

Honors Scholars & Undergraduate Research Poster Symposium



March 11, 2022

1:30–3:30 p.m.

Buller Hall Lobby
& Classrooms



J.N. Andrews
Honors Program



Office of Research &
Creative Scholarship

WELCOME

Thank you for joining us for the 2022 Honors Thesis Poster Symposium. We feel grateful and blessed to be able to gather in person to celebrate the creativity and curiosity of this year's Honors Thesis researchers. As with so many other activities, the COVID-19 pandemic has challenged the usual practices and routines associated with quality undergraduate research. I want to thank heartily all the Honors Scholars and their dedicated faculty research mentors for finding the extra resourcefulness and commitment needed to continue the thesis journey. The Honors Family and I rejoice in your perseverance and discoveries, claiming the reassurance found in 1 Corinthians 4:8-10: "We are troubled on every side, yet not distressed; we are perplexed, but not in despair; persecuted, but not forsaken; cast down, but not destroyed; Always bearing about in the body the dying of the Lord Jesus, that the life also of Jesus might be made manifest in our body."

Since its founding in the 1960s, the J. N. Andrews Honors Program at Andrews University has fostered enthusiastically the transformative experiences of undergraduate research. By means of the Honors Thesis, the Honors Program requires its students to engage in substantive primary investigations in which students take an active role in posing research questions, designing and refining methodologies, collecting data and results, and critically analyzing the significance of their conclusions.

The Office of Research and Creative Scholarship, led by Dr. Gary Burdick, serves a vital role across campus in supporting and funding quality undergraduate research. The Undergraduate Research Scholar Award was established in 2002 to facilitate more opportunities for students to engage in research and creative scholarship in greater depth than required by their individual programs of study. The URS Award enables students to work closely with faculty mentors, participate in disciplinary conferences, and develop important professional skills. Many Honors Scholars have benefited from the URS funding and have noted that support on their poster boards.

A team of highly engaged faculty research mentors makes possible a rigorous program of undergraduate research. We thank each mentor for the commitment of time and energy invested in Andrews University's young scholars. The J. N. Andrews Honors Program and Office of Research and Creative Scholarship thank the Andrews University faculty members and Honors Council members who give willingly of their time and energy to support and evaluate undergraduate research. The Honors Council Members include: Sonia Badenas, Karl Bailey, Kylene Cave, Vanessa Corredera, Ryan Hayes, Alyssa Henriquez, Shandelle Henson, Katherine Koudele, Beverly Matiko, Andras Muranyi, Benjamin Navia, L. Monique Pittman, Davide Sciarabba, Tiffany Summerscales, Karin Thompson, and Robert Zdor. We also thank our Honors Program administrative assistant and recruiter, Maxine Umaña, and the ORCS staff, Carlisle Sutton and Mordekai Ongo, as well as our student assistant, Elianna Srikureja, for their hard work in helping to make this event a success.

Many thanks for working together! Keep your masks on and observe social distancing while enjoying the learning!



L. Monique Pittman, PhD
Director of the J.N. Andrews Honors Program
Professor of English



Gary Burdick
Dean of Research
Professor of Physics

J.N. Andrews Honors Scholars

Buller Hall, Student Lounge:	
Tyler Braithwaite	<i>Art to Influence Creativity in Symbolic Music Completion</i>
Reise Campbell	<i>A Three-Dimensional Convolutional Neural Network for ECL Sensor Analysis</i>
Joshua Dulcich	<i>Exploring the Efficiency of Neural Architecture Search (NAS) Modules</i>
Matthew Dulcich	<i>Conditional Variational Auto Encoder (cVAE) for Augmentation of ECL Biosensor Data</i>
Eric Inae	Online dissemination of research is prohibited.
BUL 108:	
Elizabeth Atencio	<i>Promoting Oral Proficiency Through Textbook Activities: A Comparative Analysis Creating</i>
Lissa Caballero	<i>and Photographing a Camera Obscura: An Exploration of the Inside of the Camera</i>
Moriah McDonald	<i>Examining Katniss Everdeen's Gender Ambiguity in The Hunger Games: How Suzanne Collins Utilizes the YA Genre to Resist Feminine Stereotypes</i>
Elianna Srikureja	<i>"A Woman's Lot is to Suffer": Recognizing the Intersectionality of Oppression and Resistance in Min Jin Lee's Pachinko</i>
Taylor Uphus	<i>A Man not a Monster: Reimagining Disability in Hollow Crown's Richard III</i>
BUL 149:	
Hannah Castillo	<i>Copper (II) Sequestration by PAMAM Dendrimers in Tap Water</i>
Alyssa Henriquez	<i>Optimization of an Integrated Cartridge System for Efficient Loading and Characterization of DNA through Microfluidic Platforms</i>
Joshua Pak	<i>The Chemical Challenges of Fixing Nitrogen</i>
Nels Wangsness	<i>Investigating the Fluorescent Properties of the Copper (II)-Dendrimer Complex</i>
Seth Williams	<i>PAMAM Dendrimer Stability Analysis using Size-Exclusion Chromatography</i>
BUL 208:	
Masy Domecillo	<i>The Role of the Prodomain in the Folding of Carboxypeptidase A1</i>
Lyle Goulbourne	<i>Interspecific and Ontogenic Differences in the Molar Occlusal Surfaces of Manatees (Trichechus)</i>
Jewel Murray	<i>Reassessing the Parameters of Phonotaxis in Female Cricket Acheta domesticus</i>
Jessica Rim	<i>Phonotaxis Tuning in Male-Exposed Female Cricket Acheta domesticus</i>
BUL 250:	
Andras Muranyi	<i>Analysis of Invasion Proteins in Glioblastoma U87MG Cells Treated with Various Novel Hybrid Anti-cancer Compounds</i>
HeeYun Oh	<i>The Effect of Clay on the Inhibitory Effect of Mustard Seed Meal on Velvetleaf Seedling Growth</i>
Isabella Tessalee	<i>Synthesis of an Anticancer Molecule Containing an Isoxazoline ring and a Dibenz[b,f]azepine</i>
Jared Wallen	<i>Monitoring the Immune Status of Calves at the Agriculture Education Center</i>
BUL 251:	
Alec Bofetiado	<i>Attempted Synthesis & Antibacterial Properties of APT-6K Against NDM-1 K. pneumoniae</i>
Jonathan Homan	<i>Classifying Pregel Links Obtained by Strong Fusion</i>
Kurt Kuhlman	<i>Infamy, Lies, and Loss: The Downfall of the German-American Bund</i>
Andrew Remmers	<i>The Impact of COVID-19 on Hospital's Financial Statements as it Relates to Elective Surgeries</i>
Adoniah Simon	<i>Climate Adaptation and Mitigation Policy: Challenges and Opportunities for the Gwich'in Nation and Beyond</i>

Undergraduate Research Scholars

BUL 150:	
Caleb Jacobs	<i>Temperature and Feed Optimization in the Synthesis of PAMAM Dendrimers</i>
Emma Suvacarov	<i>Analysis of Lead in Canine Hair in Benton Harbor Michigan</i>
Daniel Fajardo	<i>Synthesis of Isoxazoline as a PAM Activator</i>
Yoel Kim	<i>Constructing an Educational MRI Model Using Helmholtz Coils and Compass Oscillation to Visually Demonstrate Proton Precessions</i>
Kara Shepard	<i>Determining the Origins of Helix Glitches in LIGO's H1 Detector</i>
Wesley Martin	<i>An Information Theory Approach to Identifying Cross-Scale Coupling in Kelvin-Helmholtz</i>
BUL 207:	
Jake Kropel	<i>Impacts of First Egg Lost to Cannibalism of Remaining Clutch</i>
Tae Hyun Lee	
Noelle Koliadko &	
Dr. Shandelle Henson	
Alexander Navarro	<i>Exploring 2nd Natural Mates and Families of Primitive Curves</i>
Benjamin High	<i>Covenant Curses in the Prophets</i>
Katherine Clayton	<i>The Necropoleis of Esbus and the Decapolis</i>
Irina Gagliu	<i>Racial Equity in the Berrien County Criminal Legal System: An Examination of Justice</i>
Cecily Kaufmann	<i>Development Towards Potential Full Spectrum Bipolar Disorder Drugs</i>

HONORS THESIS POSTER PRESENTATIONS

Buller Hall, Student Lounge

P-01 Tyler Braithwaite (Rodney Summerscales, Computing)
Art to Influence Creativity in Symbolic Music Completion
J.N. Andrews Honors Scholar

Advances in Recurrent Neural Network (RNN) techniques have caused an explosion of problems posed that revolve around the mass analysis and generation of sequential data, including symbolic music. Building off the work of Nathaniel Patterson's Musical Autocomplete: An LSTM Approach, we extend this problem of continuing a composition by examining the creative impact that injecting latent-space encoded image data, specifically fine art from the WikiArt Dataset (Saleh & Elgammal), has on the musical output of RNN architectures designed for autocomplete. For comparison purposes with Patterson, we will also be using a corpus of Erik Satie's piano music for training, validation, and testing.

P-02 Reise Campbell (Rodney Summerscales, Computing and Hyun Kwon, Engineering)
A Three-Dimensional Convolutional Neural Network for ECL Sensor Analysis
J.N. Andrews Honors Scholar

Sensor technology has the potential to revolutionize fields ranging from biofuel manufacturing to Healthcare. One major innovation in the sensor field is Electrochemiluminescent (ECL) sensors, which have low background noise, allowing for ultra-sensitivity. ECL sensors are also cost-effective as they require less instrumentation for voltage delivery and provide measurements in a matter of seconds. Traditionally, calibration curves with a predetermined feature are used for some sensors to infer the concentration based on the reading. However, this method leads to variations between sensors that would require recalibration. This project seeks to use Machine Learning to interpret the sensor data, allowing generalization across sensor differences.

P-03 Joshua Dulcich (Rodney Summerscales, Computing)
Exploring the Efficiency of Neural Architecture Search (NAS) Modules
J.N. Andrews Honors Scholar

Machine learning is obscure and expensive to develop. NAS automates this process by learning to create premier ML networks. An exploding field, months old, most research focuses on a particular combination of NAS's three parts. Despite regularly acquiring state of the art results, this practice sacrifices computing time and hardware for slight increases in accuracy; this also obstructs comparison across different combinations of modules. To discover efficient modules, my research graphs the accuracy per compute time tradeoff between combinations. A subset of these possible combinations is derived from leading research, each producing an ML model that is tested on CIFAR-10, a standard image recognition dataset.

P-04 Matthew Dulcich (Rodney Summerscales, Computing)
Conditional Variational Auto Encoder (cVAE) for Augmentation of ECL Biosensor Data
J.N. Andrews Honors Scholar

Machine Learning (ML) is vastly improving the world, from computer vision to fully self-driving cars, we are now able to accomplish objectives that were thought to only be dreams. In order to train ML models accurately, they require mountains of information to work with, but sometimes it becomes impossible to collect the data needed, so we turn to data augmentation. In this project we use a conditional variational auto encoder (cVAE) to supplement the original video electrochemiluminescence biosensor dataset, in order to increase the accuracy of a future classification model. In other words, using a cVAE we will create unique realistic videos to combine with the dataset.

P-05 Eric Inae (Niki Pissinou, Florida International University; Rodney Summerscales, Computing) Online dissemination of research title is prohibited.
J.N. Andrews Honors Scholar

Online dissemination of abstract prohibited.

Buller Hall 108

P-06 Elizabeth Atencio (Anneris Coria-Navia, Teaching, Learning, and Curriculum)
Promoting Oral Proficiency Through Textbook Activities: A Comparative Analysis
J.N. Andrews Honors Scholar

Learning a language in a scholastic environment should include intentional and significant oral communication opportunities. This project focuses on analyzing and comparing elementary-level Spanish textbooks for their usage of oral communication activities. The project also includes a literature review that addresses the importance of oral communication in the foreign language classroom. The results of the textbook analysis and literature review show the level at which textbooks support the development of oral communication skills in the early elementary Spanish classrooms in the strive for oral proficiency among Spanish language learners.

P-07 Lissa Caballero (David Sherwin, Visual Art, Communication & Design)
Creating and Photographing a Camera Obscura: An Exploration of the Inside of the Camera
J.N. Andrews Honors Scholar and Undergraduate Research Scholar

Photography has the ability to stop time, capturing light rays and memorializing the stories they tell. But how did photography come about? The answer lies within a darkened room with a single small light. This project is a reconstruction of the grandparent to the modern camera: the camera obscura. By following the ancient design one can transform any ordinary room into a giant camera, allowing for a unique view into the interior of the camera. The resulting images are captured using a modern camera. Thus, creating a collaboration between the ancient and modern camera to create a finished image.

P-08 Moriah K. McDonald (Vanessa Corredera, English)
Examining Katniss Everdeen's Gender Ambiguity in The Hunger Games: How Suzanne Collins Utilizes the YA Genre to Resist Feminine Stereotypes
J.N. Andrews Honors Scholar and Undergraduate Research Scholar

Having grown up as a teenager in the 21st century, I have noticed the unrealistic expectations imposed on women by the media—the binaries of wholly good or wholly bad. Such themes remain heavily featured in young adult (YA) literature, a genre specifically aimed at teenagers. Thus, in analyzing *The Hunger Games* trilogy by Suzanne Collins, I undertake a twofold analysis. I aim to not only illustrate how Collins's works tackle the specific issue of binary representation of women in the media, but also to validate the usefulness of the YA genre in commenting on current day issues facing teens.

P-09 Elianna Srikureja (Vanessa Corredera, English)
“A Woman’s Lot is to Suffer”: Recognizing the Intersectionality of Oppression and Resistance in Min Jin Lee’s *Pachinko*
J.N. Andrews Honors Scholar

Min Jin Lee’s novel *Pachinko* (2017) portrays the historically based lives of a displaced Korean family during Japan’s colonization of Korea from 1905-1945. The novel’s attention to the ways that colonial endeavors complicate Confucian family and national structures exemplifies the interrelation between gender and racial oppression facing Lee’s Korean women. However, by centering female voices all too often silenced, Lee also depicts modes to subvert such oppression. Using feminist and postcolonial theory, historical analysis, and close reading analysis, this project examines the construction of oppression and subversive resistance measures and, ultimately, argues the necessity of articulating local specificities instead of universalizing and homogenizing the experience of women worldwide.

P-10 Taylor Uphus (L. Monique Pittman, English)
A Man not a Monster: Reimagining Disability in Hollow Crown’s Richard III
J.N. Andrews Honors Scholar and Undergraduate Research Scholar

Traditional portrayals of William Shakespeare’s *Richard III* (1592) in film interpret Richard’s physical disability as an outward reflection of his evil. In recent years, disabilities studies scholars have reconsidered the historic association of Richard’s physical deformity with immorality. Unlike previous *Richard III* films, the BBC’s *Hollow Crown: Richard III* (Dominic Cooke, 2016) highlights Richard’s mental abuse and trauma. While the film does not shy away from Richard’s villainy, its more empathic depiction of Richard contests the one-dimensional stage and film representation of him as a conniving monster. Ultimately, this film presents *Richard III* to critique society’s treatment of disabled individuals.

Buller Hall 149

P-11 Hannah Castillo (Ryan Hayes, Chemistry & Biochemistry)
Copper (II) Sequestration by PAMAM Dendrimers in Tap Water
J.N. Andrews Honors Scholar and Undergraduate Research Scholar

Dendrimers are nanomaterials that are widely studied for a variety of applications because of their distinctive properties. One such property of the generation 2-PAMAM Dendrimer is its specific affinity for copper (II) ions. This could be influential in selective heavy metal extraction, particularly in contaminated water. The research showed the selectivity of the G2-octyl PAMAM dendrimers for copper (II) in a chemical environment with interfering species using Inductively Coupled Plasma Optical Emission Spectroscopy. Such environments that were analyzed includes Andrews University tap water, where magnesium (II) and calcium (II) are present at significant quantities.

P-12 Alyssa Henriquez (Ryan Hayes, Chemistry & Biochemistry)
Optimization of an Integrated Cartridge System for Efficient Loading and Characterization of DNA through Microfluidic Platforms
J.N. Andrews Honors Scholar

Microfluidic platforms have critical implications for field-based clinical diagnostics. They can aid in accelerating the process of diagnosis, which is crucial for patients who are too ill to wait several days for results. The objective of this project was to create a cartridge system that improves the efficiency of loading and running biochemical assays in microfluidic platforms. This was accomplished by designing three separate cartridges made of polydimethylsiloxane (PDMS), laser-cut acrylic, and 3D-printed resin, and subsequently evaluating their ability to load a microfluidic chip once pressurized. Ultimately, 3D-printed cartridges were shown to be the most effective in loading microfluidic platforms.

P-13

Joshua Pak (Ryan Hayes, Chemistry & Biochemistry)
The Chemical Challenges of Fixing Nitrogen
 J.N. Andrews Honors Scholar

Breaking the triple bond of dinitrogen is chemically challenging requiring high temperatures, high pressures, special iron catalysts, and carefully engineered systems to “fix” dinitrogen and make it usable as ammonia. Fixing dinitrogen is critical to the survival of all life on Earth. The enzyme nitrogenase, found in nitrogen-fixing organisms, can fix nitrogen at ambient temperatures and pressures. Can chemo-biological evolution adequately explain nitrogenase’s emergence or are there critical chemical barriers that suggest the intentional involvement of intelligence? Our methodology uses primary scientific research to understand nitrogenase’s cellular mechanism, chemical structure, and reaction mechanism alongside genetic ancestral phylogeny of diazotrophs.

P-14

Nels Wangsnæs (Ryan Hayes, Chemistry & Biochemistry)
Investigating the Fluorescent Properties of the Copper (II)-Dendrimer Complex
 J.N. Andrews Honors Scholar

Polyamidoamine (PAMAM) dendrimers are extremely versatile nanoscale molecules, with many variations of sizes in the nanometer dimension and surface groups that control solubility and reactivity. Specifically, PAMAM dendrimers with octyl- end chains have shown promising characteristics of fluorescence and specificity towards copper(II) ions. This research will present the basic excitation and emission properties of these dendrimers in dichloromethane. These “unloaded” dendrimers fluorescence properties were compared to copper(II) “loaded” dendrimers using a G2-octyl-PAMAM. Observed differences to previous PAMAM dendrimer fluorescence will be presented. This system could be incorporated into various industries as a copper sensor.

P-15

Seth Williams (Ryan Hayes, Chemistry & Biochemistry)
PAMAM Dendrimer Stability Analysis using Size-Exclusion Chromatography
 J.N. Andrews Honors Scholar

Enzymatic and thermal stability of dendritic nanoparticles is not well characterized in peer-reviewed literature. To establish methods and procedures to test nanoparticle stability, protocols were developed using bovine serum albumin (BSA) as a model for expensive PAMAM dendrimers since they share many of the same amide bond linkages. The amide structures was exposed to different environments such as pH, temperature, and proteases for various amounts of time and then evaluated using size exclusion chromatography (SEC). This research could prove beneficial to many disciplines that use dendrimer nanoparticles including medicinal uses involving oral delivery of pharmaceuticals.

Buller Hall 208

P-16

Masy Domecillo (Peter Lyons, Biology)
The Role of the Prodomain in the Folding of Carboxypeptidase A1
 J.N. Andrews Honors Scholar

Carboxypeptidase A1 (CPA1) is a digestive enzyme. This enzyme contains a prodomain region, which must be cleaved for enzymatic function. Previous studies have hypothesized that the prodomain is necessary for CPA1 structural stability. However, the discovery of a related enzyme, carboxypeptidase O (CPO), which does not have a prodomain, challenges this assertion. In order to investigate the need for a carboxypeptidase prodomain, or other stabilizing features, an antibody tag was added through polymerase chain reaction (PCR). The prodomain was then removed via PCR. Western Blots and enzyme assays confirmed formation of the protein with the antibody tag and will be performed to determine proper formation and function of CPA1 without the prodomain.

P-17 Lyle Goulbourne (Daniel Gonzalez-Socoloske, Biology)
Interspecific and Ontogenic Differences in the Molar Occlusal Surfaces of Manatees (Trichechus)
J.N. Andrews Honors Scholar and Undergraduate Research Scholar

Manatees combat their abrasive herbaceous diet by continuously replacing their teeth along a horizontal axis, with new teeth added at the posterior end and older teeth falling out at the anterior end. To describe the teeth, we photographed and labeled features of manatee molars and premolars. We also measured molar occlusal area vs skull length to determine whether teeth increase in size as manatees age. The results determined that relative tooth size increases with age. This research will add to our understanding of manatee feeding ecology, which may allow us to better understand manatee diet and health and help provide improved habitats.

P-18 Jewel Murray (Benjamin Navia, Biology)
*Reassessing the Parameters of Phonotaxis in Female Cricket *Acheta domestica**
J.N. Andrews Honors Scholar and Undergraduate Research Scholar

When evaluating phonotaxis, two parameters have been used to determine a positive response; i) the distance travelled toward the source of a sound is twice that of the distance away and ii) the path of travel towards the sound is within a -60/+60° angle. These parameters, established years ago, are widely accepted. The latter parameter, however, may not accurately describe the quality of phonotaxis of a given animal. This research assesses the angular orientation of phonotaxis in female crickets by further exploring the significance of the -60/+60° parameter; looking at its variation and what it could elucidate in terms of the quality of tracking.

P-19 Jessica Rim (Benjamin Navia, Biology)
*Phonotaxis Tuning in Male-Exposed Female Cricket *Acheta domestica**
J.N. Andrews Honors Scholar

Phonotactic behavior of female cricket *Acheta domestica* has been shown to vary among individuals. While some females are finely tuned to calls with syllable periods in the natural range of conspecific males, others respond phonotactically to a wider range of syllable periods and therefore lack the ability to discriminate between attractive and unattractive calls. When females are exposed to males but prevented from mating, their ability to discriminate attractive calls is reduced, suggesting that factors other than mating alter phonotactic behavior. This study evaluates the effect of male exposure on the females' tuning of phonotaxis and its underlying neural elements.

Buller Hall 250

P-20 Andras Muranyi (Denise Smith, Biology)
Analysis of Invasion Proteins in Glioblastoma U87MG Cells Treated with Various Novel Hybrid Anti-cancer Compounds
J.N. Andrews Honors Scholar

This research tested effectiveness of compounds 2-TBH, PKP2, PKP3, PKP5, and DMOB, demonstrated to have anti-cancer properties. Glioblastoma cells were exposed to each compound at the LC50 concentration, then processed to collect proteins from the cells. Proteins were analyzed via Western blotting for specific protein levels of matrix metalloproteinase 2 and 9 (MMP) and disintegrin and metalloprotease 12 and 17 (ADAM). Previous research indicates these proteins are involved in the invasive properties of glioblastoma cells. Preliminary results show that the different compounds result in varying levels of MMP-2 and 9 as well as ADAM-12 and 17 proteins.

P-21

HeeYun Oh (Robert Zdor, Biology)

The Effect of Clay on the Inhibitory Effect of Mustard Seed Meal on Velvetleaf Seedling Growth

J.N. Andrews Honors Scholar and Undergraduate Research Scholar

Mustard seed meal has been studied as a biofumigant in suppressing weed growth in farming systems lacking herbicide usage. MSM contains glucosinolates that hydrolyzes into volatile isothiocyanates which have herbicidal properties. Previous studies have shown that MSM in elevated sand content was highly effective in suppressing the germination of velvetleaf weed seeds, and that it decreased in an increased clay/silt content. Based on this, it was postulated that clay may inhibit MSM efficacy by preventing isothiocyanate action. Two different types of clay were tested at various concentrations to measure the reduced inhibition of seed germination by MSM. Low concentrations of both types of clay didn't inhibit the weed suppressive properties of MSM.

P-22

Isabella Tessalee (Lisa Ahlberg, Chemistry & Biochemistry)

Synthesis of an Anticancer Molecule Containing an Isoxazoline ring and a Dibenzo[b,f]azepine

J.N. Andrews Honors Scholar and Undergraduate Research Scholar

This poster displays an anticancer molecule synthesis and describes the biological mechanism targeted by this model compound. The synthesis of this model allows us to test the chemistry described in the literature and then apply it to a new proposed compound. Our proposed structure is hypothesized to be a more effective anticancer molecule than the model with which we start. Based on research of known agonist AC-5216 and antagonist PK11195 of the TSPO receptor in mitochondrial membranes, the addition of an isoxazoline ring to the model structure is hypothesized to induce apoptosis of cancer cells.

P-23

Jared Wallen (Katherine Koudele, Agriculture)

Monitoring the Immune Status of Calves at the Agriculture Education Center

J.N. Andrews Honors Scholar

Each year at the Andrews University Agriculture Education Center calves are born to the resident cows and five to seven calves are purchased to be raised by the students in the agriculture program. In each of the previous two years that calves have been raised, morbidities have been observed. To try and prevent any calves from dying and reduce the morbidities, the research project was designed to monitor the calves' immune status. By doing weekly blood draws, the total serum protein levels can be determined and used as a standard for their health. Body temperature, food and water intake, and activity levels will also be used as health indicators.

Buller Hall 251

P-24

Alec Bofetiado (Melissa Poua, Medical Laboratory Sciences; Desmond Murray, Chemistry & Biochemistry)

Attempted Synthesis & Antibacterial Properties of APT-6K Against NDM-1 K. pneumoniae

J.N. Andrews Honors Scholar and Undergraduate Research Scholar

NDM-1 K. pneumoniae is a highly resistant bacterial organism that is capable of causing debilitating nosocomial infections in immunocompromised patients. Only "last-resort" antibiotics—such as colistin—work against this organism. Therefore, new antibiotics are needed to help fight against these types of infections. APT-6K is a novel compound that was demonstrated to be effective against MRSA with nanomolar concentrations in a prior study. Novel methods of APT-6K synthesis and its testing for antibiotic effects against NDM-1 K. pneumoniae were attempted in this research. However, APT-6K synthesis was unsuccessful. Commercially-prepared APT-6K also did not demonstrate growth inhibition against NDM-1 K. pneumoniae nor against a wild-type K. pneumoniae. Suggestions for future research are discussed.

P-25 Jonathan Homan (Anthony Bosman, Mathematics)
Classifying Pretzel Links Obtained by Strong Fusion
J.N. Andrews Honors Scholar

The strong fusion of a mathematical link joins two components of the link via a band and adds an unknotted circle about the band. We present a complete and original classification of those pretzel links which can be obtained by strong fusion. The primary tools we depend on are linking number and a dichromatic resolution of the link in which we conceive of the link as being colored with two colors and resolve crossings in such a way that respects those colors. Solving the classification problem in a number of subcases gives the general result.

P-26 Kurt Kuhlman (Stephanie Carpenter, History & Political Science)
Infamy, Lies, and Loss: The Downfall of the German-American Bund
J.N. Andrews Honors Scholar

This project focuses on the German-American Bund, the largest Nazi organization in the United States, and those specific events that led to its collapse. First, a February 1939 Bund rally in Madison Square Garden made them more infamous across the country. Then *Bundesführer* Fritz Kuhn appeared before the Dies Committee in Congress to testify about Bund activities in the U.S. Finally, in December 1939 Kuhn was convicted on charges of larceny and forgery and sent to prison. Following his incarceration, the Bund was unable to hold together without his leadership, and dissolved within two years, immediately following Pearl Harbor.

P-27 Andrew Remmers (Carmelita Troy, Accounting, Economics and Finance)
The Impact of COVID-19 on Hospital's Financial Statements as it Relates to Elective Surgeries
J.N. Andrews Honors Scholar and Undergraduate Research Scholar

Coronavirus has negatively affected the financial health of hospitals. As hospitals reached in-patient capacities with Covid-19 patients, hospitals were not able to provide more profitable services, such as elective surgeries. Elective surgeries account for approximately 43% of hospitals' total revenue and profits. The impact of Covid-19 has put some hospitals into a precarious financial position. Variants of the coronavirus pandemic, such as Delta, have filled hospitals and critical care units with patients. With the increase in demand from these patients, hospitals have to adapt their strategies to remain financially viable during an unpredictable pandemic.

P-28 Adoniah Simon (Curtis VanderWaal, Social Work)
Climate Adaptation and Mitigation Policy: Challenges and Opportunities for the Gwich'in Nation and Beyond
J.N. Andrews Honors Scholar

This thesis addresses limitations of climate adaptation and mitigation efforts for the Gwich'in Nation, an indigenous group located in the Arctic Circle region of Alaska. By performing a content analysis of the oral testimonies of 21 Gwich'in representatives within the 2019 Arctic Indigenous Climate Summit Report, the largest climate related concerns of the region will be evaluated. Then, these policy priorities will guide a secondary content analysis of H.R. 5376: Build Back Better Act and to what extent such a bill meets urgent climate priorities. Finally, the implications of such policy documents will be discussed, and recommendations will be made.

UNDERGRADUATE RESEARCH POSTER PRESENTATIONS

Buller Hall 150

P-29 Caleb Jacobs (Ryan Hayes, Chemistry & Biochemistry)
Temperature and Feed Optimization in the Synthesis of PAMAM Dendrimers
Undergraduate Research Scholar

PAMAM dendrimer synthesis involves a very exothermic reaction, which poses a problem as low reaction temperatures must be maintained while reactant is manually added. This project sought to automatically control reactant input via temperature feedback using an Arduino Uno microcontroller connected to a temperature probe. The Arduino was programmed to control one of two devices based on temperature readings. The first was a servo motor attached to the valve on an addition funnel, and the second was a solenoid valve connected to a reactant reservoir. While each option had pros and cons, both were functional and had similar performance.

P-30 Emma Suvacarov (Ryan Hayes, Chemistry & Biochemistry)
Analysis of Lead in Canine Hair in Benton Harbor Michigan
Undergraduate Research Scholar

Recent success in sequence generation has been seen in the problem of Polyphonic Music Generation. This study Exposure to lead has been shown to cause kidney damage, brain damage, and even birth defects. Heavy metals, such as lead, can be retained in the hair as metabolic products during the growth process. Recently animals, such as cats and dogs, have been used as indicators for environmental pollution. The objective of this research was to analyze dog hair obtained in Benton Harbor, Michigan for lead. Ashed hair samples were assessed using Induced Coupled Plasma Spectroscopy to determine lead amounts. This idea could be used to alert health officials to heavy metal exposure in a community.

P-31 Daniel Fajardo (Lisa Ahlberg, Chemistry & Biochemistry)
Synthesis of Isoxazoline as a PAM Activator
Undergraduate Research Scholar

Alzheimer's disease (AD) is correlated to degeneration of muscarinic acetylcholine receptors (mAChR). Activation of M1 receptor (G protein) with positive allosteric modulator (PAM) has shown to bind to the receptor slowing the degeneration. Structural motifs with PAMs, that provides potent activity and weak agonism indicates a novel isoxazoline compound containing a top, core, and pendant motif. Our strategy was to synthesize the isoxazoline pendant first, followed by the core and top motif attachment. We observed that the reactions to form the pendant motif have not yet provided a substantive yield and further experimentation is required.

P-32 Yoel Kim (Mickey Kutzner, Physics)
Constructing an Educational MRI Model Using Helmholtz Coils and Compass Oscillation to Visually Demonstrate Proton Precessions
J.N. Andrews Honors Scholar and Undergraduate Research Scholar

Our goal was to make a physical model of an MRI as a teaching tool to demonstrate its physics concepts visually, as well as be manipulable for hands-on learning. We used two nested Helmholtz coils, positioned perpendicularly to each other (on providing AC, the other DC), with four clusters of compasses placed at the center. By manipulating the currents flowing through the coils and four loops of wire stationed around the contraption, we could cause the compass needles to oscillate, mimicking proton precession in MRIs. Proof of individual concepts were tested and confirmed as viable; final prototype construction in progress.

P-33

Kara Shepard (Tiffany Summerscales, Physics)
Determining the Origins of Helix Glitches in LIGO's H1 Detector
 J.N. Andrews Honors Scholar and Undergraduate Research Scholar

Because the LIGO detectors are so sensitive, they are highly susceptible to short duration bursts of noise (glitches) from various sources that can disrupt gravitational wave signals. Thus it is important to reduce or eliminate these glitches in the detectors, and in order to do this, the cause of the glitches must be found. I am researching the Helix glitch in the H1 detector to try and determine its origin. This is accomplished by studying the times at which the glitch occurred in the detector, and searching through the H1 electronic log for various factors happening around the same time. This will show if there are any correlations between the occurrences of the Helix glitch and factors that could be causing the noise.

P-34

Wesley Martin (Jay Johnson, Engineering & Physics)
LIGO BayesWave Signal Algorithm
 Undergraduate Research Scholar

Kelvin-Helmholtz vortices frequently develop at the magnetopause boundary of planetary magnetospheres. The nonlinear development of vortices involves coalescence, where smaller vortices combine into larger vortices in an inverse cascade. Large-scale structures tend to grow slower, yet saturate at larger amplitude, so the shift in scale may simply result from small-scale structures nonlinearly saturating while large-scale structures grow linearly. Alternatively, energy could be transferred between scales through nonlinear cross-scale turbulent coupling. We utilize transfer entropy to explore cross-scale coupling in hybrid simulations of Kelvin-Helmholtz instability. The analysis provides evidence that nonlinear coupling across scales is important in the coalescence process and identifies the temporal and spatial scales over which the coupling occurs.

Buller Hall 207

P-35

Jake Kroepel, Tae Hyun Lee, Noelle Koliadko, Dr. Shandelle Henson
 (Shandelle Henson, Mathematics & Biology)
Impacts of First Egg Lost to Cannibalism on Cannibalism of Remaining Clutch
 Undergraduate Research Scholar

Female gulls lay three eggs: A, B, and C, laid in that order. When sea temperature rises, gulls cannibalize neighbors' eggs. A-eggs are cannibalized preferentially and are eaten the day they are laid, and the odds of this decrease with the number of A-eggs laid that day. Here we considered nests in which the A-egg was cannibalized. We investigated whether B-eggs were cannibalized more than C-eggs, whether they were eaten the day they were laid, and whether the odds decreased with the number of B eggs laid that day. Our results supported the first two hypotheses but not the third.

P-36

Alexander Navarro (Yun Oh, Mathematics)
Exploring 2nd Natural Mates and Families of Primitive Curves
 J.N. Andrews Honors Scholar and Undergraduate Research Scholar

The natural mate of a unit speed curve is generated by letting its principal normal vector be the tangent vector of the new curve. Expanding on Deshmukh et al., we demonstrate that given a curve, the primitive curve of which it is the natural mate is not uniquely determined, giving a family of curves with the same natural mate. We then explore the 2nd natural mate, demonstrating a simple relationship between its curvature and torsion, and proving several smaller theorems regarding how constraints on the primitive, 1st natural mate, and 2nd natural mate may constrain the other curves.

P-37 Benjamin High (Rahel Wells, Religion and Biblical Languages)
Covenant Curses in the Prophets
Undergraduate Research Scholar

Contrary to Scriptural claims, many scholars believe that the Torah was written after or together with the prophets. As a test case, I read and analyzed 88 articles related to covenant curses. Many articles only talked about covenant theology, but several referenced the origin of the Torah. Some mentioned how the covenant curses were shaped by the Torah, while others noted how themes from the prophets were based on ANE traditions and the Torah. Overall, most authors thought that the Torah was written before the prophets, which is in contrast to many source-critical assumptions about the provenance of the covenant curses and needs to be considered in any final analysis.

P-38 Katherine Clayton (Øystein LaBianca, Behavioral Sciences)
The Necropoleis of Ebus and the Decapolis
Undergraduate Research Scholar

Are the tomb designs found in Ebus also present in Decapolis cities? Often the Decapolis is thought of as a league of 10 cities. However, there is evidence that it was a political and cultural region of those main cities and the surrounding areas. The theory of transculturation suggests that if two cultures/societies are in close contact for a prolonged period, there should be an exchange of cultural traits, in this case, tomb designs. This study posits that due to transculturation between Romans and the Levantine people, some of the tomb designs common in the Decapolis are also common at Ebus.

P-39 Irina Gagi (Kristen Witzel, Behavioral Sciences)
Racial Equity in the Berrien County Criminal Legal System: An Examination of Justice
J.N. Andrews Honors Scholar and Undergraduate Research Scholar

Do racial disparities exist in any aspect of the Berrien County Criminal Justice system? This study seeks to explore potential racial inequities that reside amongst a local county's criminal justice system. Through an analysis of jail data from the Berrien County Jail, we plan to highlight disparities amongst prisoners which pertain to specific demographic variables—including racial/ethnic identity. By considering previous research on racialized social systems, we plan to establish our results on a more community-applicable scale in an effort to aid in the elimination of racial injustice on a criminal justice level.

P-40 Cecily Kaufmann (Marlene Murray, Biology; Desmond Murray, Chemistry & Biochemistry)
Development Towards Potential Full Spectrum Bipolar Disorder Drugs
Undergraduate Research Scholar

The goal of this research project is to develop full spectrum bipolar disorder drugs; there is currently only one on the market. Our approach here is to create single molecular entities with the capacity to address both the manic and depressive phases of bipolar disorder. This is part of our ongoing work in which valproate, a known antimanic agent, is covalently linked to amines known and regularly used as antidepressants. We synthesize these compounds utilizing a one-flask, three-step reaction sequence involving acyl chloride formation, then electrophilic carbonyl addition followed by nucleophilic substitution. Our hybrid quaternary ammonium acylals contain both the valproate and the antidepressant tertiary amines. Currently, the antidepressant amines under study are amitriptyline, imipramine and diphenhydramine, the latter being the antidepressant found in Benadryl. Our bioassaying protocol involves measuring the inositol concentrations of human cell lines upon independent exposure and treatment with (a) our synthesized hybrid compounds, (b) mixtures of valproate and antidepressant, and (c) valproate and antidepressant controls. The cell lines are lymphoblasts obtained from patients diagnosed with bipolar disorders I and II and unaffected individuals.

ABSTRACTS FOR ANDREWS UNIVERSITY UNDERGRADUATE RESEARCH STUDENTS, PRESENTING AT MICHIGAN ACADEMY OF SCIENCE, ARTS, & LETTERS (MASAL) 2022

Behavioral Science

M-01 Samantha Davis (Herbert Helm)
An analysis of university students' motivation levels in in-person, remote, and hybrid courses
Undergraduate Research Scholar

Purpose: With recent events, there has been a debate as to whether students who are learning inside the traditional classroom are receiving the same quality of education as they would in the less traditional classroom (remote and hybrid). For this study, we are particularly interested in their motivational level. Procedure: Subjects were college students who needed to have taken at least two different types of classes, either in-person, remote, or hybrid, within the past year. The scale used to determine their self-reported level of motivation was The Situational Motivation Scale (SIMS). The different types of motivation measured are situational intrinsic motivation, identified regulation, external regulation, and amotivation. Expected Results: Currently, data is being obtained for the study. Once collected, a one-way repeated measures ANOVA will be done on the participants' levels of motivation across the three separate conditions: in-person, remote, and hybrid. Implications: The specific interest of this study is to determine the outcome of intrinsic motivation. If intrinsic motivation is found to vary significantly across the three separate conditions: in-person, remote, and hybrid, the next question to address will be how can intrinsic motivation be increased in settings where it is found to be low in order to enhance student learning.

M-02 Irina Gagi (Kristen Witzel)
Racial equity in the Berrien County criminal legal system: An examination of justice
J.N. Andrews Honors Scholar and Undergraduate Research Scholar

Do racial disparities exist in any aspect of the Berrien County Criminal Justice system? This study seeks to explore potential racial inequities that reside amongst a local county's criminal justice system. By ultimately analyzing the recent policing, sentencing, and prosecuting data of the Berrien County Jail, we plan to complete a multi-staged research project which will highlight disparities amongst prisoners which pertain to specific identifying demographic variables—including age, gender, and racial/ethnic identity. Additionally, we aim to explore the need for increased data transparency amongst judiciary institutions' records, as the organization of this data may affect potential designs for statistical analysis in research. The need for community-based research in accordance with the procedural justice theory will also be addressed given the needs and concerns of the examined county's residents. In this phase of our research study, we are currently observing the relationships between sentencing variables amongst jail data—including pre-sentencing decisions, jail-bond lengths, types of crime, days spent in jail, and sentencing outcomes—and the aforementioned demographic variables. By considering previous research on racialized social systems, we plan to establish our results on a more community-applicable scale in an effort to aid in the elimination of racial injustice on a criminal justice level.

M-03

Caralynn Chan (Karl Bailey)
Spatial distraction and speech recognition thresholds
Undergraduate Research Scholar

Multiple forms of distraction permeate our lives, such as visual, kinetic, or auditory distractions (Forster & Lavie, 2015). Cell phones can introduce several distractions, including spatial distractions. As a result, cell phones distract individuals from completing tasks in situations such as in the workplace or while driving (Wilmer et al., 2017). However, does cell-phone-related spatial distraction affect other processing modalities, such as speech processing (Cohen & Gordon-Salant, 2017)? We have designed an experiment that analyzes how spatial distractions introduced by cell phone games affect participants' speech recognition thresholds. Participants will complete a speech recognition threshold task alone and another speech recognition threshold task with a cell phone game task as a competing task. We will use several measures to assess participants' speech recognition thresholds, including the American Speech-Language-Hearing Association method (ASHA, 1987). We will utilize the Cognitive Failures Questionnaire (Broadbent et al., 1982) as a trait measure to determine spatial distraction. We hypothesize that participants will exhibit decreased hearing sensitivity due to spatial distraction. We will have consistent tasks for participants that we can record scores from - such as the Cognitive Failures Questionnaire and a cell phone game. We have piloted our process, and the initial results are encouraging.

M-04

Karl Bailey, Myrnaliza Tan, Duane McBride (Karl Bailey, Duane McBride)
To train up a child: Family religious environment and religiosity in a global sample
Undergraduate Research Scholar

Religiosity is passed on within a family environment (Myers, 1996; Petts 2009) and influences communication, emotional support, and parental monitoring (Malinkova, 2019). We used a culturally-diverse global sample of Seventh-day Adventist church members age 21 or older, with at least one Adventist parent, who either were born into an Adventist household (minimum N = 9714), joined the church as a child (minimum N = 3135), joined as a teenager (minimum N = 2175), or left the church and returned (minimum N = 2043). We examined whether these different family histories were associated with different profiles of religious transmission in correlations between a novel multidimensional measure of family religious environment (MacDonald's omega = .838) and a set of religiosity measures. Family history modified relationships between family environment and aspects of religiosity. Respondents who joined as a teen showed a weaker positive relationship with core Adventist beliefs, but a stronger positive relationship with legalism. Respondents born in the church, on the other hand, showed stronger positive relationships with core beliefs and practices, and no relationship to legalism. All family history groups showed similar relationships with spiritual growth. Our study shows the continuing influence of family religious environment and history on adult religiosity.

M-05

Aidan Li (Karl Bailey, Duane McBride)
Examining consistency in measures of religious identification across the globe
Undergraduate Research Scholar

Religious identification is a unique form of social group membership (Ysseldyk et al., 2010) that affords belonging to a social group (Ryan, Rigby, & King, 1993), as well as solutions to existential crises (Greenberg et al., 2020). Religious identification is expressed by adopting belief and behavior norms (Louis, 2021) which may be in tension with the surrounding culture. Emerging adulthood is a time of identity development, including adopting a religious identity (Liang & Ketcham, 2017). We examined the relationships between prospective religious identity (strength of commitment to lifetime religious identification) and belief and behavior measures in 47 (belief, N = 10834) and 49 (behavior, N = 9795) geocultural regions using a Bayesian meta-analytic approach (Gronau et al., 2021) to identify evidence for an overall relationship and for variation across regions. Our sample consists of individuals between 18 and 29 years of age in the Global Church Member Survey II (2017-2018), a global survey of Seventh-day Adventist church members. We found very strong evidence for a small relationship between prospective religious identity and belief and behavior, as well as very strong evidence for global variation in those relationships. Surprisingly, cultural indices explained relatively little of that variance between geocultural regions.

M-06 Clara Kolinek (Karl Bailey)
Competition and cooperation in board games
Undergraduate Research Scholar

Competition, cooperation, and aggression have typically been studied through video games (Bayeck, 2020). Literature concludes cooperative play results in continued cooperativeness even after a game's conclusion while competitive play does not, neither competitiveness nor cooperativeness during game play tends to increase state hostility (Waddell & Peng, 2014), and people prefer playing competitive games over cooperative ones (Kivikangas et al., 2014). This study seeks to extend this research through board games to better understand the roles of cooperation and competition during play. There will be two components. Information will be collected and coded about thematic content (violent/non-violent imagery) and gameplay design (cooperative/competitive) of preferred board games, as well as trait aggression, need for cognition, and social dominance scales in samples drawn from MTurk and a university gaming club. After calculating theme and gameplay orientations, we will test whether these are predicted by the trait measures using a linear regression. Second, participants will play the board game Codenames using cooperative or competitive instructions, then complete a competitive reaction time task separately to measure aggression. Earlier trait measures will also be collected to control for trait difference between our subjects, and analyzed using t-tests. Expectations are that people will generally prefer more competitive games, and competitive priming will lead to an increase in the competitiveness of players.

M-07 Zoe Shiu (Karl Bailey)
The pragmatic role of emoji in text communication
Undergraduate Research Scholar

Face-to-face pragmatic signals include prosody, tone, and gesture (Kelley, 1999); informal written communication (social media posts or texts) must rely on other features (Gunraj, 2016). The current study, a 2x2 within-subjects online experiment, manipulated the presence of emoji in text conversation screenshots where the last line could be interpreted either as complementary or sarcastic depending on pragmatic context (the helpfulness of the interlocutor). We hypothesized that participants ($N = 603$) would detect more sarcasm (on a 100-step slider) in texts to helpful interlocutors with emoji than without, and that sarcasm directed toward a helpful interlocutor would be perceived (on a 100-step slider) as making less sense (by introducing pragmatic ambiguity; Okanda et al., 2015). Indeed, texts to unhelpful interlocutors were uniformly perceived as sarcastic, but while texts to helpful interlocutors were perceived as less sarcastic, the presence of sarcastic emoji increased the perception of sarcasm [$F(1, 602) = 66.5, p < .001$]. Sarcastic emoji decreased ratings of sense when directed to helpful interlocutors, but increased ratings of sense when directed toward helpful interlocutors [$F(1, 602) = 66.9, p < .001$], suggesting that emoji are functioning as pragmatic markers in informal online writing.

M-08 Christina Stowell (Karl Bailey)
A network analysis of persistence
J.N. Andrews Honors Scholar and Undergraduate Research Scholar

Does an individual's personality affect their persistence on tasks? Within the last two decades, the research on persistence has focused primarily on the relationship between persistence and grit. Only in the last three years has research focused on the big five personality traits (Howard & Crayne, 2019). Researchers assumed that the trait "conscientiousness" would positively correlate with the level of persistence. However, Howard and Crayne (2019) found there was little to no correlation between any of the big five personality traits and persistence. We intend to replicate and extend this finding to better understand the placement of persistence within personality and cognitive psychology. We will use a network analysis to locate persistence within a range of other persistence-like measures. The measures we will utilize are the Persistence in Academics Scale (Lufi, 1979), the Tenacity Scale (Gartner, Gatewood, & Shaver, 1991), the Career Advancement Ambition Scale (Desrochers & Dahir, 2000), and Pursuit of Excellence Measures (Cassidy & Lynn, 1989), the Child-Adolescent Perfectionism Scale (Flett et al., 2016), the Big Three Perfectionism Scale (Smith et al., 2016), Nowicki-Strickland Locus of Control Scale (Nowicki & Duke, 1983), Levenson's IPC Scale (Levenson, 1981), and the Spheres of Control Scale (Paulhus & Christie, 1981).

M-09 Crystal Collins, Myrnaliza Tan, Mallary Anderson, Destiny Miller, (Karl Bailey)
What is the relationship between the COVID burden and personality traits?
Undergraduate Research Scholar

Problem: What are the relationships between levels of quarantine loneliness, pandemic-related stress, and personality factors? Bartusevičius discovered that the COVID burden increased psychological strain (Bartusevičius et. al, 2021) and Gubler found that emotional regulation could determine loneliness levels (Gubler et al., 2020). Therefore, we examined the pandemic stress burden on college students and if their personality traits predicted quarantine loneliness. Methods: In this correlational survey study, the UCLA Loneliness Scale measured levels of loneliness, (Russell, 1996)). Subscales from the BFI-44 measured personality traits (John, Donahue, & Kentle, 1991). We made a three-item scale to measure pandemic stress burden (Cronbach's $\alpha = .859$). We used a regression to predict loneliness in two blocks (personality, then stress burden). Results: Extraversion, agreeableness, and conscientiousness correlated negatively with loneliness while neuroticism and pandemic stress burden correlated positively with loneliness. Each of these were significant independent predictors of loneliness in the final regression model. Conclusions: Our study agreed with Gubler that emotional stability is a key personality factor. Our findings also paralleled a recent meta-analysis (Buecker et al., 2020) of personality and loneliness, indicating the pandemic did not change this relationship. Students with high pandemic stress burden independently reported higher levels of loneliness.

M-10 Tsz Yan Liane Kwong (Harvey Burnett)
Exploring the relationship between baking, resilience, and psychological wellbeing
Undergraduate Research Scholar

Purpose: Research has shown engaging in cooking/baking behaviors has been associated with better mental health outcomes. The purpose of our study was to examine how resilience, happiness, self-efficacy, perceived stress and psychological distress are related to better mental health outcomes through baking (i.e., breads, cookies, cakes, etc.) satisfaction. Procedure: Our study utilized a survey design. Data was collected from 246 subjects who were recruited through Amazon Mechanical Turk and were provided a link to the study online through LimeSurvey. After giving informed consent, subjects completed a demographic questionnaire, the 10-item CD-RISC Scale, the Subject Happiness Scale, a 2-items Perceived Stress Scale, the Brief Symptom Inventory-18, the New General Self-Efficacy Scale, and a Benefit of Baking Scale. Subjects who completed the study were compensated \$0.25. Our study received IRB approval (IRB protocol #21-131). Results: Utilizing multiple regression analysis, we found baking satisfaction was significantly predicted by self-efficacy ($\beta = .41, p < .001$), subjective happiness ($\beta = .24, p < .001$), and resilience ($\beta = .20, p < .001$). Implications: Our study suggests that individuals who enjoy engaging in baking activities have higher resilience, strong self-efficacy and are happier. Thus, engaging in baking behaviors may contribute to boosting one's resilience capacity.

M-11 Myrnaliza Tan, Kayla Hope Bruno (Harvey Burnett)
Examination of psychological body armor, parental care, adverse childhood experience, and academic efficacy/apathy among college students
Undergraduate Research Scholar

Purpose: Our study examines how resilience (psychological body armor (PBA)) are related to parental care, adverse childhood experiences (ACEs), and academic efficacy among college students. Procedure: Our study utilizes a survey design. Data will be collected from college students from the University's Behavioral Science Research Subjects Pool and Amazon's Mechanical Turk. Upon giving informed consent, subjects will complete a demographic questionnaire, Psychological Body Armor Scale, Parental Care Scale, Academic Efficacy Scale and the Adverse Childhood Experiences Questionnaire through the Limsurvey online platform. Our study is pending IRB approval (IRB Protocol 21-153). Results: Our study will utilize multiple regression analysis to examine the relationship between academic efficacy and apathy and psychological body armor, parental care and ACEs among college students. We expect that academic efficacy will be predicted by high resilience (PBA) and parental caring scores and lower ACE scores, while higher ACE scores and lower PBA and parental caring scores will predict greater academic apathy. Implications: Understanding how resilience, parental care and ACEs are associated with academic efficacy and apathy among college students may help campus therapists provide appropriate counseling and other support services to help them succeed in a demanding postsecondary environment.

M-12

Kyra Collins (Harvey Burnett)
The connection between coping styles and impulsivity
Undergraduate Research Scholar

Purpose: This study examines the connection between the problem-focused coping style and the emotion-focused coping style to determine which style has a stronger connection to impulsivity. “Our ability to cope adaptively enables us to respond directly to environmental stimuli and adjust our behavior accordingly” (Persaud, 2020). Coping is perceiving the world and adapting moment by moment and excessive impulsivity can be interrupting. **Procedure:** Subjects will be recruited from the university’s research subjects pool. Subjects will complete the COPE Inventory, the Barratt Impulsiveness Scale and a demographic questionnaire through an online platform. This study is in the process of obtaining IRB approved. **Expected Results:** We expect a strong positive correlation between the emotion-focused coping style and impulsivity in comparison with problem-focused coping and impulsivity. **Implications:** College students face a unique amount of stress coming from angles such as academics, personal life, family relations, finances, and future career stress. Impulsivity is not a welcome addition to these existing concerns. If one could easily determine their coping style and its implications, it would create the opportunity to find better personal solutions by being convenient and accessible.

Biochemistry & Molecular Biology

M-13

Hugo Jie Qin, SungBeen Han, MinSeo Kang, *Nathaly Manrique, *Rekha Issac, *Sarah Wolf, Jasmine Cha, Lun Kim (Ryan Hayes, Padma Uppala, Brian YY Wong)
Selective induction of apoptosis via modulation of pro-apoptotic and anti-apoptotic proteins by aqueous extract of (Bryophyllum pinnatum) in HCT-116 colon cancer cells and CCD-841 CoN colon epithelial cells
*J.N. Andrews Honors Scholar and Undergraduate Research Scholar

Bryophyllum pinnatum (BP) has been widely used in tropical regions as traditional medicine. It is reported to have antioxidant, immunomodulatory, anti-diabetic, anti-inflammatory, anti-hypertensive, wound healing, cytotoxic, and anti-tumor promoting activities. Its major secondary metabolites include bufadienolides, flavonoids, triterpenes, and steroids. In this study, the effectiveness of BP in apoptotic modulation of colon cancer HCT-116 cells and normal colon epithelial CCD-841 cells was investigated using green/red/blue fluorescent Apoptosis/Necrosis Detection Kit and the Human Apoptosis Antibody Array - Membrane (43 Targets) test by the Abcam cooperation. Our data have shown that 3-hour treatment with 2.5 mg aqueous extract of BP induced a statistically significant percentage of apoptosis in HCT-116; while it was not noticeable in CCD-841 CoN. Modulation of various apoptosis markers production such as up-regulation of pro-apoptotic proteins Bad, Bax, BID, BIM, C3, C8, CD40L, cytoC, HTRA, IGFBP-6, p53, and SMAC; and down-regulation of anti-apoptotic proteins HSP27, IGFBP-1, TRAILR-3, and TRAILR-4 was observed in HCT-116. There was no significant induction of pro-apoptotic proteins in CCD-841 CoN. These results suggested that BP contains phytochemicals that selectively induce apoptosis in HCT-116 cancer cells by regulating these protein markers while not significantly affecting the normal CCD-841 CoN colon epithelial cells.

M-14

Jasmine Cha, Lun Kim, Hugo Jie Qin, SungBeen Han, MinSeo Kang, *Nathaly Manrique,

*Rekha Issac, and *Sarah Wolf, (Ryan Hayes, Padma Uppala, Brian YY Wong)

Induction of apoptosis via modulation of pro-apoptotic and anti-apoptotic proteins in glioblastoma U87-MG cancer cells by aqueous extract of Chinese medicinal herb (Oldenlandia diffusa)

*J.N. Andrews Honors Scholar and Undergraduate Research Scholar

Oldenlandia diffusa (OD) has been used in Traditional Chinese Medicine for treating cancer of the lung, liver, colon, and glioblastoma. OD and another herb *Scutellaria barbata* are included in most of the herbal cancer treatment formulas in China and Taiwan hospitals. Glioblastoma is an aggressive and lethal tumor of the brain with few treatment options. In this study, the effectiveness of OD in apoptotic modulation of U87-MG was investigated using green/red/blue fluorescent Apoptosis/Necrosis Detection Kit and the Human Apoptosis Antibody Array - Membrane (43 Targets) test by the Abcam cooperation. Our data have shown that 3-hour treatment with 2.5 mg aqueous extract of OD induced a statistically significant percentage of apoptosis in U87-MG cells; Modulation of various apoptotic proteins such as up-regulation of Bad, Bax, BID, BIM, C3, C8, cytoC, p27, p53, and SMAC; and down-regulation of Bcl-2, Fas, HSP27, and p21 was observed in U87-MG cells. These results suggest that OD contains phytochemicals that induce apoptosis in glioblastoma U87-MG cancer cells via the modulation of these pro-apoptotic and anti-apoptotic proteins. Further study of the specific effects of modulation effects of phytochemicals of OD on apoptosis is warranted to reveal its potential chemopreventive and therapeutic properties against glioblastoma.

M-15

Joshua Rotich (Denise Smith & Desmond Murray)

Novel temozolomide-NSAIDs compounds and mixtures as potential antiglioblastoma Agents

Undergraduate Research Scholars

Glioblastoma multiforme (GBM) is a brain tumor in humans. It is the most common, the most aggressive and the one with the poorest prognosis. Currently, the existing treatment options have had limited success in increasing the overall survival. One of the main challenges is the blood brain barrier that limits concentration of drugs passing through to reach the target site. Treatment of GBM often involves surgical removal of the tumor followed by temozolomide (TMZ) chemotherapy and radiotherapy. Lab studies have been done with an aim to investigate if TMZ potency can be increased by combining it with other pharmacologic agents e.g. chloroquine. Other lab studies and clinical trials found that a combination of TMZ and epigallocatechin gallate (EGCG) compound from green tea was more effective against brain tumors compared to when TMZ alone was used. Nonsteroidal anti-inflammatory drugs (NSAIDs) are drugs that decrease pain, fever, inflammations and prevent blood clots. Research has shown that NSAIDs like Aspirin and Diclofenac has anticancer effects. In my research, I have combined TMZ and 6 different NSAIDs and determined whether the combinations increased TMZ potency against Glioblastoma cells.

Chemistry

M-16

Daniel Fajardo (Lisa Ahlberg)
Synthesis of isoxazoline as a PAM activator
Undergraduate Research Scholar

The progression of Alzheimer's disease (AD) is correlated to the degenerative activation of muscarinic acetylcholine receptors (mAChR) located in the brain. Activation of an M1 receptor (G protein) with positive allosteric modulators (PAM) have shown to bind to the allosteric pocket and slow the degenerative process of AD with minimal intrinsic effects. Structural motifs of potent PAM activity and weak agonism proposed a synthesis of a novel isoxazoline compound, incorporating a 1,3-dipolar cycloaddition. Structural characteristics of isoxazoline contain a top, core, and pendant motifs. Initial core motif experiments were successful by detecting it through Gas Chromatography Mass Spectroscopy (GCMS). But, the addition of a top or pendant motifs for that route proved to be difficult. We changed our strategy to synthesize the pendant first, followed by the core and top motif attachment. We observed that the reactions to form the pendant motif have yet provided a substantive not yield and further experimentation is required.

M-17

Hannah Castillo (Ryan T. Hayes)
Copper ion sequestration by PAMAM dendrimers in tap water
J.N. Andrews Honors Scholar and Undergraduate Research Scholar

PAMAM dendrimers are highly branched nanomaterials that have been shown to capture Copper(II) ions at high efficiency when compared to extraction of other transition metals, nickel(II) and cobalt(II) from aqueous solutions. Our research project focuses on the sequestration of copper(II) ions from tap water which presents multiple interfering ions such as calcium and magnesium. G2-octyl-PAMAM dendrimers are not soluble in water which provides a way of removing the Copper (II) ions from tap water after solutions of tap water and dendrimers in dichloromethane have been agitated together and then allowed to separate into layers. Using an ICP-OES analysis, metal ion concentrations in the dendrimer-dichloromethane layer are quantitated and compared to previous experiments. Previous research in our group has shown that seven Copper (II) ions are captured per G2-octyl-PAMAM dendrimer, and we will report how interfering ions change this value. Sequestering copper (II) ions with polymer nanoparticle technology is important to show how highly branched nanomaterials can serve as selective heavy metal extractors. Dendrimers could be valuable for selectively remediating copper contaminated water or turned into materials that selectively detect copper(II) ions.

M-18

Emma Suvacarov (Ryan T. Hayes)
Heavy metal analysis in canine hair collected in the Benton Harbor, MI area
Undergraduate Research Scholar

Non-communicable diseases such as stroke, heart diseases, cancers, and chronic respiratory diseases amount to nearly two-thirds of the total deaths caused by an unhealthy environment. Michigan ranks 25th out of 50 states nationwide in producing total Toxic Inventory releases per square mile. Benton Harbor, MI has been suffering through a lead pipe issue that has exposed city residents to unsafe levels of lead in their drinking water. Human hair has been previously identified as a valuable tool to assess heavy ingestion over longer periods. Animal hair has also been studied and heavy metals correlated to heavy metal exposure that could have come from plants or contaminated water sources. Animals could provide a role as sentinels indicating environmental exposure to toxic heavy metals such as lead, cadmium, or arsenic. Our research uses the ICP-OES analysis of lead, arsenic, and cadmium in canine hair from the Benton Harbor area to determine the presence and quantity of these three heavy metals. Our presentation will provide the initial results from the collection, processing, and analysis of canine hair collected in the Benton Harbor, MI area.

Health & Human Services

M-19 Anthony Daniels (Jean Cadet)
Lifestyle factors and non-alcoholic fatty liver disease
Undergraduate Research Scholar

Background: Non-alcoholic fatty liver disease (NAFLD) is the leading cause of chronic and end-stage liver disease. Specific dietary components, including intake of total calories, added sugars and saturated fats, may increase the risk for NAFLD. The purpose of this study was to determine the association between lifestyle factors, physical activity, intake of specific dietary components and NAFLD. Methods: This is a case-control study where 34 subjects seen in a single specialty clinic in Fayetteville, NC, between October 2015 to January 2020 with NAFLD (cases) and 76 subjects from the same clinic who were referred for a screening colonoscopy were recruited. The Dietary Health Questionnaire (DHQ), the International Physical Activity Questionnaire (IPAQ) and the Alcohol Use Disorders Identification Test (AUDIT) were used to collect the study data. Results: 24 cases and 60 controls completed the 3 questionnaires. Increased added sugar increased the likelihood of the diagnosis of NAFLD, odds-ratio 1.008 (95% CI: 1.000, 1.015). Earning a college degree decreased the likelihood of having NAFLD, odds-ratio .328 (95% CI: .127, .829). Conclusion: A diet high in added sugars and not attaining a college degree are factors that increase the likelihood of developing NAFLD. Further research is needed to explore this possibility.

Language & Literature

M-20 Taylor Uphus (L. Monique Pittman)
A man not a monster: Reimagining disability in (Hollow Crown's Richard III)
J.N. Andrews Honors Scholar and Undergraduate Research Scholar

Traditional portrayals of William Shakespeare's *Richard III* (1592) in film interpret Richard's physical disability (his crookback and withered arm) as an outward reflection of his moral evil. Such approaches to performance fail to fully acknowledge the pain and psychological trauma Shakespeare's titular character experiences as a disabled individual. In recent years, disabilities studies scholars have called for a reconsideration of how Richard's physical deformity has historically been associated with immorality. Unlike previous *Richard III* films, the BBC & *Hollow Crown: Richard III* (2016), directed by Dominic Cooke, takes a more personal approach into the mind and world of Richard, highlighting his mental abuse and trauma as background to Richard's villainy. Through various film techniques such as lighting, props, shot angles, and editing, Cooke takes his audience into the mind and world of *Richard III*, uncovering the psychological and emotional darkness he inhabits. Therefore, while the film does not shy away from holding Richard accountable for his actions, its more empathic approach to portraying Richard contests the one-dimensional stage and film representation of him as a conniving monster. Ultimately, this film presents *Richard III* to critique society's treatment of disabled individuals and to provide a psychologically complex approach to Richard.

Mathematics

M-21 Alexander Navarro (Yun Oh)
Exploring 2nd natural mates and families of primitive curves
J.N. Andrews Honors Scholar and Undergraduate Research Scholar

The natural mate of a unit speed curve is generated by letting the principal normal vector of the curve be the tangent vector of the new curve. Expanding on Deshmukh et al., we demonstrate that given a Frenet curve, the primitive curve of which it is the natural mate is not uniquely determined, and thus, that there exists a family of curves which all have the same natural mate. We then explore the 2nd natural mate of a curve, that is, the natural mate of its natural mate, demonstrating a simple relationship between its curvature and torsion. We then prove several smaller theorems regarding how constraints on the primitive, 1st natural mate, and 2nd natural mate may constrain the other curves.

M-22 Jeannelle Green, Gabriel Palacios, Moises Reyes, and Noe Reyes (Anthony Bosman)
 The delta-unlinking number
 Undergraduate Research Scholars

A link is an embedding of circles into 3-dimensional space; its components may be knotted. It is known that algebraically split links (links with vanishing pairwise linking number) can be transformed into the trivial link by a series of local moves on the link diagram called delta-moves. We define the delta-unlinking number to be the minimum number of such moves needed. This generalizes the notion of delta-unlinking number, defined to be the minimum number of delta-moves needed to move a single knot into the unknot. While the delta-unlinking number has been well-studied and calculated for prime knots, no prior such analysis has been conducted for the delta-unlinking number. We determine upper bounds for the delta-unlinking number by searching for the shortest delta-pathways to the trivial link. Moreover, we prove two relationships between the delta-unlinking number and classical link invariants: in particular, that it is bounded below by half the unlinking number and that it is bounded below by the sum of the delta unlinking numbers for each component.

M-23 Moises Reyes, Jeannelle Green, Gabriel Palacios, and Noe Reyes (Anthony Bosman)
 The delta-Gordian distance for links
 Undergraduate Research Scholar

We continue the study of the delta-unlinking number, defined to be the minimum number of moves needed to transform a link into the unlink, extending it to study the delta-Gordian distance between any two links. We show that the delta-Gordian distance is bounded below by the difference between the 4-genus of the links. It follows that the delta-unlinking number is bounded below by 4-genus. Moreover, we show that the delta-Gordian distance is mod 2 equivalent to the sum of the Arf invariants of the links, which gives that the delta-unlinking number is mod 2 equivalent to the Arf invariant. These relationships allow us to determine the precise value of the delta-unlinking number for algebraically split prime links with up to 9 crossings as well as determine the 4-genus for most of these links.

Zoology

M-24 Gloria Oh (Daniel Gonzalez-Socoloske)
 Utilizing citizen science to determine marine mammal diversity in the Bay Islands of Honduras
 J.N. Andrews Honors Scholar and Undergraduate Research Scholar

Accurately identifying the species inhabiting a country is crucial to preserving its biological diversity. Honduras is a biodiverse country; however, many taxonomic groups lack a comprehensive list of extant species, including marine mammals. Data on marine mammal species can be difficult to collect due to limited resources, few specialists, and the vast areas they inhabit. However, areas like the Bay Islands of Honduras (BIH), that are popular tourist destinations, provide ideal locations to utilize citizen scientists to assist in data collection. Thus, this research will compile published and unpublished data of the marine mammals in BIH, including grey literature, museum specimens, and citizen scientists' reports regarding marine mammals sighted near the BIH. Citizen scientists include, but are not limited to, tourists, photographers, dive shop employees, and locals. We will reach out to them by direct contact, social media, or online surveys. Collected data will be organized using a summary table and a geographic map that indicates the sighting locations. By utilizing citizen science, we expect to determine the current marine mammal species diversity in the BIH. In doing so, we hope to lay the foundational work regarding marine mammals distribution and their diversity in the BIH.

M-25

Kieran Taylor & Geo Kim (Daniel Gonzalez-Socoloske)

Preliminary findings regarding mammals collected during the Andrews University biology expeditions to Peru
Undergraduate Research Scholars

The department of Biology at Andrews University arranged three expeditions to central Peru in 1964, 1965, and 1968. They collected approximately 1800 mammal specimens during their first expedition and prepared these as voucher specimens/skins with associated skulls. Mammal collections for the 1965 and 1968 expeditions were not as vast, numbering 167 and 94 specimens, respectively. Combined, for all three expeditions, the vast majority (approximately 80%) of collected mammals were chiropterans and rodents. The rest (approximately 20%) comprise of members of Artiodactyla, Carnivora, Didelphimorphia, Pilosa, and Primates. Currently, the Andrews University Museum of Natural History (AUMNH) houses approximately 315 of these specimens. Comparing the original specimen lists from 1965 and 1968 with the specimens housed in the AUMNH, we accounted for 98% of the collected specimens. The same could not be done for the 1964 trip as we lack the original specimen lists. Currently, we have 54 specimens in the AUMNH from 1964 and we know of an additional 1867 in the American Museum of Natural History (AMNH) and 354 in the United States National Museum (USNM). Further analysis of the mammals collected should hopefully shed light on the mammal diversity present in the habitats of central Peru, with possible important conservation implications.

M-26

Lillyanna Widdicombe, (Benjamin Navia)

Evaluation of phonotaxis in crickets treated with a PKC inhibitor H7
Undergraduate Research Scholars

Crickets communicate acoustically and as such use auditory stimulus to locate potential mates, making them a good model to study neurobiological basis of behavior. Research indicates that female crickets *Acheta Domesticus* respond preferentially to model calls with syllable periods ranging between 50-70 ms (the range for the call of the male). Young crickets have been shown to respond more selectively to attractive calls than older crickets. The cause of this difference is the varying amounts of juvenile hormone III (JH III) present in crickets. Data shows that JHIII affects the auditory circuitry and specifically the response of the L3 prothoracic auditory neuron. High levels of JHIII have been shown to cause increased selectivity. The literature suggests that JHIII works through a protein kinase C second messenger system to influence the response of the L3 neuron. H7 is a protein kinase C inhibitor that is thought to disrupt the intracellular processing system of L3. It is hypothesized that injection of H7 into the prothoracic ganglion will alter the phonotactic selectivity of the cricket by blocking the signaling pathway used by JHIII. This will disrupt the response of the L3 neuron causing the cricket to fail to discriminate attractive calls.

M-27

Jessica Rim (Benjamin Navia)

*Does female exposure to males in crickets *Acheta domesticus* affect their phonotactic ability and threshold?*
J.N. Andrews Honors Scholar and Undergraduate Research Scholar

The phonotactic behavior of female cricket *Acheta domesticus* as observed in the lab, has been shown to vary among individuals. In response to computer-generated auditory stimuli, some females are finely tuned and attracted to calls with syllable periods which match those of the natural calls of the males (50 – 70 ms). Other females respond phonotactically to calls with a wider range of syllable periods (30 – 90 ms) including or not the most attractive range. Therefore, lacking the ability to discriminate between attractive and unattractive calls. Factors that contribute to this variability include age, temperature and levels of juvenile hormone III. When females are exposed to males, without allowing to mate, their ability to discriminate attractive calls is reduced. This implies factors other than mating, alter the females' phonotactic behavior. The effect of these factors in identified auditory neurons such as the L3, continues to be evaluated. The response of L3 in females with the ability to discriminate attractive calls also varies. Implications of results of the study and proposed mechanism are discussed.

M-28 Lyle Goulbourne (Daniel Gonzalez-Socoloske)
Interspecific and ontogenic differences in the molar occlusal surfaces of manatees (Trichechus)
J.N. Andrews Honors Scholar and Undergraduate Research Scholar

Manatees combat their abrasive herbaceous diet by continuously replacing their teeth along a horizontal axis, with new teeth added at the posterior end and older teeth falling out at the anterior end. While much is known regarding limitless horizontal replacement of manatee teeth, the morphology, topography, and enamel structure of the teeth have not been formally described, nor have developmental and interspecific differences in relative tooth size been described. To describe the teeth, I will image and characterize the teeth with photographs and use a microCT to produce 3D images and standardized measurements of the teeth. I will also determine whether teeth increase in size as manatees age by measuring the occlusal areas of the teeth belonging to a wide range of manatee skulls and comparing this to the skull size of each manatee. The relative tooth size results determined that relative tooth size increases with age. Results from the microCT may show West Indian manatees have a thinner enamel layer, explaining their greater wear compared to other species. This research will add to our understanding of manatee feeding ecology, which may allow us to better understand manatee diet and health and help provide improved habitats.

M-29 Jewel Murray (Benjamin Navia)
*Reassessing the parameters of phonotaxis in female cricket *Acheta domestica**
J.N. Andrews Honors Scholar and Undergraduate Research Scholar

To study phonotaxis in crickets a trackball system has been traditionally used, which consists of a spherical, air supported styrofoam ball placed in a soundproof container in which crickets are tethered to. Two computer mice detect its movement. A speaker is at one end of the container, and it is connected to a computer which generates calls with pre-set parameters. Once a cricket is attached to the trackball system, it can freely navigate toward the source of the sound, while the styrofoam ball remains stationary. This apparatus has been used to measure the walking distance and angular orientation. Traditionally, when evaluating phonotaxis, two parameters have been used to determine a positive response; i) the distance travelled toward the source of the sound has to be twice that of the distance traveled away from the sound and ii) the path of travel towards the sound is within -60° / $+60^\circ$ angle. These parameters, established many years ago, have been widely accepted. The latter parameter, however, may not accurately describe the quality of phonotaxis of a given animal. This research assesses the angular orientation of phonotaxis in female crickets by further exploring the significance of the -60° / $+60^\circ$ parameter. It looks at the variation within that parameter and what it could elucidate in terms of the quality of tracking.

DECEMBER 2021 HONORS THESIS POSTER PRESENTATIONS

D-01 Michael Lee (Rodney Summerscales, Computing)
Application of Approximate Q-Learning to Simplified Macromanagement in StarCraft II
J.N. Andrews Honors Scholar

Contemporary research in Machine Learning in regards to StarCraft II has recently utilized the power of both neural networks and reinforcement learning in the form of “Deep Reinforcement Learning,” and has risen greatly in popularity. Unfortunately, the use of neural networks comes with great costs in resources and requires expensive hardware to run in a manageable amount of time. Instead, we propose the use of a modified form Approximate Q-learning and forego the use of neural networks to explore the performance of non-neural network strategies in the StarCraft II environment in regards to outpacing an enemy in simplified macromanagement gameplay

D-02 Marvin Schatzschneider (Alan Kirkpatrick and Lucile Sabas, School of Business Administration)
The Positive Relationship Between Stock Price of Technology Firms and ROA, EBITDA margin, Bond ratings, and Current Ratio
J.N. Andrews Honors Scholar

This research updates expanding literature in the financial field on the relationship between stock price and financial performance indicators – return on equity, debt to assets, net margin, return on assets, EBITDA margin, bond rating, and current ratio. Specifically, stock prices of year-end 2018 were examined to 2018 year-end financial data. The hypothesis developed is that financial performance indicators validate the stock price. Therefore, using an (OLS) multivariate regression analysis the explanatory variables were tested for their significance to price. Return on equity, debt to assets, net margin, and current ratio proved to be statistically significant.

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