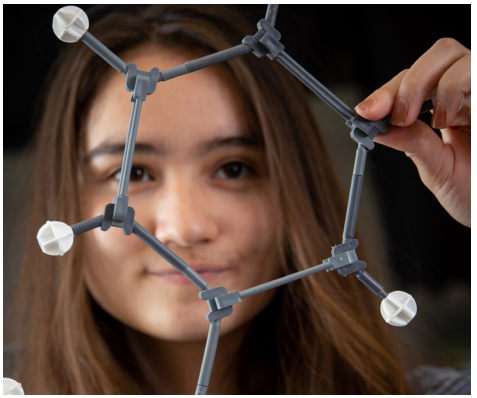
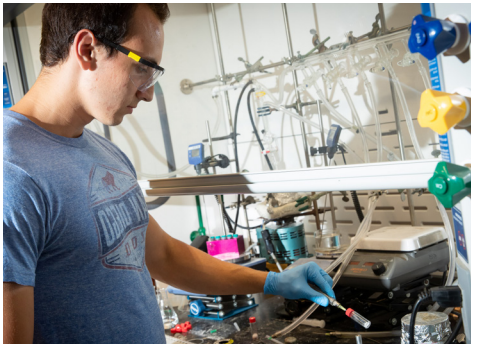
WESTMONT

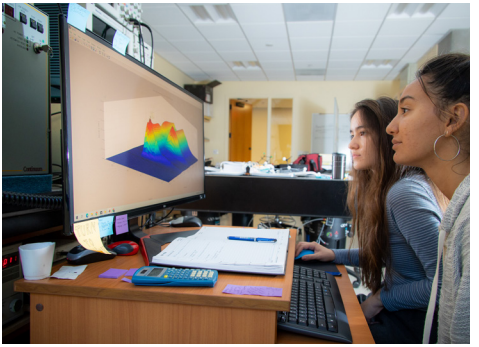
2021 CELEBRATION OF SUMMER RESEARCH

September 24, 3:30-5:00pm

Winter Hall 3rd Floor Atrium







RESEARCH PROJECT SUMMARIES

Determining the Effect of Aggregated Tau R3 Fibrils and Varying Concentrations of Covid Spike-1 and Spike-2 Proteins on the Signaling Activity of Cultured Mouse Neurons Through the Use of a Micro-Electrode Assay

Joseph Hemry, John Baker (Supervisor: Yi-Fan Lu, Biology)

It has been well documented through research that aggregation (misfolding) of Tau fibrils are associated biomarkers in the development of Alzheimer's disease. Increased concentrations of these fibrils have been shown to be correlated with cognitive decline. The spike protein of COVID has been found to bind to specific sites on certain types of nervous cells. This creates a potential route for infection and, with this infection, an opportunity for damage to be done. The goal of this study was to determine the effect of the tau fibrils and covid spike proteins on the signaling activity of culture mouse neurons through the use of a micro-electrode assay. A computational analysis tool in Rstudio, developed by previous researcher Grant Thomas, was used to analyze the electrical data recorded by the MEA throughout the experiment. The cultures were exposed to the aggregated fibrils on a dose dependent curve, and the results demonstrated a negative correlation between the decrease in neuronal signaling and an increase in the dose of fibril introduced to the culture.

Firewise Plants for a Flammable World

Laura Dagg, Isabelle Hugoniot (Supervisor: Laura Schultheis, Biology)

Our project focused on measuring and analyzing structural and functional traits that contribute to the flammability of 25 Santa Barbara native plant species, which were chosen for their appeal to homeowners and availability in stores. Samples and measurements were taken at the Santa Barbara Botanical Gardens and UCSB. On-site measurements consisted of plant height, width, and amount of branching. Samples were taken off-site to determine moisture content of leaves, leaf area, and leaf length. This research was conducted in collaboration with the UCSB Firewise Plant Project. The goal is to develop a running list of species' flammability, encouraging homeowners to plant "firewise" plants, and reducing the spread of wildfires in semi-urban landscapes.

In addition, because there is no systematized way of measuring plant flammability, an on-going goal is to formulate a standardized method to measure flammability.

Palms and Oaks Predict Urban Acorn Woodpecker Occupancy Across the California Coast

Caleb Courson, Theo Patterson, Sophia McRae (Supervisor: Amanda Sparkman, Biology)

As our world becomes increasingly developed and native habitats are lost, understanding how urbanization impacts animal behavior is critical. Acorn Woodpeckers are a widespread species across the western United States that can be found in both wild and urban habitats, but little is known about what habitat characteristics they require to survive in urban areas. To determine what factors affect urban woodpecker occupancy the most, we conducted surveys in seven cities along the California coast to test for differences in woodpecker occupancy in relation to several habitat characteristics. We found that woodpeckers were more likely to be present with more Canary Island palms, fan palms, oaks, and lower imperviousness. These findings create a foundation for future testable hypotheses regarding the importance of certain habitat components for woodpecker survival and reproduction, as well as explaining why there are many more Acorn Woodpeckers in Santa Barbara compared to other central coast cities.

The Light at the End of the Cavity: Changes in Acorn Woodpecker Cavity Direction in Response to Light Pollution

Sophia McRae, Theo Patterson, Caleb Courson (Supervisor: Amanda Sparkman, Biology)

Urbanization can have an array of effects on wildlife behavior. Light pollution is among the urban disturbances to which wildlife must adapt. Acorn Woodpeckers are a cavity-roosting species that have been well-studied in the wild, but little is known regarding their response to light pollution. In the wild, they construct cavities with east-facing tendencies. We predicted that urban woodpeckers would be less likely to have east-facing cavities if light levels were a factor in cavity construction. We observed 36 Acorn Woodpecker cavities, collecting data on cardinal direction, immediate light level around the cavity tree, and general light level in the area via satellite measures on a 500m scale. We found that in higher levels of general nighttime light, woodpeckers used more south-facing cavities,

and in detectable immediate artificial light, woodpeckers used more west-facing cavities. We hypothesize that these differences are related to altered sun-tracking behavior, cavity temperature regulation, and/or sleeping patterns in artificially-lit areas.

Diabetes: A Serious Problem

Ethan Walker (Supervisor: Kristi Lazar Cantrell, Chemistry), Westmont College; Aleksandra Antevska, Thanh Do, University of Tennesee – Knoxville

Insulin is a peptide involved in regulating blood glucose levels. While humans only have one type of insulin, mice have two. Previous studies have shown that insulin 2 regulates mouse blood glucose levels similarly to human insulin, but the function of insulin 1 is not well understood. To better understand the function of these peptides, segments of both peptides were synthesized (Ins1 B 9-23, Ins2 B 9-23) using Fmoc chemistry, purified using high performance liquid chromatography (HPLC), and identified using electrospray ionization mass spectrometry (ESI-MS). The peptides were allowed to aggregate in conditions emulating human physiology. Images collected using transmission electron microscopy (TEM) indicated that both peptides formed fibrils. Future studies will include both testing if circular dichroism (CD) measures any peptide structure prior to aggregation and observing how the peptides aggregate over time using CD, Thioflavin T fluorescence, and ion-mobility mass spectrometry studies with computational modeling.

Building Molecular Legos - How Cyanoplatinates and Dirhodium Paddlewheels Can Form Square Networks

William J. Grubbs (Supervisor: Stephen M. Contakes, Chemistry)

This project seeks to construct chain and square complexes using nucleophilic cyanometallates and electrophilic dirhodium paddlewheel derivatives, specifically with cyanoplatinate and dirhodium acetate, dirhodium trichloroacetic acid or dirhodium trifluoroacetic acid. The research has primarily used 2:1 ratios of dirhodium complex to cyanoplatinate in different solvent environments in order to create and study the creation of new colors beyond pink, with the expectation of the creation of square complexes due to the stoichiometric ratio.

Zig-Zag Swag: Synthesis and Structural Characterization of a 1D-metal Cyanide Coordination Polymer

Siena Verdon, Francesca Montemurro, Luke Perrin, (Supervisor: Stephen M. Contakes, Chemistry), Westmont College; Guang Wu, University of California – Santa Barbara

As part of our efforts to prepare new cyanometallate coordination polymers and polyhedra, we developed a high-yield synthesis of 4,7-dicarboxyphenanthrolinedicyanidoplatinium(II), determined conditions under which that complex forms stable adducts with linear ditopic Lewis acids, successfully prepared a 1D-coordination polymer using its tetraethylammonium salt, and characterized that polymer's structure using IR and NMR spectroscopy and single crystal X-ray crystallography. The structure consists of zig-zag chains of cyanide-linked metal centers in which the anionic dicarboxyphenanthroline ligands on adjacent chains are linked into a 2D network via hydrogen bonds to intervening water molecules. This gave an open structure containing pores likely filled with disordered molecules of the solvent, acetone. Because these molecules are easily lost, crystals of the complex are metastable and crack readily in the absence of its mother liquor.

Characterizing Methemoglobin Absorption Using Evanescent-Wave Cavity Ringdown Spectroscopy

Jessica Wright, Kaylee Ivie (Supervisor: Michael A. Everest, Chemistry)

Cavity-Ringdown Spectroscopy (CRDS) is an ultra-sensitive method used for measuring the absorption of ultraviolet or visible light. We apply this method of spectroscopy to the study of interfacial chemistry, in particular the adsorption of a molecule suspended in a liquid onto a glass prism. The molecule of focus in this adsorption reaction is hemoglobin. Hemoglobin is a naturally found protein in animal blood and is known for its ability to carry oxygen throughout the body. In interfacial chemistry, the reaction of interest consists of a molecule sticking to a surface. A variety of conditions can be altered to observe the effects they have on the reaction. This can include, but is not limited to, the pH and ionic strength of the solution, concentration and pressure, the characteristics of the adsorbate, as well as the characteristics of the adsorbent. For this experimental period, the identity of the adsorbate, hemoglobin, was held constant.

Keeping an Ion Oxygen: A Computational Study of Oxenium Intermediates

John Corbett (Supervisor: Brandon E. Haines, Chemistry)

Oxenium ions, with a general structure $R\text{-}O^{+}$, are typically very unstable because they place a +1 formal charge on the electronegative element oxygen. Strategies to stabilize oxenium ions are of interest because of their potential as a source of electrophilic oxygen. Our approach is to position a Lewis-basic group in close proximity to the electron-deficient oxygen to stabilize it through intramolecular coordination. We used density functional theory (DFT) calculations to investigate the effect of 62 coordinating groups on the kinetics and thermodynamics of the formation of the O-coordinated oxenium ion from a pyridinium precursor. We found that phosphorus, sulfur, and sp^2 hybridized nitrogen stabilize the oxenium ion the most. We also found that in general an S_N1 mechanism is favored for oxenium ion formation but that the nature of the transition state depends highly on the size of the ring formed upon coordination.

The C-H Split: Whose Side Will You Choose? A Computational Study of Organic C-H Insertion Reactions and Computational Techniques

Rachel M. Lorson, Riley Johnson, John Corbett, Winston C. Gee, (Supervisor: Brandon E. Haines, Chemistry)

Cationic transition metal complexes are commonly used in chemical synthesis to activate C-C triple bonds (alkynes) toward nucleophilic attack. However, there is one example of cationic gold facilitating C–H insertion in a cyclooctyne substrate indicating the cationic gold-alkyne complex may have considerable vinyl cation character. We, therefore, undertook a computational study using density functional theory (DFT) calculations to study the mechanism and controlling factors of C–H insertion by cationic gold-alkyne complexes. Starting with an IPrAu-cyclooctyne complex the computed Gibbs energy of activation is $\Delta G^{\ddagger}$ is XX kcal mol^{-1}, indicating agreement with experimental data. Other factors examined include the effect of substrate substitution and ligands. In addition, significant progress was made in the creation of computer scripts to automate portions of computational workflow. New bash scripts called “sub” (submit), “mod” (modify), and “gen,” dramatically increase the efficiency in the preparation, manipulation, and submission of files for the supercomputer.

Bears, Beets, Boronic Esters

Alison Thomas, Braden Chaffin, Marliss Neal (Supervisor: Amanda Silberstein, Chemistry)

Boronic esters are molecules used to synthesize carbon-carbon bonds by means of the highly effective Suzuki-Miyaura cross-coupling reaction. Current methods for making boronic esters, while effective, utilize an unstable and difficult to synthesize aryl halide, have low functional group tolerance, scalability issues, and/or utilize an expensive palladium catalyst. We set out to develop a method for making a safer, cheaper, and environmentally friendlier boronic ester. This was accomplished by using the stable, environmentally friendly sulfamate instead of the aryl halide and a less toxic, more cost-effective nickel catalyst. Our method showed significant yields for electron-deficient and fused products. We demonstrated utility by synthesizing the commercial NSAID drug diflunisal in a 16% yield.

Meta-Arylated Ring by Spring

Marliss Neal, Braden Chaffin, Alison Thomas (Supervisor: Amanda Silberstein, Chemistry)

Aryl-aryl bonds are an extremely useful part of modern chemistry, providing an integral part of most drug manufacturing. Furthermore, the position at which these bonds exist is important in terms of the functionality of these compounds. However, current methods almost always limit these bonds' presence to the ortho and para positions of the ring. Meta-arylation has long provided a challenge for chemists, but its promising applications drive the study. Although a couple precedents for this type of installation have come to light in recent years, the directing groups used in these reactions are difficult to install and lack synthetic versatility. Our novel method utilizes oxygen-based directing groups to bring about meta-arylation. This has been completed using a copper catalyst and variety of directing groups, resulting in a 54% optimized yield. Another approach, using a palladium catalyst, has seen progress in the initial steps toward meta-arylation.

Programing for a Purpose

Jonathan Reitinger (Supervisor: Adam D. Goodworth, Kinesiology); Sandra Saavedra, University of Hartford

Children with moderate-to-severe cerebral palsy (CP) have major deficits in their ability to sit independently. No postural control

intervention has been consistently documented for children with moderate-to-severe CP. My goal was to examine the range of responses to one particular intervention and evaluate the association between clinical changes and laboratory based kinematic changes. I analyzed previously collected 3D kinematic data of children with CP using custom MATLAB programming. Data came from an intervention study in which training devices provided external trunk support at levels that were challenging but feasible for training. The parents worked with the child in the device 20-30 minutes 5-6 days per week, for about 6 to 9 months. More kinematic improvements were found in subjects with greater clinical improvements; and conversely, more kinematic metrics got worse in subjects with less clinical improvement. Improvements in head postural control were more prevalent than the trunk.

Shaken, Not Stirred, and a Little Perturbed: Human Balance Control and Linear Perturbation

Jared Lush, Mercy Milliken (Supervisor: Adam D. Goodworth, Kinesiology)

Human falls are an important societal health concern. When assessing someone's balance, clinicians and researchers have found it very helpful to challenge one's balance by adding a perturbation while someone is standing or walking. Perturbations also bring to light the patterns and complexity of human balance control. Therefore, our research goal was to create a machine that generates controlled destabilizing motion while walking or standing. The building of our linear perturbation platform involved the creation of CAD models as well as the coordination of platform construction with programmable software systems in order to provide real-time data acquisition for biofeedback and to control platform motion. While the platform was built with balance perturbation in mind, it provides ample opportunity for a variety of applications. Possibilities include the testing of subjects with microprocessor knees, cerebral palsy, and athletes, as well as simulation of the general kinematics during low-speed collisions or slow-braking scenarios.

Mental Strength Training Improves Running Performance While Fatigued

Karly L. Kingsley (Supervisor: Timothy A. VanHaitsma, Kinesiology)

Mental training improves athletic performance, however less is known when athletes are fatigued. This study examines the physiological changes that occur with mental training. Fourteen participants completed the study, 6 in the control group (CON) and 8 in the mental strength group (MS). To induce fatigue, participants ran 90 minutes around a track followed immediately by a 1.5-mile time trial (TT) on the treadmill. Both groups repeated this procedure after two weeks, with MS watching 3 five-minute videos for the two weeks. Subjective and objective data, including oxygen consumption, heart rate, and self-reported pain, fatigue, and rate of perceived exertion (RPE) were collected. Participants in MS improved performance in the second TT, running the 1.5-mile TT faster while decreasing heart and respiratory rates and decreasing RPE and reported levels of fatigue. These results suggest that mental strength training may decrease sympathetic activity, improving athletic performance.

Sifting Through White Noise: How to Algorithmically Break Down Images

Wesley Brown (Supervisor: Maryke van der Walt, Mathematics & Computer Science)

Hoping to more accurately separate signal interference from two dimensional images, Dr. Maryke van der Walt and Wesley Brown are exploring the Empirical Mode Decomposition algorithm. EMD describes a method by which wave signals can be broken down into component elements. This summer, Dr. van der Walt and Wesley programmed and tested multiple variations of the EMD algorithm. EMD is currently one of the standard methods for separating images. The method can be implemented across a range of imaging software. Improved EMD could potentially improve the accuracy of imaging technology used in hospitals and other settings. In his presentation, Wesley will describe how EMD functions, share some examples of images and waves that can be separated using this method, and describe the end goals of the project.

Investigating the High-Spin Decay of 71Ge

Kirsten Potts, (Supervisor: Robert Haring-Kaye, Physics & Engineering), Westmont College ; Kamali Jones, Khanh Le, Ohio Wesleyan University; Joachim Dōring, Bundesamt für Strahlenschutz; Brittany Abromeit, Rutger Dungan, Rebeka Lubna, Sam Tabor, Pei-Luan Tai, Vandana Tripathi, Justin VonMoss, Florida State University; Sylvia Morrow, Houghton College

Much like the electrons in atoms, the constituents of atomic nuclei (protons and neutrons, together called nucleons) occupy discrete orbitals grouped into "shells." These nucleons can contribute to the overall energy and angular momentum of the nucleus by either individually crossing between orbitals or by moving coherently with many nucleons (such as through collective rotations). The goal of this research project was to deduce whether the energy released by an unstable isotope of germanium (called germanium-71, or ^{71}Ge for short) was primarily a result of the individual or collective motion of nucleons. This is an important aspect of understanding how nucleons arrange themselves in nuclei to produce a variety of shapes and structures. In this study, ^{71}Ge was produced at high energy and angular momentum from a fusion reaction performed at a linear accelerator, and its energy emissions were pieced together like a jigsaw puzzle to form a level scheme, a map of the observed discrete energy states and the transitions between them. The resulting patterns that form allow us to make inferences about the structure of the nucleus. This summer, 35 new transitions and 20 new levels were found in the ^{71}Ge nucleus, and it was determined that the nucleons act both individually and collectively.

There's a Highly-Deformed Gamma Ray Decay Structure in my Boot! In my Arsenic-73 Nuclear Structure That Is.

Danny Rubin, (Supervisor: Robert Haring-Kaye, Physics & Engineering), Westmont College; Savannah Gowen, Mount Holyoke College; Kamali Jones, Khanh Le, Ohio Wesleyan University; Joachim Dōring, Bundesamt für Strahlenschutz; Brittany Abromeit, Rutger Dungan, Rebeka Lubna, Sam Tabor, Pei-Luan Tai, Vandana Tripathi, Justin VonMoss, Florida State University; Sylvia Morrow, Houghton College

Composed of protons and neutrons, atomic nuclei arrange themselves in orbital "shells" much like electrons do around the nucleus. The goal of this research project was to investigate the orbital arrangements of protons and neutrons in a rare isotope of arsenic (arsenic-73) and to specifically search for a highly unusual arrangement that would lead to a highly-deformed shape. This

structure has only been seen in this mass region in the lighter arsenic isotope As-71 and in a short-lived copper isotope Cu-67. It is explained by a proton occupying an "intruder" orbital which only becomes accessible in highly deformed shapes. To search for this rare occupation, we measured the radiation of Arsenic-73 as it released energy which creates a decay pattern that serves as the "fingerprint" of the nuclear structure. An inkling of evidence for the highly unusual decay structure was found, however, other aspects of the Arsenic-73 energy decay pattern were studied, contributing to an improvement in the understanding of the overall fingerprint.

The Effect of Antipsychotics on Processing Speed in Geriatric Neurology Patients

Allison M. Nobles (Supervisor: Steven A. Rogers, Psychology)

This study explores the impact of antipsychotic drugs (APDs) on processing speed and speed-dependent cognitive measures among geriatric neurology patients. A total of 416 neurology patients participated in comprehensive neuropsychology assessments as part of outpatient neurological evaluations. Results showed that geriatric neurology patients taking APDs had significantly slower speeds on the set of processing speed and speed-dependent cognitive measures relative to those not taking APDs. When these patients were further sub-grouped into those meeting criteria for mild cognitive impairment (MCI) and those meeting criteria for dementia, only MCI patients showed significantly slower speeds. Most of these findings are likely secondary to the loss of white matter integrity associated with APDs. This has implications for discretionary use of APDs in the geriatric neurology population, as well as for evaluating and treating cognitive impairments in this population.

Are Racial Issues in the San Joaquin Valley Being Addressed by County-Level Officials?

Jenna M. Peterson (Supervisor: Carmel Saad, Psychology)

This study investigates the relationship between county-level racial issues and the political platforms of county-level officials in 7 counties of the San Joaquin Valley. We examined whether local politicians publicly supported people of color (POC) in their counties. Interview data of POC were compared to statements of elected county supervisors. Data were collected from the supervisors' campaign websites and voter guides. The interview

data was sponsored by the United Way in Merced, Tulare, San Joaquin, Stanislaus, Fresno, Madera, and Kings counties. During the interviews, POC answered questions regarding county-level racial issues and how the United Way can advocate for POC. Answers from one question of the United Way data was used: What do you feel are the most pressing racial justice issues in your community? The results across all counties showed no current county supervisor directly supported POC, although some were vocal about secondary issues that disproportionately affect POC.

To Caffeinate Or Not To Caffeinate? A Study On The Effect of Caffeine On Cortisol and Melatonin Levels

Tiffany Gong (Supervisor: Ron See, Psychology)

Melatonin and cortisol are hormones that fluctuate daily in cyclical patterns relatively offset to each other, with cortisol levels showing a morning peak and melatonin levels a nighttime peak. Caffeine is among the most widely used drugs and has been shown to have an acute activating effect on cortisol levels. Studies on caffeine's acute effects on melatonin have been equivocal. In this single-subject study, a naive caffeine user consumed coffee or decaffeinated placebo at 0700 and salivary hormones were measured at multiple time points using ELISA assays. Cortisol and melatonin showed the predicted 24 hr fluctuations, but both hormones exhibited enhanced increases at 24 hr after three trials of caffeine consumption. These results suggest rapid changes in the effects of caffeine on the cyclical pattern of these two key hormones.

Understanding the Emotional Effects of Religious Service Attendance Using Micro-Longitudinal Data

Daniel Yugeun Jang (Supervisor: Blake Victor Kent, Sociology & Anthropology), Westmont College; Christopher G. Ellison, University of Texas - San Antonio; Bradley R.E. Wright, University of Connecticut

This study examines the relationship between an individual's religious service attendance and their emotional well-being. Existing studies on this topic are either cross-sectional or examine long-term trends, meaning we don't know much about the immediate benefits of service attendance, or how long they last. Using SoulPulse, a micro-longitudinal data set involving 24 surveys over a two week period, we analyzed emotional state on Sunday night, comparing those who attended a religious service and those who didn't. Those who attended were better off, but these effects diminished

by the next day. Then we examined whether benefits were equally distributed between those who regularly attend services (i.e., those possessing religious capital) and those who attend less often. We found those possessing religious capital (regular attenders) were better able to utilize services for emotional well-being while irregular attenders were not.

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