further Comprehending the Hydrogen Atom Transfer Mechanism

Grecia Dominici, Joan Inoa, Reem Eldabagh, Dr Yalan Xing (mentor), Dr Jonathan Foley

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Photoredox catalysis is the use of light's energy to expedite chemical reactions through electron transfers like hydrogen atom transfer (HAT). Eosin-y is a non-metallic dye that has been widely used as a photocatalyst. This literature review focuses on three studies that discuss the use of eosin-y as a photocatalyst via the HAT pathway. The first study by Monish A. Ansari et.al. described a synthesis of 1.2.4-dithiazolidines from b-ketothioamides by photocatalysis. The second study by Vishal Srivastava et.al. had an aim to create a one pot photocatalyzation of a C(sp^3)-H alkylation of amine substrates. The third study by Meng-Nan Chen et.al. reported a one pot synthesis of spiro [oxindole- 3.4'-(4'*H*-pyran)] derivatives catalyzed by eosin-y. The purpose of this literature review is to summarize the applications of advanced photocatalytic methods of organic synthesis catalyzed by eosin y and gain a deep understanding of the HAT mechanism

Using Metal Organic Frameworks as photocatalysts

Cassidy Anderson, Dr. Parminder Kaur (mentor), William Paterson University

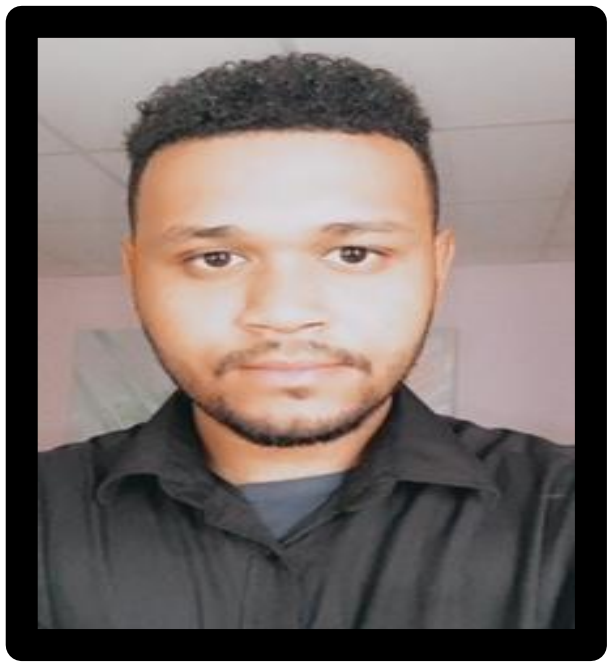
The use of metal organic frameworks (MOFs) to catalyze various reactions among organic and inorganic chemistry has been gaining attraction in recent years. A common drawback, however, is the use of precious metals during the synthesis of these metal organic frameworks. These precious metals include iridium, platinum, ruthenium, etc. and are very expensive to come across and not very environmentally friendly. To overcome this drawback, the idea to use metal-organic frameworks, created by the heterogenization of metal complexes onto the organic framework using more affordable and reusable metals. Further, the use of these MOFs as photocatalysts are ideal since they have a large surface area, they are relatively stable, affordable, and less toxic. Upon synthesis with NMR spectrometry, different substituents were observed when linking the polymer. One specific success was CF-HCP used as a photocatalyst for various organic reactions. Further investigation as to different affordable, non-precious, metals will provide a more efficient, green, and affordable way to run several organic reactions.

Metal-Organic Frameworks as catalysts for organic reactions

Emir Sehovic, Dr. Parminder Kaur (mentor), William Paterson University of New Jersey

Chemical reactions are immensely influenced by many variables with catalysts, arguably being the most important, which is where two years of my research has been dedicated. During this summer, I have been researching the effects and influence of metal organic frameworks or (MOFs) as an efficient catalyst for organic transformations. Similar to porous organic polymers or (POPs), both compounds utilize a coordinated structure and are widely favored in catalysis due to their unique porous sizes. MOF's carry several advantages that their solely metal-based counterparts do not, which is being an organic based framework that yields low hazard risks of organic compounds, the high product yield of metal catalysts, high stability with a high surface area allowing for better effectiveness. It is because of these reasons that MOF's have become a hot field in catalysis and thus far continue to excel in many applications. My further goals are to synthesize the MOFs and use them as catalysts to carry out challenging organic transformations.

Halogenative Cyclization of Tryptamine & Tryptophol



Alexander Hidalgo, Dr. Yalan Xing (mentor), William Paterson University, Department of Chemistry

In this literature review we explore and analyse the various methods for understanding the cyclization of two important indole derivatives; Tryptamine and Tryptophol. These naturally occurring precursors have valuable properties due to the presence of N-C bonds which contribute extensive investigations in areas such as medicinal chemistry and the pharmaceuticals. Our aim is to bring attention, yet comprehend which methodologies to approach this goal are more effective,in specific halogen-promoted cyclization, which involves the introduction of any of the halogen atoms to these precursors providing not only a cyclization, but access to heterocycles which play an important role in medicinal chemistry. In this context the main synthetic methodologies which have been reviewed are; Oxidation, Electrochemistry and Catalytic approaches for the halogenative cyclization.

Polymerization of Aliphatic Silanes with Insight Towards Analytic Approach and Reaction Design

Terrence Hopkins, Emma Ravaux, Dr. Bhanu P. S. Chauhan (mentor), William Paterson University

Due to the COVID-19 pandemic, our group could not meet in the lab to conduct in-person research. Our research, focuses on the synthesis of aliphatic polysilanes through a late-transition metal dehydrogenative-coupling mechanism. To highlight our research, while maintaining social distancing procedures we summarized an overview of the history and synthesis of these materials. Aliphatic polysilanes are hybrid organic-inorganic compounds containing repeating units of RSiH wherein R is an aliphatic organic substituent. Research towards these compounds have greatly increased over the past 30 years due to the inherent nature of their sigma-bond delocalization. Attributing to their unique electronic and optical properties, while being able to access sp^3-type conformations. In this review, we discuss the synthetic contributions of research towards linear aliphatic polysilanes, as well as our group's work.

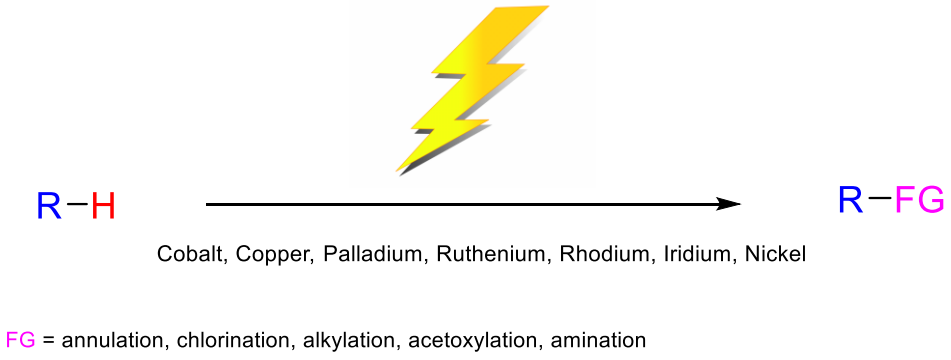
Computational Material Design & Comprehensive Research on Hybrid Solar ThermoPhotovoltaics & Multijunction.

Jose Bello, Alyssa Lakatos, Dr. Jay Foley (mentor), Department of Chemistry, William Paterson University of New Jersey.

WPTherml is a python package for the simulation and design of nanomaterials with tailored optical and thermal radiative properties. Currently built on the Transfer Matrix Equations, WPTherml is limited to the simulation of stratified planar nanomaterials. Nanostructures with spherical components represent a powerful class of materials that can be used to tailor optical absorption and thermal radiation. Mie theory can be used to simulate the absorption and scattering of an electromagnetic plane wave by uniform spherical particles. The implementation of Mie theory is done via the python programming language to facilitate seamless integration into the WPTherml package. We will describe our implementation, and present benchmark results for common nanoparticle system

Photocatalysis

Aaron Yaqoob, Dr. Yalan Xing (mentor), William Paterson University



The literature review consists of a look at various C-H activations in electro organic synthesis. Electro organic synthesis is an inexpensive and typically far safer alternative to traditional synthetic methodologies. Instead of using chemical oxidants, electricity is substituted as a cheap, efficient, and non-toxic alternative. The purpose of the literature review was to compile recent advances on C-H activation via electrochemical methods. Many of these advances utilized transition metal catalysts. Transition metal catalysts such as cobalt, copper, and nickel catalysts have shown high yield product formation for a wide variety of synthesis, including annulations, methylations and acylations, and synthesis of biaryl molecules. Modern synthesis has also looked at protocols using transition metal catalyst free alternatives, which are also explored in the literature review.

Scaffolded Nanocomposites Incorporating Aminosilane Functionalized Metal Nanoparticles

Zoraya Perez, Kaitlyn Yeh, Gurjeet Longia, Qiaxian Johnson and Dr. Bhanu P.S. Chauhan (mentor)*

This investigation consisted of a two-pot synthesis for the formation of stabilized metal core nanoparticles and nanocomposites with functional polymerizable silicon agents to create nanocomposites via grafting these materials onto other nano-scale materials such as carbon nanotubes and Stöber Silica. Both noble metals and more cost effective but less stable iron nanoparticles are protected from oxidation and are stable and active. Various analytical tools were used to conduct a thorough analysis of these synthesized materials. Morphological analysis was carried out using TEM (Transmission Electron Microscopy). Spectral characterization was carried out using FT-IR (Fourier Transform Magnetic Resonance spectroscopy) and RAMAN spectroscopy. TEM imaging analysis demonstrated that the nanoparticles are uniformly coated with 2-AST and 1124, and the presence of 2-AST was also confirmed by FT-IR. We will also disclose possible use of such nanoparticles for the development of new technological equipment and drug development.

William Paterson University
DEPARTMENT OF MATHEMATICS

Application of Origami Axioms Using Starshade and Telescope Models

David Rodriguez, Dr. Maria Vega Veglio (mentor), William Paterson University

Origami is a characteristic of nature and the mathematics of it are governed by specific axioms. Tessellations are unique as they are a repeating pattern and are the basis of the project. To show the axioms' applications, a starshade tessellation and a telescope origami model were assembled and the axioms were documented. After each fold in each model, documentation was recorded of what axiom or combination of axioms were used. Doing so provided real world applications and implications of what the axioms are. The axioms provided rules of which folding techniques follow and shows the future uses of consolidation techniques and other mathematical concepts that have been deduced by them.

Mathematical Modeling of the Spreading of Coronavirus

Abryanna Hernandez, Dr. Jyoti Champanerkar (mentor), Department of Mathematics, William Paterson University

The Coronavirus 2019 (COVID-19) has reigned havoc on people throughout the world. In the United States, COVID-19 has affected over 3.2 million people and counting. In this study, a system of ordinary differential equations is used to model a closed population with a coronavirus outbreak. A three-compartment model, popularly known as the SIR model is used to analyze the number of susceptible (S), infected (I), and recovered (R) individuals in the infected populations. Parameters will be estimated using publicly available data from various health departments all over the United States. It has been observed that the number of confirmed cases widely varies across geographic locations and across demographic compositions. The current research aims to investigate the spreading of COVID-19 quantitively between two or more populations with differing demographics. For example, how the pandemic may affect a town with lower poverty in comparison with a town with a higher poverty rate; or a town with more college educated people in comparison with a town with a smaller percentage of college graduated population. Comparison of parameter values for different populations, will give new insights in the spreading of COVID-19 and presumably indicate best measures as we move forward.

Funded by: Garden State Louis Stokes Alliance for Minority Participation in the Sciences (Award #).

On Sequence Characterization of Riordan Arrays

Kwasi Asare-Bediako and Dr. Melkamu Zeleke (mentor), William Paterson University of New Jersey

A Riordan array is an infinite lower triangular matrix consisting of an initial row (1,0,0, 0,…) where its initial column is constructed from a given Z-Sequence and its internal numbers are constructed from a given A-Sequence by taking linear combinations. The simplest example of a Riordan array is the Pascal's triangle and it can be constructed using $Z = \{1, 0, 0 , 0, ...\}$ and $A = \{1, 1, 0, 0, 0, ...\}$. Using the A-Sequence and the Z-Sequence to construct a Riordan Array is not very convenient as it gives you one entry at a time. Hence, ordinary generating functions are also used to define Riordan arrays. Alternatively, a Riordan array is an array of numbers defined by two generating functions $g(x)$ and $f(x)$, satisfying the conditions $g(0) = 1$ and $f(x) = x + \cdots$, where the k^{th} column of the array has generating function $g(x)f(x)^k$, for $k = 0, 1, 2, 3, ...$.

The primary focus of this summer research is showing that the two approaches to defining a Riordan array are mathematically equivalent. To do this we used the properties of the Riordan group, an algebraic structure obtained by defining a multiplication operation on Riordan arrays, introduced by Lou Shapiro and his colleagues in the early 1990s and the Stieltjes transform of Riordan arrays or what is commonly known as the Production Matrix. Riordan arrays are named after an American mathematician John Riordan, who worked as a research mathematician for Bell Labs from 1926 to 1968, and they provide an interesting connection between modern algebra and combinatorics.

The Applications of Continued Fractions in Number Theory

Joshua Trigoura, Dr. Cihan Karabulut (mentor), William Paterson University.

Continued fractions have many applications in Number Theory as an algorithmic tool. They allow us to simplify many problems which would otherwise be difficult to solve. One such application is in providing an easy and fast way to write lengthy primes, when possible. A second way that continued fractions have been utilized is by Euler in his proof that the mathematical constant e is irrational, he did this by showing that its continued fraction is infinite. This research into continued fractions enables us to further study their uses in different branches of mathematics. Consequently, we could also expand this concept from the field of real numbers to the complex numbers.

THE ANNUAL STATE WIDE GS-LSAMP -CONFERENCE WITH POSTER PRESENTATIONS WILL TAKE PLACE VIRTUALLY ON MARCH 5, 2021