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1. **In situ neutron and synchrotron diffraction studies of oxygen transport membrane La0.9Sr0.1Co1-yFe3O3 by Mara Milhander, Dr. Allyson Fry-Petit**

Oxygen transport membranes (OTMs) can obtain pure oxygen cheaper than current cryogenic methods and may be applicable as a cheaper alternative to the catalytic converters currently used in cars. La0.9Sr0.1Co1-yFe3O3, y= 0, 0.25, 0.75, 1, are known oxygen transport membranes. Through reduction and oxidation reactions, it is possible for the material to lose or gain oxygen from its structure. While it is known that this is possible, the mechanism of oxygen motion within the structure is not yet known. Therefore, we analyzed the synchrotron and neutron diffraction of the compounds at industrially relevant temperatures under reducing and oxidizing atmospheres to probe structural changes. When cycled under those conditions, the y=0 and y=1 samples reverted to their initial structures: a key component to industrial applications.

2. **Rational Design of Non-Cooperative Octahedral Tilting Perovskites Pb2SrWO6 & Pb7.47Sr3.53W4O23 by Joshua Li, Dr. Allyson Fry-Petit**

This research investigates non-cooperative octahedral tilting (NCOT) perovskite to understand their formation. Design principles must be defined since the tolerance factor, used ubiquitously with perovskites, cannot predict NCOTs. Utilizing data mining, Pb2SrWO6 and Pb7.47Sr3.53W4O23 were predicted to adopt an NCOT structure. Pb7.47Sr3.53W4O23 is a cation deficient variant of Pb2SrWO6, which is explored from previous results on molybdenum analogs. Both were synthesized through the traditional ceramic method, structurally analyzed via powder x-ray diffraction (XRD). Initial XRD results suggest that both compounds adopt the same structure similar to other NCOTs. These results are added to the database to improve understanding and design.

3. **Investigation of the effects of Ni2+ substitution on Li2CuP2O7 as a potential cool pigment by Maureen Sison, Dr. Joya A. Cooley**

The urban heat island phenomenon occurs in urbanized areas, where cities experience higher temperatures than other surrounding cities. This is caused by the rapid growth of global warming due to high energy consumption, especially in places packed with commercial buildings and vehicles with less greenery. Cool pigments are one of the solutions used to reduce heat buildup in buildings and improve the surface of buildings due to their high solar reflectivity property, which helps maintain a lower temperature on exterior surfaces and interior of the building, thus reducing heat buildup and electrical energy consumption. This
research presents the synthesis and characterization of a potential "cool" pigment through a solid-state reaction to mitigate urban heat island effects. LiCu_{1-x}Ni_{x}P_{2}O_{7} (x=0–1) was prepared via solid-state synthesis to study color tunability on potential pigments. The powder samples were characterized via X-ray diffraction and CIE L*a*b* colorimetry to study their phase purity and the effects of substituting 3d transition-metal Ni^{2+} at the square planar sites of Cu^{2+}. XRD and Rietveld analyses reveal that the doping of Ni^{2+} has retained the Li_{2}CuP_{2}O_{7} structure where x is 0.1 to 0.4. Samples exhibited a gradual color change from blue to green to yellow in the complete series. It will be further analyzed by obtaining near IR reflectance values and SEM images to study and determine their potential as cool pigments. Additionally, microwave-assisted synthesis will be attempted to control particle sizes and accelerate the synthesis of cool pigments.

4. Evidence That Dog Ceruloplasmin Is Aggregating And How Potassium Phosphate Might Be Affecting Such Aggregation

Ceruloplasmin (CP) contains 6 Cu atoms and is the major Cu-carrying protein in blood. Compared to other mammals, our lab has shown that dog CP elutes as a bigger protein in size exclusion chromatography (SEC) and may be aggregating. Using a 24mL Superdex-200 column for example, CP eluted in fractions 24-25 in 20 mM potassium phosphate (KP) buffer, pH 7, and in fractions 29-20 in 300 mM KP – like CP from other mammals. The purpose of my research was to replicate previous results, going from low to high KP concentrations, and to see whether this could be reversed by going back to a low concentration (20mM), using 250µL portions of dog plasma applied to a Superdex-200 or Sephacryl-300. CP elution was determined by measuring Cu concentrations in the fractions, using furnace atomic absorption spectrometry. My initial studies showed that at lower KP concentrations, dog CP eluted earlier than with the higher KP concentrations; and that when the copper peak with 300mM buffer was pooled, concentration and re-run in 20mM buffer, dog CP tended to elute earlier, supporting the concept that dog CP aggregates in a reversible way. Additional computational research was begun to identify structural differences in dog CP that might explain the aggregation. A protein folding predicting software (AlphaFold2) predicted the protein structure of dog CP using its amino acid sequence. A structure with 91.72% accuracy was predicted with AlphaFold2 plus ChimeraX modeling, and compared with that from human and rat CP. Some differences were observed.

5. The Effects of Estrogen and Progesterone on mRNA Expression of CP and ATP7B

Ceruloplasmin (Cp) is a multifunctional Cu binding protein in blood fluid expressed by the liver and kidney. Cp is synthesized by ribosomes on the surface of the endoplasmic reticulum and is then sent to the trans-Golgi network, where it receives Cu pumped in by the Cu pump ATP7B. After receiving 6 Cu^{1+} ions, Cp is exported to the blood via exocytosis. During pregnancy, Cp levels in the blood plasma increase in response to increased circulation of estrogen and progesterone. Besides pregnancy, oral contraceptives increase circulating Cp levels for the same reasons. This research aims to determine whether estrogen and progesterone increase the levels of circulating Cp by increasing mRNA expression of Cp and...
ATP7B in the rat liver and kidney of female Sprague Dawley rats, and in cultured rat hepatoma cells (RHC).

Rats were either injected subcutaneously with 17b-estradiol daily or impregnated. Rats treated with estrogen were euthanized after two weeks and impregnated rats were euthanized 15 days after mating with a male rat. Blood, liver, and kidneys were extracted for analysis. RHC cells were treated with progesterone and harvested after 7 days. Through Real-Time qPCR, relative to 45S rRNA, mRNA levels were quantified. mRNA expression for Cp and ATP7B in liver and kidney were not significantly altered by estrogen and pregnancy. Progesterone also had no effect when given to the cultured RHC. However, mRNA expression of ATP7A, a similar Cu pump to ATP7B, did increase in RHC. In contrast to this, Cp enzyme activity increased due to pregnancy and estrogen treatment. In conclusion, this research suggests the increase in enzyme activity from estrogen and pregnancy is not due to an increase of mRNA expression.

6. **Co2-xNixP2O7 as a potential cool pigment** by Carolina Avalos, Dr. Joya Cooley

Urban heat islands, such as Los Angeles, experience more heating than surrounding rural areas, leading to detrimental effects to human health and the environment. “Cool” pigments painted on infrastructure in urban heat islands have the advantage of displaying pleasing colors while also reflecting away much of the sun’s near-IR radiation (heat). Dark objects absorb most of the sun’s light and convert it into heat, which means that there is an increase in energy consumption from using air conditioners. This is extremely important because of the increase in energy demand, lack of energy supply, and rapid growth of global warming. Furthermore, prevailing methods to synthesize “cool” pigments often require several days of heating at high temperatures, increasing detrimental environmental effects. This research presents designing, synthesizing, and characterizing solid-state inorganic ceramic solid solutions towards understanding color tunability in potential cool pigments. It also utilizes an innovative synthesis method using a domestic kitchen microwaves to develop rapid synthetic methods that synthesize materials and potentially control particle size towards controlling near-IR reflectance. Several syntheses will be presented using both furnace heating and microwave-assisted heating to synthesize Co2-xNixP2O7 pigments, and these materials are characterized using X-ray diffraction, FTIR data analysis, colorimetry, and electron microscopy. The heat-reflectance properties are measured using diffuse reflectance spectroscopy in the near-IR region. An understanding of color tunability and the effects of particle size control on heat-reflectance in this family of materials will allow a greater understanding of rational design of cool pigments.

Department of Biological Science

7. **Friend or Foe? Effect of Eelgrass Density on Filter Feeder Biomass and Condition Index in a Multi-habitat Living Shoreline** by Brandon Quintana, Dr. Danielle Zacherl

Over the past decades, estuarine ecosystems have suffered significant habitat loss. Implementation of multi-habitat living shorelines can restore lost habitat function.
Researchers constructed a MHLS from 2016 to 2017 in Newport Bay, California by restoring eelgrass and oyster beds together and in isolation. Increased sedimentation from eelgrass could threaten oysters and other filter feeders. This study will investigate how eelgrass impacts filter feeder biomass and condition index. To compare short-term and longer-term success of oysters restored with varying densities of adjacent eelgrass, I will calculate the total biomass and per capita condition indices of native and non-native filter feeders on restored oyster beds one- and two-years post-restoration. I hypothesize that increased eelgrass density will increase sedimentation rates onto adjacent oyster beds, causing declines in filter feeder biomass and per capita condition indices. I excavated filter feeders from quadrats on oyster beds, identify by species, and weigh to determine wet and dry tissue and shell weight, and quantify condition index. I quantified sedimentation by measuring mud deposition on oyster beds using a periodontal probe and quantified filter feeder and eelgrass densities using quadrat surveys.

Mud deposition during each year from 2018 to 2020 was significantly higher on oyster beds restored adjacent to eelgrass vs oyster beds restored alone. In 2018, every species had higher biomass on oyster bed restored alone vs. with eelgrass. In 2018, *M. senhousia* had higher condition index on oyster bed restored with eelgrass vs. alone. Increasing understanding of the relationship filter feeders share with eelgrass will inform future management decisions about whether to restore multi-habitat living shorelines together or in isolation.

8. Effects of a Non-Indigenous Bryozoan on the Recruitment of the Native Olympia Oyster, *Ostrea lurida* by Leeza-marie Rodriguez (and Valerie Goodwin), Dr. Danielle Zacherl

Non-indigenous fouling organisms settling onto artificial and natural hard substrata in estuaries can negatively impact native species via space competition, predation, or other mechanisms. The effects of *Amathia verticillatum*, and other fouling organisms on the recruitment of *Ostrea lurida*, were studied to determine whether their presence, biomass, and abundance affect oyster recruitment.

Terracotta tiles, proxies for available hard substrata, were deployed in Newport Bay, California at tidal elevations between -0.4 and +0.1 feet MLLW, April-October 2020, during the oyster’s spawning and recruitment season. Five treatment groups (n=5 replicates per tile) were established to examine the effects of *A. verticillata* and other fouling organisms on recruitment of *O. lurida*: unmanipulated controls, *A. verticillata* removals, *A. verticillata* plus other fouler removals, other fouler removals with *A. verticillatum* additions, and other fouler removals with 2X *A. verticillata* additions. The treatment groups were maintained by adding or removing *A. verticillata* foulers as appropriate per treatment; all removals were quantified via volume displacement as a proxy for biomass. During tile retrieval, the volume displacement and wet weight of *A. verticillata* and other foulers were recorded. Oysters recruiting to the tiles were measured for length and width, identified, and counted. Percent cover of all species recruiting to the tiles using point contact techniques was recorded.

Results suggest that *A. verticillata* is facilitating *O. lurida* recruitment as *A. verticillata* removals had lower oyster recruitment. Some non-indigenous fouling organisms may not be as problematic as predicted when restoring native species in estuarine communities.
9. Bivalve Bodyguards: Eelgrass *Zostera marina* Meadows May Buffer High Energy Boat Wakes And Reduce Sedimentation Stress On Olympia Oyster *Ostrea lurida* Beds Constructed For A Living Shorelines Project by Valerie Goodwin, Dr. Danielle Zacherl

Significant development in Southern California coastal areas has altered marine habitat that would normally buffer wave energy, leaving shorelines vulnerable to erosion. Living Shorelines projects seek to address this problem by restoring native habitat with the goal of rebuilding ecosystems in a way that provides ecosystem services such as shoreline stabilization. Foundation species such as oysters and eelgrass are increasingly used in these projects because they provision habitat and reduce erosion. Native Olympia oyster beds and eelgrass beds were restored at four sites in Upper Newport Bay in 2016 as part of the Upper Newport Bay Living Shorelines Project to explore the possible combined benefits of restoring two foundation species. All sites have seen differential success since initial restoration in terms of oyster density and bed growth. Human activity such as trampling and wave energy has been previously linked to mussel and oyster bed degradation, so to understand the impacts of human activity on restored oyster beds 30-minute human use surveys were conducted at all sites and all instances of human activity including recreation, fisher activity, boating, and the size of wakes produced by each passing boat were documented. Water level loggers were also deployed to directly measure boat wake energy with and without Living Shorelines plots.

10. Not So Shellfish After All: How Native Oysters *Ostrea lurida* May Aid Eelgrass *Zostera marina* Restoration By Nitrogen Filtration by Mason Emery*, Kevin Nichols, Katie Nichols, Dr. Danielle Zacherl

Eelgrass (*Zostera marina*) is a foundation species in coastal waters that provide vital ecosystem services from habitat provision to trophic support. However, populations have declined globally at alarming rates including within Upper Newport Bay (UNB), CA. A multi-habitat restoration approach with native oysters (*Ostrea lurida*) may be key to promoting more successful eelgrass restoration. Oysters may increase nitrogenous nutrients in sediment porewater for uptake by eelgrass by mediating nitrogen transfer via filter-feeding and depositing nitrogenous waste. Resource managers are concerned about the efficacy of co-restoration with oysters due to potential negative interactions with eelgrass, a protected species. Little research has been conducted to date to address the efficacy of restoring these species together. In summers 2019 and 2021, we collected eelgrass shoots and pore-water samples from three restored sites within UNB, each with eelgrass restored alone versus eelgrass restored adjacent to oysters. We measured leaf and rhizome growth rates, and organic tissue nitrogen. We analyzed these response metrics relative to distance from and density of oyster beds using co-variogram models. Results indicated positive associations between oysters and eelgrass at closer distances, and elevated tissue nitrogen in the oyster treatments across all sites. Given this potentially positive relationship, project managers should consider restoring both species in combination because each species can return unique ecosystem functions.
11. Long-term effects of Kalamazoo River Oil Spill on health of Northern Map Turtle by Nicholas J. Torres, Dr. Jeanine M. Refsnider

The drilling, storage, and transport of crude oil represents one of the most substantial threats to the health and biodiversity of aquatic ecosystems. Through both acute and chronic accidental leakage and spillage, exposure to oil leads to various negative health effects on wildlife including hypothermia, reduced mobility, and mortality from ingestion. Despite the extensive evidence of the short-term effects on the survival and health of wildlife caused by oil pollution, less is understood of the long-term effects. The continued demand for oil as a source of energy necessitates an increased understanding of the potential chronic health effects caused by oil pollution on wildlife. We conducted an observational experiment to assess the health of a freshwater turtle species, the northern map turtle, using several metrics of individual stress levels, immune function, and body condition ten years following the Kalamazoo River Oil Spill. We collected blood samples from turtles captured from four sites along the Kalamazoo River that underwent varying levels of oil exposure. We assessed immune function using assays that measure bacterial-killing and natural antibody agglutination capacity, estimated physiological stress levels using heterophil: lymphocyte and eosinophil ratios, and quantified body condition and carapace algae cover. We found no difference in any measure of health among the four sites, suggesting subsequent recovery from health detriments potentially caused by oil exposure following the 2010 spill. These results contribute to the understanding of the chronic effects of oil exposure as well as the effectiveness of rehabilitation efforts to be considered during future instances of oil pollution.

12. Exploring the effects of herbivory on competition between *Foeniculum vulgare* and two California native herbs by Samantha Hubbard (and Nicholas Torres), Dr. Joel K. Abraham

Allelopathy is the release of chemicals by plants that inhibit the growth or survival of other plant species *Foeniculum vulgare* (fennel), a potential allelopathic invader in California, competes with California native plants throughout the state. However, it is also subject to herbivory by several California native insects and mammals. Herbivory can impact the magnitude of allelopathic activity of plants, so this herbivory could potentially have indirect effects on native competitors. In this greenhouse study, we are comparing CA native plants (California poppy and common yarrow) grown in monoculture or in competition with fennel, which either underwent simulated herbivory or no herbivory. We predicted that native plants in simulated herbivory treatments should have lower biomass and height than those competing with undamaged fennel. As of this point in time, we have found no height differences across treatments, but data collection is ongoing. At the end of the experiment the plants will be dried and their aboveground biomass will be measured. We hope to learn more about how fennel competes with California native plants to better understand the impact of its invasion.

13. Differences In Goliath Grouper Habitat Use Between Day and Night Within a Refuge Habitat by Lizbeth Gonzalez, Dr. Jennifer L. Runaford

Refuge habitats, such as mangrove forests and seagrass beds, sustain a rich biodiversity by providing protection from predation for many juvenile sport fish. It also provides a higher
oxygen content and a nutrient-rich environment for many prey items. The existence of these complex environments allows for places like Florida’s economically important recreational fisheries to thrive. The purpose of this project was to identify interactions between fish species and examine their fine-scale movement. More specifically, we tracked the Goliath Grouper, a fish that is currently vulnerable to being listed as endangered, according to the IUCN. To track their movement and triangulate precise GPS positions, we used acoustic telemetry and a newly developed algorithm called Yet Another Position Solver (YAPS). Using Geographic Information Systems (GIS), these data were then overlaid onto a map with different types of habitats to identify where the fish were spending most of their time. Preliminary results indicate that the goliath grouper uses the mangrove forests during the day and the seagrass habitats at night. Understanding fish movement plays an important role in identifying environment interactions. The results could be useful in assessing the habitats with the most need for conservation efforts, while demonstrating the importance of preserving habitats like mangroves and seagrass beds.

14. Joshua trees, a Mojave desert icon under threat: using herbarium specimens to generate niche models to predict the impact of future climate change on species distribution by Analisa Ayers, Dr. Joshua Der

The Joshua tree (*Yucca brevifolia*) is one of the most remarkable species in the Mojave Desert. With limited dispersal ability, as environmental change impacts the survival and recruitment of Joshua trees, the species is at increasing threat of extinction. To characterize the impact of climate change on habitat suitability for Joshua trees, we are using environmental niche modeling using historical herbarium specimens and models of future climate to quantify the potential impact on species distribution. The loss of habitat for Joshua trees is a serious threat for species survival unless the effects of climate change can be mitigated.

15. Human urine effect on *A. baumannii* response by Alonzo Ozuna (and Christina Lopez), Dr. Maria Soledad Ramirez

Cefiderocol (CFDC) is a novel catechol-substituted siderophore cephalosporin, approved by Food and Drug Administration. Our previous results showed that if human serum, HSA, or human pleural fluid are present in the milieu, the *Acinetobacter baumannii* minimal inhibitory concentration (MIC) of CFDC is higher. These fluids are also associated with a reduction in the expression of genes related to iron uptake systems, which could explain the need for higher concentrations of CFDC to exert antibiotic action. CFDC is used for treating urinary tract infections, where bacterial cells are exposed to urine. We analyzed the impact of human urine (HU), which contains low albumin concentrations, on the expression of iron-uptake related genes and MIC values of two carbapenem-resistant *A. baumannii*. Levels of resistance to CFDC were not modified by HU in strain AMA40 but were reduced in the case of strain AB5075. Tests on other carbapenem-resistant *A. baumannii* isolates showed that the resistant levels were unmodified or reduced in the presence of HU. The expression of *piuA*, *pirA*, *bauA*, and *bfnH* was enhanced in both strains when HU was present in the culture medium was determined by qRT-PCR. All four tested genes are involved in recognizing ferric siderophore complexes or internalization into the cell’s cytosol. The effect of HU on genes associated with
resistance to β-lactams, antibiotics commonly used to treat urinary tract infections caused by *A. baumannii*, was not consistent. The transcriptional analysis of *php1, php3, blaOXA-51*-like, *blaADC*, and *blaNDM-1* showed different increase, reduction, or unmodified responses by different genes in various strains. In summary, HU, probably due to the albumin and free iron content, does not adversely impact or slightly improves the activity of CFDC when treating *A. baumannii*.

**16. Human urine effect on *A. baumannii* response** by Christina Lopez (and Alonzo Ozuna), Dr. Maria Soledad Ramirez

Cefiderocol (CFDC) is a novel siderophore cephalosporin. Previous results showed that when *Acinetobacter baumannii* was exposed to either human serum or human pleural fluid, the minimum inhibitory concentration (MIC) of CFDC is higher. These fluids are associated with a reduction in the expression of genes related to iron uptake systems. We decided to analyze the impact of human urine (HU), which contains low albumin concentrations, on the expression of iron-uptake-related genes and MIC values of two carbapenem-resistant *A. baumannii*. Levels of resistance to CFDC were not modified or reduced in the presence of HU. The expression of *piuA, pirA, bauA*, and *bfnH* determined by qRT-PCR was enhanced.

**17. Cystic Fibrosis: Understanding the Interplay between the Burkholderia cepacia complex and Staphylococcus aureus** by Jenny Escalante, Dr. Maria Soledad Ramírez

Cystic Fibrosis (CF) is an autosomal, recessive disease affecting around 1,000 individuals per year in the United States. These patients acquire a mutation in the CFTR gene leading to an improper movement of Cl- ions and dense mucous buildup. Overtime, these patients become prone to developing bacterial infections leading to severe morbidity and mortality. Prior studies have not yet explored co-interactions between bacterial pathogens. My research will investigate co-interactions between two pathogens affecting CF, *Staphylococcus aureus* and the *Burkholderia cepacia* complex. Bec’s response in the planktonic and biofilm conditions will be analyzed using transcriptomic data and phenotypic assays.

**18. Lactic acid bacteria with antimicrobial activity against Acinetobacter baumannii** by Nardin Georgeos (and Baoyi Ma), Dr. Maria Soledad Ramírez

*Acinetobacter baumannii* (AB) is an important nosocomial pathogen with a high ability to persist in the hospital environment and to rapidly acquire resistance to several antimicrobials. Thus, it becomes difficult to treat AB infections with available antibiotics. New therapeutic alternatives for the control of AB are an urgent priority. In this work, the antimicrobial activity of eight lactic acid bacteria (LAB) strains (*Latilactobacillus curvatus* CRL705; *Limosilactobacillus mucosae* CRL573; *Lacticaseibacillus casei* BL23; *Lactobacillus acidophilus* CRL641; *Fructobacillus tropaeolis* CRL2034, *Lacticaseibacillus rhamnosus* CRL1505 y CRL75 y *Limosilactobacillus reuteri* CRL1101) against AB118 was evaluated. The inhibitory activity of cell pellets and their supernatants were determined, respectively, by the soft-agar overlay and the well diffusion methods. R values (Inhibition diameter - Spot diameter) were determined and interpreted as R<2mm (no inhibition), 2-5mm (low inhibition), and >6 mm (high inhibition). The pellets of all LAB strains assayed, except *F.*
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tropaeolis, showed R values >6 mm (with diameters of inhibition >20mm). No inhibitory activity was observed for all supernatants. The cell viability of AB118, assessed in co-culture with probiotic L. casei BL23, showed 6-log decrease in AB118 CFU/mL and changes in AB118 colony morphology. While, the cell viability of AB118, assessed with supernatant or filtrate from BL23/AB118 co-culture, showed 1-2 log decrease in AB118. Thus, the interaction between LAB/AB cells seems to be critical for antimicrobial activity. Future trials are needed to elucidate the mechanism involved.

19. The relationship between human serum proteins and susceptibility of Acinetobacter baumannii to cefiderocol (a novel antibiotic) by Brent Nishimura, Dr. Maria Soledad Ramírez

Cefiderocol is a novel antibiotic that utilizes the iron uptake system of bacteria through a siderophore moiety to more directly impact cell wall synthesis. Analysis has shown that Acinetobacter baumannii has responded to human fluids like pleural and serum, as well as human serum albumin, by down regulating iron uptake genes, and up regulating beta lactamase genes conferring potentially higher resistance. Minimum inhibitory concentrations of cefiderocol were measured and showed higher values in cultures supplemented with human fluids. These results are evidence of a correlation that could explain a lowered clinical efficacy of cefiderocol in treating A. baumannii bloodstream infections.

20. Using Charcoal to Reconstruct a Fire History of the Carrizo Plains, CA by Dahlia Serrato, Dr. Matthew Kirby

Southern California is characterized by a distinct fire season. The destruction forest fires wreak is profound, though the paleohistory of fires is poorly documented in Southern California. This study aims to reconstruct the first fire history of the Carrizo Plains National Monument to increase understanding of the conditions that cause fire activity in the past and provide knowledge of present and future fire activity. The Carrizo Plains are located roughly 85 miles north of Santa Barbara adjacent to the San Andreas Fault Zone. Core CLPC21-4 was extracted from a dry lakebed (34 59’31.0” N, 119 29’00.4 W) selected for its ability to collect water from the surrounding area. Fire activity was measured by quantifying woody and grassland charcoal extracted from 30-156 cm of core CLPC21-4. Sediment was extracted in 1 cm³ increments and washed with deionized water of extraneous debris smaller than 125 μm. Charcoal was identified and recorded manually by binocular light microscope. Results shows an increase in charcoal at three points in the core, a period of very sparse charcoal, and variable fluctuations elsewhere. In combination with visual interpretation of the sediment, the peaks can be inferred as charcoal deposition due to flood events rather than true accounts of fire. Quantities of charcoal following these events are indicative of greater fire activity likely due to an increase in vegetation as fuel during wetter climate regimes. No conclusions can be drawn as to whether the period of low charcoal counts was a result of dampened fire activity or poor charcoal preservation due to drier climates. Further geochemical and physical analyses will provide greater insight into the complex history of the area.

21. A Morphological Investigation of the Cephalic Tenaculum of Hydrolagus colliei by Kaitlyn Kern, Dr. Misty Paig-Tran
Chondrichthians (cartilaginous fishes: sharks, rays, skates, and chimeras) use internal fertilization as a mode of sexual reproduction. All male Holocephalans (chimeras) have accessory copulatory structures called cephalic and pre-pelvic tenacula. The cephalic tenaculum punctures the pectoral fins while the pre-pelvic tenaculum punctures the ventral body to remain attached to the female during mating. While the presence of the cephalic tenaculum has been documented, the shape changes and surface morphology have not been well described. The focus of this study was to investigate the surface morphology in the cephalic tenaculum in *Hydrolagus colliei* using SEM and macro photography. I measured the density, length, width, curvature, and sharpness of the denticles on the cephalic tenaculum. I photographed these structures using a macro lens and analyzed the structures on ImageJ software. I created stereopairs to show the 3D anatomy of the pouch that holds the cephalic tenaculum bulb. I found that the denticles are shortest and widest along the dorsal portion of the bulb, longest and thinnest at the distal stalk, and mid-length along the proximal stalk. Mapping the surface anatomy of the cephalic tenaculum is an important first step to determining the functional performance relative to the morphology. I plan to compare the anatomy of *Hydrolagus colliei* to other taxa of Holocephali using these techniques and CT scans as this study progresses.

22. Exploring the filtration mechanisms in juvenile and adult whale sharks (*Rhincodon typus*) by Nicole Steplewski, Dr. Misty Paig-Tran

Whale sharks (*Rhincodon typus*, the largest extant fish) are hypothesized to use a cross-flow filtration mechanism for separating their zooplankton prey from water, though this has not been documented *in vivo* or with physical or computational models. Whale sharks grow over three orders of magnitude throughout their ontogeny and therefore, it is likely that these changes in their anatomy affects the method of filtration employed. I investigated the filter surface anatomy in both juvenile and adult whale sharks using a macro lens and Micro-Computed Tomography (μCT) to obtain visual morphological data. The gross anatomical features I observed in the images of juvenile whale shark filter pads resemble the filter lobes of manta rays, which resembles a fern leaf with a central vane and wings attached on either side. Imaging results have allowed me to visually analyze show differences in anatomical structure (pore size, pore shape, total open pore area) between juvenile and adult whale sharks. The central vanes in juvenile filter pads are visually thinner than the adults. Thus, the pore sizes and total pore area are larger in the juveniles versus the adults. This leads the pore shape to differ between the juveniles and adults. Images of the juvenile filter pad show possible evidence of maturation of the filter pad. Using the imaging data acquired, I plan to continue investigating the anatomical differences in juvenile and adult filter pads through Scanning Electron Microscopy for visualization and Matlab to quantify the morphological characteristics of both age groups.

23. How Lipids Regulate the Cell Surface Localization of HSPA1A, a Stress-inducible 70-kDa Heat Shock Protein by Rachel Altman, Dr. Nikolas Nikolaidis

HSPA1A is a molecular chaperone that regulates survival stressed and cancer cells. In addition to its cytosolic pro-survival functions, HSPA1A also localizes at the plasma membrane (PM) of stressed and tumor cells. In cancer cells, the presence of HSPA1A at the cell surface allows the latter cells to develop resistance to radiation therapy, show increased
invasiveness, and develop distant metastasis. Therefore, abolishing HSPA1A from the surface of tumor cells is a promising therapeutic. However, HSPA1A’s pathway to the cell surface remains enigmatic because this protein lacks membrane localization signals. Considering that HSPA1A binds with high selectivity to negatively charged lipids, like phosphatidylserine (PS) and mono-phosphorylated phosphoinositides (PIPs), we hypothesized that the interaction of HSPA1A with these lipids allows the chaperone to translocate and anchor to the PM. To test this hypothesis, we subjected human cell lines to heat shock, depleted specific lipid targets, and quantified HSPA1A’s PM localization using confocal microscopy and cell surface biotinylation. These experiments revealed that depletion of PS, PI(4)P, and PI(3)P by co-transfecting HSPA1A with known lipid-biosensors, significantly reduced HSPA1A’s surface presentation. In contrast, reducing PI(4,5)P 2 availability by overexpression of the PLCδ-PH biosensor had minimal effects on HSPA1A’s PM-localization. Next, we manipulated the cellular lipid content using ionomycin (a PLC activator), phenylarsine oxide (PAO) and GSK-A1 (general and a selective PI4 Kinase inhibitors, respectively), wortmannin (a PI3-Kinase inhibitor), and fendiline (a repurposed FDA approved drug that reduces PS) using lipid-biosensors as positive and negative controls. These experiments revealed that HSPA1A’s PM localization was unaffected by ionomycin but was greatly reduced in the presence of PAO, GSK-A1, wortmannin, and fendiline, corroborating the findings obtained by the co-transfection experiments. We further verified these results by selectively depleting PI(4,5)P 2 and PI(4)P using a well-established rapamycin-induce phosphatase system. Our findings strongly support the notion that HSPA1A’s surface presentation is a multifaceted lipid-driven phenomenon controlled by the binding of the chaperone to specific endosomal and plasma membrane lipids. These finding provide the basis for future interventions to render tumor cells sensitive to radiation therapy.

24. A mechanosensitive channel, TbrMscS, is responsible for mitochondrial homeostasis in the protozoan parasite Trypanosoma brucei by Melvin Williams, Dr. Veronica Jimenez Ortiz

Mechanosensation is an evolutionary conserved trait that allows cells to sense their external and internal conditions, effectively responding to changes in their environment. Beyond the canonical functions such as volume regulation and surface sensing, intracellular mechanosensitive channels play a role in maintaining organelles physiological functions. We have identified a mechanosensitive channel (TbrMscS) homologous to the small conductance mechanosensitive channel found in E. coli. Expression in spheroplasts followed by electrophysiological recordings indicate that TbrMscS is directly activated by tension and has a conductance of 0.2 pS. When expressed in E. coli strains lacking mechanosensitive channels, TbrMscS complemented the function of the mutants, restoring their ability to regulate volume upon osmotic shock. These results confirmed the nature of TbrMscS as a mechanically-gated channel and showed the conservation of its role as an osmotic relief valve. In the parasites, the channel is expressed in both life stages, with higher levels in procyclic forms, and localizes to the mitochondria, as expected by its genetic homology with bacterial-like channels. Reduction of TbrMscS expression by RNAi caused a decrease in the growth of procyclic forms with no significant changes in bloodstreams. Downregulation of the channel also caused defects in cell volume regulation under hyper-osmotic conditions and abolished social motility behavior on semi-solid agar plates. Furthermore, reduction in TbrMscS expression caused dissipation of the mitochondrial membrane potential,
demonstrating its role in the regulation of this organelle. Our results provide the first evidence of mechanosensation in *T. brucei* and its role in mitochondrial homeostasis in protozoan parasites.

25. **Whyda-ya live here: Is speciation occurring in the southern California pin-tailed whydahs, as a result of anthropogenic involvement?** by Christina Ceballos (and Nadia Naji), Dr. William J. Hoese

Pin-tailed whydahs (*Vidua macroura*) (PTW) are birds from Africa that were introduced to southern California (SoCal). PTWs are songbirds that learn song from conspecifics, allowing them to communicate with their own species. PTWs were transported to California for the pet trade; once the population established locally, their songs may have diverged from the African source population. This project aimed to investigate the effects of the geographic isolation from the PTWs ancestors. We hypothesized that male SoCal PTWs would have a stronger response to SoCal song versus African song. We created playbacks of both the SoCal and African song. We conducted simulated territorial intrusions with five male PTWs using a speaker and song recordings; each 300-second playback trial consisted of Africa song, SoCal song, and control (silence) segments. For each male PTW, the number of chirps, flyovers, trills, and number of times the birds entered the playback radius were recorded. PTWs changed perches significantly more often during SoCal playbacks compared to Africa and control playbacks (p < 0.05 ANOVA). The mean number of flyovers and vocalizations were higher during SoCal playbacks than during Africa and control playbacks, however, the responses were not significantly different (p > 0.05 ANOVA). Our results suggest that allopatric speciation may be occurring due to the geographical separation of the PTWs an divergence in response to locally recorded song versus song from Africa. Future research entails expanding our sample size to better understand how male PTW recognize song and to investigate responses by female PTWs.

**Geological Sciences**

26. **The timing and magma source of the Sonora dike swarm and Standard pluton, Sonora, California, and comparison to other Jurassic dike swarms in the Sierra Nevada Batholith** by Caitlin Bates, Dr. Valbone Memeti

The Sierra Nevada Batholith (SNB) contains several swarms of late-Jurassic dikes and small mafic intrusions. Among these is the Independence dike swarm (IDS), a ca. 148 Ma dike swarm that is found in the eastern SNB and to the east in the Inyo Mountains and the Mojave Desert with a wide range of felsic to mafic lithologies and isotopic values ranging Sr= 0.705324-0.710445 and εNd= -9.74 to -1.18 (Glazner et al., 2008). Dikes with bimodal felsic and mafic compositions intruding the King Creek pluton in the central SNB are slightly older and isotopically more primitive than the IDS. They have a LA-ICPMS U/Pb zircon age of 152.5±2.7 Ma and isotopic values of Sr= 0.70465-0.70470 and εNd= 5.40 to 7.63 (Wesley et al., 2019). In the western SNB, the basaltic-andesitic Sonora dike swarm is less well-known and understood. It intrudes metasedimentary host rocks and the granodioritic to dioritic Standard pluton. Field observations and samples were collected to determine the timing and source of the Sonora dike swarm and its relation to other dike swarms in the
In addition, two samples from a mafic body in the May Lake metasedimentary pendant, one from a gabbroic complex near the Snow Lake metasedimentary pendant, one from a dike in the Alabama Hills were collected and analyzed to determine their relationship to the late-Jurassic dike swarms in the SNB.

Mafic dikes intruding the Standard pluton show a mingling relationship with the host magma, making them coeval. The Standard pluton revealed a LA-ICPMS U/Pb zircon age of 162.27±0.36 Ma. The Sonora dike swarm was thus emplaced before the central SNB King Creek dikes and the IDS. Isotopic analysis of three Sonora dikes and the Standard pluton range from $\text{Sr}_{i}= 0.703701-0.705657$ and $\varepsilon\text{Nd}= -1.49$ to 6.83. This suggests that the magma source for the Sonora dikes and King Creek dikes as well as the associated Standard and King Creek plutons, respectively, is depleted mantle with minor crustal or enriched mantle input, while the source for the IDS is more evolved. The geographic location of these three Jurassic dike swarms and associated intrusions and their isotopic affinities indicate that the Sonora dikes in the northwestern SNB and King Creek dikes in the central SNB were sourced from asthenospheric mantle, while the IDS in the southeastern SNB and to the east and southeast thereof likely tapped a lithospheric mantle and/or a crustal source, or at least were highly contaminated by these sources. Finally, the three dike swarms expand the Jurassic extensional period in the SNB to at least episodic (spatially and temporally) events ranging from 162-148 Ma.

Physics

27. UV Absorption in Uncoated Fused Silica Samples by Erick Engelby

Higher than expected absorption of UV light can be found in uncoated fused silica witness samples. To investigate the amount of absorption (ABS), we implement Pump-probe microscopy by exposing the samples to 193nm light and measuring the amount absorbed in the medium, from measuring the expansion. Ion-Beam figuring (IBF) can remove thin layers from the samples by using an Argon-plasma ion gun to sputter away surface material without causing surface damage or wedge errors. By combining intervals of IBF surface removal with proceeding ABS measurements over three FS witness samples, we can compare data to initial, premeasured values to determine the depth of surface removal for minimizing absorption. After three intervals of removal and corresponding ABS measurements, as well as premeasurements with identical measurement processes, ABS was significantly improved after the first 1µm of removal, such that higher absorption definitively resides within the top layer and/or surface of the medium.

28. Calculating Fundamental Modes of Neutron Stars by Mary Usufzy (and Phil Landry)

Neutron stars are small, compact stars that are often the result of a supernovae explosion. They are one of the densest objects in stellar evolution that can emit gravitational waves. Their fundamental modes (f-modes) oscillations provide information on their structure and interior composition. The TOV (Tolman-Oppenheimer-Volkoff) equations for a spherically symmetric body can improve understanding about a neutron star’s equation of state. With the TOV equations, masses and radius for each neutron star can be determined. Similarly, the
procedure can be reversed to figure out which equations are compatible with the equation of state. In this experiment, Python code was implemented a simulation of four datasets that computed variables in a neutron star’s structure. Four plots illustrated the relationships between multiple observables, such as mass, radius, pressure, and density. Thus, solving the TOV equations can provide valuable insights about the physical properties of neutron stars and their origins in our universe.