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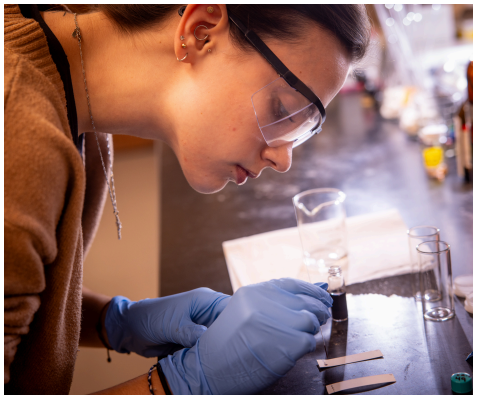
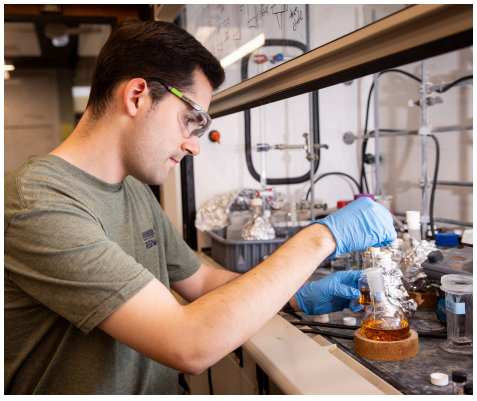
WESTMONT

# 2024 CELEBRATION OF SUMMER RESEARCH

October 4, 3:30-5:00pm Winter Hall 3rd Floor Atrium





# WELCOME TO THE 2024 CELEBRATION OF SUMMER RESEARCH

A hallmark of Westmont's outstanding undergraduate liberal arts education is providing opportunities for students to conduct significant research with faculty.

Approximately 1,300 undergraduates enjoy a student-to-faculty ratio of 11 to 1 and an average class size of 18, which allows them to develop close relationships with outstanding faculty who are committed to teaching, scholarship, research, service and involving undergraduates in research.

Westmont's faculty place high value on research. Each summer, over 30 students from many disciplines work as full-time research assistants, collaborating closely with professors on cutting-edge projects.

This past summer, faculty and students were very busy conducting research with a record 45 students from seven departments participating in the summer research program, all in the natural and behavioral science departments.

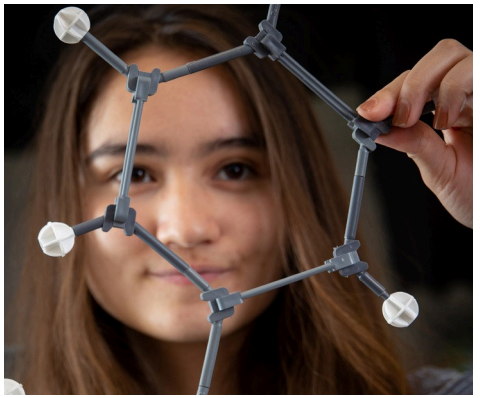
Many of these research projects extend into the school year.

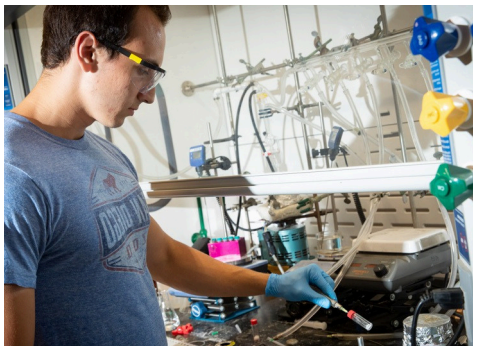
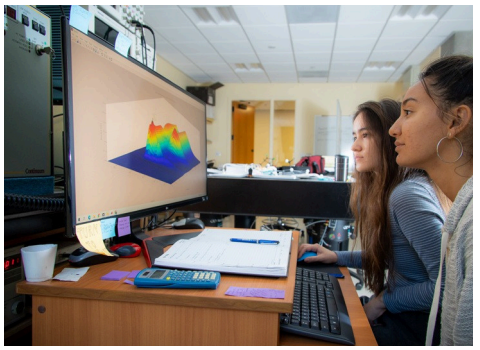
Some students even co-author scholarly papers with their faculty. These are extraordinary opportunities that advance and make significant contributions to research.

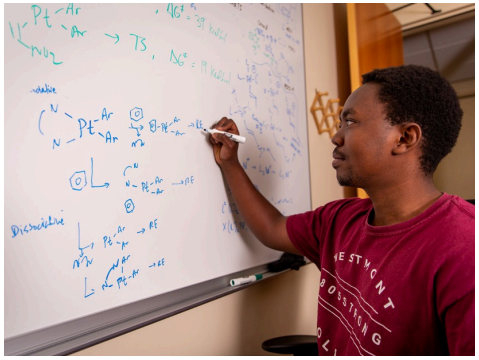
Congratulations to all the summer research students and the great work they have accomplished with their professors and academic disciplines. We celebrate you!

**FOR MORE INFORMATION ON WESTMONT'S RESEARCH, GO TO**
**WESTMONT.EDU/RESEARCH**







# '24 SUMMER RESEARCH PARTICIPANTS

**Melinda Amick**
*Chemistry*
Poster #19

**Sophia Chan**
*Chemistry*
Poster #3

**Junia Coe-Renner**
*Chemistry*
Poster #11

**Isabella Garcia**
*Biology*
Poster #15

**Meredith Gibson**
*Biology*
Poster #10

**Lukas Goodworth**
*Engineering*
Poster #18

**Katherine Goostrey**
*Biology*
Poster #10

**Anthony Gose**
*Chemistry*
Poster #14

**Michael Hemmett**
*Physics*
Poster #9

**MaKenna Jacob**
*Chemistry*
Poster #13

**Skylar Jones**
*Chemistry*
Poster #16

**Maria Judy**
*Engineering*
Poster #5

**Daniel Kim**
*Chemistry*
Poster #2

**Todd Knight**
*Engineering*
Poster #4

**Alan Lopez**
*Chemistry*
Poster #7

**Berit Lunstad**
*Physics*
Poster #12

**Roger Marcellin**
*Chemistry*
Poster #17

**Cara McGuffee**
*Chemistry*
Poster #16

**Miriam Melkonian**
*Chemistry*
Poster #13

**Jesse Nieman**
*Chemistry*
Poster #7

**Mia Rapalo**
*Engineering*
Poster #4

**McKenzie Rion**
*Biology*
Poster #6

**Jessica Rosenfeld**
*Chemistry*
Poster #8

**Noah Shen**
*Engineering*
Poster #4

**Elise Short**
*Psychology*
Poster #1

**Reese Toepfer**
*Chemistry*
Poster #8

**Landon Vanderhyde**
*Engineering*
Poster #4

# RESEARCH PROJECT SUMMARIES

***POSTER #1***

## How Does Diabetes Impact the Cognitive Functioning of those with Parkinson's Disease?

***Elise D. Short*** *(Supervisor: Dr. Steven A. Rogers)*

Diabetes is becoming increasingly recognized as a risk factor for Parkinson's disease (PD), in part due to the prevalence of insulin dysregulation. However, there is a gap in literature regarding the impact of diabetes on the cognitive functions of those with PD. This study examines the cognitive differences between individuals with PD who are positive and negative for diabetes. A total of 147 patients diagnosed with PD participated in comprehensive neuropsychological assessment as part of outpatient neurology evaluations. Participants completed measures of attention, processing speed, frontal-executive and visuospatial functioning, language, and verbal and nonverbal memory. Results reflect that diabetes has a distinct and negative impact on the attentional, processing speed, frontal-executive, visuospatial, and nonverbal memory abilities of those with PD. Better appreciation of this comorbid relationship will enable early identification of individuals at high-risk for PD, improving clinical practice, prevention, and treatment.

***POSTER #2***

## Computational Study of Neighboring Groups on Oxenium Ion Stabilization

***Daniel Kim*** *(Supervisor: Dr. Brandon Haines)*

The goal of our research group is to research the stability and reactivity of oxenium ions. Oxenium ions are composed of an oxygen ion with a positive charge rather than a negative charge attached to a benzene ring. Because oxygen typically wants to accept electrons rather than give it away, oxenium is highly unstable. Attaching a neighboring group to the benzene ring helps to stabilize the oxenium ion; however, if the neighboring group is too stable, the oxenium ion cannot be repurposed and studied for its uses, such as C-H insertion. As a result, one primary objective is to determine computationally how much energy it would take to form a neighboring group and how much energy it would take to break it. We determined through energy measurements that ketopyridine groups seem to be stabilizing the oxenium to the desired degree. We also studied possible side reactions of neighboring group stabilized oxenium ions.



***POSTER #19***

## Computational Study of Substituents on Neighboring Group Stabilized Oxenium Ions

***Melinda Amick*** *(Supervisor: Dr. Brandon E. Haines)*

Aryloxenium ions (or aryloxylium ions) are hypovalent oxygen cations that are a potential source of electrophilic oxygen. They are stabilized through resonance with an adjacent aromatic ring which leads to mixtures of O- and C-functionalization products. A promising alternative approach to stabilizing the aryloxenium ions is through coordination a Lewis basic neighboring group. This computational study systematically investigates the effect of a diverse set of electronic substituents on i) the aryloxenium ring and ii) a pyridine neighboring group (NG) on the formation and stability of the NG-coordinated aryloxenium ion. Data were collected at the B2PLYPD3/def2-TZVPP//B3LYP/6-31G(d) level of theory with a PCM solvent model. For most of the substituents, the NG-coordinated aryloxenium ion is more stable than the uncoordinated (or resonance stabilized) aryloxenium ion with modest variation in the energetics. Electron donating groups in the para-position of the aryloxenium ions tended to stabilize the uncoordinated aryloxenium more than other positions. In addition, electron withdrawing groups in the ortho-position of the pyridine NG tended to weaken the stability of the NG-coordinated aryloxenium ion the most. These findings increase our knowledge of the role of substituents in affecting the stability of aryloxenium ions. Applications of these findings to the C–H insertion reactivity of oxenium ions will also be addressed.

This resulted in a decrease in emission consistent with either energy or electron transfer ot perchlorate that was not observed when perchlorate was added to either Ir(ppy)2(Hcppy) or physical mixtures of G2.0 PAMAM dendrimer and Ir(ppy)2(Hcppy). Further, the rate at which emission decreases with perchlorate levels is consistent with binding of the perchlorate to dendrimer in both strong and weak sites with dissociation constants of 59 micromolar and 48 millimolar, respectively.

***POSTER #18***

## Lunar Rocket Landing Pad Stress Analysis

***Lukas Goodworth*** *(Supervisor: Dr. Doug Fontes)*

As humanity advances toward sustainable lunar exploration, including the construction of active research facilities, the need for safe and controlled landing methods becomes increasingly critical. One potential solution is the implementation of lunar landing pads designed to mitigate the chaotic dispersal of surface debris caused by rocket landings. These landing events subject the pad to high mechanical stresses, both externally and internally, particularly in worst-case scenarios where the pad is simply vertically supported along its edges. This study employs Mechanics of Materials principles to analyze the relationship between principal stresses, material properties, and pad thickness, utilizing surface pressure data from previous rocket plume simulations. We examine the performance of various pad materials through literature review, assessing their ability to withstand the stresses without yielding. Additionally, the sensitivity of key variables, including pad thickness and the mechanical properties of the lunar regolith based material, are explored to inform optimal pad design for future lunar landings.



***POSTER #3***

## Progress Towards the Total Synthesis of Herbicidin A

***Sophia Chan,*** *Tu-Anh Nguyen (Supervisor: Dr. Martin Tomanik, New York University)*

With the increase in bacterial resistance to antibiotics, new compounds need to be explored as potential treatments for infection. Herbicidins, a class of sugar molecules called nucleosides, are naturally occurring compounds found in Streptomyces bacteria that act as herbicidal agents against dicotyledon plants1. While their mode of action and mechanism is unknown, Herbicidins are shown to be successful at targeting bacteria Xanthomonas oryzae, which is Gram Negative (highly resistant to antibiotics). Currently, only syntheses of the simpler Herbicidins B and C are reported, and thus a synthetic route that is easily applicable to all members is necessary. This project seeks to find a creative synthesis of the Herbicidin backbone using C-glycosylation via reductive lithiation. Two routes explored this summer include lithium di-tert-butylbiphenylide (LiDBB) coupling and silane tethering.

***POSTER #4***

## Artificial Intelligence & Engineering Design: How AI Impacts a Suite of Design Innovation Methods

***Noah Shen,*** *Landon Vanderhyde, Todd Knight, Mia Rapalo, Mark Rogers (Supervisor: Dr. Dan Jensen)*

Human-centered engineering design process and methods are continually evolving. Artificial Intelligence (AI) has the potential to enhance the engineering design process. AI has proven to sometimes be a tremendous asset, sometimes be a detriment and occasionally be misused. This research takes engineering design methods from a design process called Design Innovation (DI) and reports on efforts to incorporate AI-based tools to enhance those methods. Design methods such as Journey Mapping, Functional Decomposition, Mind Mapping, CAD and design change data management are addressed. A variety of AI-based tools are used including LLMs (Chat GPT, CoPilot, Perplexity, etc.), image generators such as Dall-E and AI-based video generators. Specific instructions and examples for the use of the AI tools to enhance various design methods demonstrate how some of these emerging AI capabilities can enhance the engineering Design Innovation process.

***POSTER #5***

## Numerical Investigation of Deflector Cones in Lunar Environment

***Maria Judy*** *(Supervisor: Dr. Doug Fontes)*

NASA plans to establish a sustained human presence on the moon to advance science, develop technologies, promote the space industry, and explore deep space. However, the different atmospheric and gravitational conditions of the moon affect how the rocket impinges on the lunar surface. During rocket landing and launching, the plume often cause craters to form and dust ejecta to harm the landing site and surrounding and structures. A proposed solution to mitigate these risks is a deflector cone launch pad. Three deflector shapes—cone, parabolic, and sinusoidal—were tested using a numerical particle simulator and compared against a flat surface datum. The results provide insights into the most effective deflector design for dispersing plumes upwards and radially out, thereby enhancing safety during lunar landings.

***POSTER #6***

## How the PlrSR two-component system helps Bordetella bacteria make the ingredients to live its best life

***McKenzie C. Rion*** *(Supervisor: Dr. Steve Julio)*

Bordetella bacteria cause respiratory tract infections, and one species, B. pertussis, is the causative agent of the human-specific disease whooping cough. We are trying to determine how Bordetella infect and survive in the respiratory tract, and previously discovered a genetic switch, called PlrSR, that helps the bacteria accomplish that goal. Among the five genes we evaluated, we observed that PlrS highly regulates the expression of the genes BB2646 and BB4840. Importantly, this regulation is dependent on the amount of nitrogen in the growth media. Finally, the regulation patterns we observed were specific to particular amino acids in the growth media, indicating a complex relationship between carbon source, nitrogen status, and influence of PlrS. Since nitrogen assimilation in Bordetella is known to be required to make all the biomolecules it needs, these data indicate it is essential for helping the bacteria to live its best life.



***POSTER #16***

## The Development of Novel Oxygen-Based Directing Groups in ortho-Arylation

***Skylar Jones, Cara McGuffee,*** *Mia Kenyon (Supervisor: Dr. Amanda Silberstein)*

Carbon-carbon bonds are the backbone of all organic molecules, making them essential for life. The formation of these bonds are especially critical for pharmaceuticals, agricultural fertilizers and insecticides, along with plastics. Despite how important carbon-carbon bonds are, they are difficult to make due to a limited number of known reactions and most also require preactivation or specific conditions. Our group aimed to utilize C-H activation to make a carbon-carbon bond between two aryl groups with a specific placement on the starting material. We focused on optimizing a reaction using an oxygen-based directing group, to form a carbon-carbon bond adjacent to the directing group. This reaction is facilitated by palladium catalysis, which is one of the variables that we worked on optimizing. By comparing the yields of different starting materials and the alteration of different variables, we were able to explore the scope of the reaction.

***POSTER #17***

## Towards the Photocatalytic Reduction of Perchlorate Using Iridium-Labeled Dendrimers

***Roger Marcellin,*** *Anneka E. Reinstra, Nicholas M. Choi, Madison J. Taylor Cheung-Damonte, and Mya Brushey (Supervisor: Dr. Stephen Contakes)*

The removal of the inorganic anion perchlorate from water is of high interest as it interferes with thyroid iodide uptake and is present in water sources throughout the United States. One approach to addressing this problem involves the tethering of Iridium-based complexes that become highly reducing when they absorb light to bushlike molecules known as dendrimers, which bind perchlorate andprovide an electron transfer pathway through which the perchlorate can be reduced into the harmless chloride anion. In this work, Ir-modified dendrimers with less than one Ir per dendrimer on average were prepared by coupling the photoactive iridium diimine complex Ir(ppy)2(Hcppy) to G2.0 PAMAM dendrimers using HOBt and EDC-mediated amide coupling in DMF. The interaction between the photoactive complex and perchlorate was then studied by monitoring light emission by the complex in the presence of increasing amounts of perchlorate.

***POSTER #14***

## A Computational Study of Stereoselective C–B and C–H Bonds Functionalization of PolyBorylated Alkenes

***Anthony E. Gose*** *(Supervisor: Dr. Brandon E. Haines)*

Alkenes are essential functional groups, but synthesizing them stereoselectively is still a challenge. To address this problem, the Masawara group developed a synthetic method to selectively functionalize polyborylated alkenes. This research investigates the mechanistic pathways and selectivity in C–B and C–H bond functionalization steps of their method using density functional theory (DFT) calculations. We also explore the outcomes of coupling reactions with different substrates, examining that the amount of potassium carbonate affects the formation of Z- or E-α-borylalkenyl Rh intermediates. Detailed DFT analyses of transition states indicate that the Z-pathway is kinetically favored compared to the E-pathway due to release of steric build-up in the anionic substrate and better catalyst-substrate interactions. In addition, we show that C–H functionalization in aryl alkene substrates is energetically feasible through a 1,4-Rh transfer pathway as consistent with experimental results.

***POSTER #15***

## Purposeful Planting: Characterizing Plant Flammability Using Functional Traits for Defensible Space

***Isabella Garcia,*** *Robert L. Fitch, Shane Dewees (Supervisor: Dr. Laura Drake Schultheis)*

While fire influences biodiversity and ecosystem processes, particularly in the chaparral biome of Southern California, the historical fire regimes have become increasingly altered by anthropogenic climate change and an increase in human-caused ignitions due to modern development and encroachment into the WUI. This study investigates the relationship between plant functional traits and flammability characteristics, aiming to enhance fire risk management in Southern California. Using functional traits associated with the dimensions of flammability, 23 native California plant species were measured and ranked. Through comparison with the Behave modeling system, we evaluated the reliability and accuracy of existing flammability predictors, identifying potential gaps in current models. Our preliminary findings highlight the need for data-driven landscaping guidelines that facilitate the creation of defensible spaces in at-risk communities, ultimately aiming to mitigate wildfire impacts.



***POSTER #7***

## Using Biphenyl to Probe the Surface Nature of Organic Molecules on Al2O3

***Alan Lopez, Jesse Nieman,*** *Reese Toepfer, Jessica Rosenfeld (Supervisor: Dr. Allan Nishimura)*

Nishimura's research group measured and analyzed the variable fluorescence of biphenyl to investigate the surface nature of thin layers of organic molecules.

***POSTER #8***

## Fluorescence Spectral Analysis of Adsorbed Molecules on Al2O3 During TPD

***Jessica Rosenfeld, Reese Toepfer,*** *Alan Lopez, Jesse Nieman (Supervisor: Dr. Allan Nishimura)*

The data analysis of the absorption spectra allows for more accurate data to be obtained from the spectra. Deconvolution of the data using Igor took the raw data, which was inaccurate visually as the peaks were interfering with each other, and allowed for the actual values of each peak to be obtained, ranging from the peak height, the width of the peak at half height, and the area under each curve. Furthermore, the Python code for the Avrami equation took the wavelengths and intensities to find the n and k-values of the Avrami equation. The n-value describes the dimensionality of the disorder-to-order transition, while the k-value describes the rate at which the phase transformation occurs.

***POSTER #9***

## Machine Learning for High Energy Physics: A jet energy regression model for particle detector hardware trigger implementation

***Michael Hemmett,*** *Stephen Roche (Supervisor: Dr. Ben Carlson) Tae Min Hong (University of Pittsburgh)*

Particle detector experiments on the Large Hadron Collider (LHC) collect several terabytes of data every second – and this rate will increase with coming LHC upgrades – but most data is not interesting or useful to the discovery of new physics. To maximize the efficiency of the detector's computing resources, highly specialized algorithms are implemented on low-level

hardware, deciding which fraction of events to pass on the scale of nanoseconds. This project proposes one such algorithm, using simulated Delphes inputs and a boosted decision tree (BDT) machine learning model to calibrate quark and gluon jet energies and minimize pileup noise. The BDT model is built on annular energy inputs centered on reconstructed jet coordinates in pseudorapidity and average pileup density. It is then compared against reconstructed jets and simple cone energy summation, revealing the BDT's minimal energy dependence and superior resolution and 4th jet efficiency on a simulated di-Higgs sample.

***POSTER #10***

## Profiling a Global Enemy: A comprehensive analysis of the different components of SARS-CoV-2 and their impact on cardiomyocyte and neuronal activity

***Meredith Gibson, Katherine Goostrey,*** *(Supervisor: Dr. Yi-Fan Lu)*

Since 2019, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has been the cause of a cataclysmic global pandemic with serious associated human health implications. The various proteins of SARS-CoV-2 may help expand our knowledge of the infection's mechanism and its subsequent long term symptoms. This study aimed to explore the potency of the membrane (M), envelope (E), and spike (S) protein on the signaling activity of cultured neonatal mouse neurons and cardiomyocytes using multi electrode arrays (MEA). Computational analysis processed by RStudio revealed that S and higher concentrations of M had a significant effect on neuron activity, while E produced non-significant results. S also had a significant effect on cardiomyocyte signaling. These findings suggest that S plays a critical role in the effectiveness of SARS-CoV-2 on both tissue types and inspires further investigation of the role M may have in increased transmission rates.

***POSTER #11***

## Finding Color in Colorless Molecules

***Junia Coe-Renner*** *(Supervisor: Dr. Michael Everest)*

Isoprene is a plant-produced chemical that is abundant in the atmosphere. Although isoprene is essentially colorless, we measured its ability to absorb visible light. Infrared light can be absorbed by molecules causing their bonds to vibrate like springs. If a bond were an ideal spring, quantum mechanics would predict that the molecule's energy could only increase by one unit when it absorbed light.



However, real chemical bonds are not ideal springs. Therefore, an increase of more than one energy unit is possible. However, these transitions, called vibrational overtones, are very weak. Cavity ringdown spectroscopy is an extremely sensitive method for measuring light absorption. We used cavity ringdown spectroscopy to measure the absorption of light when isoprene is excited to have 6 units of C-H stretching motion. The maximum absorption of light by isoprene in the 590–650 nm region occurred at 602 nm (red-orange light).

***POSTER #12***

## Where's Waldo? The Search for a Missing Half of the Higgs Boson

***Berit Lunstad*** *(Supervisor: Dr. Ben Carlson)*

This summer I searched for a missing half of the Higgs Boson as it decayed into photons and dark photons - a proposed dark matter particle. These were studied by looking at the decay of Higgs Bosons produced by the W and Z bosons. The decays were selected by cutting out various backgrounds like fake particles using knowledge of the different decay processes and an anomaly detection neural network. I also had some operations work as a data quality shifter and as a shifter at the Trigger and Operations desks in the control room of the ATLAS detector at CERN.

***POSTER #13***

## Synthesis and Characterization of WT and Mutant ALS SOD1 Peptides

***MaKenna R. Jacob, Miriam J. Melkonian*** *(Supervisor: Dr. Kristi L. Lazar Cantrell) Dmitriy Prokopovich, Dr. Michael Bowers, (UCSB)*

Superoxide dismutase 1 (SOD1) is a metal-binding dimeric protein that aggregates in familial cases of amyotrophic lateral sclerosis (ALS). This aggregation is characterized by corkscrew oligomers that have been associated with the gain of a toxic function to motor neurons, leading to muscle degeneration and cell death. Five mutations in the amyloidogenic core (amino acids 28-38) have been identified. The wildtype and mutant SOD1 (28-38) peptides were made using solid phase synthesis and purified using High Performance Liquid Chromatography (HPLC). The samples were subjected to incubation with shaking over a one week period, and circular dichroism (CD) was used to determine the secondary structure of the peptides in solution. Surprisingly, only one of the peptides displayed β-sheet secondary structure by CD and fibrils by electron microscopy (EM) after one week of incubation with shaking.