

# DISCOVERY

16<sup>th</sup> Annual  
College of Science Research Symposium

Friday, April 28, 2023  
12 – 2 p.m.  
University Quad  
(in front of Building 8)

**BIOLOGICAL SCIENCES****1. Effect of Maternal High Fat Diet on Hypothalamus-Pituitary-Adrenal Gland axis of Offspring in Sheep.**

Digisha Ahir, Advisor: Juanita Jellyman

Maternal consumption of a high fat diet (HFD) during pregnancy is associated with metabolic dysfunction and altered Hypothalamus-Pituitary-Adrenal Gland (HPA) axis function in the offspring. These effects are well established in species with short gestation length (e.g., rodents), but not in species with longer gestation periods more comparable with humans. We hypothesized that maternal HFD increases food intake, body weight, and basal and stimulated cortisol secretion in the offspring.

Pregnant ewes were housed individually and randomly assigned to control (n=2) and HFD (n=3) groups. The control group was fed farmers best complete ewe and ram pellets with molasses. The HFD group was fed the same diet with an extra 30% of Megalac, a rumen protected fat. Feed intake was measured daily, and body weight weekly. After birth lambs were weaned at 12 weeks of age and given a 2-week of adjustment period prior to the start of a feeding trial to assess appetite. Lambs had free access to control pellet diet with grains and food intake was measured daily. After an in vivo ACTH challenge (2 µg/kg body weight; Cortrosyn), plasma cortisol was measured by ELISA.

Maternal weight gain during pregnancy was similar in control (40 ± 2 kg) and HFD sheep (38 ± 2 kg). At birth, lambs from the control group were heavier (3.0 ± 0.5 kg; n=3) than lambs from the HFD group (2.5 ± 0.5 kg; n=3). We will present preliminary data on the lamb's growth, appetite, and adrenal cortisol secretion in response to ACTH.

**2. The effects of maternal exposure to Δ9-THC during mid-gestation on fetal growth**

Sandra M. Banzon, Andrea Reyes, Oshini Cooray, Zoe Walker, Advisor: Juanita Jellyman

Cannabis use has increased over the past 10 years, including use by pregnant women. Exposure to the psychoactive phytocannabinoid in Cannabis sativa, delta-9-tetrahydrocannabinol (Δ9-THC), throughout pregnancy decreases birth weight in humans and animals. However, whether maternal exposure to Δ9-THC during the period of rapid placental growth only (gestational days (GD) 11-16) decreases fetal weight is unknown.

Pregnant mice were untreated (control group, n=8), received an intraperitoneal (IP) injection of vehicle (ethanol, cremophor, and saline; 1:1:18; vehicle group; n=8), or 4 mg/kg Δ9-THC in vehicle (Δ9-THC group; n=8). After euthanasia on day 16, fetuses and their placentas were weighed, and the fetal:placental weight ratio was calculated.

Maternal body weight was similar in untreated, vehicle, and  $\Delta 9$ -THC mice on GD 1, and there was no difference in maternal weight gain on GD 16 among the groups. Maternal food consumption was lower in vehicle-treated ( $5.3 \pm 0.1$ g) and  $\Delta 9$ -THC-treated ( $5.3 \pm 0.2$ g) than untreated mice ( $5.9 \pm 0.3$ g;  $P < 0.05$ ). When data were analyzed for the lightest fetus in each litter, fetal weight was similar in untreated ( $0.32 \pm 0.03$ g), vehicle-treated ( $0.41 \pm 0.04$ g), and  $\Delta 9$ -THC-treated ( $0.38 \pm 0.06$ g) mice. Similarly, there were no differences in placental weight or efficiency. When data were analyzed for the heaviest fetus in each litter, fetal weight was similar in untreated ( $0.48 \pm 0.03$ g), vehicle-treated ( $0.53 \pm 0.04$ g), and  $\Delta 9$ -THC-treated ( $0.59 \pm 0.06$ g) mice. There were no differences in placental weight or fetal:placental weight ratio among the groups. The data suggests that maternal exposure to  $\Delta 9$ -THC during the period of most rapid growth of the placenta does not alter fetal growth.

### 3. **Use of the National Diabetes Prevention Program in a Library Setting to Reduce Diabetes Risk in Altadena, California**

Nairi Azazian, Advisor: Juanita Jellyman

With the growing prevalence of diabetes, it is becoming evident that type 2 diabetes and its complications are a major worldwide public health problem (Wu et al., 2014). In the current study, we determined the feasibility of offering a free, yearlong, in-person CDC-recognized diabetes prevention program (DPP) in a diverse Los Angeles County community shortly after the social isolation of the COVID-19 pandemic. We hypothesized that participation in the DPP would reduce diabetes risk through weight loss, increased physical activity, and decreased percentage of glycosylated hemoglobin (HbA1c%) to less than 5.7%.

Weekly meetings of the diabetes prevention program were held in a library in Altadena, California. Weight and activity minutes were collected weekly. Biometrics, including waist and hip circumference, and HbA1c%, were measured at 0, 6 and 12 months in 5 pre-diabetic participants.

Body weight, waist and hip circumference, and the number of minutes spent engaged in physical activity each week didn't change when comparing months 0 and 12. Participant HbA1c% tended to decrease from  $5.9 \pm 0.1\%$  (pre-diabetic) at 0 months to  $5.7 \pm 0.2\%$  (pre-diabetic) at 6 months, and  $5.4 \pm 0.4\%$  (healthy) at 12 months. Although these data did not reach statistical significance ( $P = 0.057$ ), it appears that participation in the DPP lifestyle intervention program in a library setting did decrease the risk of type 2 diabetes as evidenced by HbA1c% within normal healthy range.

### 4. **Morphological Characteristics of the Placenta of Arabian Mares Foaling at the W.K. Kellogg Arabian Horse Center**

Ivanna Marroquin, Jose Cabrera, Advisor: Juanita Jellyman

The current study determined the morphological characteristics of the placenta of Arabian mares. Nine pregnant mares housed at the Cal Poly Pomona W.K. Kellogg Arabian Horse Center were used in the study. Mares were observed during foaling via digital cameras and the placenta was

collected immediately after it was delivered. The weights of the placenta and umbilical cord, the number of umbilical cord vessels, and number of twists identified on the umbilical cord were recorded. The placenta was everted to exteriorize the allantoic surface, laid out in an F-configuration, and photographed from above with a measuring tape beside it to allow the area of the allantochorion to be measured using Image J. We will present preliminary data on the linear dimensions and characteristics of the placentas from the foals born during January and February 2023.

### 5. **Gymnodoris systematics**

Jade De Souza-Canal, Advisor: Ángel Valdés

On the coast of New Caledonia, the number of marine mollusk species recorded is much higher than in most other comparable areas on Earth. Moreover, islands like New Caledonia present extraordinary high levels of endemism, and the fauna is largely composed of rare species. Undescribed species still represent 80% of all the species present there.

The taxonomy of the nudibranch genus *Gymnodoris* (Mollusca, Gastropoda) is examined in this study, with specimens collected from New Caledonia that will be investigated with an integrative approach. This genus is composed of 30 known species, with most less than 2 cm in length, with yellow, orange and white markings. A total of 97 specimens of *Gymnodoris* and tissue samples are studied, using dissecting microscopy and scanning electron microscopy for morphological descriptions; and DNA extraction and amplification, sequencing and phylogenetic trees for phylogenetic analysis.

The results from this taxonomic study will help broaden our knowledge and understanding of the evolution and diversification of the genus *Gymnodoris*. Studying the taxonomy of New Caledonia nudibranchs will provide insight on this region's endemism, and more generally, help unravel biogeographical patterns of marine endemism, as identifying undescribed species helps to better estimate species richness and biodiversity.

### 6. **Role of FcγRI and the Immune Defense Against *Trichomonas vaginalis***

George Tseng, Suhani Bhakta, Kassandra Lopez, Advisor: Frances Mercer

*Trichomonas vaginalis* (*T. vaginalis*) is the causative agent for the most common nonviral sexually-transmitted infection, called trichomoniasis. Although most infected individuals are asymptomatic, symptomatic trichomoniasis is higher in women than men. Unresolved or persistent trichomoniasis infection leads to various complications, including infertility, pelvic inflammatory disease, increased HIV susceptibility, and cervical cancer risk. In vivo evidence in humans has identified neutrophils (PMNs) as the primary immune cell recruited to the site of infection to combat *T. vaginalis*. However, PMNs do not utilize the three classical known effector functions of phagocytosis, degranulation, or NETosis against *T. vaginalis*. Instead, PMNs use a fourth novel function called trogocytosis. PMNs surround *T. vaginalis* parasites and proceed to remove small

pieces of *T. vaginalis*' cell membrane until the parasite dies. However, the mechanism and pathways that facilitate PMN contact, trogocytosis, and killing of *T. vaginalis* parasites remain unknown. We hypothesized that (1) antibodies, (2) cell surface antibody receptors, and (3) signaling pathways downstream for these receptors are required for PMNs to perform trogocytic killing of *T. vaginalis*. First, we hypothesize that human antibodies, specifically IgG antibodies, bridge the contact between PMNs and *T. vaginalis* during trogocytosis. Here, we show that human antibodies IgG1, IgG2, and IgG3 were present on the surface of serum-coated *T. vaginalis* parasites. Second, we hypothesize that two PMN antibody receptors, specifically FcγRI and FcγRIII, mediate PMN trogocytic killing of *T. vaginalis*. Here, we show that FcγRI, not FcγRIII, is present on the cell surface of terminally differentiated neutrophil-like cells (NLCs) derived from HL-60 or PLB985 promyelocytic stem cell-like model. The knockout of FcγRI in NLCs led to a minor reduction of the cytotoxic killing of *T. vaginalis*. Third, we hypothesize that spleen tyrosine kinase (Syk), a signaling intermediate downstream of Fc Receptors in PMNs, may be involved in PMN trogocytic killing of *T. vaginalis*. Here, we show that inhibition of Syk kinase significantly reduced cytotoxic killing of *T. vaginalis* parasites by NLCs. Our results may provide a greater understanding of the current immunological response against *T. vaginalis*, potentially informing the development of novel therapeutics or vaccines.

### 7. Effects of Delta-9-Tetrahydrocannabinol ( $\Delta$ 9-THC) on Chick Embryo Growth

Kenneth Paredes, Advisor: Juanita Jellyman

Over the past decade, use of marijuana (*Cannabis sativa*) was approved for medical purposes in 37 states and for recreational purposes in 21 states<sup>1</sup>. Marijuana use has increased over a similar time, including use by pregnant women<sup>2-3</sup>. Infants exposed to marijuana in utero have lower birth weights and reduced head circumference<sup>4</sup>. Similarly, mouse offspring exposed to the psychoactive component of marijuana,  $\Delta$ 9-THC, in utero were born small<sup>5</sup>. The current study used a chick embryo model to study the direct effects of  $\Delta$ 9-THC on growth in ovo without the complications of confounding changes in maternal or placental physiology. We hypothesized that exposure to  $\Delta$ 9-THC causes asymmetrical growth restriction of the chick embryo.

All experiments were approved by the Institutional Animal Care and Use Committee at Cal Poly Pomona. Chicken eggs (*Gallus gallus domesticus*) were injected with 0.025 mg  $\Delta$ 9-THC in vehicle (THC group; n=28), or with ethanol-cremophor-saline vehicle (1:1:18; vehicle group; n=19) on alternate days starting on embryonic day 6. A third group of eggs was not injected (control group; n=16). After euthanasia on embryonic day 20 (term = 21 days), the egg, chick embryo, heart and liver tissues were weighed. Head diameter and crown-rump length were measured. Growth efficiency was calculated as the ratio of the 'measured fetal weight at day 20' and the product of 'the egg weight at day 20' minus 'the weight of the egg after embryo removal on day 206'. To calculate the partitioning of the resource, both the 'measured fetal weight at day 20' and 'egg weight at day 20 - the measured fetal weight at day 20' were expressed as a percentage of the egg weight at day 206. Data (mean  $\pm$  sem) were analyzed by one way ANOVA and Tukey's HSD.

Body weight and crown-rump length were lower in vehicle- ( $23.3 \pm 0.6$  g;  $65.5 \pm 0.8$  mm) and THC-treated ( $24.4 \pm 0.4$ g;  $67.3 \pm 0.6$  mm) than control ( $27.4 \pm 0.5$  g;  $71.1 \pm 0.8$  mm;  $P < 0.05$ ) chick embryos, respectively. Liver weight was lower in vehicle- ( $0.41 \pm 0.02$  g) and THC-injected ( $0.43 \pm 0.01$  g) embryos than in controls ( $0.51 \pm 0.01$  g), but there were no differences in heart weight, or head circumference between the groups. Growth efficiency was lower in vehicle- ( $83 \pm 4$  %) and THC-treated ( $83 \pm 3$  %) than in controls ( $122 \pm 4$  %). Nutrient partitioning was lower in vehicle- ( $44 \pm 1$  %) and THC-injected ( $45 \pm 1$  %) embryos than in controls ( $54 \pm 1$  %).

Together, these data show asymmetric growth restriction in both the vehicle and THC-treated groups with decreased resource uptake and utilization for growth. Further studies are needed to determine whether  $\Delta 9$ -THC decreases fetal growth independently of the ethanol-cremophor vehicle.

#### **8. Effects of Maternal Exposure to $\Delta 9$ -THC on Fetal Growth in Mice**

Andrea Reyes, Jessica Martinez, Advisor: Juanita Jellyman

Marijuana is composed of the leaves and flowers of plants within the genus Cannabis. Although marijuana is illegal on the Federal level, some states have legalized its use for medical or recreational purposes. In parallel with changes in legalization, use of marijuana has increased, including use by pregnant women. Delta-9-tetrahydrocannabinol ( $\Delta 9$ -THC) is the psychoactive component of marijuana that interacts with the endocannabinoid system by binding to the cannabinoid receptors CB1R and CB2R. The CB1R is abundant within tissues of the reproductive system, including the uterus and placenta. The current study determined the effects of maternal exposure to  $\Delta 9$ -THC on fetal growth. All studies were approved by the Animal Care and Use Committee at Cal Poly Pomona. First-time pregnant Swiss Webster mice were used in the study. After mating, maternal body weight and food intake were recorded daily. Pregnant mice were injected with either  $\Delta 9$ -THC (5 mg/kg in ethanol; cremaphor, saline; THC-treated group;  $n=5$ ) or vehicle (ethanol, cremaphor, saline 1:1:18; Vehicle-Injected group;  $n=5$ ) or were untreated (no injections; Control;  $n=5$ ) from day 14 to day 19 of pregnancy during the period of most rapid fetal growth. After euthanasia on day 19, the weight of each fetus and placenta was determined. There were no differences in maternal food intake or weight gain between the groups. We will present preliminary data on the placental and fetal weights from Control, Vehicle-Injected and THC-treated mice.

#### **9. Understanding Developmental and Molecular Changes Underlying Floral Organ Abscission in Aquilegia and Delphinium - Two Horticultural Plants**

Ana Alcaraz Echeveste, Mankirat K. Pandher, Advisor: Bharti Sharma

Floriculture is a branch of agriculture recently categorized under “Specialty Crops” by the United States Department of Agriculture USDA. Being a multi-billion industry, it is one of the important branches of specialty agriculture integral to the economy. Producers of cut flowers depend heavily on specific holidays to generate the majority of revenue for their farms. Careful and precise

management of post-harvest handling and keeping qualities of flowers is very important. This project aims to assist growers in managing flowering by developing a system to increase the shelf life of flowers by delaying the dehiscence of flower organs. Flower organ drop is initiated due to a highly regulated process, which originates with the formation of a detachment or abscission zone (AZ). We will identify the timing of detachment zone formation and study the genes that promote flower aging. Using *Aquilegia coerulea* (Columbines) and *Delphinium bellamosum* as model systems, the proposed project goals are to understand 1) morphological and developmental changes underlying floral organ expansion and maturation 2) the genetic basis of organ maturation and identification of genes underlying the process of organ shedding or abscission in sepals and petals 3) the molecular and developmental changes in the gynoecium before and after pollination through seed set. We use histology and scanning electron microscopy (SEM) for developmental analysis. The developmental work will identify a) the timing of abscission zone (AZ) formation in showy sepals and petals and b) track morphological changes in the gynoecium as it matures. We are also conducting RNA-sequencing on sepals, petals, carpels, and ovules from critical stages identified through developmental studies. The transcriptomic dataset from sepals, petals, and receptacles will be used to identify candidate genes that are involved in Abscission zone formation. The transcriptome data from carpels and ovules will be used to understand the molecular changes in gynoecium pre and post-pollination.

### 10. **Engineered Endolysin as an Alternative to antibiotics for preventing and treating Avian Colibacillosis**

Richard Nunez-Gomez, Meera Kelley, Victor Perez Advisor: Junjun Liu

The California poultry industry is one of the state's agricultural leaders, with an enormous impact on the state's economy, generating sales in excess of \$2.5 billion annually. One of the diseases threatening the poultry industry is colibacillosis, which is caused by avian pathogenic *E. coli* (APEC). In the past, antibiotics were used to control the disease. However, frequent use of antibiotics has resulted in resistance, which raises food safety concerns. As a result, California law now prohibits the routine use of antibiotics, making it important to develop alternative approaches to prevent and treat colibacillosis. Endolysin is an enzyme coded by bacteriophage genome that is capable of lysing bacteria and is therefore an attractive candidate. This study aims to develop recombinant endolysin for the control of APEC. Our preliminary data shows that the recombinant endolysin being engineered is capable of piercing the outer membrane of Gram-negative bacteria such as APEC, and is able to cause bacterial lysis.

### 11. **Investigating signatures of selection in Oceanic swallows using runs of homozygosity**

Dylan Zubieta, Advisor: Elizabeth Scordato

A major question in evolutionary biology is how anthropogenic changes to the environment drive rapid adaptation in other species. One way to address this question is to study the evolutionary history of commensal species, which are closely associated with human environments. Oceanic swallows are a group of facultatively commensal birds, meaning that some populations rely on



manmade structures to build nests, and others are non-commensal and nest on natural structures. In this study, we investigate the effects of human development on the genomic architecture of Oceanic swallows. Since there are commensal and non-commensal populations, we can compare the genomes of populations that have and have not adapted to human development. We did this using runs of homozygosity (ROH), a genomic analysis used for detecting signatures of selection and inbreeding. ROH scans a genome and locates areas that have extended segments of consecutive homozygous alleles. Since selection often decreases diversity in populations, ROH may correspond to a signature of selection. Here we compare ROH between both commensal and non-commensal populations of Oceanic swallows. If there are regions of the genome potentially under selection for adaptation to human development, we expect to find areas that differ between a commensal population and a non-commensal. Identification and the comparison of ROH in genomes of commensal and non-commensal populations is the starting point for future research on the effects that humans have on Oceanic swallows.

### 12. Investigating the role of Neutrophil degranulation in Trophocytic Killing of *Trichomonas vaginalis*

Bethany Sesti, Advisor: Francis Mercer

The extracellular parasite, *Trichomonas vaginalis* (Tv), is a unicellular protozoan responsible for causing the most common, non-viral, human sexually transmitted disease called Trichomoniasis. Symptoms include itching or burning during/after urination and vaginal/penile discharge. Complications may be infertility, preterm delivery, and increased risk of contracting HIV. Neutrophils are the predominant type of leukocyte to respond to the site of infection and actively kill *T. vaginalis* through trophocytosis, which is a contact-dependent and dose-dependent means of killing. However, the mechanism of parasite digestion during trophocytosis is unknown and under characterized. We hypothesize toxic granule content release aids in digestion during trophocytic killing of the Tv parasite. To test this hypothesis, we will knock out the STXBP2 gene in a neutrophil-like-cell line (NLC) responsible for exocytosis of toxic granules. The NLC precursor cells will be transfected with an HDR oligo via the CRISPR/Cas9 mechanism. We will then screen the resultant mutant clones to confirm loss of degranulation. Finally, a co-culture between STXBP2 knockout NLCs and *T. vaginalis* will be performed to determine whether the loss of degranulation affects efficiency of trophocytic killing. The conclusion of this research could inform the development of preventative pharmaceuticals and new treatment methods for individuals at risk, infected with, or afflicted by trichomoniasis.

### 13. The Phylogeny and Diversity of: Bat-Winged Sea Slugs

Kathrina Belle Garcia, Advisor: Ángel Valdés

- Resolve phylogenetic relationships of Family Gastropteridae by determining same vs. different species
- Identify morphological characteristics and sequence molecular data to decipher genetic boundaries



- What are the main driving forces behind the formation of cryptic species complexes in Gastropteridae?

#### 14. **Daple-FLT3 Gene Fusion Causes Tyrosine Kinase Domain Activation and Subcellular Localization**

Michael Acquizzino, Advisor: Jason Ear

Receptor tyrosine kinases (RTKs) are cell surface receptors involved in cell signaling upon ligand binding. Hyperactivation of RTKs (due to genetic mutations) can contribute to cancer by allowing cell signaling pathways to be constitutively active and increasing cell survival, cell proliferation, and cell migration. The coiled-coil domain (CCD) of Daple, a cell signaling scaffolding protein, has been shown to be involved in gene fusion with the RTKs FLT3 and PDGFRB. It is hypothesized that this gene fusion product causes the tyrosine kinase domain to be mislocalized in the cell and leads to rampant cell signaling of either the Ras/Raf/MAPK, AKT, and/or STAT5 signal transduction cascades. Using fluorescently labeled Daple-FLT3, we showed that the gene product is subcellularly localized to the peri-centrosome and active. Further understanding into the function of this gene product may unveil novel strategies into targeting this protein.

#### 15. **ESTABLISHING A MODEL OF PULMONARY ASPERGILLUS IN MALE ICR MICE WITH DIFFERING METABOLIC CONDITIONS**

Kimberly Acosta, Jon Olson, Advisor: Nancy Buckley

Obesity has been associated with various metabolic conditions including Type II diabetes mellitus (T2DM), resulting in increased morbidity, mortality, and increased susceptibility to microbial infections, such as invasive fungal infections. Obesity, diabetes mellitus, and host-pathogen interaction can influence drug pharmacokinetics (PK), pharmacodynamics (PD), and drug efficacy. In the present studies, we sought to establish models of pulmonary aspergillosis infection in normal, obese, and obese-T2DM mice for subsequent testing of intermittent intravenous AmBisome® treatment.

Normal male ICR mice were maintained on a standard 6.2% fat diet for 4 weeks prior to being immunosuppressed with triamcinolone acetonide (28 mg/kg), IP, sedated with a combination of Ketamine (80 mg/kg) and Xylazine (16 mg/kg), IP, and intranasally (IN) challenged with  $3.9 \times 10^5$  *A. fumigatus* spores in 30 $\mu$ L PBS (sp/30 $\mu$ L),  $8.1 \times 10^5$  sp/30 $\mu$ L,  $4.2 \times 10^6$  sp/30 $\mu$ L, or  $7.95 \times 10^6$  sp/30 $\mu$ L. Additional normal mice were not immunosuppressed but were sedated and challenged IN with preincubated spore concentrations of  $1.39 \times 10^6$  sp/30 $\mu$ L or  $3.85 \times 10^6$  sp/30 $\mu$ L. Some normal mice were maintained on a high fat 60% diet for 4 weeks to induce obesity, then sedated and challenged IN with preincubated concentrations of  $2.48 \times 10^7$  sp/30 $\mu$ L,  $6.65 \times 10^7$  sp/30 $\mu$ L or  $3.40 \times 10^7$  sp/30 $\mu$ L. Some obese mice were chemically induced with a single dose of nicotinamide (NA, 60 mg/kg, IP), followed by streptozotocin (STZ, 100 mg/kg, IP) 15 minutes later, to induce T2DM, and considered diabetic when fasting blood glucose levels greater than  $\geq 200$  mg/dL were measured. Obese-T2DM mice were sedated and challenged IN with preincubated concentrations of  $4.98 \times 10^8$  sp/30 $\mu$ L,  $1.67 \times 10^8$  sp/30 $\mu$ L or  $2.47 \times 10^8$  sp/30 $\mu$ L. Mice were monitored for

morbidity and mortality until day 21 or 29. Mice were euthanized, lungs collected and processed to determine the fungal burden as colony forming units (CFU) per gram of lung tissue. Normal immunosuppressed mice inoculated with  $7.95 \times 10^6$  sp/30 $\mu$ L resulted in significant increased disease scores and a poor survival rate of 15%. Normal non-immunosuppressed mice with either spore dose had 100% survival rate with no statistical difference in their lung fungal burden data. Obese mice that received the challenge dose of  $3.40 \times 10^7$  sp/30 $\mu$ L resulted in a significantly poor survival rate of 22% and greater percent weight change with minimal weight recovery, compared to the two other challenge doses. Obese-T2DM mice that received the challenge dose of  $2.47 \times 10^8$  sp/30 $\mu$ L had a significantly low percent survival rate of 36%, however did not meet the desired mortality with early mouse death.

The concentration of *A. fumigatus* spores was selected based on previous studies using immunosuppressed female Swiss Webster mice with *A. fumigatus* spores causing a lethal infection and with the death of the first mouse occurred between days 7 or 8 and an overall survival rate <20%. In these studies, fungal challenged male ICR mice were used showing comparable results only when an immunosuppressant was also used. Without immunosuppression, the desired disease symptoms and morbidity levels were not achieved. In obese and obese-T2DM mice inoculated with  $10^7$  and  $10^8$  spores per mouse, respectively, a sufficient fungal challenge was given to generate early mortality, however, morbidity was not sustained, and all mice slowly improved in their disease status over time. Further evaluation of *A. fumigatus* spore challenge concentrations would be necessary to establish a model of pulmonary aspergillosis in obese and obese-T2DM mice for the use of PK/PD evaluation of antifungal drugs.

**16. Melanochlamys Sea Slugs - Mapping Diversity & Phylogeny**

Michelle Millan, Advisor: Ángel Valdés

Eleven specimens of *Melanochlamys* sea slugs from Japan will be analyzed to determine their identity. The genus *Melanochlamys* is known to contain several cryptic species, which share many morphological similarities but show major differences in their genetic makeup. Because of this, determination of species relies heavily on molecular analysis. Because the Japanese specimens show some external differences from known species and are from areas of Japan previously under sampled, I suspect they could constitute new species. To determine their identity, I will conduct molecular analyses of these samples and compare them to other species available in GenBank. This project has the potential to discover new species for science and provide valuable data to understand the evolution of these poorly known marine organisms.

**17. The Quantification and Identification of Microplastics in Oyster Populations Along the Southern California Bight**

Ashton Espino, Advisor: Andrea Bonisoli Alquati

Microplastics (MPs) are increasingly prevalent in coastal waters due to exponential growth in plastic production and use. Approximately 320 million tons of plastics are introduced into our

environment through land-based sources each year. Biotic and abiotic factors degrade plastic debris, creating fragments easily ingested by marine organisms. Ingesting MPs can expose organisms to additives and adsorbed chemicals that may bioaccumulate, causing toxicological effects. MPs' ubiquity in marine environments and the toxicity of chemicals leaching from them have raised concerns, especially with human consumption of contaminated seafood. Previous studies conducted by the Bight Program quantified anthropogenic litter in the Southern California Bight (SCB) shelf strata via trawls. However, MPs and their associated toxicants were never quantified in shellfish within estuarine environments. To quantify and identify MPs in southern California's coastal waters, field collection will be conducted as part of the Bight Program during summer 2023. Shellfish tissue samples (n=30) will be collected at low tide from estuarine habitats throughout the SCB to quantify the prevalence of MPs of various materials in shellfish. We will conduct MP extractions from tissue samples using the core method adopted by the Southern California Coastal Water Research Project (SCCWRP) and MPs will be chemically identified using Fourier-transform infrared (FTIR) spectroscopy. Prevalence data will be analyzed using generalized linear mixed effects models (GLMMs) in R. Analyzing MP concentrations in shellfish is important because they are sentinel organisms, whose response to environmental stressors alerts us about the impacts of those stressors on ecosystems and human health.

### 18. **Investigation of the role of vesicle trafficking in volatile emission of *Petunia hybrida* flowers**

George Mariscal, Advisor: Natalia Dudareva

Volatile organic compounds (VOCs) are essential for plants to communicate with their environment. VOCs serve in various ways for plants, as a defense mechanism against pests and pathogens, an attractant to pollinators, signaling between plants, and even protecting against abiotic stressors. Thus, plant volatiles are of biological importance in understanding plant communication. Although biosynthetic pathways of VOCs have been studied and identified largely, the mechanism(s) of how VOCs are emitted remains unclear. Passive diffusion had been considered the sole mechanism of VOC emissions. However, recent studies showed that active biological mechanisms are also involved in VOC emission. Although our understanding of how VOCs traverse cytosol to reach the plasma membrane is still lacking, vesicle trafficking was proposed as a biological mechanism of VOC transport across the cytosol. We searched our RNA-seq datasets generated from *Petunia hybrida* flowers, which produces high levels of benzenoid and phenylpropanoid volatiles, to find vesicle trafficking-related genes with expression profiles matching VOC biosynthesis and emission patterns. We identified PhSV2-1 and PhSV2-2, homologs of mouse synaptic vesicle protein 2A (MmSV2A), which is important for the fusion of vesicles to target membranes in mice. This project aims to determine whether PhSV2s are involved in VOC emission. If PhSV2s play a role in VOC emission, we expect that the downregulation of PhSV2s will decrease VOC emission. To test this, we generated transgenic plants with downregulation of PhSV2s using virus-induced gene silencing (VIGS). The expression of PhSV2s was tested using quantitative RT-PCR and VOC emission was measured using GC-MS.

**19. Swarm, Bite, Digest: How Neutrophils Kill the Parasite *Trichomonas vaginalis***

Ashley Ramirez, Advisor: Francis Mercer

*Trichomonas vaginalis* (Tv) is a flagellated unicellular parasite responsible for causing the most common non-viral STI worldwide, trichomoniasis. It is known that a type of white blood cell, neutrophils, kill the parasite via a contact-dependent mechanism called trogocytosis, in which neutrophils swarm the parasite and take bites preceding parasite cell death. However, the molecular mechanisms and subcellular events involved in trogocytosis remain unknown. Since a previous study identified neutrophil cell surface receptor CD32a, as being required for neutrophil trogocytosis of breast cancer cells, we hypothesize that CD32a may also be required for neutrophil trogocytosis of Tv. To test this, we created CD32a knock-out (KO) clones and conducted cytotoxicity assays in which percent parasite killing was determined. We determined that CD32a KO neutrophil-like cells (NLCs) show a significant decrease in percent parasite killing compared to negative control NLCs. To determine whether trogocytosis is affected by the absence of CD32a, trogocytosis assays were performed. We determined that CD32a KO NLCs exhibit decreased trogocytosis of Tv. Additionally, to determine if the trogosome, the compartment in which bites of Tv are taken up, fuses with lysosomes, trogocytosis assays are being conducted in which NLCs and Tv are co-incubated and observed over time in the presence of lysosome markers. Preliminary data suggests that some bites of Tv localize to NLC lysosomes following trogocytosis. The results of these studies will give a deeper understanding of the molecular mechanisms and subcellular events that neutrophils use to kill this highly prevalent parasite.

**20. Genomic Signatures of Selection for Resistance to Lead Exposure in the Turkey Vulture (*Cathartes aura*)**

Alexandria Koedel, Alexandra Gresham, Peter Bloom, Miguel Saggese, Allison Shultz, Advisor: Andrea Bonisoli Alquati

Turkey Vultures (*Cathartes aura*) are key scavengers in ecological communities, often feeding on carcasses left behind by hunters who use lead (Pb) ammunition. Ingested Pb may cause two main adverse responses: (1) triggering of the oxidative stress pathway and (2) calcium homeostasis disruption in cholinergic neurons. The long-standing use of lead (Pb) ammunition has resulted in multi-generational exposure to this toxic metal and possibly a population genetic response. Yet, genetic variation in susceptibility to Pb or potential selection for increased resistance to Pb remain unexplored in any raptor. Here, we analyzed ten Turkey Vulture genomes for signatures of selection by running neutrality and outlier loci tests and calculating genome-wide linkage disequilibrium. The results indicated balancing selection as the primary force acting on the genome. Linkage disequilibrium and genetic diversity were generally low, signifying that the species experienced a population bottleneck, in line with previous demographic studies. We also identified 212 regions undergoing strong positive selection, which included genes involved in oxidative stress response, neurotransmitter communication, and voltage-dependent ion channels (K<sup>+</sup> and Ca<sup>+</sup>), in line with Pb's neurotoxic effects and role in triggering oxidative stress response. Of those regions, we have identified four in complete linkage and sixteen experiencing high linkage, validating the presence of signatures of selection. The involvement of these genes in an

adaptive response to Pb exposure will need confirmation, including through transcriptomic analysis of individuals varying in exposure to Pb. Our results will unveil how raptors respond to toxicological risk from Pb, and what the role is for evolution, as opposed to plasticity, in supporting their persistence of Turkey Vulture populations in the face of widespread Pb contamination.

#### 21. **Lead Exposure of Female and Male Turkey Vultures**

Jocelyn Urias, Alexandria Koedel, Pete Bloom, Advisor: Andrea Bonisoli Alquati

Does sex play a role in Turkey Vulture exposure to lead?

Hunting practices with lead ammunition have historically caused lead (Pb) toxicosis in a variety of raptor species, including the Turkey Vulture (*Cathartes aura*). Due to their scavenging habits, raptors ingest lead from carcasses abandoned by hunters. In July of 2019 the State of California set a ban on the use of Pb ammunition for hunting, a law that increased the protection of wildlife and could reduce Pb exposure in raptors, especially the critically endangered California Condor (*Gymngyps californianus*). As part of a larger study analyzing Pb exposure in Turkey Vultures in California, I have been molecularly sexing Turkey Vultures to investigate whether sex plays a role in determining Pb exposure. Blood samples collected from live vultures at two sites, in Anaheim and the Big Morongo Canyon Preserve, were analyzed for Pb concentrations. To sex the birds, I extracted DNA from blood samples, amplified it using a PCR approach, and visualize results using gel electrophoresis. Statistical tests are being used to test for any association between Pb concentrations and sex. Thus far, a two-way ANOVA with sex and age as categorical variables has demonstrated no significant statistical difference between Pb concentrations of female and male vultures at any age. However, I am currently working on expanding the sample size to ensure the power and accuracy of the test. Since most studies only account for male vultures, our analyses will help further the understanding of how sex impacts Pb exposure and toxicosis in vultures.

#### 22. **Investigating Genetic Systems for Sulfolobus Turreted Icosahedral Virus 3 in Sulfolobus species of archaea**

Sydney Chase, Jenny Peng, Advisor: Jamie Snyder

Microbial organisms are omnipresent, pervasive, and play a critical role in all ecosystems on earth. Despite microbial organisms being the most abundant life on earth with the most genetic diversity, they are the least understood group and most methods to understand them are underdeveloped. Archaeal viruses are a relatively new area of research and most lack a model system for study. They are extremely unique and very different from viruses infecting organisms within the bacterial and eukaryotic domains of life. With the discovery of the STIV family of viruses and the creation of genetic systems for these viruses, we have increased our knowledge of archaeal virus replication. STIV thrives in extremely hot (75-80°C) and acidic (pH 2-3) conditions. STIV1 replicates within *Sulfolobus solfataricus* in which there is not a genetic system; therefore, we are unable to fully analyze virus-host interactions. However, the more recently discovered

STIV3 replicates within *Sulfolobus acidocaldarius* in which genetics is possible. The aim of this project is to develop a genetic system for the host of STIV3. This will be accomplished using the “pop-in/pop-out” method, where a plasmid containing the pyrEF gene “pops-in” to the host genome via growth on a uracil-free plate. *S. acidocaldarius* has a several hundred base pair deletion within its own pyrEF gene and hence unable to synthesize uracil, *S. acidocaldarius* must utilize the pyrEF gene located in the plasmid. The pyrEF gene acts as a selective marker to select for the cells that transformed with the plasmid. The cells will then be grown on a second round of selection plates that contain 5-fluoroorotic acid (5-FOA). This will result in the plasmid to “pop-out” of the STIV3 host genome, along with the gene of interest (GOI). Developing a genetic system for the host of STIV3 will allow us to conduct further study on the virus-host interactions that are currently not well understood. In addition, this research will promote the analysis and of unknown gene functions in archaea that can be used for medicinal and therapeutic purposes, along with elucidating the viral replication cycle of STIV3. Furthermore, archaea are becoming ever more relevant in biotechnology as their cultivation of genetic systems improve and potential for avenues of sustainable industrial utilization have major potential.

### 23. **RNA-seq Analysis Using Data from GLDS 289 Mission 1 to Investigate the Impact of Gravity on Gene Expression of the Murine Thymus**

Romar Rivera, Amanda M. Saravia-Butler, Wei-Jen Lin, Advisor: Wei-Jen Lin

The effect of space flight on the human body has been investigated, especially when looking at effects on the immune system. Spaceflight can have significant effects on the thymus, a crucial organ for the immune system. Using data gathered from mission SpaceX-9 within GLDS 289 Mission 1 (MHU-1), we have conducted a suite of data processing workflow in the Jupyter Notebook environment to process RNA-seq data to determine what genes are being under or overexpressed between the changes in conditions pertaining to spaceflight. In the study conducted, a total of 18 mice at 8 weeks old were subject to a 35-day ground and flight control. Among them, 12 mice were sent to the International Space Station (ISS) for the flight test study, 6 of which were subjected to microgravity ( $\mu\text{G}$ ) and the remaining 6 were subjected to simulated gravity via centrifugation (1G). The last 6 mice were kept on Earth for ground control studies (GC) being kept in identical cages to those on the ISS. After processing the collected data, the normalized and filtered gene counts were analyzed using plots such as the Principal Component Analysis (PCA), Heatmaps, Volcano Plots, and Geneset Enrichment Analysis plots (GSEA). The number of genes in the rawCounts data after normalization and filtering was reduced to 22,619 from 55,536. Our RNA sequencing analysis of the thymus suggests that there is a significant reduction in the expression of cell-cycle-related genes, specifically genes involved in the regulation of cell cycle. This may explain the shrunk thymus due to spaceflight. As we look forward to more long-term spells of space travel and the potential colonization of planets such as Mars, having an understanding of the effects of Space travel on immune system functions with organs such as the thymus will be incredibly important.



**24. Decomposition of native and non-native annual plants in Southern California**

Amanda Jennings, Brittany Sheets, Advisor: Erin Questad

In ecological restoration, it is important to identify and understand the factors that promote invasion and inhibit native plant growth. Plant litter, or thatch, may inhibit or promote the germination and growth of different species. The decomposition rate of thatch may differ among species and directly influence how long thatch remains in a community, affecting the next generation of annual plants. The decomposition rate may be influenced by the nutrient quality or C:N ratio of the litter. This study investigates whether the decomposition rate differs between the dominant native and non-native annuals in a coastal sage scrub community. This field experiment is part of a master's thesis project investigating the effects of mowing and thatch removal at varying propagule pressures on competition between native and non-native annual plants. This study is being conducted in the Voorhis Ecological Reserve (VER) on the Cal Poly Pomona campus. The VER had a historically high diversity of native annuals but has become dominated by invasive grasses and forbs after disturbance by cattle grazing and fires, making it ideal for this study. The species examined were the dominant native, *Amsinckia intermedia*, and the dominant non-natives, *Bromus diandrus*, *Centaurea melitensis*, and *Hirschfeldia incana*. A total of 80 litter bags containing these species were deployed in December 2022. Sixteen bags will be collected three times every eleven weeks to gather data on the percent mass loss as a measure of decomposition over time. The first collection was completed in February 2023 and *H. incana* was found to have a lower mean percent mass loss than the other three species. Analysis of the C:N ratios of each species did not explain why *H. incana* decomposed slower in the first eleven weeks.

**25. The Potential Effects of MPAs on Fish Age Structure**

Natalie Shubin, Casey B. Pua, Advisor: Jeremy Claisse

Marine Protected Areas (MPAs) can be an effective tool fishery management tool and protect marine biodiversity and resources. However, MPAs may have different effects on fish species in relation to their life history and movement patterns. This project will aim to predict the potential for MPA effects on fish species age structure. It is part of a larger CPP Claisse Lab project investigating MPA effects using fish provided by the Los Angeles County Sanitation District (LACSD). The LACSD annually collects fish from three zones surrounding the Palos Verdes Peninsula for required toxicology monitoring inside and outside of the Point Vicente SMCA and the Abalone Cove SMCA. A literature search and review will be conducted for the species *Embiotoca jacksoni*, *Pleuronichthys verticalis*, *Genyonemus lineatus*, *Paralabrax clathratus*, *Paralabrax nebulifer*, and *Scorpaena guttata* to assess their life history strategies and movement patterns in order to predict how likely MPA effects will be observed for each species. Measurements and data will be collected on the fish provided by the LACSD on their measurements, otoliths, gonads, and tissue samples.



**26. Characterization of B8 adeno-associated virus in the mouse brain across varied genetic backgrounds**

Fernando Garcia, Victor Baurista, Anaya Cosby, Advisor: Andrew Steele

Adeno associated viruses (AAV) are viruses which are non-pathogenic and therefore can be used as vehicles for genetic cargo delivery, without causing significant damage to the organism. Naturally occurring AAVs are used to engineer more variants through directed evolution with the main goal being to discover a variant with the highest performance possible in targeting the brain with low susceptibility for the liver. When a large amount of virus enters the liver it could cause liver toxicity. To test the efficiency of, B8, an engineered virus, a series of three genetically different mice strains; C57BL6/J, NOD, and DBA, were injected retro-orbitally with B8. The mice were then incubated for three weeks, and then euthanized through cardiac PFA perfusions for the collection of the brain, liver, and other organs. The brains and livers were then sectioned at 100 microns and stained using immunofluorescence; NEUN, S100 $\beta$ , and DAPI to visualize expression in different cell types. GFP was used to visualize the virus. A confocal microscope was then used to collect images for visualization and quantification. Through engineering, qualitative, and quantitative analysis we were able to characterize the expression pattern of B8 which revealed the way the virus responded across all strains of mice and the selected cell types, which in this case the virus was more neuronal.

**27. Investigating Community Assembly Filters in Areas that Differ in Water Availability and Land-use**

Noah Szczesinski, Advisor: Erin Questad

Investigating Community Assembly Filters in Areas that Differ in Water Availability and Land-use along the Santa Clara River Valley.

Community assembly is a framework of understanding that helps to explain the observed community of species in an area compared to all the species possible in the species pool; the influence of “filters” in a community determines the species, and their abundances, within that community. There are three community assembly filters that filter out species from potentially establishing within a community: dispersal, abiotic, and biotic. Seed rain and seeds found in the soil seed bank (“propagule pressure”), water availability and land-use, and granivory and herbivory (“consumer pressure”) represent specific types of each filter, respectively. Increased levels of propagule pressure and water availability often increase the establishment of a species within a community, while consumer pressure acts to decrease establishment. The interaction of these factors is often more complex and can make predicting outcomes difficult. Consumer pressure can be so severe that it overcomes propagule pressure to completely eliminate plant establishment or substantially decrease plant population size. On the other hand, propagule pressure can be so large that it is minimally affected by consumer pressure. Depending on the level of water availability, the interaction between consumer pressure and propagule pressure can be shifted such that one significantly influences the other in some areas but not others. As such, this study will investigate how community assembly filters differ in areas that differ in water availability and land-use along the Santa Clara River Valley. Sites for this study will be placed along

the Santa Clara River Valley across Ventura County, ranging from east of Filmore, CA to the western edge of Santa Paula, CA. The project will consist of four separate sites with three plots at each to compare community assembly filter between agricultural and natural sites. At one site, six plots in relatively drier upland areas and six plots in relatively wetter riparian areas will be established to compare areas with different water availabilities. Consumer pressure will be quantified with granivory and herbivory cafeteria experiments in both upland and riparian areas to see which consumers are present and which seeds/seedlings are being consumed. Propagule pressure will be measured using seed rain funnels and soil seed bank analyses. Lastly, the interaction of consumer pressure and propagule pressure will be analyzed to see how they influence plant community composition. Understanding how consumer pressure, propagule pressure, and the interaction of the two affects plant community composition in the Santa Clara River Valley can improve restoration outcomes in the area.

### 28. **Genetic Identification of a Population of Dopamine Neurons That is Necessary for Circadian Food Anticipatory Activity**

Jacqueline Trzeciak, Sarah Sharif, Cameron Harrington, Advisor: Andrew Steele

Dopamine (DA) signaling plays a vital role in circadian entrainment to food availability, particularly the development of food anticipatory activity (FAA). FAA is characterized by high levels of locomotor activity preceding a scheduled meal time and is regulated independently of the suprachiasmatic nucleus (SCN), the structure responsible for orchestrating the body's circadian response to light. Prior experiments have failed to pinpoint a single locus of control for FAA and the neural circuitry controlling the behavior is still largely unknown. Several studies have implicated that DA signaling acts to link mealtime to activity cycles- due to its role in reward pathways, understanding DA signaling and its contribution to circadian food entrainment may give insight into diet-induced obesity, eating disorders, and addiction pathologies. Prior studies within our lab have shown that conditional deletion of tyrosine hydroxylase (Th), the rate limiting enzyme for DA synthesis, using Cre recombinase targeted to DAT (Dopamine transporter)-expressing neurons results in a large loss of Th expression in the midbrain coupled with a severe lack of FAA. In addition, restoration of Th expression to DAT-Cre DA neurons in the substantia nigra (SN) re-established FAA in the DAT cKO mice. To further refine an FAA-mediating neuron population, we screened several candidate DAT-positive populations by deleting Th using Crhr1-, FoxP2-, Ntsr1-, Sox6-, Vglut2- and Calbindin1-Cre driver mouse lines. Despite creating massive Th deletions through the midbrain, most of these deletions either did not impair or only slightly impaired FAA. Deletion of Th using Calbindin1-Cre, however, resulted in a dramatic impairment in FAA while being the most limited Th deletion of all our cKO lines to date. These results suggest that a population of the DAT-Cre, Calbindin1-Cre -expressing DA neurons in the SN play a key role in promoting FAA. Understanding the subpopulations of dopaminergic neurons that are required for FAA will not only further our understanding of this behavior, but may also help shed some light onto the still-unidentified neural circuitry of food entrainable circadian rhythms.

**29. SHOW ME THE GREEN: WILDLIFE, GREENSPACE, AND THE 'LUXURY EFFECT' IN SAN GABRIEL VALLEY, CALIFORNIA**

Adrianna Elihu, Advisor: Janel Ortiz

Development of natural land is expanding; with increased urbanization, wildlife are challenged to adapt to human-dominated environments. Urban greenspace including parks, yardspace, and natural lands, provide habitat to many species. Greenspace characteristics, such as size and proximity to other greenspace, have been found to have positive effects on wildlife communities. For humans, access and greenspace availability have shown to improve health. Benefits are furthered for some by the 'Luxury Effect' where wealthy neighborhoods have higher rates of biodiversity compared to low-income neighborhoods. However, understanding how wildlife use the urban landscape within San Gabriel Valley, an extremely developed region of Los Angeles County, California, has yet to be discovered. Here we will identify and quantify greenspace characteristics to determine relationships with wildlife diversity and determine how socioeconomic factors influence greenspace and access to wildlife. Twenty-five camera traps were set along a transect from Diamond Bar to the San Gabriel Mountains to document wildlife. Greenspace metrics and socioeconomic variables will be analyzed using 3 m unsupervised land cover classification and 2020 U.S. Census data. I expect greenspace that is larger, complex, and in less urbanized areas to have higher species richness and areas with higher socioeconomic status to have higher species richness supporting the 'Luxury Effect'. Twelve of the 25 sites have documented eleven species. Data analysis for the socioeconomic variables is ongoing. In recognizing significant greenspace metrics that positively affect wildlife, city planners and urban ecologists can develop greenspace that improves biodiversity, provide information to modify existing greenspace, and improve access to the outdoors and wildlife for everyone.

**30. Reaction of White Blood Cells and Bone Marrow Stromal Stem Cells to Prosthetic Metal Ions**

Julian Alberto, Olivia Carrillo, Abbygail Benitez, Anthony Lee, Advisor: Steve Alas

Metal human prosthetics are typically composed of stainless steel or titanium-based alloys that can include aluminum, vanadium, magnesium, and other metals. As these prosthetics corrode and deteriorate overtime, single and double strand DNA breaks can occur from the metal ions they shed. HL-60 cells are promyeoloblasts isolated from the peripheral blood. They are precursors to a variety of myeloid cell types found in the blood stream. HS-5 cells, a bone marrow stromal stem cell line, function by providing a microenvironment that influences the function and differentiation of blood cells. They are also progenitors of skeletal tissue components such as bone, cartilage, the hematopoiesis-supporting stroma, and adipocytes. Both HL-60 and HS-5 cells represent tissue types that are exposed to human prosthetic metals and ions that are shed from them. The purpose of this study is to examine a series of novel alloys and to find which of them produce the least amount of metal ion-induced DNA damage in these different cell types.

### 31. **The Effect of Genistein on Bypassing the G1/S Phase Arrest in *Saccharomyces cerevisiae***

Joseph Alas, Advisor: Wendy J. Dixon

One of the leading causes of morbidity and mortality in the world is cancer. The most frequently diagnosed cancer types worldwide are lung, breast, and colorectal cancer. While many chemotherapeutics and anticancer drugs have been developed, they do not work on all types of cancers and can have unwanted side effects. Therefore, studying alternative agents is important. Genistein, a phytoestrogen found in soybeans, is known to lower the risk of cancer in patients, though limited research has been done to show this. Genistein is shown in in vitro studies that many different human cancer cell lines with small amounts of genistein can induce the apoptosis mechanism. There are not many in vivo studies that show genistein is effective as an alternative cancer treatment. Genistein causes G2/M arrest and can override the G1/S phase arrest in human cancer cells. My research project uses *Saccharomyces cerevisiae* to study the cell cycle. We are using hydroxyurea to cause a cell cycle arrest and then using genistein to see how it can override the hydroxyurea cell cycle arrest. We are determining the phases of the yeast cells with microscopy and FACS analysis to show the phases of the yeast cells by DNA content. We will then use mass spectrometry to identify which proteins are being downregulated or upregulated when the override mechanism has occurred. After the mass spectrometry experiments, we will validate our findings with SDS Western Blotting. We are looking to see if in yeast the G2/M arrest is induced and/or the G1/S phase override occurs. So far, we only see the override of the G1/S phase arrest.

### 32. **Comparison of the Reference Culturing Method and an Antibody Base Rapid Test for the Detection of *Listeria monocytogenes***

Diana Duenas Alejandre, Wei-Jen Lin, Advisor: Wei-Jen Lin

*Listeria monocytogenes* causes listeriosis, a serious foodborne illness in humans. *Listeria* species are abundant in soil, vegetations, and intestines of some animals. The microorganism can withstand substantial environmental hardship and persist in the natural and built environment for an extended amount of time. In addition, *Listeria* species are able to reproduce at refrigeration temperature, posing a serious food safety concern especially for refrigerated ready-to-eat food products. Outbreaks of listeriosis have been associated with the ingestion of a variety of raw and processed foods. *Listeria monocytogenes* is one of the most costly foodborne pathogens owing to its frequent involvement in large outbreaks, product recalls, and hospitalizations. Current FDA and USDA guidelines require the absence of *Listeria monocytogenes* in ready-to-eat meats, poultry, and deli products, as well as the absence of *Listeria* species on the food contact surfaces and environment of food processing facilities. Therefore, a reliable and efficient food and environmental *Listeria* monitoring method is essential for the compliance of the current food safety guidelines, as well as the protection for consumer safety. In this study, a rapid *Listeria* testing protocol was assessed using an improved rapid enrichment medium and the antibody-based lateral flow device using polyclonal antibodies targeting pathogen specific proteins for *L. monocytogenes* detection. The reference methods by USDA and FDA involve multiple culturing steps which takes 4 days to obtain the result. The rapid method developed should be able to help

timely detection of *L. monocytogenes* to prevent foodborne illness and reduce recalls on foods

**33. BirdNET Validation Efficacy of Passive Acoustic Recordings in the Santa Clara River Valley**

Danny Perez, Advisor: Elizabeth Scordato

In the Santa Clara River Valley, two observational methods occur to identify avian species; in-field point counts and passive acoustic recordings gathered from fixed, battery-operated devices. Collecting avian survey data requires expert training, time, and long hours at field sites, while passive acoustic recorders provide a way to cut down on these expenses. Using BirdNET, a computer program that uses auditory data to classify various avian species based on their vocalizations, it was found that while accurate, the precision in which certain species could be identified had weak points in noisy habitats and with less vocal individuals. Validation curve data shows that commonly found birds- Lesser Goldfinch, Oak Titmouse- in quiet habitats had increased confidence scores and nearly 100% accuracy as opposed to those found in noisy habitats that were not as commonly recorded i.e., Red tailed Hawk. It is from these findings the efficacy of BirdNET is compared against traditional point count methods. The use of passive acoustic recording has great potential in garnering data on species richness, however the BirdNET software seems to be most effective in identifying species in quiet/low human noise areas.

**34. XCL1 facilitates the interaction with CD8+ T-cells and XCR1+ DCs within the Cervical Lymph Nodes during WNV encephalitis**

Kristen De La Torre, Advisor: Douglas Durrant

West Nile Virus (WNV), a neurotropic flavivirus, causes encephalitis, especially in elderly and immunocompromised individuals. Previous studies have demonstrated that CNS-localized dendritic cells (DCs) protect against WNV neuroinvasive disease by establishing antiviral T-cell responses in the CNS. In this study, we investigated the role of the XCL1-XCR1 interaction since its primary function is to facilitate DC-mediated CD8+ T cell immunity. XCL1, also known as lymphotactin, is expressed by various immune cells, including activated CD8+ T cells, and binds to XCR1, a chemokine receptor expressed predominately by a subset of DCs. Following subcutaneous infection with WNV, XCL1 expression increased within the CNS on day 6 post-infection after local viral replication began. In contrast, the expression of its receptor, XCR1, increased by day 9 post-infection in wild-type (WT) mice. We found that WNV-infected XCR1-deficient (XCR1<sup>-/-</sup>) mice demonstrated increased symptomatic disease and mortality in conjunction with the increased viral burden correlating with decreased CD8+ T-cell recruitment and activation at day 12 post-infection in the CNS compared with their WT counterparts. We found that XCR1+ DCs were present in the cervical lymph nodes at days 6 and 9 post-infection and in the CNS at day 12 post-infection. Taken together, these results suggest that the XCL1-XCR1 interaction promotes viral clearance and protection against WNV neuroinvasive disease.

**35. Development of bioplastics for use in biodegradable household products**

Julia Chaidez, Carmel Dill-Cruz, Guadalupe Rodriguez, Camille Sanshu, Advisor: Steve Alas

The accumulation of plastics and non-degradable products continues to be an issue worldwide. The amount of garbage that pollutes bodies of water (oceans, lakes, rivers, streams) and contaminates land contributes largely to the demise of plant and wildlife, as well as results in a large financial cost to local and federal agencies in clean-up. The goal of this project was to use biodegradable materials and produce formulations that could be used to generate bags, bowls and other household products that could degrade readily after disposal. The experimental compositions were based on combinations of agar, flour, cornstarch, glycerin and vinegar. Formulations were combined, in the presence of heat or without, and placed to dry 24-72 hours. The different varieties of formulations have a spectrum of stiffness, brittleness, texture and color. The formulations hold potential regarding biodegradable materials for fast degradation.

**36. Water Analysis and Restoration of Cal Poly Pomona Duck Pond**

Danielle Cifuentes, Samantha Guzman, Beatrice Martinez, Arai Medina, Isabel Rodriguez, Advisor: Steve Alas

The Cal Poly Pomona Duck Pond has suffered for many years from poor water quality. It is home to many dozens of turtles, koi fish and migrating birds. The goal of this project was to analyze the chemical components in the water known to contribute to algal growth and restore water quality. Over the period of two years, two groups of students analyzed the pond water chemistry, pond microbes, and attempted to reverse the algal bloom through a variety of approaches. The pond water was found to have high levels of phosphate, which drives algal growth. The water was treated with different types of beneficial bacteria. Some bacteria strains compete with the algae for nutrients, while other varieties degrade the organic matter found at the bottom of the pond, which feeds the algal bloom. An air compressor was installed to aerate the pond at four different points and plants were introduced to also compete with algae for nutrients. Results have shown phosphate levels have decreased and the plan is to cultivate more water plants in the pond and supplement with further beneficial bacteria so as to restore the health of the water and benefit the wildlife that inhabits a pond that predates the creation of the University.

**37. Secretion of Tsh Autotransporter in Pathogenic E.coli**

Aidan Barnett, Eric Son, Isabella Barry, Suzuka Mizusawa, Emily Lile, Advisor: Christos Statopoulos

Temperature sensitive hemagglutinin (Tsh) is a virulent serine protease autotransporter protein secreted by pathogenic E. coli. Using four E. coli strains (XL1-Blue PTsh-L1, RW193/pTsh, UT5600/pYA3108, UT5600/pTsh-L1) and one polyclonal antibody (poly2010), we aimed to determine which strain secreted the most Tsh. It was determined that UT5600/pYA3108 secreted the highest amount of Tsh, and thus was further tested using two additional anti-Tsh antibodies (CPP2; Rabbit9) in a western blot assay. It was discovered that the Rabbit9 Tsh antibody gave the most specific reaction against the Tsh protein. Further studies with other uropathogenic, avian

pathogenic, and probiotic *E. coli* strains can determine which secrete the Tsh SPATE autotransporter protein.

### 38. **Analysis of Caffeine's Potential to Enhance the Effects of Chemotherapy**

Randy Hernandez, Diego Ponce, Advisor: Steve Alas

Cancer remains the second highest killer of people in the United States, behind heart disease. The main approach for treatment of patients going through cancer therapy is a regimen of chemotherapeutic drugs. While these drugs can have many mechanisms, damaging the tumor cells' DNA is a common way to induce cell death. Caffeine is known to increase the rate of cell division. When cells divide more rapidly, they have less time to spend in the G2 phase of the cell cycle, which leads to less time to repair any damage to the DNA. This project has the goal of analyzing whether exposure to caffeine, which lessens the time for DNA repair, has any effect on the damaging ability of two chemotherapeutic drugs, cisplatin and 5-fluorouracil. The hope is that caffeine would potential the ability of drugs to induce DNA damage and, thus, be more effective in killing tumor cells.

### 39. **Role of FcγRI and the Immune Defense Against *Trichomonas vaginalis***

George Tseng, Suhani Bhakta, Cassandra Lopez, Advisor: Francis Mercer

*Trichomonas vaginalis* (*T. vaginalis*) is the causative agent for the most common nonviral sexually-transmitted infection, called trichomoniasis. Although most infected individuals are asymptomatic, symptomatic trichomoniasis is higher in women than men. Unresolved or persistent trichomoniasis infection leads to various complications, including infertility, pelvic inflammatory disease, increased HIV susceptibility, and cervical cancer risk. In vivo evidence in humans has identified neutrophils (PMNs) as the primary immune cell recruited to the site of infection to combat *T. vaginalis*. However, PMNs do not utilize the three classical known effector functions of phagocytosis, degranulation, or NETosis against *T. vaginalis*. Instead, PMNs use a fourth novel function called trogocytosis. PMNs surround *T. vaginalis* parasites and proceed to remove small pieces of *T. vaginalis*' cell membrane until the parasite dies. However, the mechanism and pathways that facilitate PMN contact, trogocytosis, and killing of *T. vaginalis* parasites remain unknown. We hypothesized that (1) antibodies, (2) cell surface antibody receptors, and (3) signaling pathways downstream for these receptors are required for PMNs to perform trogocytic killing of *T. vaginalis*. First, we hypothesize that human antibodies, specifically IgG antibodies, bridge the contact between PMNs and *T. vaginalis* during trogocytosis. Here, we show that human antibodies IgG1, IgG2, and IgG3 were present on the surface of serum-coated *T. vaginalis* parasites. Second, we hypothesize that two PMN antibody receptors, specifically FcγRI and FcγRIII, mediate PMN trogocytic killing of *T. vaginalis*. Here, we show that FcγRI, not FcγRIII, is present on the cell surface of terminally differentiated neutrophil-like cells (NLCs) derived from HL-60 or PLB985 promyelocytic stem cell-like model. The knockout of FcγRI in NLCs led to a minor reduction of the cytotoxic killing of *T. vaginalis*. Third, we hypothesize that spleen tyrosine kinase (Syk), a signaling intermediate downstream of Fc Receptors in PMNs, may be involved in PMN



trogocytic killing of *T. vaginalis*. Here, we show that inhibition of Syk kinase significantly reduced cytotoxic killing of *T. vaginalis* parasites by NLCs. Our results may provide a greater understanding of the current immunological response against *T. vaginalis*, potentially informing the development of novel therapeutics or vaccines.

**40. Garlic's effects on LPS-induced TNF- $\alpha$  secretion through NF- $\kappa$ B Signaling in J774A.1 murine macrophages**

Esbai Rabadan, Advisor: Nancy Buckley

Garlic (*Allium sativum*) has been used for thousands of years for its medicinal benefits, including its immuno-regulatory effects. In the case of infections, macrophages, specialized immune cells, can detect and remove pathogens. Macrophages have many functions including the production of cytokines, small proteins that are important in cell signaling. Macrophages are a major producer of the pro-inflammatory cytokine tumor necrosis factor- $\alpha$  (TNF- $\alpha$ ). Lipopolysaccharide (LPS), an outer membrane component of Gram-negative bacteria can bind to specialized receptors on macrophages called toll-like receptor-4, (TLR4). LPS binding to TLR4 causes cells to produce cytokines such as TNF- $\alpha$ , by initiating a signaling cascade that includes the translocation of the transcription factor known as nuclear factor kappa beta (NF- $\kappa$ B). NF- $\kappa$ B is known to be necessary for the transcription of TNF- $\alpha$ . Previous studies have shown that aqueous garlic stimulates LPS-induced TNF- $\alpha$  production in J774A.1 cells (mouse macrophage cells). This project aims to investigate whether garlic's effects are mediated via NF- $\kappa$ B, whether garlic modulates NF- $\kappa$ B translocation induced by LPS. To carry out this project, J774A.1 murine macrophages were treated with pyrogen-free water (PFW), garlic at a dilution of 1:500, LPS+PFW, or LPS+G in the absence or presence of the NF- $\kappa$ B inhibitor SN50 (18 $\mu$ M final concentration in well). Our findings suggest that NF- $\kappa$ B is partially mediating garlic's effects on LPS-induced TNF- $\alpha$  secretion because TNF- $\alpha$  secretion is significantly reduced, but not totally, in the presence of the NF- $\kappa$ B inhibitor.

**41. Characterizing the activation of brain regions in a dopamine mutant that fails to entrain circadian activity to scheduled mealtime**

David Banuelos, Ricardo Nunez-Gomez, Jason Lee, Jacueline Trzeciak, Andrew Steele, Advisor: Andrew Steele

The brain region responsible for food anticipatory activity (FAA) has yet to be discovered. Our aim is to locate the exact region and cell type that is responsible for FAA by staining for markers of neuronal activity. We utilized mice with a conditional deletion of tyrosine hydroxylase in calbindin1 neurons (TH cKO) and in wild type mice to isolate feeding patterns in the brain that correlate to FAA. Brain samples were collected from mice, sectioned, and stained with antibodies against c-Fos, which is a marker for activation, pre- and post- mealtimes. The current results indicate activations in the hypothalamus, amygdala, midbrain and cerebral cortex for both wild type and TH cKO mice, with particularly high staining in the TH cKO mice prior to feeding.

**42. Orange Pomace Processing & Utilization Based on Antimicrobial Properties**

Francisco Sierra, Alvin Choi, Advisor: Yao Olive Li

This study sought to determine the impact of orange pomace (OP) processing onto the quality of subsequent OP powder and to optimize the OP powder for use in both practical and analytical applications. Processing variables such as drying time and temperature, grinding specificity, and grinding time were analyzed based on their impact on water activity, moisture content, particle size distribution, and yield of powder during grinding processes. An optimized process was then developed, and an optimal OP powder specification was proposed. Results showed that a very low water activity, low moisture content powder could be produced consistently at 160°F for 10 hours with a favorable particle size distribution and 99%+ yield in both non-specific and specific grinding methods. OP powder produced to these specifications have been used in parallel studies to compare its antimicrobial effect to pure polyphenol assays. Further use of OP powder as food additives, processing aids, and active packaging are also being pursued and proposed.

**43. Bite Rates & Chafing Behavior of Two Acanthurids, Convict and Yellow Tang**

Amaris Bellord, Advisor: Jeremy Claisse

Convict Tang (*Acanthurus triostegus*) and Yellow Tang (*Zebrasoma flavescens*) are similarly-sized reef fish of the family Acanthuridae commonly observed in the waters of the Big Island of Hawai'i. Members of each species (n=40) were observed at Puako Bay (Hawai'i County, Hawai'i, USA) for 3-minute intervals to determine feeding rate (number of bites per minute). The incidence of a behavior described as 'chafing' in the literature was also recorded. Convict Tang feeding rate (mean: 29.35, 95% CI: 25.90 to 32.8) was 2.3 times higher (mean difference: 20.5, 95% CI: 15.6 to 25.4,  $p < .0001$ ) than that of Yellow Tang (mean: 8.88, 95% CI: 5.42 to 12.3). In addition, 80% of Convict Tang 'chafed' as opposed to only 12.5% of Yellow Tang.

**44. Evaluating Antimicrobial Effects of Orange Pomace on Foodborne Pathogens**

Jack Antich, Advisors: Wei-Jen Lin, Yao Olive Li

Orange pomace, a by-product of the juicing process, is abundant in phenolic compounds and could be applied as valued-added ingredients for functional food applications. This study examined the potential antimicrobial effects of processed orange pomace and its associated polyphenols. In addition, modified forms of these compounds were evaluated to determine if chemical or enzymatic transformations improved antimicrobial effects. The compounds naringin, naringenin, hesperidin, hesperetin, and limonene were tested against a variety of pathogenic and food spoilage organisms using minimum inhibitory concentration (MIC) assay. The concentration at which the microbial growth was inhibited was recorded and compared to solvent controls containing only the solvent that was used to solubilize the polyphenol compound in the culture medium. Results show that the modified polyphenols have a stronger antimicrobial effect than the naturally occurring forms, specifically, naringenin, the aglycone part of its naturally occurring flavanone glycoside naringin after the removal of the sugar moiety, seemed to present stronger antimicrobial effect against the two Gram positive bacteria tested, *Listeria monocytogenes* and

*Staphylococcus aureus*. The ongoing tests include to compare hesperetin (the aglycone form) versus its naturally occurring glycoside, hesperidin. The results from this project will greatly support a parallel study, where orange pomace is utilized as a food-grade ingredient or processing additive for a variety of food and packaging applications, especially for extended shelf life based on its potential antimicrobial effects.

#### 45. **The World of Scientists Podcast**

Jennifer Flores Moreno, Kimberly Aguilar, Advisor: Kenneth Lam

Post-pandemic, there has been a need to reconnect students to the classroom, their majors, and departments. Fortunately, podcasts have served as effective educational interventions for undergraduate students to learn about the different voices in the STEM field. To bridge the gap here at Cal Poly, The World of Scientists Podcast interviews STEM faculty, highlighting their past academic and career experiences so students have an accessible way to learn about their faculty and career pathways available to them. The podcast is currently being implemented into BIO 1220L: Foundations of Biology Lab to investigate if 1. Do biology students at Cal Poly Pomona find podcasts in the classroom useful and 2. Does an on-campus podcast highlighting STEM faculty experiences have a greater impact versus a non-campus affiliated podcast. Results from this project will build on the current work investigating media interventions in the classroom and how students' identities are affected by relevant scientist narratives.

#### 46. **HIF-2a Staining of L-EC II Cells**

Alexis Guardado, Nayeli Rocha, Alondra Matos, Jose Ortiz, Shrugal Mudunuri, Advisor: Glenn Kageyama

Dementia is a typical symptom of Alzheimer's disease (AD). However, in approximately 30% of cases of people diagnosed with Alzheimer's neuropathy are non-demented. Individuals diagnosed with Alzheimer's neuropathy but do not display signs of dementia are termed Non-demented individuals with Alzheimer's neuropathy (NDAN). These individuals are able to maintain their cognitive function while simultaneously holding on to neurons that are otherwise absent in AD.

The Kageyama group have preliminary evidence to suggest that brains in NDAN cases may be hypoxically adapted, as suggested by the presence of the elevated levels of HIF2a. The dentate gyrus (DG) is a structure found in the hippocampus that holds granule cells while the CA4 area in the brain is an extension of the CA3 with a role in memory. However, there is little evidence showing AD to affect the CA4 or the DG granule cells. Students were taught how to distinguish between cells on thirteen HIF2a stained images of both CA4 and DG at 20x magnification. Students assigned HIF2a CA4 counted neurons, astrocytes, oligodendrocytes, and pericytes, as well as measured the area of the largest HIF2a+ and HIF2a- neurons. The neurons were categorized by localization of HIF2a. Analysis of the dentate gyrus was performed via HIF2a+ and HIF2a- neuron and blood vessels count. All data was recorded on an excel spreadsheet organized by cell type and their score which was used as a method to label what was visible in an image (between 0 and +4).

The purpose of this study was to determine if there was a significant difference in count and measurements for HIF2a+ and HIF2a- neurons between a patient diagnosed with AD as opposed to NDAN. The results revealed that NDAN cases have almost double the amount of HIF2a+ compared to AD in the DG; AD cases have HIF2a+ in 9% of neurons while NDAN cases have HIF2a+ in 17% of neurons within the CA4 region.

**47. Exploring social housing as a modulator of food entrainment in mice**

Kalif Johnson, Advisor: Andrew Steele

The goal of our project is to understand the effects of social housing compared to single housing of mice on a restricted feeding schedule for 1) body weight, 2) temperature regulation, 3) activity, and 4) food intake. Preceding this experiment, studies of food entrainment in rodents are typically always done on single housed mice to make recording behavior simpler. Mice are normally in social settings, and we sought to explore how social housing influences circadian entrainment to scheduled feeding. We implanted nanotags subcutaneously to record temperature and activity of mice in group housed settings and compared them to mice from single housed data. We also measured food intake and body weight for both groups of mice as they underwent temporal food restriction, with 3 hours of food access every day. Finally, we also explored their response to a mealtime shift: after day 21 of the experiment the food availability was shifted to an earlier time (by 3 hours). This research is still in progress, but our tentative conclusion is that mice show food entrainment under social conditions similar to that of single housed conditions.

**48. Analysis of HIF2a staining in the CA1 Region of the Brain**

Yaman Sebai, Amir-Hadi Boroumand, Aliuddin Khaja, Makayla Chin, Ayah Elsamad, Advisor: Glenn Kageyama

Alzheimer's disease (AD) is a neurodegenerative disorder that leads to neuronal loss and dementia. However, some individuals with AD neuropathy remain cognitive: NDAN (Non-Demented with Alzheimer's Neuropathy). It is hypothesized that HIF-2a, a hypoxic-induced transcription factor, may be one of the factors leading to hypoxic adaptation of neurons for survival within NDAN individuals. We conducted a quantitative analysis using immunohistochemically HIF-2a stained hippocampal tissue to quantify the presence and degree of staining within the CA1 subregion of the hippocampus. Our results were that HIF2a+ stained neurons in NDAN (65%) and control (65%) are much higher compared to AD (38%). This may account for the neuroprotective effect of HIF2a in NDAN.

### 49. **Computational Analysis of Human Adipogenesis**

Cristián Jiménez, Zachary Skovgaard, Advisor: Yuanxiang (Ansel) Zhao

Adipogenesis is the process of uncommitted human mesenchymal stem cells (hMSCs) differentiating into adipocytes. hMSCs can be stimulated to differentiate into adipocytes in vitro using adipogenic induction media (AIM) composed of insulin, dexamethasone, and 3-isobutyl-1-methylxanthine (IBMX). Our study aimed to construct a single-layer perceptron, a machine learning algorithm that is exceptionally good at delineating binary classifications, on features extracted from images with the goal of accurately identifying adipocytes and non-adipocytes from each other. These features included the percentage overlap between a DAPI stain (nuclei) and an ORO stain (lipid droplet), the nuclear area of a DAPI stain, and the euclidean distance between a nucleus and its first nearest neighbor. Using these features, a software program was developed to automate the process of identifying adipocytes, and non-adipocytes were capable of being identified from each other.

### 50. **Making Headway into Alzheimer's Disease: CA4 and DG Regions**

Clara Guirgis, Sara Guirgis, Dalal Oyoum, Fatima Martinez, Kim Becerra, Advisor: Glenn Kageyama

Dementia is a typical symptom of Alzheimer's disease (AD). However, in approximately 30% of cases of people diagnosed with Alzheimer's neuropathy are non-demented. Individuals diagnosed with Alzheimer's neuropathy but do not display signs of dementia are termed Non-demented individuals with Alzheimer's neuropathy (NDAN). These individuals are able to maintain their cognitive function while simultaneously holding on to neurons that are otherwise absent in AD.

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## 51. **Save Our Butterflies & Pollinators**

Emely Bonilla, Stephanie Barillas, Ashlee Eiland, Emely Ortega, Marisa Persuad, Advisor: Glenn Kageyama

Multiple veins of evidence corroborate that there is a steady decline in pollinators globally [Simon 2010]. Lepidoptera, known as butterflies and moths, are a part of this decline. Butterflies play a pivotal role in pollinating the world's flowering plants. If we do not act to preserve these distinct species from declining any further there will be a direct negative impact on our ecosystems and food supplies [Michael 2021]. Due to the current global biodiversity crisis, one of the best ways a layperson can support various pollinator species is by planting native plants. This also plays a role in water conservation, which is crucial in southern California's dry Mediterranean climate that often leads to drought throughout the region. The use of native plants allows for beautiful gardening that is environmentally friendly and can help sustain both imperiled pollinator species and native plant species.

## 52. **Effects of thatch removal at varying propagule pressures on competition between native and non-native annual species**

Brittney Sheets, Erin Questad, Advisor: Erin Questad

In native habitat restoration, it is important to limit biotic and abiotic factors that favor invasion. Analyzing mechanisms behind invasive species success and prohibiting them is key to successful native habitat restoration. One mechanism of invasion success is propagule pressure, or the amount of propagules in a community. When this pressure is high and in favor of a well-adapted invader, invasion is favored and likely. Also contributing to successful invasion of native communities is thatch and ground litter accumulation. This is especially prevalent in communities where annual species make up the majority of the biodiversity, including coastal sage scrub and grasslands. Specifically, the increase in invasive annual grass species and the thatch they produce is concerning for the establishment of native vegetation as heavy invasive grass thatch has been found to prohibit success of native forbs in California native annual communities. In an effort to increase the success of competing native forbs, mowing treatments have been used to reduce non-native annual grasses over time by decreasing their inputs to the seed bank. Combining a thatch removal and mowing approach may lead to native competitive advantage, establishment, and overall habitat restoration.

The purpose of this study is to analyze whether increasing native propagule pressure combined with a mowing and thatch removal treatment will result in the competitive advantage of native species. A field experiment will be conducted at the Voorhis Ecological Reserve on the Cal Poly Pomona campus. Native annual species will be hand-seeded at five different propagule pressures into uncaged research plots within a fenced block, with the exception of one invasive control plot receiving no seed. Half of the blocks will receive the mowing and thatch removal treatments for comparison with unmowed blocks. Photosynthetically active radiation (PAR) and red to far-red light will be measured monthly in all plots. Estimated vegetative cover data will be taken using a point intercept method at peak phenological times throughout the growing season. Trail cameras

will be used to track consumer behavior as analyzing the influence of consumers is important when applying a method that could increase their abundance. Understanding the competitive dynamics between native and invasive species in local plant communities is important to restoring and preserving native habitat effectively.

**53. Does pesticide use influence phenology and fitness of California birds? A study using citizen science data**

YuZhong Zhang, Advisor: Andrea Bonisoli Alquati

The widespread use of agricultural pesticides has proven a threat to non-target vertebrates. For example, farmland birds are in steeper decline than birds from other ecosystems, with insecticides as contributing factors. This study investigates whether agricultural insecticides are associated with negative impacts on birds' fitness, by testing whether higher insecticide use is associated with lower clutch size and fledging success, and delayed breeding dates. To this aim, we used breeding phenology and insecticide data, respectively from NestWatch and the California Department of Pesticide Regulation. From 2008 to 2018, NestWatch collected 21,276 California nest records across 87 species. Seven species accounted for 91% of total records of clutch size, clutch initiation date, and fledging success. California agriculture used >1.2 billion lbs. of insecticides from 2008 to 2018. Of the 456 active chemicals, 50 accounted for >95% of usage and 88% of total application areas. We classified them into 14 groups based on their chemical composition, mode of action, and risk level. Within group, we accounted for their individual toxicity using relative potency factors based on estimates of LD50 and ED50. Insecticides with the lowest LD50 will be used as index chemicals, while all others will be converted into the toxic equivalent of the index chemical. Insecticide usage and citizen science data have been spatially joined in a GIS framework before spatial autocorrelation analysis and regression analysis. Since habitat loss and climate change may also contribute to phenology changes and population declines, future investigations will incorporate descriptors of human disturbance, urbanization, and bioclimatic variables. This study tests the association between insecticide usage and birds' fitness, with associations potentially due to direct (toxicological) or indirect (ecological) pathways.

**54. The Effects of Lead Exposure on Turkey Vulture Migratory Flight**

David Landis, Alexanria Koedel, Pete Bloom, Andrea Bonisoli Alquati, Advisor: Andrea Bonisoli Alquati

Since 2019 California has required that nonleaded ammunition be used when hunting wildlife. This was implemented to help protect wildlife from becoming exposed to lead, a toxic metal that affects multiple systems, including the vascular and nervous system. Turkey Vultures (*Cathartes aura*) are one of many species that experience sublethal and lethal effects from ingesting lead fragments from the remains of hunted carrion. Our previous results indicate that migrant Turkey Vultures have higher Pb concentrations than resident birds, and lower antioxidant levels, possibly indicating physiological stress. Another study showed that lead exposure predicts a decrease in flight altitude and movement rate in resident Golden Eagles (*Aquila chrysaetos*). We hypothesized



a similar effect on Turkey Vulture flight, possibly exacerbated by the added metabolic stress of migration. To test this hypothesis, we placed GPS trackers on four Turkey Vulture migrants and collected blood samples to measure lead exposure. To ensure accurate analyses, the precision of utilized satellites (hdop, vdop, and time to fix) were used as filters for the data set. GPS locations were also filtered to exclude points with instantaneous speeds judged biologically implausible. Elevation values above ground level were calculated using the R package *elevatr*, and flight patterns were then visualized using the package *moveVis*. Future developments will include the analyses of movement angles, elevation, and speed, while controlling for environmental variables like wind speed and direction, temperature, and topography. We hope our study will contribute to understanding the behavioral effects of exposure to heavy metals and help promote regulatory and conservation actions.

**55. HOW MUCH SEED DO WE NEED? SUCCESS OF VARIED SEEDLING DENSITIES AND WATERING EFFORTS ON SOUTHERN CALIFORNIA SHRUBLAND RESTORATION IN PLASTIC TREE SHELTERS**

Meghan Jeffus, Advisor: Erin Questad

Southern California shrubland communities face expansive type conversion into invasive grasslands due to many anthropogenic factors. A solution to unpredictable precipitation is to add water manually as part of a restoration; though the associated costs may prove difficult in large-scale projects. Native species are outcompeted by intense propagule pressure from invasives, which can be solved by increasing the density and frequency of seeded natives. Plastic tree shelters have shown to increase plant growth success by providing favorable conditions for seedlings, though seeding annual species directly into tree shelters is relatively novel. By removing the unpredictable precipitation by watering, we predict there will be higher success at lower seeding densities, reducing the frequency of reseeding needed for successful restoration. To determine if watering is worth the additional cost, and if it influences seeding density success in a restoration, we propose an experimental restoration field experiment in tree-shelters at the John T. Lyle Center for Regenerative Studies at Cal Poly Pomona. *Amsinckia intermedia*, a species commonly utilized in restorations, has been seeded into tree shelters at varied densities from 10 to 200 seeds per shelter. In 2022, half the tree shelters were given water on a schedule based on outplant watering regimes. In 2023, half the shelters were reseeded for a second growing season. Preliminary seedling presence and amount data from both years has been collected. This study aims to quantify the effect of watering treatment on the number of seeds necessary for a successful restoration without a surplus of wasted resources and costs.

**56. Study of Cal Poly Pomona plant life and analysis of potential antimicrobial activity**

Juan Maldonado, Aaron Perez, Miguel Gutierrez, Advisor: Steve Alas

Deaths from infectious disease continue to be an issue worldwide. Antibiotics have been a pivotal tool against bacteria that can cause serious illness in people. For instance, *E. coli* infections cause approximately 265,000 illnesses in the US per year and >300 million illnesses worldwide, including nearly 200,000 deaths by diarrheagenic *E. coli* globally each year. Although treatments exist for

E.coli infection, we have seen antibiotic-resistant strains of many bacterial types throughout the world. Therefore, new antibiotics must continually be discovered or synthesized. This study intended to study the plant wildlife on the Cal Poly Pomona campus and analyze whether these plants possessed any antimicrobial activity.

## **CHEMISTRY AND BIOCHEMISTRY**

### **57. Synthesis of Substituted Isatins as Potential Antibacterial Agents**

Joanna Feng, Timmy Nguyen, Nathalie Nalbandian, Advisor: Thomas Osberger

The decline in the development of new antibiotics, combined with their overprescription against bacterial pathogens, has resulted in an increase in the antibiotic resistance cycle and accounts for much of the hospitalized-infection rates. Therefore, this represents an urgent health priority in the synthesis of novel antibiotics. Our research focuses on the expansion of substituted indole-1H-2,3-dione derivatives, most commonly known as isatin. Isatin is a heterocyclic compound with significant synthetic versatility for its highly reactive C-3 carbonyl group and N-1 amino group, whose derivatives can serve as a precursor for potential antibiotics and pharmaceuticals.

The unique properties of isatin's structure lend it to perform a broad variety of structural modifications to synthesize structurally diverse derivatives and yield a large spectrum of biological activity dependent on the substituent properties. Many of the synthetic routes involve substitutions at positions C-3, C-5, C-7, and N-alkylation reactions. Previous studies have observed the greatest antimicrobial activity when substituting electron-withdrawing groups at the C-3 and C-5 positions due to the increase in the overall lipophilic character to facilitate transport across the hydrophobic membrane.

We synthesized a library of substituted isatin derivatives to investigate how substitutions on the C-3 carbonyl and the bromination of the aromatic moiety at the C-5 and C-7 positions can affect the antibacterial properties. These derivatives involve Henry reactions, Grignard reactions, Hydroxyalkylation, and Schiff base formations through modifications on the C-3 carbonyl of isatin, 5-bromoisatin, and 7-bromoisatin. Each compound's identity was verified through NMR to ensure the success of the synthesis. We have successfully synthesized and identified 25 isatin derivatives, with product yields ranging from 51% to 90% yield. The synthesized compound library will be screened against E. coli to measure the potential antimicrobial activity.

### **58. Amino acid and sugar remobilization in the shoot-apical meristem of rice after isotopic labeling with $^{13}\text{CO}_2$ during submergence stress**

Melissa Molina-Portillo, Advisor: Gregory Barding

Intense flooding is a common environmental stressor that drastically influences the crop yield of many Southeast Asian staple foods, such as rice. When submerged under turbid water, wildtype rice activates a survival strategy, whereby they elongate leaves to outgrow the flood. This rapidly

consumes leaf starch (carbohydrate) reserves. Alternatively, some rice varieties adopt a quiescence strategy, whereby submergence results in a suppression of growth to conserve these resources until floodwaters subside. The purpose of this experiment was to quantify the remobilization of  $^{13}\text{C}$ -labeled sugars produced through photosynthesis just prior to submergence, may be converted into tricarboxylic acid cycle metabolites and amino acids. To accomplish this, rice lines varying in ability to transport sugars from cells of photosynthetic (source) to sugar consuming (sink) tissues were gassed with  $^{13}\text{CO}_2$  in plexiglass acrylic chambers. The plants underwent submergence in minimal sunlight to mimic the conditions cultivated rice plants are subjected to during periods of intense floods. The plants were then dissected to allow isolation of the shoot apex region where active growth occurs during submergence from the rest of the shoot tissue. Samples were ground to a fine powder, and then lyophilized. Amino acids such as alanine, serine, citric acid, and malic acid demonstrated observable enrichment in the plant samples treated with  $^{13}\text{CO}_2$  via gas chromatography-mass spectrometry (GC-MS). Likewise, the enrichment of key sugars such as fructose, glucose, and sucrose were observed. Ultimately, understanding carbohydrate mobilization from photosynthetic leaves to amino acids and other metabolites to regions of elongation during submergence will provide insight into the biological processes rice undergoes to survive short term submergence. This work was supported by US NSF grant IOS-1936492.

### 59. **Analysis of Cannabis Sativa L Using Comprehensive Two- Dimensional Gas Chromatography**

Manuel Sosa, Iain W.H Oswald, Twinkle Paryani, Marcos Ojeda, Advisor: Michael Page

Comprehensive two-dimensional gas chromatography (GC  $\times$  GC) is one of the most powerful analytical tools for analyzing volatile organic compounds in complex matrices. GC  $\times$  GC provides much better separation efficiency compared to traditional techniques i.e., traditional gas chromatography. GC  $\times$  GC is comprised of a primary (normal phase) and secondary (reverse phase) column, which helps preserve the separation in the first dimension while allowing further separation in the second dimension. This technique is particularly suited for analysis of the complex aroma of cannabis sativa L due to the wide diversity of secondary metabolites it can produce. As cannabis sativa L produces over two hundred known secondary metabolites that generate its unique aroma, the high separatory power of GC  $\times$  GC provides the ability to minimize co-elution of eluents, allowing for easier and more accurate characterization and quantification of these compounds. This poster will present a review of the technology through the lens of analyzing cannabis sativa L, including fundamental principles of the technique and data processing.

### 60. **Crystallographic and Structural Determination of N-heterocyclic Carbene Base and Nickel Crystal Structures Complexes**

Neil Dudeja, Briana Arreaga, Ethan Chavarin, Advisor: Chantal Stieber

N-heterocyclic carbene (NHC) derivatives are critical ligands for metal catalysis which coordinate with a variety of transition metals. The strong sigma-donating properties of NHCs allow for stable

structure formation and successful transformations in biological and chemical reactions. This work examines the structures of a newly synthesized NHC precursor and complex and their characterization using X-ray crystallography. X-ray crystallography is commonly used to determine 3-D structures of biochemical and inorganic compounds. Crystal structures can be used to determine intermolecular and intramolecular characteristics, notably bond lengths, angles, physical distances, and more. The OLEX2 program and the SHELX(T) program were used to determine the structures of an NHC precursor and nickel complex, based on crystallography data. Structural determination included collecting X-ray diffraction data, structural determination using OLEX2, refining the structure, integrating data, finding the unit cell, and checking for data discrepancies with IUCr. Combined, this work supports successful synthesis of two new molecules.

#### **61. HPLC Analysis of Quercetin in Almond Wastes**

Garrett Hockin, Advisor: Yan Liu

There has been a cultivated universal direction for the world to go towards natural renewable and sustainable resources whether in terms of energy, transportation, and many more industries as well. Particularly, in the textile dyeing industry, there is a trend to use dyes produced from plants, repurposed from agricultural wastes. Almond wastes, which involve the hulls and shells from almond production, due to their flavonoid components being known to have antiviral, antioxidant, mordanting, and antimicrobial properties. The research in this paper is aimed at optimizing the extraction of the flavonoid quercetin and performing high performance liquid chromatography, HPLC, analysis of extract samples. A series of quercetin standards were prepared from a 0.02 M of stock quercetins with MeOH, and the HPLC analysis result of quercetin standards were used to construct a calibration curve of quercetin for quantitation. Almond waste extract samples were prepared with three different solvents to monitor the effects the most efficient extraction solvent and EtOH was able to provide the strongest peak of quercetin on HPLC chromatogram. By comparing with the calibration curve, the concentration of quercetin (~ 1.8 ppm) was found the almond waste extract samples. Future goals for this project will require the next researchers to focus on optimizing the extraction of the flavonoids, which then further the extracted flavonoids study for desired properties for dye production.

#### **62. Synthesis of Macrocyclic Bisbenzyltetrahydroisoquinolines by Pictet-Spengler Cyclodimerization**

George Hernandez, Advisor: Thomas Osberger

The constant evolution of pathogenic viruses worldwide has caused millions of deaths due to growing resistances to current treatments many of which have toxic side effects. The family of Bisbenzyltetrahydroisoquinolines (BBTHIQs), compounds found in plant natural products, has shown a wide array of bioactive effects against various viral and non-viral illnesses. Of note, members of the BBTHIQ family have been found to serve as potential treatment starting points against the parasitic-borne disease leishmaniasis. Investigation into the synthesis of BBIQs thus has potential for novel drug therapies to reduce toxic side effects and potential for increased drug

metabolism and pharmacokinetic results in the prevention and treatment of leishmaniasis as well as other illnesses.

Though studies on these compounds and their synthesis have been conducted, an effective route for their total synthesis and use in drug discovery has not been advanced upon in recent years, and synthetic derivatives have not been widely studied. This study thus aims to find a pathway for the total synthesis of the core structure of the BBTHIQ Tiliageine through development and employment of modern organic synthesis and catalytic methods. We propose a short synthetic route to two linear cyclization precursors forming a key 'head-to-head' bi-aryl linkage, culminating in a planned Pictet-Spengler cyclodimerization not previously explored in the synthesis of BBTHIQs. To-date, we have accomplished several synthetic steps towards the preparation of our cyclization precursor molecules. The end goal of this study is to investigate the potential of these efficiently synthesized molecules as starting points for novel therapeutics.

### **63. Synthesis of Novel Molecules from cis-Pinonic Acid as Potential Therapeutic Agents**

Tan Tan, Advisor: Thomas Osberger

Cyclobutane compounds have been increasingly synthesized in medicinal chemistry in quest of biological effects. The oxidation of an unsaturated bicyclic monoterpene pinene results in a cyclobutane-based molecule named cis-Pinonic Acid. Previous examinations show the major antimicrobial and anti-inflammatory impacts of its derivatives. This paper focuses on synthesizing a library of cis-Pinonic acid derivatives. From the  $\alpha$ -Pinene isomer, cis-Pinonic acid is achieved using  $\text{KMnO}_4$  as an oxidizing agent under temperature control. This would follow by amide formation, and Fischer and Steglich esterification to achieve desired structures. Acyl azide formation from starting carboxylic acid with Curtius rearrangement also furnishes certain carbamate and urea derivatives using primary alcohol and amine reagents. Further derivatization aims at an alkyl-alkyl cross-coupling reaction using Ni as a metal catalyst, transforming cis-Pinonic acid into redox-active esters such as N-hydroxy phthalimide ester. The decarboxylative C-C bond formation can be achieved with suitable treatment with alkyl zinc reagents or boronic acids that may lead to complex cyclobutane-containing scaffolds. These molecules will then be screened for potential therapeutic agents, which may result in new hits for drug discovery.

### **64. Analysis of the Physicochemical Properties of a CPP Compound Collection**

Fatima Martinez, Kaitlin Paguio, Advisor: Thomas Osberger

The majority of people use medicine in their daily lives, such as painkillers, blood pressure medicine, and cholesterol medicine. In order to have these successful-working medicines, researchers go through a strenuous process known as drug discovery. Drug discovery is the process of investigating a variety of small molecules in order to find a potential molecule that can later be synthesized or developed into a medicinal drug. To accelerate this time-consuming process, researchers developed computational methods in order to classify small molecules based on certain physicochemical properties. The majority of the computational methods are derived

from Lipinski's Rule of 5, the Fragment Rule of 3, and Veber's studies. These guidelines serve to predict what makes a molecule well absorbed by the body and permeable, which correlates with increased success throughout the drug discovery process. In order to have good absorption, certain characteristics, such as their hydrophobicity, molecular weight, hydrogen bond donors, hydrogen bond acceptors, molecular flexibility, and polar surface area, fall within certain optimal ranges. We have analyzed a collection of molecules created by Cal Poly Pomona students and calculated the physicochemical properties of the collection. This study sheds light on the molecular properties of the collection and potential to become good lead-like molecules. Future directions include expanding the small molecule collection and creating a searchable database incorporating our findings.

**65. Synthesis of Nickel Complexes with para-substituted Bidentate N-Heterocyclic Carbene Ligands**  
Romualda Aquino, Advisor: Chantal Stieber

Bidentate N-heterocyclic carbenes (NHC2s) are ligands for transition metals to make homogeneous catalysts. A carbene is a carbon atom with a lone pair of electrons bound to two additional substituents that is generally highly reactive. Carbenes are strong sigma donors that make them excellent candidates for additionally activating unreactive bonds with potential for pollution reduction of small molecules such as CO<sub>2</sub>. NHC2s are formed using bis(imidazolium) salts precursors that are deprotonated by a strong base to form the free carbenes. The wingtips of the NHC2 are highly modular and can be altered depending on the imidazole starting materials. New bis(imidazolium) salts were synthesized from linking bifonazole or imidazole anilines to dibromomethane under reflux. The products were characterized using <sup>1</sup>H NMR and COSY NMR to confirm the molecular structure. Future work will be to recrystallize for further characterization of the salts and to proceed with metal coordination and CO<sub>2</sub> activation.

**66. The Effects of Hydroxyl Protective Groups on the Stereocontrolled Synthesis of Cyclobutane Compounds**

Audrey Pamaran, Advisor: Thomas Osberger

Cyclobutane rings are important in small-molecule drug discovery due to their interesting structural characteristics and physical properties. There are limited cyclobutane structures investigated for medicinal use due in part to the challenges associated with synthesizing cyclobutane compounds with control over stereochemistry. Palladium catalyzed C-H functionalization has emerged as an effective strategy for stereocontrolled synthesis of substituted cyclobutane compounds. This research focuses on the effects of hydroxyl protective groups in stereochemically synthesizing cyclobutane compounds through Pd-catalyzed C-H arylation. This project specifically focused on synthesizing protected derivatives of 2-(4-methoxycyclohexyl)-3-oxo-N-(quinolin-8-yl)cyclobutane-1-carboxamide, and exploring the effect of the protective group on the C-H arylation reaction. Protective groups explored include silyl ethers and esters, and the results of Pd-catalyzed arylation on the cyclobutane structures will be

discussed. It is expected that the results from this study will lead to a more efficient synthesis of cyclobutane compounds in the effort of expanding small molecule drug discovery.

**67. Reactivity of bidentate N-heterocyclic carbene nickel complexes with ammonium carbamate**

Caitlyn Cruz, Advisor: Chantal Stieber

Increasing CO<sub>2</sub> emissions are directly related to increasing global temperatures at such a rate that CO<sub>2</sub> reduction by nature can no longer maintain an appropriate pace to counteract human generated CO<sub>2</sub> emissions. Synthetic catalysts with first-row transition metal centers are of interest for CO<sub>2</sub> reduction, and efforts are underway to capture CO<sub>2</sub> from air. Amines are well-known capture agents, and ammonium carbamate, H<sub>2</sub>NCOONH<sub>4</sub>, is a possible amine-CO<sub>2</sub> product. In this study, bidentate N-heterocyclic carbene (NHC<sub>2</sub>) complexes with nickel, (MesNHC<sub>2</sub>R) Ni(COD)<sub>2</sub> (R = alkyl, aryl; COD = cyclooctadiene), were synthesized and reacted with H<sub>2</sub>NCOONH<sub>4</sub> in diethyl ether to study the resulting interaction with Ni. Products were characterized using <sup>1</sup>H NMR and H-<sup>1</sup>H COSY NMR, and IR spectroscopy. Results are significant for understanding possible routes to CO<sub>2</sub> reduction and incorporation.

**68. Synthesis of Bis(imidazolium) salts with Bifonazole and Aniline Substituents**

Alyssa Tran, Advisor: Chantal Stieber

Bidentate N-heterocyclic carbenes (NHC<sub>2</sub>s) are ligands for transition metals to make homogeneous catalysts. A carbene is a carbon atom with a lone pair of electrons bound to two additional substituents that is generally highly reactive. Carbenes are strong sigma donors that make them excellent candidates for additionally activating unreactive bonds with potential for pollution reduction of small molecules such as CO<sub>2</sub>. NHC<sub>2</sub>s are formed using bis(imidazolium) salts precursors that are deprotonated by a strong base to form the free carbenes. The wingtips of the NHC<sub>2</sub> are highly modular and can be altered depending on the imidazole starting materials. New bis(imidazolium) salts were synthesized from linking bifonazole or imidazole anilines to dibromomethane under reflux. The products were characterized using <sup>1</sup>H NMR and COSY NMR to confirm the molecular structure. Future work will be to recrystallize for further characterization of the salts and to proceed with metal coordination and CO<sub>2</sub> activation.

**69. Alcohol utilization by Acinetobacter radioresistens shows remarkable adaptations**

Morgan Saunders, Advisor: Rakesh Mogul

Acinetobacter radioresistens is a strain most notable for its extremotolerance and adaptability in radiation. These gram-negative pleomorphic coccobacilli show not only remarkable growth and recovery in radiation, but microbes such as Acinetobacter have been able to survive in extremely limiting and harsh conditions. On the preflight of the Mars Odyssey orbiter, A. radioresistens 50v1 was one of the few microbes found on the surface of the spacecraft, surviving multiple decontamination methods implemented by JPL. In order to prevent extraterrestrial evolution and



hindrance to spacecraft functionality, NASA ensures the sterile production of spacecraft parts, using multiple cleaning reagents in their cleanroom. This focuses our attention on microbes using alkyl groups of common cleaning reagents as a carbon source for growth. In this study, we find the activation energy, growth curves, optimal density, and growth trends for this bacterium in the presence of aqueous ethanol and low osmolarity media. Further analysis of the peculiar contamination has led us to the testing of vaporous ethanol effects on *Acinetobacter*. Throughout this project, this strain has exhibited stable logistic growth curves in temperatures ranging from 26°C to 32°C, with ethanol serving as the sole carbon source for growth. This common cleaning reagent explains *A. radioresistens* 50v1 survival in spacecraft clean rooms. Results from this project has shown *A. radioresistens* uses carbon sources from molecules that typically harm gram-negative bacterium and they are able to maintain their growth due to their remarkably low activation energy.

### 70. Investigation of thiohydroxamic acids as potential HDAC6 inhibitors, anti-cancer agents

Lauren Bradford, Yasmine Naffaa, Advisor: Mahendran Adaickapillai

Histone Acetyltransferase (HAT) and Histone Deacetylase (HDAC) enzymes are responsible for genetic regulation through acetylation and deacetylation of lysine residues on DNA. HDAC6 in particular is found in elevated levels in cancer cells, making them a great target for cancer therapy through enzyme inhibition. Vorinostat, Belinostat, and Panobinostat are current HDAC inhibitors that utilize the hydroxamic acid functional group to coordinate  $Zn^{2+}$  found in the active site, inhibiting enzymatic activity. However, these treatments lack selectivity and demonstrate toxicity. Most recent research has found HPB and HPOB to be selective to the HDAC6 enzyme, however these molecules still contribute to mutagenic effects from the Lossen Rearrangement of hydroxamic acids. This project aims to identify thiohydroxamic acids as potential HDAC6 selective inhibitors. Thiohydroxamic acid-containing model compounds have been synthesized and fully characterized with NMR and LC-MS. Furthermore, metal binding studies have been conducted to test metal coordination abilities of the thiohydroxamic acid functional group through UV-Vis spectroscopy. Preliminary results offer evidence that electron-donating groups aid the thiohydroxamic acid's coordination ability, as opposed to electron-withdrawing groups. Current studies are investigating tautomerism, thiol vs. thione, for the effects towards metal coordination of thiohydroxamic acids. This study will also review the crystal structure of suberoylanilide hydroxamic acid (SAHA) and HPB, along with their metal coordination to metal (Fe, Cu) ions.

### 71. Determination of Organic Acids in Plant Extracts Using HPLC-FSD

Chloe Pena, Caleb Cacho, Angela Gotingo, Advisor: Gregory Barding

The Krebs Cycle is an important and well-studied mechanism that is responsible for energy production during aerobic respiration. The intermediates of the Krebs cycle, however, are broadly used for other biological purposes, including signaling and chelation. Quantification of TCA cycle intermediates is not always straightforward, and we are working to develop a simple and quantitative assay for the determination of citrate and malate in a variety of matrices where

interferences can impact the outcome. For our experiment we will be utilizing 9-Chloromethyl anthracene (9-CMA), which is a derivatizing and blocking group reagent commonly used for carboxylic acids and other compounds. To test the reproducibility and linearity of our assay, we are starting with 3 concentrations of citric and malic acid in combination with 9-CMA to test its separation in a HPLC with fluorescent detection. Unfortunately, phase separation has been occurring which has caused inconclusive results within our recent separations. Next, we used an alternative solvent to ethyl acetate such as methanol to eliminate phase separation. However, this method still produced some phase separation as well. We are continuing to explore this problem of phase separation with a few different approaches. One approach is to use a completely new procedure that is still based on citric and malic acid while still using HPLC-FD. Another direction utilizing the Fischer-Esterification process, we are hoping to find a way to synthesize 9-CMA into an alcohol. This would allow for the formation of an ester through the Fischer Esterification process.

### 72. **Ligand effects in molybdenum catalyzed oxidation of benzylic alcohols**

Ivy Wang, Advisor: Alex John

Conventional reagents used in alcohol oxidation reactions pose severe economic and environmental consequences. Nevertheless, such reagents are heavily relied upon due to the fundamental role of alcohol oxidations in the chemical processes used by various industries, such as the pharmaceutical and biofuel industries. With sustainability in mind, this project intends to evaluate alternative methods of alcohol oxidation using novel dioxomolybdenum catalysts. Due to a lack of literature surrounding molybdenum catalyzed alcohol oxidations, the role of each component will be thoroughly investigated through the evaluation of a diverse range of alcohols including primary and secondary benzylic as well as aliphatic alcohols in oxidation reactions. A comprehensive understanding of ligand effects in the context of these oxidations will also be developed. Under our optimized conditions, the oxidations can be achieved over a 24-hour reaction time at 120°C using 2 mol% molybdenum catalyst in dimethyl sulfoxide, which acts as both the solvent and the oxidizing agent. As a result, the conversions and yields in these catalytic alcohol oxidation reactions vary from 20% to >99% based on the alcohol substrate used, and there is an evident efficiency linked with the use of the novel catalysts. The reaction is chemoselective and yields aldehyde as the sole oxidation product from primary alcohol substrates. A competing dehydration pathway has been observed with certain electron-rich benzylic alcohols, resulting in the formation of corresponding olefins. With further optimization, these catalysts can be assessed for large-scale industry applications with the goal of pushing industrial processes to become more environmentally friendly.

### 73. **Two Step Oxidative cleavage of Lignin Model Compound Using Metal Complexes**

Alexander Cartolano, Pauline Cho, Advisor: Alex John

The demand for petrochemicals has been steadily increasing, leading to environmental concerns. This is due to petrochemicals, such as fossil fuels, being non-renewable. To address the issue,

aromatic compounds can be obtained from a renewable biomass source, such as lignin. Lignin is the most abundant aromatic polymer in nature and has a complicated structure, making the cleavage of lignin a formidable challenge. A simple model compound was synthesized that represented a subunit of the lignin polymer. The synthesis of the model compound includes the bromination of acetophenone, synthesis of 2-phenoxy-1-phenylethanone, and reduction of 2-phenoxy-1-phenylethanone. The simple model compound was used to study the cleavage of the b-O-4 bond using metal catalysts. For the cleavage of the b-O-4 bond to occur, a two-step process is being explored. An oxidative approach was used by catalytically oxidizing secondary alcohols to ketones, then forming carboxylic acids and phenol products from bond cleavage. A molybdenum complex was used as a catalyst to perform oxidation of the model compound resulting in yields as high as 78% with a selectivity of >99%. These reactions were done at a temperature of 120°C for various times using DMSO-d<sub>6</sub> as a solvent. The identity and yield of the products were determined using NMR analysis. Future work would include optimizing the oxidation of the model compound and investigating the cleavage of the b-O-4 bond using a copper catalyst.

**74. Synthesis of bidentate N-heterocyclic carbene nickel and cobalt complexes with xylyl linkers**

Ethan Chavarin, Mei L. Matsumoto, Jacob P. Brannon, Advisor: Chantal Stieber

Bidentate N-heterocyclic carbene complexes (RNHC-2R<sub>1</sub>)M (R = alkyl or aryl; R<sub>1</sub> = alkyl; M = metal) are used as catalysts for a plethora of reactions including cross-couplings, photocatalysis, and alkyne hydrogenation. Most catalysts with NHC<sub>2</sub> ligands contain second or third row transition metals, while those with first row transition metals are less widely explored and are mostly limited to Ni and Fe. In this work, a modified ligand precursor was synthesized by reacting mesityl imidazole (MesIm) with 1,3-bis(bromomethyl)benzene to produce [MesNHC<sub>2</sub>Xy][Br]<sub>2</sub> (Mes = 2,4,6 trimethylphenyl; Xy = xylyl), which was crystallographically characterized. With the addition of the m-xylyl linker, more space between the two NHCs is created and an aryl group is added. The ligand precursor was dissolved in THF, followed by the addition of potassium bis(trimethylsilyl)amide (KHMDs) to form the free carbenes which were complexed with CoCl<sub>2</sub> and Ni(COD)<sub>2</sub> (COD = cyclooctadiene). Two novel bidentate NHC complexes were synthesized and characterized: (MesNHC<sub>2</sub>Xy)Co(Cl<sub>2</sub>) and (MesNHC<sub>2</sub>Xy)Ni(COD). These are new examples of Ni(0) and Co(II) complexes stabilized by strongly sigma donating NHC<sub>2</sub> ligands and reactivity studies are underway in our laboratory.

**75. Synthesis of Bidentate N-Heterocyclic Carbene Cobalt Nitrosyls with a Xylyl Linker**

Mei L. Matsumoto, Advisor: Chantal Stieber

N-Heterocyclic carbenes (NHC) have been used to advance catalysis due to their strongly sigma-donating abilities. Cobalt complexes are reported catalysts for reactions such as cross-coupling and alkyne hydrogenation. However, bidentate NHC (NHC<sub>2</sub>) ligands containing first-row transition metals remain less explored and are limited to nickel and iron. The ligand precursor was synthesized by reacting mesityl imidazole (MesIm) with 1,3-bis(bromomethyl)benzene, producing [MesNHC<sub>2</sub>Xy][Br]<sub>2</sub> (Mes = 2,4,6-trimethylphenyl; Xy = xylyl). The addition of the o-xylyl created

more space between the carbenes, allowing for an aryl group to be added which may improve crystallinity.  $[\text{MesNHC2Xy}][\text{Br}]_2$  was deprotonated with potassium bis(trimethylsilyl)amide (KHMDs) to create a bidentate carbene ligand to bind the cobalt metal center. A new cobalt complex,  $(\text{MesNHC2Xy})\text{CoCl}_2$ , was synthesized by reacting the free carbenes with  $\text{CoCl}_2$ . The formally Co0 reduced cobalt complex,  $(\text{MesNHC2Xy})\text{Co}(\text{N}_2)$ , was synthesized by adding a THF solution containing sodium metal and catalytic naphthalene to the cobalt complex. A cobalt nitrosyl complex,  $[(\text{MesNHC2Xy})\text{Co}(\text{NO})_2][\text{BF}_4]$ , was synthesized by reacting  $(\text{MesNHC2Xy})\text{Co}(\text{N}_2)$  with 2 NOBF<sub>4</sub>. Products were characterized by IR spectroscopy, which supports formation of new Co-N<sub>2</sub> and Co-NO bonds.

#### 76. Enzymatic and immunoassay for determination of HbA1c

Zachary Carrillo, Thuy Phuong Linh Dao, Adebola A. John, Advisor: Sean Liu

Individuals diagnosed with Diabetes Type 2 will often undergo a test every ~3 months to determine their percentage of Hemoglobin which had been glycosylated (HbA1c). Hemoglobin is an important protein in red blood cells that carries oxygen and when Hemoglobin is exposed to blood sugar in the form of glucose a reaction occurs where glucose binds to the beta (β) chains. This occurs on N terminal valine residues in the protein and is spontaneous occurring more often when blood sugar is high. Since red blood cells live on average ~3 months measuring A1c can be a good indicator of blood glucose in the body over that time. There are several means of testing for A1c concentration, two of which are an enzymatic and an antigen/antibody approach. Of the testing methods that exist many are expensive and proprietary. One goal of this research is to understand how they work and then apply the enzymes and antibodies for developing new detection platforms. For example, applying them on disposable electrodes that can be used with glucometers.

#### 77. Synthesis of a Nickel Nitrosyl Complex with Bidentate Carbene Ligands

Jessica De La Huerta, Chantal Stieber, Advisor: Chantal Stieber

Chemical methods to reduce the atmospheric emissions of ozone-depleting molecules such as N<sub>2</sub>O are of interest because of increased global warming due to human activity. This work aims to synthesize catalysts for N<sub>2</sub>O reduction and to understand the mechanism. In this study, nickel nitrosyl complexes with bidentate N-heterocyclic carbene ligands were synthesized to study how strong sigma donating NHC ligands affect nickel-NO bonds and reduction. Mesityl imidazole was synthesized and dibromomethane was added to synthesize the mesityl bis(imidazolium) salt,  $[\text{MesNHC2Me}][\text{Br}]_2$ , which was characterized by <sup>1</sup>H NMR.  $[\text{MesNHC2Me}][\text{Br}]_2$  was then deprotonated with potassium bis(trimethylsilyl)amide (KHMDs) in THF in to form the bidentate carbene ligand,  $(\text{MesNHC2Me})$ .  $(\text{MesNHC2Me})$  was then reacted with  $\text{Ni}(\text{COD})_2$  (COD = cyclooctadiene) to synthesize the complex,  $(\text{MesNHC2Me})\text{Ni}(\text{COD})$ .  $[\text{NO}][\text{BF}_4]$  was added in a one-to-one ratio to create a new Ni-NO complex  $[(\text{MesNHC2Me})\text{NiNO}][\text{BF}_4]$  and was characterized by infrared spectroscopy. Efforts are underway to characterize the complex and investigate its reactivity.

**78. Molybdenum catalyzed deoxydehydration of vicinal diols**

Binh Nguyen, Wei Chien Tang, Thomas Herrel, Daniela Eskew, Advisor: Alex John

The demand for renewable biomass derived platform chemicals as we transition from petrochemicals provided the impetus to seek efficient processes. Often, bio-based chemicals require a process that is able to reduce the highly oxygenated biomass derivative into petrochemical like compounds. One such process is deoxydehydration (DODH) of vicinal diols. Rhenium based catalysts are known to be efficient for DODH; however, its cost and renewability detracts from its attractiveness in green chemistry. Other alternatives such as vanadium and molybdenum have recently been demonstrated to be strong candidates. Yet, little is known about the mechanism of molybdenum catalyzed DODH reactions. This present study explores the kinetics of homogeneous molybdenum catalysts in DODH through a multifaceted approach. Factors such as reductants, substituents on the ligand framework, and temperatures are known influencers of catalyst performance. We sought to optimize through manipulation of these elements and evaluate the kinetics.

**79. Computational Analysis of a Copper Containing Nitrite Reductase Using X-Ray Emission Spectroscopy**

Sage Gorney, Advisor: Chantal Stieber

Denitrification is a critical component in the nitrogen cycle involves reduction of  $\text{NO}_3^-$  and  $\text{NO}_2^-$  to  $\text{N}_2$  and  $\text{O}_2$ . All stages of denitrification are catalyzed by complex metalloenzymes inside soil bacteria, each with their own transition metal cofactors. The catalysts used during nitrite reduction to nitric oxide are nitrite reductases (NiRs). There are two main types of NiRs, one with an iron cofactor (cd1NiRs) and the other with copper (CuNiRs). The mechanisms of CuNiRs are currently not well-understood, partly due to the challenge of probing reactivity at metal centers inside large enzymes. Recent computational work reports possible intermediates in  $\text{NO}_2^-$  reduction by CuNiRs, however it is lacking experimental corroboration. X-Ray Emission Spectroscopy (XES) is a element-specific technique that has potential to be used to probe electronic structures and coordination environments of CuNiR. In XES, X-ray photons bombard a sample, exciting a 1s core electron and leaving a hole for the other electrons to fill. When electrons relax to fill a lower energy level, they give off a certain amount of measurable energy, which is what is detected in an XES experiment. Typical ranges for XES spectra for copper is in the region of 8010-8070 eV, and DFT calculated XES have shown good agreement with experimental data. The goal of this research is to computationally probe the potential of XES to distinguish proposed intermediates in  $\text{NO}_2^-$  reduction. DFT calculations were conducted for 8 proposed states of the active site in CuNiR. Calculated XES spectra are distinct for each of the 8 states, suggesting that experimental XES could be used to distinguish these. Orbital contributions to XES signals showed that shifts in certain signals could be attributed to changes in the nitrite/nitric oxide binding conformations.

Overall, these computational results suggest that XES could be used to experimentally distinguish intermediates in CuNiR.

**80. Computational X-ray emission spectroscopy for identification of [Cu<sub>2</sub>O]<sup>2+</sup> and [Cu<sub>2</sub>O]<sup>2+</sup> intermediates in methane C-H activation by copper-exchanged zeolites**

Zachary Tam, Advisor: Chantal Stieber

Copper zeolites have the ability to directly convert methane to methanol through activation of a C-H bond. Previous computational studies identified seven key intermediates in methane C-H activation and determined that C-H activation occurred at the [Cu<sub>2</sub>O]<sup>2+</sup> core, which directly correlates with Cu<sup>2+</sup>/Cu<sup>+</sup> redox couple. Experimental characterization of these intermediates is challenging due to the multi-metallic center and limited experimental probes. In order to further understand the active site intermediates, X-ray Emission Spectroscopy (XES) valence-to-core (VtC) spectra were calculated to see if XES would be able to experimentally distinguish the proposed intermediates. Using the ORCA program, density functional theory (DFT) calculations were conducted to calculate the VtC XES of the seven previously proposed intermediates. Orbital contributions to the calculated XES spectra were analyzed for each structure. Between energies 8725 eV to 8735 eV orbital contributions suggest a high sensitivity of XES to detecting subtle changes in the [Cu<sub>2</sub>O]<sup>2+</sup> core and interactions with methane. This work supports that experimental XES should be able to distinguish zeolite intermediates in methane activation.

**81. Synthesis of nickel complex with bidentate N-heterocyclic carbene ligand with pyridyl wingtips, (pyNHC<sub>2</sub>O<sub>Xy</sub>)<sub>2</sub>N**

Carlos Gutierrez, Advisor: Chantal Stieber

N-heterocyclic carbenes are common ligands for transition metals and stabilize catalysts through strong sigma donation by the carbene. Bidentate carbene (NHC<sub>2</sub>) ligands offer additional stability through two coordination sites resulting in a chelate effect. This work aims to synthesize NHC<sub>2</sub> ligands with additional pyridyl wingtips that could result in tetradentate coordination, and/or facilitate reactivity in a secondary coordination sphere. The imidazole starting material (2-(1H-imidazol-1-yl)pyridine (pyIm) was synthesized in a synthetic approach that is not reported for pyIm. The ligand precursor salt [pyNHC<sub>2</sub>O<sub>Xy</sub>][Br]<sub>2</sub> was synthesized from ortho-xylylene dibromide and 2 equivalents of pyIm, and characterized with <sup>1</sup>H NMR spectroscopy. [pyNHC<sub>2</sub>O<sub>Xy</sub>][Br]<sub>2</sub> was deprotonated with 2 equivalents of KHMDS and reacted with bis(cyclooctadiene)nickel(0). Characterization by FTIR confirms the removal of bromide counterions, suggesting the formation of a metal complex. The next step is to conduct further structural characterization via <sup>1</sup>H NMR and X-ray crystallography.

**82. Synthesis of Novel Cyclobutane Fragments**

Jessica Coronel, Kimchou Lao, Dani Rodriguez, Advisor: Thomas Osberger

Cyclobutane molecules hold a conformational rigidity and other characteristics that improve metabolic stability and physiochemical properties favored in fragment-based drug discovery (FBDD). Three-dimensional fragment libraries are growing in popularity for the analysis and development of potential medicinal drugs. The representation of three-dimensional molecular compounds allows for the display of regioselective characteristics of the molecules in question in contrast of “flat” compounds. At the start of 2022, FDA-approved drugs such as vemurafenib, venetoclax, ribociclib and others have emerged with the help of FBDD. An inconsistency that hinders FBDD is the lack of three-dimensional compounds that display the stereochemical characteristics of the molecules. Our research developed novel cyclobutane fragments through the functionalization of C(sp<sup>3</sup>)-H bonds using palladium acetate as a catalyst in the arylation of sp<sup>3</sup> C-H bonds, exploring the effects of protecting groups on the efficiency of the reaction. Purification methods includes recrystallization and silica gel chromatography. Nuclear magnetic resonance (NMR) served as the method of analysis and identification of the cyclobutane products. The collection of novel cyclobutane fragments in their respective diastereomerically pure forms are important factors that will contribute to the medicinal chemistry field for the future development of drugs.

### 83. **Synthesis and Characterization of a Visible Light Absorbing Molecule: Towards New Pharmaceuticals**

Seraiah Kinslow, Advisor: Thomas Osberger

In today’s society the discovery of new medicines is crucial to maintain global health and proactively address new threats to it. The synthesis and discovery of small organic molecules continues to be an important source of new medicines. Consequently, the exploration of new chemical reactivity can enable more efficient pharmaceutical production. We are interested in discovering new reactivity of compounds through their interactions with visible light, a field called photochemistry.

Herein, we report the synthesis of and photochemical studies on N-methyl-5-bromo-3-nitromethylideneoxindole (1). Starting from commercially available 5-bromoisatin, N-methylation proceeded in 63% yield and the structure was confirmed by NMR spectroscopy. This material was subjected to the Henry reaction to afford crude 1, which was purified and characterized by NMR and UV-Vis spectroscopy. The results of this work confirm previous studies and will provide the foundation for developing visible light-promoted photochemistry for the synthesis of novel pharmaceuticals.

## COMPUTER SCIENCE

### 84. **Cloud Based Electric/Utility Bill Management System**

Christopher Hoang, Advisor: Mohammad Husain

As companies expand into an online and digital space, the need to have a mobile or web



application for payment and bill management increases. By using a link to access the web application, customers can easily access their own bills and employees can make changes as efficiently as possible. A website was created to utilize cloud based technology in order to provide an application that makes management streamlined for electric bills. It is implemented and hosted using Amazon Web Services (AWS), utilizing the Elastic Beanstalk and RDS database services. Elastic Beanstalk allows for deployment and hosting the website, whereas RDS uses MySQL to hold database information. The frontend was developed using HTML, CSS, JavaScript, and the backend is a Flask Python project. The application additionally uses a role based access control (RBAC) system, which defines users into specific roles and permissions based on their role. Users are split into customers, regular employees, and administrators. Customers can view recent payments and make new payments, while regular employees can add bills to the system as well as add, update, or delete bills or customers from the system. Administrators have ultimate control and can manage employees. The result is that users are able to quickly view and manage their bills or other users. The usage of AWS allows seamless integration and deployment.

### 85. **Predicting the Duration of Flight Delays Using PyTorch**

Justin Kim, Advisor: Mohammad Husain

With millions of flights flying domestically within the U.S. each year, flight delays have been a significant concern for both the passengers and airlines. The inconvenience of unexpected delays can financially affect the passengers and airlines. These delays could also decrease the customer satisfaction and overall experience of the passengers. By predicting the length of flight delays, it can help passengers and airlines to make informed decisions about scheduling flights. Using historical data of flights from 2005 and leveraging deep learning in PyTorch, two different models were created to predict delays using regression and classification. Both used data for the distance in miles, planned departure and arrival times, month, day of the week, carrier, and destination. The final regression model had a resulting average error of 85.26 minutes while the final classification model had an accuracy of 59.38%. While the regression model had a considerably high error, the classification model showed some promise. In future models, with the addition of weather and previous aircraft delay data, the accuracy of the classification model could be improved.

### 86. **What factors affect a movie's success at the box office? A comparison between 1999 & 2019**

Dylan Ton, Advisor: Mohammad Husain

Over the past two decades, the film industry has undergone considerable transformations, driven by technological advancements, shifting audience preferences, and evolving market dynamics. These changes have prompted a reevaluation of the factors that contribute to a movie's success, as certain elements that once held significant influence may no longer be as prominent. The objective of this research project is to conduct a comprehensive comparative analysis of the determinants of a successful movie in 1999 and 2019, focusing on the following factors: movie ID, title, rating, genre, year, month, IMDb score, IMDb votes, director, writer, star, country, budget,

gross, studio, and runtime. The findings of this research will provide valuable insights for filmmakers, producers, and industry stakeholders, enabling them to adapt to the evolving landscape of film production and audience expectations. By identifying the key elements that have shaped box office performance, and understanding how their importance has shifted over time, the study will contribute to the maximization of success in future cinematic endeavors.

### 87. **Analyzing Transformer-based AI agents for Codenames**

Zhong Ooi, Advisor: Markus Eger

Codenames, created by Vlaada Chtil, is a word association game where a player is given 25 words and needs to generate a word and number pair to convey information that connects a subset of the given words to another group of players. This project is an extension of the "Cooperation and Codenames: Understanding Natural Language Processing via Codenames" by Kim et al., which uses Codenames as the medium to test the capabilities of natural language processing models. With a breakthrough in natural language processing through the creation of the transformer, the ability of natural language processing has increased dramatically. This project seeks to use this new technology to build an AI agent to play Codenames and use the medium of Codenames to compare these new agents against the existing baseline. Through this comparison, this project seeks to see if the new technology performs better in single-word sentence similarity when compared to Word2Vec and Glove. The agents will be evaluated based on their performance against AI agents built with and without the same natural language processing model in the backend.

### 88. **3D Image Classification of the ADNI1 Completed 3Y 1.5T Dataset**

Jose Ortiz, Advisor: Honggang Wang

The purpose of this project is to be able to identify whether a subject is cognitive normal (CN), mild cognitive impairment (MCI), or Alzheimer's Disease. It does this by integrating 3D volumetric data from magnetic resonance imaging (MRI) and meta/tabular data to train a joint model using the integrated data in an effort to deliver better predictions. The Alzheimer's Disease Neuroimaging Initiative (ADNI), provides the dataset used in this project, namely the, ""ADNI1 Completed 3Y 1.5T."" The imaging data is loaded into a built 3D convoluted neural network (CNN) which implements the NiBabel library to process the MRI scans. The metadata is prepared using OneHotEncoder and fed into a two-layer neural network with normalization and a ReLU activation. The process is expected to deliver an ROC AUC score of approximately 0.85, leaving room for improvement. Future efforts include using a more robust platform, such as cloud computing to handle training on larger datasets, which would lead to better results.

### 89. **Multiplayer Chess and Development of Game Variants**

Brandon Chao, Advisor: Mohammad Husain

Chess is a complex game that has been played for many years. Professionals learn multiple strategies in an attempt to gain advantages. Computers have also proved a crucial component of the game. With the use of Stockfish, the current AI model, players can simulate moves to understand the pitfalls and advantages of a certain move. The advantage the computer has over an individual is that its memory is purely limited by the system rather than human intuition and memory. In recent times, many grandmasters are bridging the gap and are able to recount multiple patterns. As such the game has come to a point where a winner and loser is clearly obvious based on a few moves. To reinvigorate the chess game, some tournaments have introduced simple changes to the game. The most common is rearranging the pieces into a different configurations. As such common patterns that were previously memorized had little help when playing the new formations. Players had to purely rely on their technical skills. The hope of this project is to create a chess AI model which is able to adapt to the board settings.

### 90. **Self-Driving Car Simulator**

Brandon Chao, Chun-Cheng Lee, Luc Saikali, Alondra Marin, Luis Ruiz, Advisor: Yunsheng Wang

This research project explores the convergence of artificial intelligence (AI) and Internet of Things (IoT) technologies to create a self-driving car that can enhance road safety and efficiency. We aim to develop a simulation environment utilizing a range of software and hardware tools such as LG SVL, ROS2, Autoware, QCar, Logitech G923, Nvidia Drive Orin Camera, IMU, and Lidar. The simulation environment will enable control from either an end user or the AI model, with the ultimate goal of deploying the AI model onto a physical robot. This project has potential to create opportunities for professional drivers to train or race for competitions, and individuals with health conditions or impairments to learn how to drive or have access to autonomous transportation. Our research could advance the realization of safe and efficient transportation, and revolutionize the automotive industry.

### 91. **ATM Replenishment Schedule**

Britany Flores, Advisor: Mohammad Husain

ATMs are the main means of cash supply and reduce banks' operating costs and improve customer experience. An ATM that's out of cash can negatively impact the reputation of the bank, on the other hand, an ATM that is overfilled costs more. The aim of cash replenishment planning is to reduce replenishment costs through efficient planning that benefits both the financial institutions and third-party companies. This project aimed to create a more efficient ATM Replenishment Schedule. In this project, past data from an ATM was analyzed using a forecasting model to find a better ATM replenishment schedule.

### 92. **Leveraging Large-Scale Social Media Metadata Using Neural Networks to Understand User Sentiment Towards Health Policies**

Isaiah Hessler, Henry Hu, Austin Martinez, Advisor: John Korah

The health policies and concerns that Covid-19 brought about became a controversial topic of discussion in the early 2020's. Whether it was due to location, culture, religion, family, or any other set of reasons, the response from the American public was widely split on the matter. In order to help ease the spread of important health policies and medical information, and understand the public's response, we are in need of a predictive model that can apply itself to future studies on the matter. By scraping the Twitter API for public response to health policies and using sentiment analysis to quantify the pathos of these responses and create a relationship-based social network, a neural network trained to recognize the pattern of the spread of medical-based information travels through the public is being created. In the future, this program will allow for those in the government and the medical field to understand the public response to medical advice and policies.

### 93. **Bemo Bounty Hunter**

Rebecca Lee, Kayte Chen, Joshua Barrientos, Advisor: Markus Eger

This project, Bemo Bounty Hunter, is a VR game that simulates an underwater environment. As the player, your goal is to find and catch Bemo, the capture target, with your net. After doing so, it initiates the process to go to the next level. The game features three different levels with increasing difficulties and multiple different endings.

Bemo Bounty Hunter is a showcase for the physicality provided by VR. The game capitalizes on its underwater environment by forcing players to make swimming motions to move, while inertia will cause them to slowly sink to the ocean floor. Players must manually swing their nets to capture fish.

### 94. **Security Vulnerabilities of Discord**

Krista Zargarian, Advisor: Mohammad Husain

Discord is a popular web and mobile application that uses voice, video, and text chat to communicate with anyone ages 13 and up. However, like most online platforms, Discord is not immune to security vulnerabilities. There are hackers and malicious actors that may attempt to exploit vulnerabilities in Discord's security protocols to gain unauthorized access to user accounts or obtain sensitive information. One way to track these potential security vulnerabilities on Discord is to monitor IP addresses that are associated with suspicious activity. To do this, I used Wireshark to capture packets on two virtual machines. Wireshark is a powerful packet sniffing tool that can capture and analyze network traffic, such as IP addresses. I created a "testing" Discord account to send my personal Discord account a text message and track the IP addresses of the activity. By tracking IP addresses, security professionals can identify the geographic location of a

user and potentially detect unusual or malicious activity that may indicate a security breach. Wireshark also releases the different protocols that were found in the capture; therefore, I can identify and narrow down what exactly I am looking for.

### 95. **CPP VR Lab: Drone Training Simulator**

Samantha Macaraniag, Laurence Garcia, Daniel Appel, Rida Siddiqui, Devan Mamawag, Sar Estefania Chavez, Grecia Alvarado, Advisor: Markus Eger

This project was developed for the VR Lab Senior Project. It's a virtual reality simulation that allows the user to fly a drone in simulated real-life environments and weather conditions.

### 96. **Drone Detection and Mitigation**

Edwin Ly, Dianne Lopez, Michael Tang, Samuel Raumin, Advisor: Mohammad Husain

The consumer drone market has greatly increased due to the wide array of capabilities that drones provide. Unmanned Aerial Vehicles (UAVs) provide real-time video and image capture, along with the ability to transport goods, making them lucrative for commercial and private use. However, UAVs are also being exploited to jeopardize people's privacy and well-being. To help counter these threats, we utilize Software Defined Radios (SDRs) such as the HackRF One in conjunction with GNU Radio to detect the presence of drones. To classify the drones model and brand, data collected from SDRs and processed through GNU Radio will be used to train machine learning models. Based on the classification of the drone, we can safely land the drone through mitigation techniques.

### 97. **CPP VR Lab: Push Down Automata VR Maze**

Daniel Gruhn, Isaac Diaz, Alex Gomez, Joshua Lai, Advisor: Markus Eger

This project is intended to be a teaching tool for the topic "Pushdown Automata" within the field of "Formal Languages and Automata." The player must navigate to the end of a labyrinth by obtaining the correct gems to move between each room. As the player navigates through the maze, they will gain different abilities based on the gems they have collected.

### 98. **Purrfect Pizza**

Janet Cho, Anita Mehrazarin, Brandon Moya, Gaia Dennison, Marty Scott, Thongsavik Sirivong, Advisor: Markus Eger

Purrfect Pizza is a virtual reality cooking simulation game meant to help teach the concept of the pumping lemma for regular languages in CS 3110, Formal Languages and Automata. The pumping lemma for regular languages states that all strings or words of a sufficient length in a regular language may have a middle section of the string repeated an arbitrary number of times to

produce a new string that is also part of the language. The game aims to create a fun, gamified demonstration of the essential concepts of the pumping lemma.

### 99. **FSA Rabbits**

Christopher Tomes, Emily Perez, Alec Urbany, Jason Rowley, George Matta, Advisor: Markus Eger

This game is about catching rabbits in a maze. The maze represents a Finite State Automaton (FSA). The rabbits follow a path through this maze according to the FSA rules and their assigned name. The player must figure out the FSA to catch the rabbits and return them to the starting room.

### 100. **Cybersecurity VR training**

Kennedy Janto, Alvan Zhuang, Viet Nguyen, Andrew Kim, Viswadeep Manam, Advisor: Markus Eger

A virtual reality simulation of scenarios where the player is getting scammed. The player must choose options to protect themselves from the danger of social engineering. This project trains people on cybersecurity and how to stay safe online.

### 101. **Unmanned Aerial Vehicles for Precision Agriculture using Remote Sensing and Machine Learning**

Jonathan Pena, Advisor: Amar Raheja

This study explores the use of remote sensing technology to optimize water, fertilizer, and pesticide use in California agriculture, addressing the challenges posed by climate change, labor shortages, and environmental concerns. The team used unmanned aerial vehicles (UAVs) equipped with multispectral and hyperspectral sensors to capture real-time data on crop health and soil moisture levels, focusing on indicators such as chlorophyll, nitrogen, water, and the normalized difference vegetation index. Raw data was processed and analyzed to extract information that can be used to train machine learning models. The results showed that machine learning models can be used to inform decisions about the amount of water and nitrogen fertilizer to be applied to crops, reducing waste, and minimizing environmental impact while improving overall efficiency in California agriculture. This study demonstrates the potential of remote sensing technology to address critical challenges facing the agriculture industry in the face of climate change and other disruptive forces.

### 102. **Boston Dynamics Spot Robot - Package Delivery**

Aaron Do, Neil Patrick, Francisco Serrano, Samanyu Satheesh, Jessica Ortega, Advisor: Daisy Tang

This project aims to develop a package delivery software for the Boston Dynamics Spot robot, which can autonomously navigate and deliver packages to designated locations in indoor and outdoor environments. The software will utilize various sensors and advanced algorithms to enable the robot to detect obstacles, plan efficient routes, and safely transport packages while avoiding collisions. The proposed package delivery software will offer an innovative and practical solution for assisting handicapped individuals, reducing human labor and increasing delivery efficiency. This project is expected to contribute to the development of autonomous robotic systems and pave the way for more advanced applications in the field of robotics and automation.

### 103. **Network Intrusion Detection System Using Machine Learning Classifiers**

Bryan Orellana De La Cruz, Advisor: Abdelfattah Amamra

Monitoring network traffic data is important for making sure that there is no malicious activity present, but that becomes difficult and time-consuming when analyzing large amounts of data traffic.

This project focuses on improving network intrusion detection using machine learning classifiers, specifically using Isolation Forest and K-Means Clustering algorithms to analyze HTTP logs from PCAP files. The algorithm classified the logs based on deviations in the attributes we wanted to examine, that being the communication between client and responder. The classifications and its details made it easier to detect anomalies and understand how they deviate, which also makes it easier to find potential malicious activity in large amounts of traffic.

Future research could explore the use of different machine learning models that can make the algorithm more efficient at anomaly detection.

### 104. **Edge Computing Framework for Crop Suitability Modeling**

Gareth G. Waughan, Shubhrose Singh, Advisor: John Korah

Crop suitability modeling uses remote sensing data to support decision-making for farmers and agricultural planners. Effective modeling requires high-resolution images which are scarce and often too large to quickly transfer to the cloud. In our project, we use a combination of edge devices and cloud resources to generate high-resolution data that is required for crop suitability. Previous studies have shown that edge computing frameworks offer a way to offload computation to the edge to reduce the load on cloud computing resources. Studies also find that spatiotemporal fusion methods are most sufficient in generating satellite imagery with high spatial and temporal resolutions. In addition, NDVI is found to be highly useful in vegetation



monitoring and detecting the surface reflectance of crops. Adding to this research, we first analyze high-resolution imagery for important/relevant pixels for particular crops (e.g. Almonds, Citrus) at the edge. We upload only necessary pixels to the cloud saving data transfer time before processing those pixels via a spatiotemporal fusion algorithm. We use the Spatial and Temporal Adaptive Reflectance Fusion Model (STARFM) to generate a predictive high-resolution image. This method alleviates expense and scarcity issues, as it will only transfer critical data to the cloud and generates high-resolution images used for crop suitability.

### 105. **Developing a Tennis Ball Propulsion Payload for Boston Dynamics' SPOT**

Raphael Napinas, Christopher Ernesto, Christian Garcia, Anthony Seward, Manson Pham,  
Advisor: Daisy Tang

The Boston Dynamics SPOT robot dog provides a wealth of capabilities including but not limited to pathfinding, high mobility, high stability, and 3D vision. While marketed as an assistant for industrial sensing in hazardous environments, this project intends to examine a more entertainment-focused application for commercial use. In pursuing this, we hope to expand SPOT's capabilities to more daily use to the average citizen and advance human-robot interaction to increase quality of life.

This project aims to design and manufacture a lightweight and compact payload specifically tailored to the task of launching tennis balls. This payload leverages SPOT's mobility and vision capabilities to provide a highly accurate and mobile companion for tennis training. Future work on this project can broaden applications towards other objects, and can be of assistance to the disabled and other groups.

Using object detection and machine learning, SPOT will use its onboard cameras and arm to retrieve tennis balls. SPOT will then return to the user in an identified catching position and release the balls into a custom payload. The payload will consist of a 3D-printed hopper to load the balls, and flywheel mechanism to propel them. An Arduino microcontroller will be used to operate the motors upon feedback from an ultrasonic sensor. By using an embedded system independent of SPOT's computers, room is left open for future development to construct an even more accurate system.

### 106. **Virtual Reality Project Garage: Godot Engine Game Prototype**

Jibriel Ustarz, Nathan Brown, Farhan Hussain, Byungchul Kang, Advisor: Markus Eger

Our team used the bleeding edge Godot Engine 4.0 beta to create a VR game prototype. The aim was to evaluate the use of Godot Engine for standard virtual reality features such as player teleportation, weapons, and object interactions as well as innovative features like geometry created at runtime by the player in service of gameplay.

107. **Data-Driven Mobility Scooter Driver Safety Assessment Based on Human Pose Estimation**

Jilin Ding, Ruoqi Huang, Robert Toribio, Mai Jara, Tingting Chen, Advisor: Tingting Chen

This project aims to develop a data-driven, user-centric driving safety assessment system for mobility scooter drivers. The system employs deep learning techniques to classify driver behaviors into different safety levels based on human pose estimation and time series analysis. The data collection process includes driving tasks performed by participants with mobility challenges on a mobility scooter equipped with Raspberry Pi with motion sensors, action cameras, and a heart rate sensor. A video data annotation tool has been developed to label each video frame by Kinesiologist into four groups based on the driver's body movement. Mediapipe is used for pose estimation to generate accurate 2D or 3D landmark points. The model consists of two LSTM layers followed by a softmax dense layer for classification. The results show promising performance detecting non-stable driving behaviors from the front view. However, the research faces challenges, such as unbalanced training data, incomplete information for computer vision, and error-prone data collected by users. The model's success could significantly improve mobility scooter users' safety and quality of life.

108. **Anomaly Detection using Deep Autoencoders and Recurrent Neural Networks**

Shane Dirksen, Christopher Ernesto, Advisor: John Korah

Anomaly detection is a crucial task in numerous applications such as intrusion detection, fraud detection, and system monitoring. Traditional statistical methods often require extensive resources, feature engineering, and domain knowledge to achieve satisfactory performance. In this research, we propose a machine learning-based approach that combines neural-backed decision trees (NBDTs) with autoencoders and recurrent neural networks (RNNs) for effective and efficient detection of unknown attacks. Our methodology consists of three primary components: the NBDT framework, which serves to visualize the results in a hierarchical tree structure, and two network plugins: a deep autoencoder for feature extraction and dimensionality reduction and an RNN-based model for sequence learning. Firstly, the deep autoencoder learns a compact, non-linear representation of the input data through a supervised training process. This representation preserves the essential structure of the data while eliminating noise and redundancies, which enhances the anomaly detection process. Secondly, the RNN creates a sequence of internal states, each with their own weights and biases, to model the input data when trained on a supervised dataset. RNNs use the output from previous states to inform the computation of the current state and its output. This recursive nature gives RNNs the ability to persist and store information to inform future processing, thus enabling it to model temporal relationships for detecting anomalies. We evaluate our approach using an established cyber-security dataset that provides imbalanced classes to simulate real world data. We measure our performance based on both time efficiency and using F1 scores as a performance metric to ensure a balanced evaluation of both precision and recall, highlighting the effectiveness of our method in real-world anomaly detection scenarios.

**109. Astro-Applying a Time-Dependent Travelling Salesman Problem for Optimizing Astronomical Observation**

George Matta, Advisor: John Korah

The problem of observing various celestial bodies involves several constraints; the observation must be made before a specified deadline and after a specified start time and the observation will take a variable amount of time depending on when we start the observation. The problem at hand is a variation of the classic Travelling Salesman Problem; a classic NP-hard problem in Computer Science. The base problem involves visiting every node in a given set via the shortest path possible. A variation is the TSP with time windows problem, which constrains when a given node can be visited (via a start time and an end time, known as a 'time window'). The problem we deal with in this project further constrains the TSP problem, adding a collection of time-dependent observation times for each node (meaning the node must be observed for a variable amount of time, depending on when the observation was started). The algorithm aims to (1) optimize the priority of the nodes visited (where each node has a given priority), (2) while only able to visit each node within a given time window, (3) while having to observe a given node for a given amount of time, and (4) while the time required to observe the given node changes based on the time it is reached. We developed a variety of solutions that are all effective in their own regard: a simple sorter, a greedy algorithm, and a genetic algorithm. While the genetic algorithm has proven effective, we are developing optimizations to it consisting of various threading and parallelization efforts as well as employing Nvidia's CUDA software to employ a GPU for the algorithm. The proposed solution will be used at the Palomar Observatory to maximize the number of celestial bodies observed in a night.

**GEOLOGICAL SCIENCES****110. Stasis in the Extinct La Brea Fragile Eagle (*Buteogallus fragilis*) in Response to Climate Change**  
Sunshyne Santos, Advisor: Donald R. Prothero

The evolution of the Galápagos finches is one of the most famous examples of how the environment drives the evolution of traits in birds. Other examples of modern birds also suggest that birds evolve rapidly in response to climate change. However, of all the birds studied so far from the Pleistocene asphalt deposits of Rancho La Brea, none of them show change in the size or proportions due to climate changes of the last glacial maximum and the subsequent Holocene warming, from about 37 ka to 9 ka, when the chaparral typical of today was replaced by the snowy coniferous forests during the peak of the glacial maximum, about 18-20 ka. To test this further, we measured the tarsometatarsus (TMT) of *Buteogallus fragilis*, the extinct La Brea Fragile Eagle. We found complete stasis in both the size and proportion of the leg bones from 37,000 years ago until the end the Pleistocene. Like other La Brea birds, *Buteogallus fragilis* shows no response to the climate changes of the late Pleistocene.

### 111. **EVIDENCE OF THE EFFECTS OF URBAN RUNOFF ON THE SANTA ANA RIVER SYSTEM IN EASTVALE, CALIFORNIA**

Anisa Kee Krieg, Advisor: Stephen Osborn

The Santa Ana River (SAR) is an important source of water and recreation in Southern California. In a 2019 study of the Santa Ana River, conducted by California Polytechnic University, Pomona students contained Arsenic above the EPA Primary Maximum contaminant level (of 10 ug/L) at 15.3 ug/L (Furnari, 2019). The sample was collected from a storm drain that emptied directly into the river, indicating that urban runoff may be a source. These findings suggest that the community around the Santa Ana River may be adversely affecting the water quality. This project tests basic water quality (specifically Arsenic) and the source of fluids of urban runoff to the SAR near Eastvale, Ca. To test this hypothesis, seven drainage water samples were collected during a heavy rain event (March 2022) from the gutters along Tisdale Street that lead to the river. Results are compared to previous and current SAR samples taken at the same location. Results indicate that 2 of the seven samples showed measurable arsenic and both were below the drinking water standard with a maximum of 9 ug/L. Results also indicate a lower concentration of constituents compared to the SAR water and that a significant portion of the SAR is sourced from groundwater while the urban runoff is likely sourced from rain.

### 112. **Quantifying Boulder Ejecta from Crater Impact Sites: The Influence of Target Lithology on Distribution and Degradation**

Emiliano Gonzalez, Nils Prieur, Brian Amaro, Mathieu Lapôtre, Advisor: Jonathan Nourse

Meteor impacts eject a large number of rock fragments upon crater formation on planetary surfaces. These boulders, in turn, replenish the coarsest fraction of planetary regolith or, sometimes, may even form secondary craters. Quantifying the spatial, size, and shape distributions of impact-generated boulders thus have important implications for our understanding of regolith evolution and planetary surface ages. Whereas fragmentation theory is capable of reproducing the distribution of impact-generated clasts in homogenous targets, little is known about how spatially variable lithology and degradation affect boulder statistics. Here, we explore (1) whether target lithology strongly affects generated boulders and their ejection patterns for impactors of similar kinetic energy, and (2) how target lithology may affect the degradation rate of impact-generated boulders on airless bodies. The relatively simple surface geology of the Moon, with primarily highlands and maria, and the availability of high-resolution imagery of the lunar surface makes for an ideal setup to answer our two questions. We mapped loose boulders using the QGIS mapping software and analyzed their spatial and morphometric statistics.

### 113. **Skarn Mineralogy of the Marble Mountains**

Desiree Nolls, Advisor: Nicholas Van Buer

In a specific area of the Marble Mountains, located at 34°35'29.90"N 115°31'56.64"W, a diorite, Jurassic in age, intruded limestone and dolomite, which is Middle Cambrian in age. This diorite intrusion caused the limestones and dolomite to deform and become metamorphosed, turning them into brown, striped, and white marbles. Minerals in the skarn include hematite, epidote, calcite, and almandine garnet. Later volcanic activity is inferred due to granitic dikes which also intrude the marbles and quartzite outcrops. Some questions to be determined from this research are: What is the distribution of different skarn minerals? What can this distribution tell us about the flow of fluids and various dissolved elements during the Jurassic intrusion? During January of 2023, we utilized the Optech Polaris Terrestrial Laser Scanner to complete a survey of the skarn deposit, creating a total of thirteen LiDAR scans. I then downloaded these scans into the Optech ATLAScan software, stitched each point cloud together, and then exported each aligned point cloud into ArcGIS to develop a LiDAR base map. During March, I mapped the skarn deposit, including three main mineralized veins, quartzite outcrops, and three sub-types of marble on my printed LiDAR base map. I collected around twenty rock samples, which I will use to create thin sections, and will send off for chemical analysis to better understand the mineralization and metamorphism of this research area. It appears that the diorite intrusion uplifted the quartzite outcrops which were also crosscut by granitic dikes. The order in which mineralization occurred is similar across all three veins, determined from the samples I collected out in the field. The mineralization proceeds starting away from the diorite in this order: epidote, hematite, calcite, almandine garnet. Additionally, mineralization within the veins that extend into the marbles occurs as hematite, epidote, calcite, hedenbergite. By completing this research, we will have a better understanding of how hydrothermal fluid flow reshaped the chemistry of the Marble Mountains marbles.

### KINESIOLOGY AND HEALTH PROMOTION

#### 114. **Out of resistance comes strength: A Multi-Phased Fidelity Study of an Equipment-Based Resistance Program for Older Adults**

Josephine Villicana, Vincent Barron, Lara Killick, Alex Ausland, Advisor: Lara Killick

Purpose: Within the US, people are experiencing longer life expectancy, yet these extended lifespans have not necessarily translated into years of living in good health. Research shows that regular resistance exercise carries distinct preventive health benefits for older adults. The purpose of this research is to conduct a multi-phased study to evaluate the fidelity of an equipment-based resistance training program designed specifically for older adults. Methods A three-phased study has been designed. Phase 1 consisted of a systematic literature review to identify salient measures of internal and external validity for equipment-based resistance training programs for older adults. Phase 2 is a pilot study at one location with 10 participants. The Senior Fitness Test and a pre-post survey are being used to measure the physical function and quality of life outcomes of the program. Four dimensions of internal validity (adherence, exposure, quality of delivery, and participant responsiveness) are being measured via seven observational tools, pre-post surveys, and post-program focus groups. Phase 3 scales up the evaluation program to 5 locations. Measures utilized in Phase 3 will be informed by the results

of the pilot study. Results: Our paper presents the pilot evaluation protocol. By the end of the pilot, we will evaluate the degree of internal validity, estimate the effect on physical function and quality of life outcomes, and, present program feedback from instructors and participants. Conclusions The anticipated outcomes of the study will inform the implementation of equipment-based resistance training programs for older adults.

### 115. **Examining the Relationship Between Heart Rate and Decision Making in Basketball**

Greggory Clifton-Frazier, Advisor: Srdjan Lemez

Past research has been conducted on the effects of heart rate (HR) on physical performance in basketball players. For example, a study by Ardigo and colleagues (2018) examined the three-point shooting accuracy of top Italian league players in different HR zones and reported a significant difference between 50% max HR shooting and 80% max HR shooting, where players in the lower HR zones were more accurate. However, research in this area has given relatively little attention to the effects of an elevated HR on the cognitive effects of gameplay, particularly in younger athletes. As such, this proposed study aims to examine the cognitive effects different HRs may have in basketball decision-making. The objective is to help coaches better understand how to use timeouts and pauses in a basketball game by seeing if more mistakes are made as players become more fatigued. Through a convenience sampling technique and cohort study design, 31 male basketball players will be recruited from a Southern California high school in the fall. The data will be collected through heart rate monitors and video game footage in both practice and game settings over the course of five weeks. Using decision-making as the controlled variable and HR as the independent variable, data will be analyzed by logistic regression through statistical packaging for the social sciences (SPSS). By using heart rate monitoring, a practice plan can be created to better simulate some of the stress of a real game and even go beyond the stress of the real game to prepare the players (Berkelmans et al., 2018). This could have implications on how coaches will use their game substitutions and make adjustments in their rotation patterns. Using this proposed research, coaches and players will also have a better understanding of how their raised HR can affect the rate of decision-making errors made during a game setting.

### 116. **Effects of Real-Time Performance Feedback on Muscle Force Production During the Nordic Hamstring Curl**

Holli Rosas, Emily Ko, Drew DéCoud, Rebecca Isip, Meghan McCauley, Sarah Pearce, Advisor: Edward Jo

The Nordic Hamstring Curl (NHC) is a popularized eccentric overload strategy to optimize hamstring strength development and strain prevention. As with any eccentric overload exercise, the mechanical stress and force output during the NHC remains largely dependent on voluntary contractile effort. Augmented feedback (AF) in the form of real-time objective performance data may serve as a novel method to maximize muscular force output during the NHC by potentially enhancing voluntary contractile effort. PURPOSE: To compare hamstring force production

during a maximum eccentric contraction via the NHC with vs. without real-time muscular force production feedback. METHODS: Eighteen resistance-trained males (age:  $20.9 \pm 1.6$  years) performed three trials of the NHC with (AF) and without (CON) augmented feedback on separate visits. A custom-made NHC apparatus featuring an S-type load cell force sensor was secured around the subjects' ankles on one end and to the floor on the other. Peak and average force were collected during each NHC trial. Force data were normalized to baseline force output which was collected during baseline NHC trials performed before trials incorporating AF or CON conditions. Force data were reflected as a percentage of baseline and subsequently compared between conditions (Control vs. AF conditions). A dependent T-Test was used for mean comparisons, and a significant difference was determined by a p-value of  $<0.05$ . RESULTS: Peak force was significantly ( $p=0.008$ ) greater during AF ( $103.3 \pm 7.4$  % of baseline) vs. CON ( $96.5 \pm 5.3$  % of baseline). Average force, however, was not impacted by AF ( $p=0.80$ , AF=  $98.9 \pm 14.0$  % of baseline vs. CON=  $97.9 \pm 12.4$  % of baseline). CONCLUSION: The inclusion of real-time performance feedback during the NHC enhances peak hamstring force production, which may augment training-induced strength development.

### 117. **THE POWER OF NOW: WHAT COPING STRATEGIES ARE USED BY YOUNG ADULTS FOR GENERAL ANXIETY AND STRESS?**

Thilini S. Wickramarachchi, Zakkoyya Lewis-Trammell, Alane Daugherty, Nivitigala Sumitta,  
Advisor: Zakkoyya Lewis

PURPOSE: For students with Generalized Anxiety Disorder (GAD), stress becomes a way of living. GAD is a condition used to characterize chronic long-term, intense, and excessive worry. Managing stress during college can be extremely challenging. According to the American College Health Association (2021), 20% of college students reported being diagnosed with anxiety. The purpose of this study is to identify coping mechanisms used by young adults to manage their stress and anxiety. METHODS: This study was approved through the IRB (IRB-23-16) and was an online self-reported survey. Participant eligibility requirements were young adults, ages 18-28. The survey link was distributed through campus flyers, class announcements, select meditation and yoga studios, as well as through friends and family. Data analysis included descriptive statistics, point biserial correlation and Chi-square analyses (SPSS® Statistics version 28, IBM, NY USA). RESULTS: Participants ( $n=100$ ) were 21.94 years old on average with 74% current college students. Participants reported mild anxiety (GAD-7=7.16) and mild stress (Perceived Stress Scale (PSS)=18.16). Both GAD-7 and PSS scores showed a significant correlation with social withdrawal and counseling. Although both GAD-7 and PSS scores showed a significant correlation with transference, the correlation was stronger for PSS. PSS scores were also strongly correlated with tobacco or nicotine use. Other reported coping strategies included: exercise, long drives, avoidance, listening to music, self-pleasure, and playing video games. According to the data, seven behaviors were correlated with coping strategies: social media use, energy drink consumption, fruit and vegetable consumption, exercise, meditation and mindfulness practice and time management skills. DISCUSSION: The results of this study will be used to inform the design of future studies and interventions to help reduce general anxiety and stress in young adults.



### 118. **Older Adults' Perspectives on Tai Chi Participation**

Carolina Godinez, Zakkoyya Lewis-Trammell, Lara Killick, Alexandra Auslander, Jose Rocha-Rangel, Advisor: Zakkoyya Lewis-Trammell

Background: Age related declines in strength, balance & flexibility increase the risk of falls among older adults. Tai Chi improves strength, balance, flexibility, cardiovascular fitness and decreases falls among older adults. Purpose: This study explored older adults' perspective towards participation in Tai Chi as an exercise program. Although the physiological & psychological benefits of Tai Chi have been heavily documented (Li et al., 2005) (Hong et al., 2008), not many studies have explored the perspectives of older adults with regards to Tai Chi participation. Methods: Participants were recruited from a local retirement community. An audio recorded semi-structured interview was conducted with each older adult. All participants also completed a physical activity scale survey and a health survey. Results: Participants (n=9) reported as being highly active and having a higher health status than expected for the age group. About 89% reported not experiencing a fall in the last 12 months. Only two out of nine participants had never practiced Tai Chi. Participants viewed Tai Chi as a full body exercise that provided both physical and mental health benefits. Most suggested that Tai Chi should be practiced 2-3 times per week for about 45 minutes to 1 hour. Although some participants perceived their current health status as a barrier to participating in Tai Chi, all participants stated they would like to engage in Tai Chi. Discussion: The results of this study provide valuable perspectives and information that can help retirement communities with providing suitable fall prevention physical activities, such as Tai Chi.

## MATHEMATICS AND STATISTICS

### 119. **Effect of Reallocation Costs on Environmental Resource Savings in a Multi-Facility Service Provider Model**

Gabriela Zulewski, Advisor: Jennifer Switkes

Many industries that have multi-facility providers can help save time, money, and reduce carbon dioxide CO<sub>2</sub> emissions by efficiently reallocating customers to a closer facility. Unfortunately, reallocating customers causes those facilities to suffer increased one-time costs and effort which we will call a reallocation cost. We did not consider each customer's preference in being reallocated but instead looked at what reallocation cost would be the company's best choice. Subject to constraints that incorporate the reallocation cost, we found that within a small sample size we created (1) savings within all 3 categories, (previously mentioned), can be achieved, and (2) reallocation cost plays a significant role in our optimal solution.

## PHYSICS AND ASTRONOMY

### 120. **A Compact Gamma and X-Ray Detector for Cube Satellites**

Matthew Roberts, Advisor: Nina Abramzon

As the space industry continues to grow and access to orbital flight expands, the community of academia and student-focused Cube Satellite programs is likewise rapidly growing. With this development, there comes a perceived need for lower cost and faster turnaround science instruments. These instruments would ideally have dual roles as low earth orbit explorers and classroom or hobbyist class laboratory equipment for training the future generation of the space industry.

The selection of a cosmic ray detector as the basis for this dual-role science instrument is supported by both the cosmic radiation and the relatively simple deployment of such an instrument in a space environment learning ecosystem. Cosmic Rays profuse throughout our universe with no definitive knowledge of their origin despite best estimates ranging from neighboring stars and distant galaxies that travel faster than the speed of light across the universe. Because cosmic rays are composed of ionizing particles ranging across the standard model of elementary particles, they have the irreversible potential of damaging onboard electronics during flight. In an effort to mitigate exposure, a particle, cosmic radiation detector can be used to detect and identify possible sources that produce cosmic rays in effort to provide flight path solutions from high dense radiation areas, as well as determine suitable materials used to shield against cosmic radiation.

121. **Mediational analysis of prior preparation on performance gaps of underrepresented students in introductory physics**

Brooke Webster, Advisor: Qing Ryan

This project aims to conduct a path analysis study to unravel the complicated factors that can contribute to the performance gaps in introductory physics (PHY1510, calculus based for science and engineering majors). Path analysis allows us to find out the partition of the effects on course outcome (grade or post test scores on research-based assessment) from different paths. For example, suppose there is a certain performance gap in course grade between minority and majority students, how much is this gap explained by a direct path where minority status affecting course grade directly? How much is this gap explained by an indirect path where minority status affecting course grade indirectly, while being mediated by prior preparation (such as ACT score and high school physics)? Path analysis allows us to evaluate some causal models and therefore begin to tackle the achievement gaps in the class. This project uses multiple years of institutional data to conduct a path analysis and examine the mediation of membership in a demographic group underrepresented in physics classes on course outcomes measured by course grades and scores on diagnostic test.

122. **How Precisely Can We Fit Elliptical PSFs to Data?**

Mya Do, Alexander Small, Advisor: Alexander Small

Imaging systems are limited by diffraction, resulting in the blurring of emitters' images on the focal plane. The blurring is described by the point spread function (PSF). Precision measurements in microscopy require an understanding of how precisely we can estimate image parameters. This project applies the concept of the Cramer-Rao Lower Bound to determine the best achievable precision when measuring images with elliptical PSFs and Poisson noise. Through simulations of images with circular and elliptical Gaussian PSFs, we find that the variances of the emitter's positions are proportional to inverse brightness as expected. Applying Huang (2011) correction to the multiple particle case, we verify that it fixes the variance divergence at small separations but converges to the single emitter limit at large separations.

### 123. **Perturbations of Multi-Layer Films to Probe Necklace States**

McGwire Herbert, Joel Comberiat, Advisor: Alex Small

In this study, we introduce an innovative method for investigating necklace states in multilayer films by employing perturbations. We simulate multilayer films consisting of random, distributed Bragg reflector, Fibonacci, and Thue-Morse systems, and employed transfer matrix techniques to simulate light passing through them. By examining the transmittance versus wavelength data, we pinpointed high transmittance values that signified the existence of necklace states. Our findings highlight the efficacy of perturbations for probing and characterizing necklace states in multilayer films. In particular, introducing perturbations to the system enhanced the propensity for necklace state formation, allowing us to accurately determine their locations. Overall, our research offers fresh insights into the behavior of multilayer films and showcases the potential of perturbations as a valuable tool for investigating and manipulating their optical properties.

### 124. **Spectroscopic Variability in IC 342 ULX-1**

Monique Del Toro, Advisor: Breanna Binder

An X-ray binary is a star system containing a compact object like a neutron star or black hole that accretes matter from the companion star. I used data from the Chandra X-ray telescope to study the brightest X-ray binary in the nearby galaxy IC 342. I downloaded all available observation data from the Chandra archive using the `download_chandra_obsid` script, reprocessed the data using the script `chandra_repro`, and located all X-ray sources in the image using `wavdetect`. The brightest X-ray binary in this galaxy was detected in all nine observations of IC 342. I then extracted spectra using the `specextract` tool and modeled all nine spectra using the software package XSPEC. The spectra were modeled using an absorbed power law model, from which we can measure the source's flux, the column density of hydrogen along the line of sight, and the relative proportion of higher-energy X-rays to lower-energy X-rays. By examining how the source flux and spectral parameters change over time, we can constrain how the mass accretion rate onto the compact object has evolved with time.

### 125. **The Milky Way Project: MOBStIRS (Mass-loss rates of OB Stars driving IR bow Shocks)**

Angelica Whisnant, Matthew Povich, Henry A. Kobulnicky, Advisor: Matthew Povich

The mass-loss rates of stars influence their evolution, and these values are especially significant for massive stars. Mass-loss rates of OB stars are estimated to range from  $10^{(-7)}$  to  $10^{(-4)}$  solar masses per year; however, theoretical values for their mass-loss rates can differ by an order of magnitude from those derived from various observational techniques. We aim to obtain improved estimates for the mass-loss rates of OB stars utilizing infrared stellar wind bow shock nebulae. The standoff distance between the star and the bow shock is set by momentum flux balance between the stellar wind of and the surrounding interstellar medium, which depends on mass-loss rate. We have created a citizen science website, the Milky Way Project: MOBStIRS (Mass-loss rates for OB Stars driving IR bow Shocks) using the project builder toolkit on the Zooniverse citizen science platform. MOBStIRS incorporates ~1000 color jpeg cutout images centered on cataloged IR bow shocks observed in the Spitzer GLIMPSE and MIPS GAL Galactic plane surveys. These images frequently suffer from bright, spatially varying backgrounds, against which the bow shocks themselves vary greatly in size, morphology, and IR brightness. This poses significant challenges to automated techniques for measuring morphological parameters. 20-50 student participants will draw simple shapes to measure two key morphological parameters on each image. They will also indicate whether they a given image was of sufficient quality to make confident drawings. Measurements are aggregated to constrain two key morphological parameters for each bow shock image deemed high-quality by participants. Deprojecting the bow shock + driving star system using our new inclination angles allows us to correct for systematic errors on standoff distances and derive more accurate stellar mass-loss rates.

This work is supported by the National Science Foundation under awards AST-2108347 (U. Wyoming) and AST-2108349 (Cal Poly Pomona).

### 126. **Incorporating Gaia Visible-Light Photometry into Spectral Energy Distribution Modeling of Young Stellar Objects**

William Salazar, Advisor: Matthew Povich

The latest generation of stars born in our Milky Way Galaxy are young stellar objects (YSOs). YSOs host disks comprised of gas and dust. Studying such disks yields insights about the formation of planets, which helps us understand our own solar system. To derive physical parameters of YSOs, such as luminosity and mass, we employ a technique known as spectral energy distribution (SED) modeling. We study YSOs located within the G352 giant molecular cloud, a very large, active star-forming complex located 1.7 kpc from the Sun that contains the bright ionized nebulae NGC 6357 and NGC 6334. The large, ionized field containing our target complex contains ~2500 YSOs in the Spitzer/IRAC Candidate YSO Catalog (SPICY). For our project, we focus on the subset of 800+ SPICY YSOs with available visible-light photometry from the Gaia catalog. We employ a custom Python software pipeline to fit our SPICY candidates with pre-computed YSO models. Preliminary results using only infrared photometry suggest SED

models for many YSOs will be better constrained when visible-light photometry is included. We will experiment with incorporating available Gaia visible-light photometry into the SED fitting, to determine whether any systematic corrections to the model parameters (for example, foreground dust extinction) would benefit the interpretation of the entire SPICY sample.

### 127. **Surface Modification Using an In House Atmospheric Cold Plasma Reactor**

Evan Alire, Diego Huertas, Advisor: Nina Abramzon

Atmospheric cold plasmas have numerous applications in the biomedical and manufacturing industries. Our project focuses on testing a helium based cold atmospheric plasma reactor built in our lab. With a high voltage (30kV max) power supply connected to electrodes surrounding the tube flowing helium, we tested the effects of varying power and flow rate in order to determine the optimal settings to maximize the Reactive Oxygen Species present in our the plasma. Using these settings, we then applied the plasma to metallic coupons in order to examine the adhesive wettability properties by using the contact angle technique, measuring the dimensions of 10uL water droplets on the surface. With the in house reactor, we were able to demonstrate surface changes. get results comparable to commercial reactors at fraction of the cost. This demonstrates that our plasma source is a potential cost effective alternative to commercial reactors.

### 128. **Examining the Sub-Galactic LX-SFR-Z Relationship with Multi-Wavelength Observations of Nearby Galaxies**

Jacob Payne, Advisor: Breanna Binder

High mass X-ray binaries (HMXBs) contain a high mass star and a compact object (neutron star or black hole) which orbit each other. Mass that is transferred from the donor star to the compact object radiates strongly in X-rays. HMXBs have very short lifespans, and so are only found in galaxies with recent high star formation activity. There is therefore a relationship between star formation rate and the population-averaged properties of HMXBs in a galaxy. In this project, I am creating spectral energy distributions (SEDs) which are measurements of light intensity as a function of wavelength. I am then validating my measured SEDs against published multiwavelength data using NASA/IPAC Extragalactic Database (NED). Next step would be to use the SEDs to model the galaxy with a program called Prospector, to infer star formation histories, stellar mass histories, metallicity gradients and more. The goal is to use that information to analyze the relationship between characteristics such as X-ray luminosity, star formation rates, and metallicity with the population of HMXBs. Although correlations between star formation rate, metallicity and HMXB luminosity have been established in vigorously star-forming galaxies, our group has recently found evidence that these correlations may be different in more modestly star-forming nearby galaxies. The dependence of HMXB properties on metallicity and star formation rate are important for models of the early universe.

### 129. **INVESTIGATION OF MOTH EYE NANOSCALE SURFACE STRUCTURES FOR MAXIMIZING LIGHT ABSORPTION**

Chun Chung Wong, Advisor: Kurt Vandervoort

Moth eyes typically feature a series of surface structures that inhibit light reflection, thereby maximizing light absorption, and allowing moths to see at night. An atomic force microscope was employed to image the surface of several species of moth eyes, which yielded a hexagonal array of cone shaped bumps about 100 nm in height, separated by a few hundred nm. Comparisons were made between moths known to be strictly nocturnal and moths with both nocturnal and diurnal life patterns, but no significant difference in the general geometry of these structures was discerned, indicating that the features are an evolutionary adaptation universal to all moth species. To mimic these surfaces at the macroscale, a surface was constructed with bumps approximately 1 cm in height with a few cm spacing, a scaling factor of 100,000 times greater than the moth eye surface structures. This surface was investigated for its reflective properties using microwaves, electromagnetic radiation of wavelength 100,000 times greater than visible light. So far, the results for the macroscopic studies are inconclusive.

### 130. **3D Printed Cantilever Demo**

Alexis Martinez, Advisor: Alex Small

**Purpose:** We wanted to verify the Resonant Frequencies of a 3D printed cantilever beam match standard theoretical predictions.

**Method:** We created a demo to view resonant frequencies for 3D printed cantilevers. We prepared and printed various Cantilevers with different parameters and experimentally analyzed them to find Young's modulus. We predicted the resonant frequencies using Young's Modulus and Bernoulli's beam theory. Then we utilized the mechanical vibrator driven by a function generator to observe the first two modes using a strobe light.

Results and conclusion:

We were able to measure the resonant frequencies of the cantilever beams and verify the first two frequencies were consistent with theory. We witnessed some discrepancies in the relationship between the spring constant and the radius. We assume that was due to lack of control of the temperature conditions in which we printed the cantilever beams.

### 131. **Detecting X-ray Sources in Nearby Galaxies**

Rosalie Williams, Advisor: Breanna Binder

X-ray binaries (XRBs) illuminate the sky with X-rays. The average population properties of high-mass X-ray binaries are correlated with the properties of the galaxy in which they live, such as the galaxy's star formation rate and metallicity. I am exploring these correlations. We can accomplish this goal by processing data from the Chandra telescope and creating a source list of all X-ray sources in a large sample of nearby galaxies. We create blank sky maps to account for

the variation in source detection efficiency across the Chandra detectors which will be used to make sensitivity curves and then X-ray luminosity functions (XLFs). XLFs determine the number of high-mass X-ray binaries (HMXBs) present. Then, using a Python code to generate the amount of OB stars given a galaxy's stellar mass, we can create plots of the efficiency of HMXB formation in different environments of metallicity.

**132. Properties of 5D Myers-Perry Black Holes**

Chris Hoover, Hunter Seropian, Advisor: Shohreh Abdolrahimi

We explore 5-Dimensional Myers-Perry Black Holes in the presence of external matter, which distorts the event horizon geometry of the black hole. Conducting a qualitative analysis of these hypothetical objects is challenging due to their extra-dimensional nature. This study aims to find ways to visualize some characteristics of these black holes. We discuss using Ricci Curvature to determine whether the event horizon is embedded in Euclidean Space for certain parameters. If so, we can visualize its cross-section.

**133. Investigation of SecA protein in Lipid Bilayer Using Atomic Force Microscopy**

Matthew Luna, Leona Choi, Advisor: Krishna Sigdel

Membrane proteins are key players in various important cellular processes such as protein export, signal transduction, enzymatic activities, and cell-to-cell communication. Membrane proteins also constitute more than half of all current drug targets. SecA is a member of the membrane protein family with the primary function of transporting nascent proteins through the inner membrane and into the periplasmic region of *E. coli*. Once there is energy that is released from ATP hydrolysis, SecA uses the energy to translocate these pre-proteins. Studies suggest that dynamic interactions exist between the SecA protein and the lipid bilayer during this translocation process. However, there has been a small amount of research dedicated to observing the dynamic structure of SecA in real-time. Since structural details and conformational dynamics are tied to functions, we performed high-resolution imaging of SecA interacting with a lipid bilayer in physiological buffer conditions via atomic force microscopy (AFM). We also found that the SecA is more dynamic in lipid bilayers in the presence of ATP.

**134. Temperature Sensor Based on Looped Optical Fiber**

Jacob Siegersma, Advisor: Ertan Salik

Temperature sensors based on optical fibers, such as a simple optical fiber loop, are promising technologies in harsh, turbulent environments where few sensors can survive. In addition, if a looped optical fiber is used to measure refractive index to be applied as chemical or biological sensors, the cross-sensitivity to temperature needs to be characterized. We have experimentally demonstrated the existence of interference effects in the transmission spectrum in a looped optical fiber, and that the spectral features are sensitive to temperature. When light propagates



through a looped optical fiber, some of it decouples from the core and enters the cladding. Differences in path length and effective refractive index induce a phase difference between the two modes, resulting in interference. Our experiments showed the temperature sensitivity to be about 50 pm/°C in the 20°C-80°C range, which is comparable to the reported measurements in the literature.

**135. Developing the perfect recipe: Optimizing Reactive Oxygen Species Produced by an atmospheric plasma generator**

Eric Andrew, Vincent Tran, Advisor: Nina Abramzon

Over the course of this semester, we have used optical emission spectroscopy (OES) to identify spectral lines produced by an Atomflo 500 Atmospheric Plasma reactor. In doing this, we confirmed the presence of reactive oxygen species (ROS) such as the hydroxyl radical (OH) and atomic oxygen (O). Due to the applicability of these reactive oxygen species for purposes such as sterilization, and surface alteration, our next goal was to determine which parameters that would maximize the intensity of these species. Focusing on the most prominent atomic oxygen peak located at 777.4 nm, we varied the power from 200W to 280W while holding the flow rates of the argon and oxygen constant. Analyzing the spectra in Excel indicated a positive trend between the intensity of the oxygen peak and an increase in power. This same experiment was then repeated, holding power at 280W and the argon flow rate constant, while varying the oxygen flow rate from 0.09 L/min to 0.2 L/min. From this, a negative trend was observed with increasing oxygen flow rate, up to 0.17 L/min where the intensity jumped and then began to decrease again. This will be a point of future research.

**136. Direct Visualization of Antimicrobial Peptide- Induced Defects on Supported Lipid Bilayer**

Olivia Walsh, Leona Choi, Advisor: Krishna Sigdel

Antimicrobial peptides (AMPs) play a crucial role in the innate immune systems of various organisms. AMPs interact with bacterial and mammalian cell membranes through various mechanisms, varying from nanopore formation to microscale membrane lysis process. The interactions between AMPs and cell membranes have been studied extensively through various biochemical assays, and they are thought to kill pathogens through cell membrane intervention. However, the mechanistic details behind membrane destabilization are still elusive. In this study, we used atomic force microscopy (AFM) to further explore the effects of an AMP CM15 on model E. coli lipids. CM15 is a hybrid peptide composed of Cecropin-A and melittin from bee venom. AFM is an imaging technique that utilizes close-range interactive forces to image a surface at an atomic scale, providing real-time dynamic insights into nanoscale interactions. Our study sheds light on how CM15 interacts with a supported lipid bilayer.

**137. Measuring Thermo-Optic Coefficient of Fluids using Fresnel Reflection-based Fiber Optic Refractive Index Sensor**

Liam Mauck, Advisor: Ertan Salik

We are reporting a simple and inexpensive method to determine the thermo-optic coefficients of fluids. By measuring the reflected light from an unknown and known fluid at a cleaved end of an optical fiber, we were able to solve for the refractive index of the unknown fluid using the Fresnel Equations. Completing these measurements for water using air as a reference with varying temperature allowed us to determine the thermo-optic coefficient ( $dn/dT$ ) for water, which we found to be  $(8.2 \pm 0.2) \times 10^{-5}$  RI units per  $^{\circ}\text{C}$ . This result agreed well with the literature and provided evidence of the efficacy of the sensor design. Future design in reducing the effects of power fluctuation over time, unwanted back reflection, and uncertainty in reference fluid index may lead to higher precision refractive index and thermo-optic coefficient measurements.

**138. Major Merger between a Classical Dwarf Irregular Galaxy and its Massive Ultra-Faint Satellite**

Jonathan Rivas, Jeyson Flores- Velázquez, Advisor: Coral Wheeler

Dark matter, an elusive form of matter that does not emit nor interact with electromagnetic radiation, can be observed only through its gravitational influence on the visible matter in galaxies and the large-scale structure of the Universe. One of the best ways we can study dark matter is through the kinematics of dwarf galaxies, due to their high relative dark matter content. Dwarf galaxies are classified based on their low mass, with classical dwarf irregular galaxies having stellar masses typically around  $10^5$ - $10^8$   $M_{\text{sun}}$ , and the even more dark matter-dominated “ultra-faint” galaxies having  $M^* < 10^5$   $M_{\text{sun}}$ . Because the stellar kinematics of dwarf galaxies is the best tool, we have to model their dark matter content, any external influence on the stellar motion is also extremely important to model. Major mergers in dwarf galaxies (anything with at least a 1:10 mass ratio between the central and the satellite) can impact stellar kinematics in dwarf galaxies, and so properly predicting these effects has major implications for our understanding of dark matter and its role in shaping dwarf galaxy kinematics. We study one such major merger in a high-resolution cosmological Zoom-in simulation of a dwarf galaxy ( $M^* \sim 10^6$   $M_{\text{sun}}$ ) merging with its massive ultra-faint satellite ( $M^* \sim 10^5$   $M_{\text{sun}}$ ) using the FIRE-2 simulations (Hopkins et al. 2018). We perform mock observations of the simulation before, during, and after the merger, and make testable predictions for the circular rotation, the velocity dispersion, and the stellar age gradient of classical dwarf spheroidal galaxies that may have undergone a similar collision. With these predictions, astronomers will be better equipped to disentangle the effects of dark matter and mergers on dwarf galaxies, allowing them to construct more accurate dark matter models.

**139. Is There an Ultra-Faint Missing Satellites Problem?**

Alisling Acuna, Alisar Barakat, Advisor: Coral Wheeler

Due to their high relative dark matter content, ultra-faint dwarf galaxies (UFDs;  $M^* < 10^5 M(\text{sun})$ ) are excellent testbeds for cosmological models. Historically, the number of low-mass galaxies around the Milky Way (MW) predicted by naively assigning a galaxy to each dark matter (DM) halo in a gravity-only simulation does not align with the observations (only  $\sim 60$  observed). This is known as the classical missing satellite problem (MSP), and it initially posed a major challenge to the preferred cosmological model, Lambda-Cold Dark Matter Theory (LCDM). While the MSP has been largely solved for MW satellites above the UFD mass range, it may still exist for UFDs. In order to determine if this is the case, we need to know not only how many DM halos should host a UFD, but how many should be visible with current observational capabilities that are effective surface-brightness-limited. We redefine the simulated galaxy edge for all UFDs in our high and ultra-high resolution FIRE-2 (Hopkins et al. 2018) simulations, using several methods: we first attempt different fractions of the halo radius from 10%-40%, comparing the resulting stellar mass to that calculated by the halo finder, as well as determining the effect of this edge on predicted galaxy properties. We then employ a cut in effective surface brightness (SB), re-defining this edge for all simulated galaxies with 10 or more star particles ( $M^* = \text{a few } \times 100 M(\text{sun})$ ). Using the latter method, we find that most simulated UFDs have a larger redefined galaxy edge than what is currently predicted by all FIRE-2 simulations to date. This suggests that observations of UFDs may be detecting only their brighter central cores, and that observed ultra-faint MW satellites may have unobserved diffuse stellar halos. One such halo has been observed recently in Tucana II (Chiti et al. 2021), who find new stars out to nine of the UFD's half-light radii. We make new testable predictions for the observed counts and properties of UFDs based on this SB cut, predictions that are more likely to match observations of existing observed ultra-faint galaxies.

**140. Studying the Variability of IC 10 X-2, A High-Mass X-ray Binary Containing a Possible Luminous Blue Variable and Neutron Star**

Mina Thoreson, Advisor: Breanna Binder

In this project, I am using data from the Swift Observatory and Chandra X-ray Observatory to analyze the X-ray light curve and spectra of IC 10 X-2, a high-mass X-ray binary and supergiant fast X-ray transient containing a neutron star and Luminous Blue Variable Candidate.

An X-ray binary (XRB) is a binary star system consisting of a neutron star (NS) or black hole (BH) and a donor star. The NS or BH accretes matter from its donor star, which then emits X-ray radiation. XRBs fall into two general categories: high-mass X-ray binaries (HMXBs) and low-mass X-ray binaries (LMXBs) based on the mass of the donor star. Luminous blue variables (LBVs) are massive evolved stars that undergo drastic changes in mass and luminosity. They are some of the largest and brightest stars in the universe, and they undergo giant eruptions that are so

large that they can leave nebulae and are frequently mistaken for supernovae. Even when they are not undergoing large eruptions, they consistently undergo less drastic mass loss from smaller eruptions and stellar wind.

IC 10 is a small, irregular galaxy located in the constellation Cassiopeia. At 2.3 million light years away, it is the closest known starburst galaxy to the Milky Way. It is a popular target for astronomers because it contains a high population of star forming regions and X-ray binaries. One of these XRBs, IC 10 X-2, is an XRB that likely contains a NS and an LBV. It is also a supergiant fast X-ray transient (SFXT), which is an HMXB that exhibits fast and large X-ray outbursts. In IC 10 X-2, these outbursts could be triggered by material ejected from the LBV falling onto the NS. Both SFXTs and LBVs are extremely rare, making IC 10 X-2 a unique object that will allow us to study the physics of LBV eruptions and mass transfer onto a NS.

The Neil Gehrels Swift Observatory is a multi-instrument observatory in low-Earth orbit. It was originally built to detect and study gamma ray bursts, and it contains a burst alert telescope (BAT), an X-ray Telescope (XRT), and an ultraviolet/optical telescope (UVOT). In this talk, I will be discussing data collected from Swift XRT. To analyze the data from Swift XRT, I first used a program called XIMAGE to analyze 119 X-ray images taken over the course of 15 years. XIMAGE detects X-ray sources in the Swift images and measures their positions and fluxes<sup>1</sup>. Because X-2 has such a varying luminosity, it is not detected in every reading. Once fluxes (or flux upper limits) have been measured in all available observations, I constructed plots of how flux varies with time (called a light curve). Previous studies have created an R-band red/optical curve. My plot will be similar but with X-ray light. This will help us study the neutron star and its accretion disk, since it shines brightest in X-ray wavelengths.

My light curves and subsequent analysis showed several peaks in the X-ray data that indicate X-ray flares from the NS and its accretion disk, which may have been caused by the LBV ejecting material onto the NS. Now that I have these peaks, I am following the computational procedure outlined by Sidoli et al. (2016) to analyze the light curve using Bayesian blocks to extract the flare rise and decay times and fluxes<sup>2</sup>. I then used this data to calculate the luminosity and energy of the biggest flare and one of the smaller flares and found that it was ~100 times more energetic than an average galactic SFXT. My goal now is to refine the flare and decay times by extracting more data from SWIFT and Chandra, which should give me a more accurate depiction of the main flare's energy and make it easier to pick out smaller flares. In the future, I also plan to calculate the accretion disk size and magnetic field strength during these flares.

### 141. **Measuring Refractive Index with High Precision using Fresnel Reflections**

Caden Laisy, Ryan Read, Advisor: Ertan Salik

When a light beam transitions between two media, it is partially transmitted into the new medium and partially reflected into the original medium. There are three parameters that determine how much of the light is transmitted reflected: light polarization, angle of incidence and refractive index. Using a simple experiment that involves a laser pointer, a glass slab, and a simple photodiode, we can measure reflection as a function of angle of incidence for s- and p-

polarizations. By fitting the data to the Fresnel equations, we can determine the refractive index of the glass slab. We investigated how we can improve the precision of refractive index measurement. With improvements in alignment and photodiode noise mitigation, we were able to measure the refractive index of acrylic precise to the second digit after decimal point:  $n_S=1.466\pm 0.001$  and  $n_P=1.464\pm 0.003$  for polarization perpendicular and parallel to the plane of incidence, respectively

### 142. **Zooming in on a Simulated Milky Way-Sagittarius Analog Collision**

Benjamin Snyder, Advisor: Coral Wheeler

Dwarf galaxies – low-mass galaxies distinct from star clusters by the presence of a dark matter halo – are some of the most intriguing objects in our universe. Interactions between larger host galaxies such as our Milky Way and their dwarf galaxy satellites are thought to play a key role in the evolution of the satellites – affecting everything from stellar structure to star formation. However, simulations of these collisions have thus far been either too low in resolution to study the impact on the dwarf in sufficient detail, or have been idealized – lacking the important effects of large-scale structure possible only in a cosmological simulation. By performing particle-splitting on a FIRE (Feedback In Realistic Environments) cosmological zoom-in simulation of a Milky Way-Sagittarius analog collision, we can achieve higher resolution locally around the collision site, and study in more detail than ever before what effects mergers like these might have on the dwarf galaxy and its own “ultra-faint” satellite galaxies. This project involves developing a particle counting algorithm that determines how many star, gas, and dark matter particles from the host galaxy come within a certain radius of the satellite. We present the number of interacting particles for various threshold radii in a FIRE dwarf-dwarf merger simulation as a test case for our particle counting algorithm, as well as initial results for a Milky Way-Sagittarius analog merger. Future work will include determining how far we can feasibly increase the collision-site resolution, and identifying the appropriate simulation parameters to run the simulation with particle-splitting.

### 143. **Developing the perfect recipe: Optimizing reactive oxygen species produced by a commercial atmospheric plasma reactor**

Eric Andrew, Vincent Tran, Advisor: Nina Abramzon

Over the course of this semester, we have used optical emission spectroscopy (OES) to identify spectral lines produced by an Atomflo 500 Atmospheric Plasma reactor. In doing this, we confirmed the presence of reactive oxygen species (ROS) such as hydroxide (OH) and atomic oxygen (O). Due to the applicability of these reactive oxygen species for purposes such as sterilization, and surface alteration, our next goal was to determine which parameters that would maximize the intensity of these species. Focusing on the most prominent atomic oxygen peak located at 777.4 nm, we varied the power from 200W to 280W while holding the flow rates of the argon and oxygen constant. Analyzing the spectra in Excel indicated a positive trend between the intensity of the oxygen peak and an increase in power. This same experiment was

then repeated, holding power at 280W and the argon flow rate constant, while varying the oxygen flow rate from 0.09 L/min to 0.2 L/min. From this, a negative trend was observed with increasing oxygen flow rate, up to 0.17 L/min where the intensity jumped and then began to decrease again. This will be a point of future research.