21st Annual TLSAMP Undergraduate Research Conference

Poster Presentation Abstracts
(listed in alphabetical order)

1. **Bamlak Aklilu**
   Sophomore
   Department of Biomedical Engineering (Poster Presentation)
   Vanderbilt University
   Dr. Craig Duvall

Structural Optimization of siRNA Conjugates for Albumin Binding Achieves Effective MCL1-Directed Cancer Therapy

The Duvall lab specializes in pioneering smart polymer-based technologies by reforming the intracellular delivery of biological drugs, precision targeting of drugs to inflammatory sites, and developing methods for controlled, "on-demand" drug release. As I embark on my journey towards becoming a physician, I am collaborating with graduate student Nina Cassidy to contribute to the lab's focus on the targeted delivery of albumin-hitchhiking siRNA conjugates, specifically tailored for treating triple-negative breast cancer.

At the core of our project lies the exploration of short-interfering RNA (siRNA) as a therapeutic tool to silence genes deemed "undruggable". The conventional method involves intricate nanoparticles, but their limitations, including injection reactions, have prompted the exploration of a promising alternative—chemically modifying siRNAs to eliminate the need for carriers. While this approach has yielded successful drugs for liver-related issues, extending its application to targets beyond the liver presents a unique challenge.

An important endeavor in the Duvall lab revolves around creating a diverse library of siRNA-lipid conjugates, precisely designed to identify optimal structural features for delivering siRNAs to tumors. The goal is to fine-tune such structures for enhanced tumor delivery, with a special focus on triple-negative breast cancer (TNBC), a particularly aggressive form of the disease.

TNBC poses a significant challenge due to its limited treatment options. Unfortunately, chemotherapy is often the primary recourse. The Duvall lab is honing in on a key gene called MCL1, known for promoting treatment resistance in various cancers, including TNBC. The objective is to demonstrate the therapeutic potential of the refined siRNA-lipid conjugate by effectively targeting and treating TNBC through the silencing of the MCL1 gene.

2. **Betsy Akpotu**
   Senior
   Biology Computer Science (Poster Presentation)
   Middle Tennessee State University
   Dr. April Weissmiller, mentor

Generation of a c-JUN expression vector for rhabdoid cell line engineering

Malignant rhabdoid tumors are rare and aggressive childhood cancers with little to no treatment options available. The majority of rhabdoid tumors share a common mutation resulting in biallelic loss of the SMARCB1 gene that encodes the SNF5 protein subunit of the SWI/SNF chromatin remodeling complex. The SWI/SNF chromatin remodeling complex is responsible for regulation of gene expression through impacting DNA accessibility and therefore loss-of-function of the SMARCB1 gene results in changes to gene expression that cause tumorigenesis. Recently, it has been shown that in rhabdoid cancer cell lines the AP-1 transcription factor, which is composed of dimers between JUN and FOS family members, may potentially promote the cancerous state. Specifically, recent data point to a role for c-JUN being a critical family member that can modulate AP-1 function across the genome. The goal of this project was to create a c-JUN expression vector that can be used for cell line engineering so that the contribution of c-JUN to AP-1 functionality in rhabdoid cancer cell lines can be evaluated. Using a combination of molecular biology techniques, a portion of this process was accomplished, although further work will be needed to finalize the expression vector for human cell lines.

3. **Trinity Bissahoyo**
   Sophomore
   Computer Science (Poster Presentation)
   Dr. Rongjun Qin and Song Shuang
   University of Tennessee – Knoxville
   The Ohio State University - Geospatial Data Analytics Group
   Department of Civil, Environmental and Geodetic Engineering

Automating Image Selection Based on Image Quality Assessment for Stereo Reconstruction

3D modeling is often reconstructed from specified photos that take intensive time and resources to gather and review. It would be optimal to gather photos from crowdsourced images, saving time and money. However, the web creates the biggest image dataset as millions of photos are uploaded every day from various sources such as mobile devices, drones, CCTV, satellites, and other photo-capturing devices. Creating 3D models requires quality images that take time to go through manually. This research aims to develop an automated image selection system to help speed up photo quality distribution and improve the accuracy of 3D reconstruction. The images are analyzed using Real-Time Models for Object Detection (RTMDET) and distortion detection models including Multi-dimension Attention Network for No-Reference Image Quality Assessment (MANIQA) and Language-Image Quality Evaluator (LIQE) to produce a foundation for a robust image selection model. In the future, these findings will allow researchers to improve upon 3D reconstruction Image Quality Assessments with the help of deep learning methods.

4. **Michael Davis**
   Sophomore
   Engineering (Poster Presentation)
   Vanderbilt University
   Dr. Mahadevan-Jansen

Characterizing biochemical and structural alterations in Eosinophilic Esophagitis using nonlinear Raman Microscopy

Eosinophilic Esophagitis (EoE) is defined as an allergen-mediated chronic inflammatory condition of the esophagus, marked by the infiltration of eosinophils into the esophageal epithelium. Predominantly affecting males and frequently diagnosed in pediatric populations, EoE manifests through symptoms such as dysphagia, chest pain, and vomiting, stemming from esophageal constriction due to eosinophilic infiltration. Current diagnostic modalities primarily rely on White light endoscopy or subsequent biopsy collection, followed by histopathology staining. However, these methods present limitations in differentiating EoE from overlapping esophageal disorders, such as Gastroesophageal reflux disease, and are burdened by laborious and time-intensive processes. Our research aims to quantify the biochemical and structural alterations prompted by Eosinophilic Esophagitis at both the tissue and cellular levels. Additionally, we seek to capture volumetric images of biopsy tissues representing both active and non-active stages of EoE, facilitating virtual staining for diagnostic purposes. Through the utilization of Stimulated Raman Spectroscopy (SRS), we have successfully acquired images conducive to quantitative analysis of biopsy tissue. Furthermore, leveraging MATLAB, we have developed sophisticated image processing scripts tailored to handle SRS images. These scripts enable the transformation of SRS biopsy images into multi-channel color representations, effectively illuminating multiple tissue structures. This comprehensive approach holds significant promise in advancing our understanding of EoE pathology and improving diagnostic accuracy and efficiency in clinical settings.

5. **Aaliyah Flake**
   Senior
   Chemistry (Poster Presentation)
   Tennessee State University
   Dr. Koen Vercruysse

Invisible melanin: is it overlooked?

Despite decades of research melanin is still poorly defined in terms of chemical structure and properties. In human physiology two distinct classes of melanin are responsible for the coloration of skin and hair: eumelanin and pheomelanin. The presence of elevated levels of pheomelanin in an individual's skin is a risk factor making an individual more prone to develop melanomas. The role of melanin, whether beneficial or detrimental, in existing melanomas is uncertain. Similarly, melanin is suspected to have an impact on degenerative conditions like Parkinson's disease, Alzheimer's disease, or Lewy body dementia. Given the growing and global incidence of melanoma and degenerative diseases, any improved understanding of melanin materials could be valuable in evaluating the impact of melanin on these conditions. We have observed that the in vitro synthesis of melanin leads to a colloidal, hybrid material consisting of dark-colored, eumelanin-like substances and an invisible substance. This non-colored substance exhibits strong absorbance capabilities around 280nm and broad, weaker absorbance between 300 and 400nm making it an excellent absorber of UVA and UVB radiation. Given the historical focus on the relationship between melanin and coloration, we hypothesize that the possible generation of an invisible substance during in vivo melanogenesis may have been overlooked. We have developed a synthesis and purification process to fractionate in vitro synthesized melanin into its visible and non-visible components. These materials are characterized using UV-Vis, fluorescence, and FT-IR spectroscopy.

6. **Jamari Jemison**
   Senior
   Biology (Poster Presentation)
   Tennessee State University
   Drs. William Boadi and Ryan Beni

Modulation of AMPKa IN Prostate Cancer Cell Line, PC-3,

Following Exposure to Triphenyl Methanol Derivatives (TMPS)

Epidemiological studies indicate that treatment with metformin, an AMP-activated protein kinase (AMPK) activator, reduces the incidence of cancers. Activation of AMPK has also been reported to oppose tumor progression in types of cancers and offers promising cancer therapy. Furthermore, AMPK is a master regulator of energy metabolism and has also been implicated in cell cycle progression, angiogenesis, cell transformation, migration, and cancer. We have recently synthesized novel flavonoids, namely, triphenylmethanol derivatives (TPMs), but the effectiveness of the TPMs on the activity of AMPK remains unclear. We hypothesized that the novel TPMs would inhibit cancer cell proliferation through the activation of AMPK isoforms in cells. The effects of TPMs, on prostate cells (PC-3) were investigated. Cells were exposed to TPMs for either 12 or 24 hr. at the respective doses of 0, 25, 50 100, and 200 µM based on the cell viability studies by the (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide, a tetrazole) (MTT) assay. The results indicate that cells exposed to the respective doses of TPMs increased both phospho- and total-AMPK$_\alpha$ in a dose- and time-dependent manner. The effects of the increases for the *phospho*- and *total*-AMPKα in cells were greater for the 24-hr than the 12-hr. incubation. Further studies are currently going on to elucidate the specificities of the said insults in increasing the *phospho*- and *total*-AMPKα activities and for the other respective isoforms.

7. **Autumn Jones**
   Sophomore
   Biology (Poster Presentation)
   Tennessee State University
   Drs. Nsoki Phambu[2] and Bashiyar Almarwani[1]

Interaction studies of the antimicrobial peptide R5W4 with lipid bilayers mimicking the *E. coli*, *S. aureus*, and *B. cereus* membranes

Multidrug-resistant bacteria or superbugs have developed resistance to conventional antibiotics. The scientific community is looking for new types of antibiotics with new mechanisms of action. Antimicrobial peptides (AMPs) are promising candidates as future antibiotics. R5W4 is an antimicrobial peptide (AMP) in the family of antimicrobial peptides involved in host defense; it has been shown to inhibit the growth of bacteria, viruses, and fungi. Very few studies have been devoted to this peptide, to understand its mechanism of action. But the topic is still open to debate. The objective is to investigate the interactions of R5W4 with three model biological membranes mimicking *Escherichia coli (EC)*, *Staphylococcus aureus (SA)*, and *Bacillus cereus (BC)* membrane bilayers. UV visible, fluorescence, and infrared techniques are employed. The interaction was performed in a wide range of peptide-to-lipid weight ratios.

At very low peptide concentrations, R5W4 shows no specific interaction with the amine, carbonyl, and phosphate groups of SA and BC. However, fluorescence data indicate a blue shift of the wavelength of R5W4 in the presence of SA, and BC, not of EC. These results are confirmed by UV-visible data. Taken together, IR and fluorescence data suggest that R5W4 inserts into the SA and BC model membranes. IR curve fitting data at very low peptide concentration reveal that R5W4 undergoes a lipid-induced conformational transition from helix structure to a sheet-like structure in SA and BC cells and not in EC cells. R5W4 may be a good antibiotic candidate against SA and EC.

8. **Adaline Leong**
   Junior
   Institute for Software Integrated Systems (Poster Presentation)
   Vanderbilt University
   Dr. Daniel Balasubramanian

Improving Community and Neighborhood Safety through Open Data Collection

Communities have long considered public safety, which is foundational to health and well-being, as one of the top concerns regarding their neighborhoods. Modern technology, including cameras, sensors, and algorithms that capture and analyze data, is rapidly changing the way public safety is viewed and implemented. For instance, crowdsourcing and data sharing allow communities to share information at speeds and scales that were previously impossible. To date, these types of crowdsourcing efforts have been driven by private companies, raising many questions about control over such data, trust about how it is used, and personal privacy. Once data is given to a private company, it is often unclear how long the data is stored, how the data is used, and who can access the data. The goal of this project is to study how communities can both generate and control their own data. This model differs significantly from the model driven by private companies, in which voluntarily contributed data is privately maintained. As part of this project, our team has developed a prototype open data collection platform in the form of a mobile app and accompanying backend server software that allows communities to share data about both lost and found vehicles and pets. Each community can determine their own data access and retention policies, which provides a unique opportunity to study how communities can benefit from transparent data models that operate in accordance with their social expectations of privacy.

9. **Afrika Lewis**
   Junior
   Biology (Poster Presentation)
   LeMoyne-Owen College
   Dr. Moniruzzaman Syed Professor

Structural and Electronic Impact on Various Substrates of TiO2 Thin Film using Sol-Gel Spin Coating Method

Titanium dioxide (TiO2) thin film has been deposited on glass and silica substrates by using Sol-Gel spin coating method. The effect of annealing temperature on the structure, surface morphology, optical and electrical properties of these films are characterized by Raman, XRD, FT/IR, UVvis and four-point-probes measurements. XRD confirms the anatase phase of TiO2. Maximum crystal sizes are found to be ~31 nm on silica and ~23 nm on glass substrates at 500oC respectively. Electrical resistivity decreased with increasing annealing temperature having the higher value on glass substrates observed.

10. **Jennifer Milad**
    Sophomore
    Physics (Poster Presentation)
    Middle Tennessee State University
    Dr. Hanna Terletska

Simulating Ferromagnetic Phase Transitions

It is important to simulate this transition to prepare for projects using magnets in hot places to see the effectiveness of the magnet. When magnets are heated up, they lose their magnetism. This is due to a ferromagnetic phase transition. The heat changes the direction of the spins to where they are no longer uniform in direction, hence the magnetism is lost. Simulating ferromagnetic can be done using the Ising model and Monte Carlo algorithm. This study shows the more Monte Carlo cycles, the more accurate the values are compared to accepted graphs.

11. Jamil Muhammad

Senior

Chemistry (Poster Presentation)

LeMoyne-Owen College

Dr. Moniruzzaman Syed Professor

Fabrication and Characterizations of Aluminum Doped Cadmium Oxide (CdO:Al) Thin Film using Sol-Gel Spin-Coating Method

Aluminum-doped cadmium oxide (CdO:Al) thin films are deposited on silica substrates by the sol–gel spin-coating method as a function of spin coater's rpm (revolution per minute). Cadmium acetate dihydrate and Aluminum nitrate have been taken as the precursor material and a source of Al-dopant respectively. CdO:Al thin films are characterized by Raman spectroscopy (Raman), x-ray diffraction (XRD), Fourier Transform Infrared (FT/IR), Field emission scanning electron microscopy (FE-SEM) and SEM-EDX. Raman and XRD results indicate the highest crystallinity at 6000 rpm with a XRD crystallite size of 31.845 nm, cubic phase formation, and strain of ~1.6 X10-2. FE-SEM/SEM/EDX shows the well-faceted homogeneous surface structure at 6000 rpm having the average particle size of 130.05 nm. FT/IR confirms the presence of CdO:Al in the film with the peak position shifting to higher wavenumbers.

12. Samirah Salifu
Sophomore
Chemical Engineering (Poster Presentation)
Vanderbilt University
Dr. Ethan Lippmann

Controlling Peptide Binding Chemistry and Density within Gelatin Hydrogels

In an effort to test hydrogels without excessive animal testing, we are developing a microfluidic device to serve as a screening tool. These microfluidic devices will be used to grow vascular tissue in several hydrogel conditions. Each hydrogel has a gelatin base with different vascular promoting peptides chemically bound. My project has focused on synthesizing and quantifying these hydrogels across three different peptide factors: sequence, binding chemistry, and concentration. The three peptide activities being tested include QK (a VEGF mimetic peptide), N-cadherin (cell adhesion peptide), and HepPep (a heparin binding peptide). Two peptide-binding chemistries are being assessed in this experiment, click-chemistry via a maleimide-thiol reaction and EDC/NHS coupling. Finally, each peptide was bound at three concentrations, resulting in a low, medium, and high format of each. In total 18 distinct hydrogel formulations are being created for our screen. Additionally, to accurately quantify the amount of peptide in each dose of hydrogel, all variants will be duplicated with a fluorescently tagged peptide. Utilizing UV-Vis spectroscopy, the quantity of fluorescent peptide within each batch will be measured using Beer Lambert's law. By combining Nuclear Magnetic Resonance data with the fluorescent dataset, we can accurately quantify the peptide content within each hydrogel dose. Next steps include testing each hydrogel variation in the microfluidic devices to screen with vascular antibodies to determine the best hydrogel formulations. Subsequently, the best formats will progress to mouse fat pad injections for further evaluation and validation.

13. Logan Strong
Sophomore
Chemistry (Poster Presentation)
Tennessee State University
Drs. Bashiyar Almarwani (1) and Nsoki Phambu (2)

Antimicrobial Activity of RIR, a Short Peptide Identified in Water Buffaloes

The increasing reports of bacterial infections and the reduced efficacy of antibiotic therapy have inflated the clinical challenge of bacterial infections. With the antibiotics reservoir cornered to the remaining few last-resort antibiotics, the treatment regime is witnessing a gradual shift toward alternative therapeutics such as antimicrobial peptides (AMPs). A short AMP RIR has been identified in water buffaloes, a species known for its disease resistance. It has a proven antimicrobial activity, but its killing mechanism is still open to debate. The objective is to investigate the interaction of RIR with lipid bilayers mimicking model membranes. Therefore, zwitterionic dipalmitoylphosphocholine (DPPC) and anionic palmitoyloleoylphosphoglycerol (POPG) lipids were chosen as models for, respectively, eukaryotic, and bacterial membranes. Infrared (IR), thermogravimetric analysis (TGA), scanning electron microscopy (SEM), and fluorescence techniques were employed. At very low peptide concentrations, IR spectra indicate that RIR adopts a major α-helix structure without model membranes. An increase in the β-sheet structure content of RIR is observed in the presence of POPG while a random coils structure of RIR is observed in the presence of DPPC. TGA data indicates that the complex RIR-POPG is stronger than the complex RIR-DPPC. Fluorescence data indicate a decrease in fluorescence intensity and a blue shift in wavenumbers of RIR in the presence of POPG. These results indicate that RIR prefers the bacteria-mimicking negatively charged phospholipid; RIR promotes membrane disruption by forming pores in POPG. They also suggest that RIR has considerable potential for future development as a novel antibiotic drug.

14. Miracle Walker
Sophomore
Biology (Poster Presentation)
Tennessee State University
Drs. Nsoki Phambu2, and Bashiyar Almarwani1

Drug-drug interactions involving antimalarials and antibiotics

Bacterial and malaria co-infections are common in malaria-endemic countries and thus necessitate co-administration of antibiotics and antimalarials. There have long been anecdotal clinical reports of interactions between penicillin and antimalarial agents, but the nature and mechanisms of these interactions remain to be investigated. The objective is to investigate the effect of co-administration of selected antimalarial and antibiotics on their respective pharmacokinetics. We hypothesize that the reduction of these antibiotics' bioavailability might be attributed to antimalarials. Quinine (Qn) plays a significant role in the treatment of complicated, cerebral, and resistant malaria. Vancomycin (Van) is the most prominent clinically used glycopeptide antibiotic and exhibits potent activity against Gram-positive bacteria.

A combination of biophysical techniques such as infrared (IR), fluorescence, and UV visible are employed. IR data show that the amide I group of Van at 1658 cm-1 is shifted to lower wavenumbers in the presence of a small amount of Qn, suggesting the formation of a complex Van-Qn, thus reducing the bioavailability of Van. Fluorescence data also show a decrease in the fluorescence intensity of Qn in the presence of a small amount of Van. A significant decrease in the intensity of Van is also observed in UV-visible data. These results confirm the reduced bioavailability of Van in the presence of Qn. This project informs patients, physicians, pharmacists, and other healthcare providers that a possible interaction between Van and Qn may occur if these two drugs are co-administered. The possible mechanism involved is also discussed.