# 2023 Postdoc Symposium
# Discoveries, Contributions, and Community: UVA Postdoctoral Research in Action

## Abstract Book (sorted alphabetically)

***Direct electrodeposition of graphene on the copper substrate through aqueous media***
***Ali Akbarisehat, Giovanni Zangari***

Chemical vapour deposition (CVD) has been used to synthesize graphene on copper substrates for the past ten years. Although the CVD process produces graphene with few layers, it is time-consuming, expensive, and complicated. We describe a quick and direct way to deposit graphene on a copper substrate by dissolving organic molecules in an electrolyte. A cathodic current on the copper metal causes organic molecules to lose their oxygen functional groups, resulting in the formation of graphene layers on the copper substrate. Depending on the time and the applied voltage value, the layers of deposited graphene can be varied. Two distinct G (1360 cm-1) and D (1620 cm-1) peaks of electrodeposited graphene on the copper substrate were visible using the Raman method.

***Decarbonizing Institutional Investor Portfolios: Helping to Green the Planet or Just Greening Your Portfolio?***
***Vaska Atta-Darkua, Simon Glossner, Philipp Krueger, Pedro Matos***

We study whether and how climate-conscious institutional investors, i.e., institutions that join climate related investor initiatives, are decarbonizing their equity portfolios. Decarbonization could be achieved by re-weighting portfolios towards lower carbon emitting firms or targeted engagements with portfolio companies to reduce emissions. Our analysis suggests that portfolio re-weighting is the predominant strategy used by climate-conscious institutions to green their portfolios, in particular by investors based in countries with carbon emissions pricing schemes. Institutions also rely on engagement, particularly following the 2015 Paris Agreement. Furthermore, we find no evidence that climate conscious investors allocate capital towards firms developing climate patents, but they do re-weight towards firms generating more green revenues. Overall, our analysis raises doubts about the effectiveness of investor-led initiatives in reducing corporate carbon emissions and helping take necessary action to tackle climate change for an all-economy transition to “green the planet”.

***Unwinding the role of DEAD-box RNA helicase DDX39B in RNA alternative splicing.***
***Shefali Banerjee, Chloe Nagasawa,Gaddiel Galarza-Muñoz, Minato Hirano, Steven G. Widen, Samuel Fagg, and Mariano A. Garcia-Blanco.***

Alternative RNA splicing expands the coding capacity of a pre-mRNA transcript such that a single mRNA can encode for multiple protein isoforms. Aberrant RNA splicing has been linked to many autoimmune disorders like multiple sclerosis (MS), diabetes and rheumatoid arthritis. The decision whether an exon or intron gets included is a multistep process involving dynamic interactions between a pre-mRNA and the multicomponent spliceosome machinery. DEAD-box RNA helicases assist in spliceosome function through their RNA unwinding and ATPase activities. We have shown that DDX39B-a DEAD-box RNA helicase-regulates alternative splicing of immune-related genes such as IL7R and FOXP3 mRNAs which are essential for T-cell function. Diminishing DDX39B activity skews the splicing patterns of these genes possibly resulting in abnormal T-cell function. We have identified cis-acting elements within pre-mRNAs which dictate their sensitivity to DDX39B-mediated alternative splicing. These findings open avenues for designing RNA-based therapeutics to correct for aberrant splicing activity in diseases.

***Not so simple: understanding the structure of cell membrane mimics***
***Christopher P. Baryiames, Matthew Necelis, Linda Columbus***

Understanding the structures of membrane proteins is critically important to understand how bacteria and viruses infect humans, as these proteins are often the first point of contact between human cells and disease-causing entities. However, to form properly, these proteins need to be embedded in a lifelike environment. Unfortunately, their natural environments are often too complex to study directly. Several simpler systems have been developed to preserve the essential components of the natural cell membrane while making scientific studies easier, but there are still questions of how realistic those simple systems are. My research focuses on bicelles, one family of these mimics, and how they interact with membrane proteins. I show that simplified membranes are not as ideal as we think and that adding a protein to the bicelle actually makes the problem worse.

***The Sodomy Consultant of Paris: Education, Morality, and Sexuality in the Early Modern City, 1688–1737***
***Benjamin Bernard***

Through the 1720s in Paris, the morals bureau of the Lieutenancy General of Police tracked, arrested, and imprisoned hundreds of so-called “sodomites” through the gardens and alleyways of the city. How did just two sodomy inspectors learn enough about this “sodomitical subculture” to police it effectively? This presentation demonstrates the central role played by Nicolas Theru, a grammar regent at the Collège Mazarin from 1688 until his retirement in 1732. By day, this Artesian priest taught Latin to teenage boys—but by night, he presided over a vast network of informants to track, denounce, and have imprisoned hundreds of queer men. While such

activities seem surprising for a teacher to undertake, upon inspection they fit the Collège's imperial mission for the ethical instruction of elite provincial youth. The case illustrates how the modern of policing of sexuality emerged from the moral aims of higher education institutions under an absolutist monarchy.

***Does space chemistry provide the building blocks of life?***
***M. Bonfand***

Everything that makes up the matter around us was originally created in space. Our main suspects for transporting this material to Earth are comets and meteorites, on which hundreds of amino acids, the building blocks of proteins, have been discovered. But how, where and when were these molecular species formed? To answer these questions, I use telescopes from all around the world to dig inside the interstellar clouds that form stars. These clouds, composed of gas and dust, are prodigious factories to produce interstellar molecules. To date, nearly 300 distinct molecular species, from simple diatomic molecules to larger ones composed of up to 19 atoms, have been detected in star-forming regions. I run numerical simulations to predict the formation/destruction pathways of these species as they evolve in space, and to understand how interstellar chemistry makes up large molecular species, such as amino acids, building blocks of life as we know it on Earth.

***How to miniaturize the Schrödinger's cat***
***Léandre Brunel***

Light has long been recognized as a promising candidate for developing quantum technologies, thanks to its wave-like and particle-like nature. With the ability to be guided through optical fibers, light can be exploited to adapt existing quantum experiments on small chips. Such projects are crucial in the development of quantum computers, where compactness and scalability are essential.

In this talk, I will present how I am exploring the interactions between light and matter to develop small chips that allow us to generate, manipulate and detect objects arising from the quantum nature of light. Specifically, I will present the kind of quantum object that can be created and I will discuss the factors that may limit the exploitation of those on the chip. The goal of this research is to make existing experiments more compact, paving the way for future breakthroughs in the field of quantum computing.

***AgRP Neurotrophin Signaling: Navigating Adaptations to Energy Excess and Scarcity***
***O Yipkin Calhan, Sara K Michel-Le, Shishir S Sriramoju, Elizabeth N Godschall, Brandon M Podyma, Christopher Deppmann, Ali D Guler***

Obesity is a global health issue that increases the risk of comorbidities and reduces life expectancy. Improved diet and exercise are crucial for managing obesity, but long-term weight loss remains challenging due to evolutionary adaptations to calorie scarcity. It is unclear how the brain adapts to calorie excess or scarcity, despite mapping of the neuronal circuits regulating metabolism. Specific neuron populations, AgRP neurons, in the hypothalamus regulate feeding behavior. Brain-derived neurotrophic factor, and its receptors, TrkB and p75NTR, impact metabolic disorders, but their mechanisms are still being investigated. We here show that antagonistic functions of TrkB and p75 during caloric excess and scarcity dynamically regulate AgRP neuron function and feeding behavior to adapt to the presence and absence of calories. Elucidating the intricate mechanisms governing AgRP neurons may pave the way for novel therapeutic strategies targeting obesity and its associated comorbidities.

***A Targeted Nanofiber Reduces Atherosclerotic Plaque Size***
***Vina Y. Chhaya, Sophia L. Maragos, Ruomeng Qiu, Simon A. Egner, Mark R. Karver, Samuel I. Stupp, Nick D. Tsihlis, Melina R. Kibbe***

Introduction: Heart attacks and strokes are leading causes of death worldwide. Nanotechnology can treat these diseases by targeting medications directly to areas of plaque buildup while avoiding side effects seen with other treatments.

Methods: A nanofiber targeting plaque was developed and loaded with a drug that can reduce plaque size. Mice were fed a high-fat diet to cause plaque buildup and then injected twice/week with a targeted nanofiber drug. Cholesterol in the blood and plaque buildup in the heart were evaluated.

Results: A targeted nanofiber containing a plaque-reducing drug makes atherosclerotic plaques about 5% smaller compared to placebo (42.4% vs. 38%, $p \leq 0.0001$). There was no difference in blood cholesterol or triglyceride levels between treatment groups.

Conclusion: We have developed a nanofiber targeting plaque that is loaded with a drug that reduces plaque size. This treatment has the potential to delay or even avoid surgical intervention for blocked arteries.

***Using Geometric Similarity Metrics to Rank Auto-Delineation Models with Respect to Manual-Delineation***
***Jason Czak, Abishek Karki, Hashir Rashad, Victor, Jeffrey V. Siebers, Victor Gabriel Leandro Alves***

Our work aimed to compare geometric indices between manual delineations and automated contouring models through statistical analysis. Manual contours and automated contouring results were compared using Segmentation Evaluation Tools, generating conventional matrices for comparison. The Auto-Contouring software included results from Carina, Siemens, SPICE, Radformation, and CarinaV2. The data analysis parameters were volume Dice similarity coefficient, 95% Hausdorff distance, and surface Dice similarity coefficient with 1mm tolerance. The results were tabulated for Left and Right Parotid, Brainstem, Mandible Bone, and Spinal Cord, and analyzed using a t-test. The study found that CarinaV2 showed the highest criterion, indicating a more accurate representation of the physical structures for the Parotid Glands. The results provide a standard benchmark for selecting and evaluating the reliability of Auto-Contouring software. Overall, statistical analysis on geometric indices derived from comparing automated contouring software results with manual delineations can be a valuable tool for improving accuracy in medical imaging.

***From gene, through cell, to color: The making of colorful fish.***
***de Mello, Pietro; Parichy, David***

A fundamental quest in biology is to understand how biological diversity arises and is maintained through time. Given their conspicuousness and variability, colors patterns have played a fundamental role in this endeavor. For example, in finding that stripe formation in the charismatic Zebrafish is largely dependent on the interaction between three types of color cells, our lab has corroborated the hypothesis that repetitive patterns are substantially determined via its self-organizing elements. Not all patterns, however, are repetitive. In my research I use the colorful Trinidadian guppy to determine whether the presence of a spot is determined by its position in the skin. We predict that a pre-pattern is established by skin cells surrounding the color cells, providing the latter with factors that determine their fate as colorful cells. Only by characterizing the mechanisms behind colorful patterns will we be able to understand the evolutionary processes that generate and maintain them.

***The Role of Cep55 in the Developing Brain***
***Dingsdale H, Ross EH, Filipek K, Dwyer ND***

Tight regulation of neural stem cell division in the developing brain is crucial for generating the correct number and placement of neural cells. Divisions occur at the ventricular surface, with factors including the angle and speed of cell division influencing the phenotypic fates of daughter cells. Cep55 plays a key role in these divisions, recruiting proteins that precisely cleave the last connection between daughter cells. Deletion of Cep55 leads to delayed and failed divisions, cell death, altered cell fates, and microcephaly. Given these drastic effects, it is

unclear which outcomes relate to the direct function of Cep55 in individual cells and which to the secondary consequences of disrupted brain development.

Here, we use Mosaic Analysis of Double Markers to isolate autonomous and non-cell autonomous functions. Through deletion of Cep55 in only a sparse population of neural cells, we study its role in both individual cells and in the wider brain.

***The role of coastal ecosystems in climate change mitigation***
***Carolyn Ewers Lewis and Karen McGlathery***

Blue carbon (C) ecosystems – seagrass meadows, tidal marshes, and mangrove forests – are responsible for as much as 50% of the ocean's C burial, making them important natural ecosystems for mitigating climate change. However, we still have much to learn about how their ability to store C is impacted by disturbance (e.g., marine heat waves) or connectivity (spatial relationships with other ecosystems). The barrier island system of the Virginia Coast Reserve Long Term Ecological Research site, USA, is home to one of the largest successful seagrass restorations in the world that is over 20 years old. Here, we performed the largest seagrass disturbance experiment to date and developed a study to determine the contribution of seagrasses to marsh soil carbon. The outcomes from this research will help us understand how to maximize the potential of coastal ecosystems to mitigate climate change.

***MACHINE LEARNING FRAMEWORK TO EXPLAIN COMPLEX GEOSPATIAL SIMULATIONS: A CLIMATE CHANGE CASE STUDY***
***Tanvir Ferdousi, Mingliang Liu, Kirti Rajagopalan, Jennifer Adam, Abhijin Adiga, Mandy Wilson, S. S. Ravi, Anil Vullikanti, Madhav V. Marathe, Samarth Swarup***

Simulation data generated by large and complex models can be challenging to interpret. We present a framework to analyze such models by processing multidimensional data through a pipeline of target variable computation, clustering, supervised classification, and feature importance analysis. As a use case, the well-known large-scale hydrology and crop systems simulator VIC-CropSyst is utilized to evaluate how climate change may affect water availability in Washington, United States. We study how snowmelt varies with climate variables (temperature, precipitation) to identify different response characteristics. Based on these characteristics, spatial units are clustered into six distinct classes. A random forest classifier is used with Shapley values to rank static soil and land parameters that help detect each class. The results also include an analysis of risk across different classes to identify areas vulnerable to climate change. This paper demonstrates the usefulness of the proposed framework in providing explainability for large and complex simulations.

***From Mine to Ours: Methodological Reflections on a Community-Based Action Research Study***
***Jessica V. Forrester***

Community-based participatory action research (CBPAR) is an inclusive research approach that involves engagement from community stakeholders in all stages of scholarly inquiry. My dissertation study utilized aspects of CBPAR to create community-inspired mathematics activities for an after-school tutoring program in North Minneapolis. Methods included interviews with youth and adult community members, focus groups with parents, content analysis of local newspapers, and feedback sessions with attendees of the tutoring program. Although these methods gave insight into the contextual nuances of the community in order to design mathematics activities, I argue that additional steps can be taken to transcend from an interactive study to a participatory study according to Swartz and Nyamnjoh's (2018) continuum of research methods. This presentation will detail my dissertation's methodological choices and findings while providing future research suggestions that highlight the possibility of shared power and ownership between researchers and participants.

***Three Gene Expression States during Chronic Viral Heart Infection***
***Cameron D. Griffiths, Millie Shah, and Kevin A. Janes***

Most viral heart infections are self-limiting, but some persist in an undiagnosed chronic state. Using unmapped RNA-sequencing reads, we identified viral infections in 19.3% of patient heart samples from three publicly available databases (1026 samples). The virus-positive samples show one of three gene expression profiles. One profile is associated with heart failure, while another shows signs of resolved infection. In parallel, we engineered twelve clonal cardiac cell lines to be chronically infected by coxsackievirus B3 (cardio-pathogenic virus) and analyzed them by RNA-sequencing. The chronic clones each display a gene expression profile that corresponds to one of the patient-derived profiles. Inhibiting the p38 or tumor necrosis factor alpha (TNFÎ±) signaling pathway causes the profile of the chronic clones in the heart failure cluster to shift towards the other two clusters. This project provides insight into chronic viral infection and may lead to interventions that halt the progression to heart failure.

***Identifying the sources of air pollution inequalities in US cities using satellites***
***Xuehui Guo, Jon-Paul Mastrogiacomo, Debra Wunch, Isabella Dressel and Sally Pusede***

Air pollution disproportionately harms communities of color and low-income communities in US cities. Recent work has demonstrated that nitrogen dioxide (NO2) inequalities within cities can be observed from satellites. However, we have less understanding of the neighborhood-level variability in other combustion-related pollutants such as carbon monoxide (CO) and of the emission sources driving neighborhood inequalities. In this talk, I will discuss my work evaluating the use of satellite CO observations for describing census tract-scale inequalities with race-ethnicity in major US cities. We couple satellite data with US Census data to derive population-weighted inequalities separately for Black and African Americans, Hispanics and

Latinos, and Asians. Our results provide observational evidence that communities of color are overburdened with diesel traffic pollution on weekends, and that diesel traffic emissions are more persistent on weekends for these same groups than for non-Hispanic whites. The policy implications of these results will also be discussed.

***Applications of color tracking using a smartphone to measure strain and displacement***
***Harrell, T.M., and Li, X.***

Image-based techniques such as Digital Image Correlation (DIC) and grid method are commonly used to measure strain and displacement, but these methods can be expensive and require marking the sample, which is not always possible. Fiducial markers are used in such cases. This study proposes a color tracking technique to track colored fiducial points on materials that cannot be marked via standard techniques. The approach is demonstrated using a conventional smartphone and a moving pendulum setup with a green ball tied to a tow of nylon fibers. The difference in color is used to automatically detect the point. This non-contact method is shown to be effective in tracking displacement with minimal noise and has potential for measuring strain and as an educational tool. The proposed method offers a low-cost alternative to traditional imaging methods and could have practical applications in various fields.

***Bodies in Flight: Afro-Colombian Women Imagining Lives Beyond the Sovereign Nation-State***
***Amber M. Henry, PhD***

How does it feel to belong? How might minorities' experiences of both belonging and dispossession nuance our understanding of the possibilities and limitations of state sovereignty in 21st century Latin America? This anthropological research interrogates how a group of Afro-Colombian women who belong to an indigenous population of runaway enslaved Africans, mobilize spiritual practices, linguistic patterns and aesthetic traditions in ways that mark them as a unique ethnic population. I analyze how private and state actors seek to fix the women as apolitical caricatures of the tourist industry while the women use gendered, racialized, and classed forms of grassroots mobilization and everyday forms of refusal to affirm their agency. In this way, I explore the formal and informal strategies through which these women articulate themselves within and against the sovereignty of the modern nation state.

***Non-muscle myosin II paralogs in intestinal homeostasis and pathogenesis***
***Gaizun Hu, Khosiyat Makhmudova, Sharon Zheng, Mahi Gudi, Alina Alfaro, Yuta Ohno and Seham Ebrahim***

The monolayer of epithelial cells lining our intestinal tract is the most rapidly renewing cell population in the body, where cell division rates in crypts is perfectly balanced with cell extrusion at villus tips. Forces generated by actin and non-muscle myosin II (NMII) within IECs drive these events, and dysregulation of NMII paralogs, NMIIA and NMIIC, has recently been linked to colon cancer metastases. However, while NMIIA was found to act as an oncogene, NMIIC acts as a tumor suppressor. Our goal was to determine the paralog-specific functions underlying these differences.

We find that NMIIC localizes to epithelial junctions and stabilizes the monolayer, while conversely, NMIIA drives cell division, rearrangements, and extrusion. Further, ablation of NMIIC significantly attenuates cellular extrusion from villus tips. The resultant dysregulation of cell turnover is a prospective trigger for tumor initiation. These data highlight the likely mechanisms underlying paralog-specific functions of NMII in cancer metastases.

***How red pigments are produced in fish***
***Delai Huang, Victor M Lewis, Tarah N Foster, Matthew B Toomey, Joseph C Corbo, David M Parichy***

Animal pigment patterns play important roles in behavior and, in many species, red coloration serves as an honest signal of individual quality in mate choice. Among Danio fishes, some species develop red pigment, whereas other species, like model organism zebrafish, only have yellow pigment. Here, we use zebrafish close-relative pearl fish to expolore the mechanisms of red coloration. First we identify the predominant carotenoids that confer red coloration, and then use Crispr-Cas9 screening to pinpoint genes required for red coloration.We further confirm it’s a conserved mechanism by over-expressing the two “red genes” in zebrfish, which sufficiently converts zebrafish yellow pigment to red. Our analyses are a first step towards defining the mechanism underlying the development of red coloration in fish.

***Model-driven characterization of functional diversity of clinically isolated Pseudomonas aeruginosa strains with broad range of morphologies***
***Mohammad Mazharul Islam, Glynis L. Kolling, Emma M. Glass, Joanna B. Goldberg, and Jason A. Papin***

Metabolic functions that vary across diverse P. aeruginosa clinical isolates are poorly understood. To better understand the metabolic repertoire of P. aeruginosa in infection, 971 clinical isolates of P. aeruginosa previously collected from 590 patients with corresponding patient metadata, bacterial morphological phenotypes, and antimicrobial susceptibility profiles, were utilized. We selected 25 phenotypically representative isolates for whole genome sequencing from this isolate collection through stratified random sampling. The genome

sequence data was used for comparative genomic analysis using the PA14 strain as the reference genome. The genotypic clustering was compared to the phenotypic clustering generated from a multi-parametric analysis to assess the genotype-phenotype correlation. Each of the complete genomes of the isolates was annotated based on the KEGG biochemical database and a genome-scale metabolic network reconstruction was developed for each isolate through extensive amendment to an existing PA14 reconstruction, iPau21. These network reconstructions show diverse metabolic functionalities and substrate dependencies, as well as enhance the collective P. aeruginosa pangenome metabolic repertoire.

***Targeting ERG and DNA binding in ERG – TMPRSS2 fusion proteins in Prostate Cancer***
***Ashish Kabra, Venkata Sesha Kiran Kumar Srimath Tirumala, Adam Boulton, Michael Regan, Daniel Gioeli, John H. Bushweller***

Prostate cancer is a common type of cancer in men worldwide and is associated with gene fusions between ERG and TMPRSS2 in about 50% of cases. ERG is a transcription factor that belongs to the ETS family and each subclass in ETS family is regulated by a mechanisms which is specific to that subclass. Our lab showed that the auto-inhibition of ERG is due to the NID and CID (N- and C-terminal inhibitory domain) regions, which form an auto-inhibitory cassette and prevent DNA binding. We used this information to design specific inhibitors against ERG-TMPRSS2 fusions and screened for fragment-based and covalent inhibitors. We linked the optimized fragment-based and covalent inhibitors to increase potency. Biochemical and cellular assays were performed to check the on-target effect, and we used NMR spectroscopy to map the binding surface of the potent inhibitor on ERG structure. These findings could lead to the development of new therapies for prostate cancer that target the ERG-TMPRSS2 fusion.

***Trained Ensemble Models for Epidemic Forecasting***
***Aniruddha Adiga Gursharn Kaur, Benjamin Hurt, Lijing Wang, Przemyslaw Porebski, Srinivasan Venkatramanan, Bryan Lewis, Madhav Marathe***

Real-time forecasting of non-stationary time series is a challenging problem, especially when the time series evolves rapidly. For such cases, it has been observed that ensemble models consisting of a diverse set of model classes can perform consistently better than individual models. Motivated by the robust performance properties of ensemble models, we developed a Bayesian model averaging ensemble technique consisting of statistical, deep learning, and compartmental models for fore casting epidemiological signals, specifically, COVID-19 signals. We observed the epidemic dynamics go through several phases (waves) and thus propose a modification to the ensembling method to employ this phase

information and phase-based weighting schemes for each to produce improved forecasts. We also propose a phase prediction algorithm to estimate the phases using the leading indicators and evaluate our proposed methodology on our currently deployed COVID-19 forecasting model and the COVID-19 ForecastHub models.

***Co-transport of methanol and formate in crosslinked phenyl acrylate-based ion exchange membranes: Effect of steric hindrance***
***Jung Min Kim, Yi-hung Lin, Sean M. Bannon, Geoffrey M. Geise, and Bryan S. Beckingham***

Understanding the co-transport behavior of CO2 reduction products (methanol and formate) in ion exchange membranes (IEMs) is of interest for CO2 reduction cells (CO2RCs). The role of an IEM in a typical CO2RC is to suppress the crossover of all CO2 reduction products while allowing the transport of electrolytes. Tuning the polymer rigidity of the membrane is a key contributor to such highly controlled transport of organic solutes in a hydrated membrane. We investigate the effects of structural modification on co-transport behavior by introducing quaternary carbons within the membrane. We measured the relative permittivity properties to determine if the presence of the organic solutes impacted the nature of the hydrogen bond network. We observed that the films with methyl group incorporation have effectively constant relative permittivity values when exposed to solutions containing organic solutes. These findings may assist in designing membranes for applications, including CO2 reduction cells and water-organic separations.

***Co-electrocatalytic CO2 reduction involving a molecular chromium complex mediated by a dibenzophosphole oxide***
***Connor A. Koellner, Amelia G. Reid, Charles W. Machan***

The exacerbating circumstances of the geochemical landscape have driven innovations in the development of green strategies and technologies. An area of major importance is the generation of commodity and feedstock chemicals via the utilization of atmospheric carbon dioxide (CO2). Specifically, the chemical reduction of CO2 to carbon monoxide (CO) requires the use of electrocatalysts to facilitate chemical conversion.  Our research group focuses on studying the behavior and of catalytic molecular systems and their activity towards CO2 reduction. Presented herein is a new example of a mediated co-electrocatalytic system selective for the reduction of CO2 to CO, which is comprised of a previously reported molecular chromium metal complex and 5-phenylbenzo[b]phosphindole-5-oxide (PhBPO) which mediates and enhances catalysis.

***Explicit and Implicit Verbal Support: A Case Study of the Integration of STEM+CS in Elementary Science Projects***
***Sarah Lilly, Anne M. McAlister, Jennifer L. Chiu***

National frameworks for science education  have worked to bring science, technology, engineering, mathematics, and computer science (STEM+CS) disciplines together in K-12 classrooms. This study describes how two elementary teachers verbally supported fifth-grade student engagement within two disciplinary-focused lessons (i.e., science lesson and CS lesson). Transcripts of whole-class discussion were analyzed for instances in which teachers verbally supported the integration of STEM+CS disciplines. Results indicated that teachers most

commonly added verbal support for the integration of mathematics. In the science lesson, the majority of instances were added and explicit; there were no instances of planned, explicit support. In the CS lesson, most instances were added and implicit; planned instances were evenly split between being made explicit or implicit. Implications of this study include recommendations for support that teachers need to engage in the important, but challenging, work of enacting STEM+CS curricula within elementary science classrooms.

***Harnessing the interfacial thermal conductance between graphene and substrate by mechanical loadings***
***Qingchang Liu; Baoxing Xu***

Strain engineering has been leveraged to tune the thermal properties of materials by introducing stress, which poses a detrimental threat to the mechanical integrity of materials and limits the capability to regulate thermal transport. Here, we report that the interfacial thermal conductance of graphene on a soft substrate can be regulated by harnessing the out-of-plane deformation of graphene. These obtained graphene structures are free of significant in-plane mechanical strain and have infinitesimal distortion to the intrinsic thermal properties of graphene. The molecular dynamics (MD) simulation shows that the thermal conductance between graphene and the substrate is uniquely determined by the morphological features of graphene. The underlying mechanism is elucidated to understand the thermal transport across graphene and substrate. We further demonstrate that the normalized thermal conductance decreases monotonically with the increase of the equivalent mechanical strain, showing the capability of mechanically programmable interfacial thermal conductance in a broad range of strain.

***An Elementary Teacher's Learning and Experience of Integrating ScratchProgramming into Instruction: A Phenomenological Single-Case Study***
***Ruohan Liu, Jennifer Maeng, Amanda Gonczi***

Scratch is a powerful programming tool that can support both computer science and interdisciplinary instruction. This phenomenological single-case study examined an elementary teacher's experience of learning Scratch programming in a STEM professional development program, his experience of integrating Scratch programming into science content instruction, and the challenges he encountered. Through an inductive analysis of multiple data sources, the findings suggest that while the teacher initially planned to use Scratch to teach both content and programming knowledge, in his actual teaching, Scratch was primarily used for reinforcing and demonstrating content knowledge, with minimal emphasis on programming knowledge. This study identifies insufficient computer science content and pedagogical knowledge as a significant barrier to the teacher's ability to provide effective programming instruction.The results underscore the need for additional professional development support to build teacher capacity for the successful integration of programming into teaching. Based on the findings, we offer actionable implications for future research and professional development design.

***Evaluation of Muscle Performance in Vibrational Environments with a Simulated Helicopter Flight***
***Ana I. Lorente, Robert S. Salzar***

The vibrational load in helicopters has been related to chronic back pain. Pilots report injuries after repetitive flights but there is a lack of knowledge about how vibrational environments affect back muscles. A protocol to test the muscle response in a seat that replicates the dimensions and vibrational load of a helicopter was developed. Volunteers were seated for one hour while their muscle activity in eight neck and back muscles was recorded using electromyography. Muscle strength and endurance evaluations were included before and after the vibrational loading to better understand the effects of vibration in muscle performance. Furthermore, changes in the seating posture of the participants were also recorded with a motion capture system formed by 8 cameras. This experimental data is supporting the development and validation of a computational model whose goal is the prediction of chronic injuries in loading environments.

***A novel immunotherapy to treat pediatric solid cancers***
***Amanda M. Lulu, Joseph J. Caruso, Dustin A. Cobb, Daniel W. Lee***

Rhabdomyosarcoma is the most common soft-tissue cancer in children. Despite this, the standard treatments, surgery, chemotherapy and radiation, have not changed in decades and usually do not work for relapsed or metastatic disease. With no new drugs to treat relapsed or metastatic disease, it is often fatal. Immunotherapy is a treatment modality in which the patient's own immune system is armed, reinvigorated or engineered to attack their cancer. One type of immunotherapy called Chimeric Antigen Receptor-T cell therapy (CAR-T) uses the person's own immune cells, engineers them to recognize the tumor, and then reintroduces the cells into the patient's blood to kill the tumor. CAR-T has been extremely successful for children with leukemia. We have created a novel CAR-T immunotherapy for pediatric rhabdomyosarcoma that we think will also be effective against pediatric brain tumors. Of particular importance for developing children, our CAR-T contains safety mechanisms to limit toxicity.

***Trivial Incidents and Wearisome Material: A Regime Agnostic Education***
***Max Lykins***

Where do we derive our ethical views from? Arguably the most authoritative answer to this question in antiquity was the regime. The regime, or form of government, of a polity was held to shape how citizens understood moral categories, especially justice. Breaking with this argument, the Roman historian Tacitus suggests that regimes do not educate citizens in this way. In doing so, he replaces the regime with the historian as the source of civic and ethical education. If historians are to serve this purpose, however, there must be a philosophy of history underpinning their efforts. My research reconstructs Tacitus' philosophy of history, which the political situation at Rome forced him to communicate indirectly, and thinks through the civic and ethical implications of this philosophy. Ultimately, I argue that Tacitus's philosophy of history

provides a better grounding for understanding the stakes of democratic politics and the necessary measures to support it.

***Biomimetic materials for gynecological tissue engineering***
***Beverly Miller, Wiley Wolfe, James L. Gentry, M. Gregory Grewal, Christopher B. Highley, Raffaella De Vita, Monique H. Vaughan, Steven R. Caliari***

Pelvic organ prolapse (POP) impacts around 50% of women who have given birth, leading to over 300,000 surgeries each year in the U.S. With the FDA's ban on transvaginal mesh for POP repair, there's an urgent need for alternatives to reduce the 40% failure rate of standard surgery. Tissue engineering for POP involves using biomimetic gels, called hydrogels, to enhance the surgical repair and potentially lower the failure rate. Our team created a hydrogel compatible with the pelvic floor and set up the first animal model to test its effectiveness. In our 6-month study, we successfully delivered and placed the hydrogel during POP surgery, which gradually degraded over six weeks. Mechanical tests showed that the hydrogel significantly increased tissue load bearing compared to the standard surgery procedure, even after the hydrogel had degraded. This hydrogel-based approach could offer improved treatment options for POP, providing hope for the millions affected.

***Guerrilla Policy Makers: Inclusivity and Post-Conflict Educational System Planning in Newly-Independent Zimbabwe (1980-Present)***
***Naseemah Mohamed***

This research project interviews war veterans and education administrators who were active in shaping educational policy immediately before and after Zimbabwe’s transition to independence in 1980. I analyze how the newly-independent nation attempted to create a more inclusive and equitable educational system and society in the wake of violent political conflict, racial segregation and inequality, and virulently racist curricula. Using recorded histories of veterans, educators, and policymakers' attempts to diagnose and address the legacies of colonial conquest I analyze the efficacy of these interventions and attempts to transform the Zimbabwean educational system. In what ways did these initiatives lead to the intended outcomes? How were these attempts received? Based on these histories and analyses, I derive suggestions for best practices for educational policy in other post-conflict societies with legacies of educational segregation and inequality. The experiences, successes and failures of Zimbabwean policy makers and educators in this period of transition are relevant to many other contexts in which educators are grappling with similar challenges and striving to create more inclusive, equitable, and just educational systems and societies.

***Wearable microneedle system for sampling and sensing of cortisol from interstitial fluids***
***Ajith Mohan Arjun, Nathan Swami***

Interstitial fluids (ISF) within spaces around cells are essential for the intercellular transport of metabolites and nutrients. An important source of ISF is the dermis layer under the skin from where it can be extracted non-invasively using microneedles. Monitoring biomarker profiles in ISF is especially of interest, since they correlate directly to those observed in blood. Cortisol is a glucocorticoid hormone that plays an important role in regulating multiple physiological states, including stress, sleep and vigilance. Cortisol can be detected using aptamers, which are short sequences of DNA, RNA, or peptides that are specific to a particular molecule. We present the integration of electrochemical aptamer-based sensing of cortisol with ISF extraction from the dermis using wearable microneedles. Through integration of micro-sampling and wearable biosensing of this important metabolite in ISF media using immobilized aptamer arrays, we envision a roadmap towards facile monitoring of biomarkers within the circulatory system.

***Are all underimmunized clusters equally critical?***
***Sifat Afroj Moon, Achla Marathe, Anil Vullikanti***

Disruptions in routine immunizations due to the COVID-19 pandemic have become a significant concern for health organizations. This research develops a system science approach to examine the potential risk of geographical clustering of underimmunized individuals for an infectious disease like measles. We use an activity-based population network model to identify underimmunized clusters of zip codes in Virginia. Although Virginia has high vaccine coverage at the state level for measles, finer-scale investigation finds three statistically significant underimmunized clusters. A stochastic agent-based network epidemic model shows that different clusters can cause vastly different outbreaks depending on their size, location, and network characteristics. This research aims to understand why some underimmunized geographical clusters do not cause a large epidemic while others do. Detailed network analysis shows that it is not the average degree or the underimmunized percentage but the average eigenvector centrality of a cluster that is important in determining its potential risk.

***Reshaping Model Predictive Control Penalties for an Automated Insulin Delivery System in Type 1 Diabetes***
***Marcela Moscoso-Vasquez, Jose Garcia Tirado, Patricio Colmegna, Marc Breton***

Model Predictive Control (MPC) is one of the most popular control algorithms for Automated Insulin Delivery (AID) in Type 1 Diabetes (T1D). Several MPC formulations of varying complexity have been proposed, but there is no consensus on how to define their cost weights. In this work, we evaluate the performance impact of reshaping the error weight (Qz) of RocketAP, a previously developed AID system that has been successfully tested both in in–silico and in–vivo trials. We analyzed two strategies: (i) a constant and (ii) a time-varying Qz. In both cases, function parameters are determined via grid search optimization with a cost function computed from glycemic outcome metrics. Performance is assessed on the 100-adult cohort of

the FDA-accepted UVA/Padova metabolic simulator in two different 48-hour scenarios. Results indicate that the time-varying weight leads to a significant improvement in glycemic control compared to using a constant error weight.

***Gender Bias in Clinical Trial Enrollment: Female Authorship Matters***
***Vina Y. Chhaya, C. Chase Binion, Shanen M. Mulles, Paige A. Tannhauser, Daniel Z. Aziz, James D. Greenwood, Mark H. Barlek, Jessica R. Rouan, Thomas G. Wyatt and Melina R. Kibbe***

Female representation in clinical trials remains low despite policies by the NIH to promote equal enrollment. We hypothesize first and/or senior author gender is correlated with female enrollment in human clinical trials. Clinical trials published in three high-impact journals from 2015-2019 were analyzed, with 2,104,509 females and 2,616,981 males (44.6% vs. 55.4%, $p \leq 0.0001$) enrolled in 1,427 studies. Stratifying by author, female first author and female senior author (female-female) had higher female enrollment compared to male (51.7% vs. 48.3%, $p \leq 0.0001$) using one-sample $\chi 2$ pairwise comparisons. Further analysis of first-senior authorship pairings revealed lower female enrollment in the following descending order: female-male (48.9%), male-female (48.6%), and male-male (40.5%, $p \leq 0.0001$ compared to female-female authorship). Similar results were noted in subset analyses, such as funding source and geographic location. Understanding the importance of authorship in clinical trials may help transform the gender bias that exists in scientific research.

***Building an artificial model of the human lymph node***
***Tochukwu Ozulumba, Jennifer Ortiz-Cardenas, Jonathan Zatorski, Rebecca Pompano***

Replicating the functions of our organs outside the human body can enable researchers to better understand how diseases progress and test new drugs. Furthermore, it addresses ethical concerns surrounding the use of animals in research. Models of organs such as the heart, lungs and kidneys have been replicated by growing cells isolated from those organs in small plastic devices called ‘chips’.

Despite the successes with these organs, there is no model currently available for the lymph node, a key organ which controls how our bodies respond to vaccines and fight infections. Therefore, my research is focused on building an artificial model of the lymph node. Cells are grown in water-based materials called hydrogels and housed within chips following a pattern that matches the architecture of living lymph nodes. We predict that replicating spatial organization is important for maintaining lymph node function.

We reproducibly developed chips containing cells in hydrogels that remain alive overnight. Next, we will keep the cells growing for longer and include different cell types to test complex functions. If successful, this will be the first spatially organized model of the human lymph node and will guide future models for studying diseases and drug testing.

***Acute myeloid leukemia stratifies as two clinically relevant sphingolipidomic subtypes.***
***B. Bishal Paudel, Su-Fern Tan, Todd E. Fox, Johnson Ung, Jeremy Shaw, Wendy Dunton, Irene Lee, Arati Sharma, Aaron D. Viny, Brian M. Barth, Martin S. Tallman, Myles Cabot, Francine E. Garrett-Bakelman, Ross L. Levine, Mark Kester, David Claxton, David J. Feith, Kevin A. Janes, Thomas P. Loughran, Jr.***

There is a growing interest in going beyond genomics to stratify Acute myeloid leukemia (AML). We profile the sphingolipid family of bioactive molecules in 213 primary AML samples and 30 common human AML cell lines. Using an integrative approach, we identify two distinct sphingolipid subtypes in AML with a reciprocal abundance of hexosylceramide (Hex) and sphingomyelin (SM) species. The two Hex-SM clusters organize diverse samples more robustly than AML mutations and are coupled to transcriptional states. Using transcriptomic data, we develop a machine-learning classifier to infer the Hex-SM status of AML cases in TCGA and BeatAML repositories. The analyses show that the sphingolipid subtype with deficient Hex and abundant SM is enriched for leukemic stemness and comprises an unappreciated high-risk subgroup with poor clinical outcomes. Our sphingolipid-focused examination of AML raises the possibility that sphingolipidomic interventions could switch the subtype of AML patients who otherwise lack targetable alternatives.

***Intra-tumor heterogeneity of non-coding transcripts in luminal breast cancer using 10-cell RNA-seq***
***Przanowska Roza K, Janes Kevin A***

The cellular composition of estrogen receptor positive (ER+) breast cancers is heterogeneous at multiple scales that may affect disease progression and response to therapy. Previously, our lab found out that these cancers experience a broader landscape of protein coding oncogenes and tumor suppressors through transcriptional heterogeneity than indicated by genomic aberration. It is less understood what role long non-coding RNAs (lncRNA) might have in distinguishing luminal tumors. To examine carcinoma cell-to-cell heterogeneity in lncRNAs, we began with previously published 10c-RNA-seq data and aligned to mRNAs supplemented with the latest assembly ncRNAs. Using an abundance-dependent overdispersion statistic, we determined that ncRNAs are similar to mRNAs in their transcript dispersion and distribution of adjusted variance scores. Next, we identified 35 Recurrent Heterogeneously Expressed lncRNAs (RHE-lncRNA) that recur in ≥50% of the cases considered. Based on a detailed literature review and publicly available data sets, we vetted the most promising candidates.

***ANKLE1 cleaves mitochondrial DNA and contributes to breast cancer risk by promoting apoptosis resistance and metabolic dysregulation***
***Piotr Przanowski, RÃ³Å¼a K Przanowska, Michael J Guertin***

Alleles within the chr19p13.1 locus are associated with increased risk of breast cancer and increased expression of the ANKLE1 gene. ANKLE1 is molecularly characterized as an endonuclease that efficiently cuts branched DNA and shuttles between the nucleus and cytoplasm. However, the role of ANKLE1 in mammalian development and homeostasis remains unknown. In normal development ANKLE1 expression is limited to the erythroblast lineage and it is not expressed in normal breast epithelium. We show that ectopic expression of ANKLE1 in breast epithelial-derived cells leads to genome instability and mitochondrial DNA (mtDNA) cleavage. mtDNA degradation then leads to mitophagy and causes a shift from oxidative phosphorylation to glycolysis (Warburg effect). Reduction in mitochondrial content contributes to apoptosis resistance, which may allow precancerous cells to avoid apoptotic checkpoints and proliferate. These findings provide evidence that ANKLE1 is the causal cancer susceptibility gene and describe mechanisms by which higher ANKLE1 expression promotes cancer risk.

***An extensive disulfide bond network prevents tail contraction in Agrobacterium phage Milano***
***Ravi R. Sonani, Nathaniel C. Esteves, Abigail A. Horton, Amanda L. Sebastian, Rebecca J. Kelly, Fengbin Wang, Mark A.B. Kreutzberger, Petr G. Leiman, Birgit E. Scharf, Edward H. Egelman***

A contractile sheath-rigid tube machinery is a widespread mechanism by which bacteriophages, tailocins, and the bacterial type VI secretion system penetrate cell membranes. In this mechanism, contraction of an external sheath powers the motion of an inner tube through the membrane. The structure, energetics, and mechanism of the machinery imply rigidity and straightness. The contractile tail of Agrobacterium tumefaciens bacteriophage Milano is flexible and bent to varying degrees, which sets it apart from other contractile tail-like systems. Here, we report structures of the Milano tail including the sheath-tube complex, baseplate, and putative receptor-binding proteins. The bent-to-straight transformation of the Milano sheath and tube upon contraction can be explained by their unique electrostatic properties. All components of the Milano tail, including sheath subunits, are crosslinked by disulfides, some of which must be reduced for contraction to occur. The putative receptor-binding complex of Milano contains a tailspike, a tail fiber, and at least two small proteins that form a garland around the distal ends of the tailspikes and tail fibers. Despite being a flagellotropic phage, Milano contains no thread-like tail filaments that can wrap around the flagellum and is thus likely to employ a different mechanism for binding to the flagellum.

***Generation of entanglement between light particles for quantum computing***
***Paul Renault***

Quantum computing is a technology that utilizes quantum properties of matter or / and light to perform complex calculations much faster than traditional computers. The potential applications are very wide such as cryptography, artificial intelligence...

Our experiment aims to generate entanglement between particles of light called photons, which is a critical step towards building a quantum computer. Entanglement means these photons are correlated with each other, and measuring one photon instantaneously determines the state of the other, regardless of the distance between them. We achieve this by designing a crystal that, when exposed to a laser beam with a specific wavelength, generates pairs of entangled photons.

During the presentation, I will explain our experimental setup, including the techniques we use to generate entangled photon pairs and how can we use them for quantum computer.

***Development of In Vivo two-photon FLIM imaging system to investigate metabolism in Live Animals***
***Vijay Kumar Sagar, Prakash Raut, Horst Wallrabe, Shagufta R Alam, Andrés Norambuena, Ammasi Periasamy***

Biology is not static-it is dynamic. Investigation of small sensitive changes can be detected or monitored using fluorescence lifetime imaging microscopy (FLIM) techniques. FLIM's sensitivity in monitoring biological events in real time is based on its profound sensing of environmental changes.

2photon-FLIM is widely used to capture auto-fluorescence signals (NAD(P)H) from cellular components to investigate dynamic physiological changes in live cells and tissues. We developed a 2p-FLIM imaging system that can measure the bound coenzymes of NAD(P)H (reduced nicotinamide adenine dinucleotide) and FAD (oxidized flavin adenine dinucleotide) signals in live animals as a marker for cellular metabolic state. There are several biological applications for this assay which are any cancer cells, neurons, acute amyloid leukemia (AML), diabetes, etc.

In this presentation, we explain the 2p-FLIM imaging development and the animal preparation to investigate the change in NADH bound coenzyme in the wild type and Alzheimer disease (AD) animal model.

***Deep learning-based Visual Sensing within an Adaptive Digital Twin Framework from Limited Data Using Transfer Learning***
***Mehrdad Shafiei Dizaji, Devin K. Harris, Zahra Zhiyanpour, Aya Yehia***

Digital Twins place models and simulations at the center of decision processes, providing an agile and adaptable platform for direct integration of measured results into a continuous feedback loop with the structure's representation. Despite the widespread use of measurement techniques such as Digital Image Correlation in classical SHM frameworks, these methods often come with a significant computational cost that restricts real-time interaction between data and simulations. The proposed research aims to overcome this barrier through a common visualization framework that leverages advances in Artificial Intelligence (AI) to facilitate effective real-time simulation and experimentation to inform understanding of operational performance. Our approach leverages deep Convolutional Neural Networks (CNNs) to conduct real-time analysis of structural behavior, avoiding the need to solve complex physics-based equations, which is capable of learning the correlation between sequences of DIC speckle pattern images and the corresponding deformation fields.

***Neuronal Morphology Segmentation using Swin Transformer***
***Mohammad Shafkat Islam, Pratyush Suryavanshi, Samuel M. Baule, Joseph Glykys, Stephen Baek***

Neuronal morphology analysis is crucial to quantitatively evaluate the changes in neuronal size due to physiological and pathological conditions. However, due to complex morphological structures, the segmentation of neuronal morphology is challenging. Determining where the cell body of a neuron ends and where the axons and dendrites begin is difficult. Most current approaches for detection and segmentation are based on manual or pseudo-manual annotations of the neuronal boundaries by human experts, which are both time-consuming and have intra-/inter observer variability. Leveraging the current success of vision transformers, we developed a deep-learning-based approach for automated, reproducible, fast, and robust neuronal morphology segmentation using a state-of-the-art vision transformer (Swin transformer). Our algorithm achieved a mean dice score of 0.91, precision, and recall of 0.83 and 0.86, respectively, outperforming a Mask-R CNN approach. Our algorithm can assist in quantitatively evaluating the changes in neuronal morphology from different underlying physiological and pathological conditions.

***Targeting joint iron and polyamine transporters as a new antibiotic strategy***
***Mohammad Sharifian Gh., Fatemeh Norouzi, Gordon W. Laurie***

Antimicrobial resistance has become a pressing global crisis as a result of the emergence of highly virulent strains, such as carbapenem-resistant Acinetobacter baumannii, Enterobacteriaceae, and Pseudomonas aeruginosa. One major concern, as identified by the World Health Organization (WHO), is the absence of approval for new antibiotic classes to treat Gram-negative pathogens. To address this issue, it is critical to comprehend the mechanism of

action of natural bactericidal agents in order to develop innovative approaches to antibiotic treatment that prevent the emergence of resistance and avoid side effects.

In the present study, we demonstrate that the human tear lacritin bactericidal proteoform, designated as 'N-104', interacts significantly with model membranes of both Gram-positive and Gram-negative bacteria without causing significant membrane disruption or hemolytic activity. Our comprehensive genetic screening followed by several validation procedures has revealed that the activity of N-104 involves the inner-membrane transporters FeoB and PotH, as well as the lipoprotein YaiW in outer-membrane translocation, leading to the regulated cell death of the targeted pathogen. Additionally, our RNA-seq analyses support the notion that the N-104 mechanism is linked to bacterial cellular respiration.

***ACE-2-like enzymatic activity is associated with immunoglobulin in COVID-19 patients***
***Yufeng Song, Regan Myers, Lila Murphy, Bailey Brooks, Jeffrey M. Wilson, Alexandra Kadl, Judith Woodfolk, and Steven L. Zeichner***

COVID-19 includes some features with unclear pathogenesis, like autonomic dysregulation, coagulopathies, and high levels of inflammation. The receptor for SARS-CoV-2 spike protein receptor binding domain (RBD) is angiotensin converting enzyme 2 (ACE2), a metalloprotease that requires Zn2+ for activity. We hypothesized that some COVID-19 patients may develop antibodies having negative molecular image of RBD sufficiently similar to ACE2 to yield ACE2-like catalytic activity – ACE2-like abzymes. By studying COVID-19 hospitalized patient plasma obtained about 7 days after admission, we found that plasma from some patients could cleave a synthetic ACE2 peptide substrate, even though in the presence of disodium ethylenediaminetetraacetate (EDTA) anticoagulant. The plasma did not cleave ACE2 substrate peptide after >99.99% immunoglobulin depletion. The data suggest that some COVID-19 patients develop antibodies with abzyme-like activity capable of cleaving synthetic ACE2 substrate which indicate anti-RBD abzymes may contribute to some otherwise obscure COVID-19 pathogenesis since proteolytic cascades regulate many physiologic processes.

***Role of FOXO in Drosophila neuroblast proliferation***
***Bharath Sunchu, Xin Yuan, Sarah Siegrist***

Stem cells remain in a poised, non-proliferative state known as quiescence, which helps them to withstand environmental insult and metabolic stress. It is unclear how stem cells transition from quiescence into a proliferative state and vice versa. Understanding how quiescence entry and exit are controlled during different physiological and pathological states will lead to new therapeutic strategies to treat human diseases and physical injury. My work focuses on how FOXO, an evolutionarily conserved transcriptional regulator, regulates neural stem cell (NSC) proliferation. As FOXO is known for repressing cell proliferation, we hypothesized that inactivating FOXO would lead to a faster reactivation (transition from a quiescent to a proliferative state). Surprisingly in our preliminary experiments, inactivating FOXO led to a delayed reactivation in Drosophila NSCs. Future studies will investigate the cell-autonomous

and non-autonomous role of FOXO in regulating NSC proliferation and identifying the downstream/upstream factors around FOXO.

***Perturbations of cellular interaction networks in the melanoma tumor microenvironment following immune checkpoint blockade***
***Anne Talkington, Heman Shakeri, Sepideh Dolatshahi***

While early-stage melanoma is generally considered treatable, metastatic melanoma patients face a 30% 5-year survival rate. Standard-of-care therapy for such patients consists of immune checkpoint inhibition (ICI), which is designed to disrupt tumor- and immune-immune interactions that contribute to an immunosuppressive tumor microenvironment (TME). We apply de novo network inference methods to predict which mechanisms of cellular crosstalk are active in the melanoma TME prior to and after ICI. Our results from two publicly available single cell RNA-sequence (scRNA-seq) databases of melanoma biopsies, split into pre- vs. post-ICI and response vs. nonresponse, suggest that macrophage – cytotoxic T cell communication contributes substantially to immunosuppression in the TME. Specifically, intercellular interactions associated with T cell exhaustion and altered macrophage polarization processes are implicated in several nonresponding patients. Our models hold the potential to suggest avenues of complementary therapy based on our understanding of evolving TME dynamics following the administration of ICI.

***Data-driven Dynamical Systems and Applications***
***Ali Tavasoli, Heman Shakeri***

To describe the dynamics of high-dimensional systems and obtain mechanistic views, one can not practically hope to work with systems of differential equations. Instead, we find suitable embedding to some space of linear operators that describe conditional probabilities associated with the actions of the dynamics. Tools from machine learning, such as Kernel methods pave the way to employ powerful concepts from functional analysis, operator theory, and spectral analysis.

If the measurement of each observable at a state gives a well-defined unique result to describe the system, we have trajectories, i.e., time series data. However, if the available measurements are time-stamped snapshots, e.g., in single cell data, states are observed in density forms. These approaches provide novel insights into understanding large-scale complex systems by exploring and interpreting the engineering systems based on the most basic elements that create their features.

***Adapting Nitroreductase Cell Ablation Assay to Drosophila***
***Dr. Gary Teeters, Sagar Kasar, Dr. Sarah Siegrist***

The regenerative capacity of an organism depends on the tissue which is damaged as well as the age of the organism. Neural tissue appears to be resistant to regeneration as previous studies have shown little to no neurogenesis leaving glia as the primary responder to brain injuries. Why are neural tissues so limited in their capacity to regenerate and repair and why does this regenerative capacity decline with age. I will address these questions using the genetically tractable model system of Drosophila Melanogaster. Like mammals, Drosophila generates neurons through neural stem cells which divide to self-renew and produce differentiating daughter cells. I will ablate specific sub-populations of neurons in a temporally and spatially controlled manner, using a method novel to Drosophila. Using microscopy along with molecular and genetic tools I will examine how neural stem cells respond to the loss of their fully differentiated progeny.

***Tuning condensates – a new approach to treat diseases***
***Aleksandra Ulman, Yansu Song, Hao Jiang***

The human body is built of 100 trillion cells and each of them handles many biochemical processes. Cells use their genetic material as a base for protein production which constitutes the main effectors in the cell. Proper execution of the biochemical processes is crucial to keep cells in an equilibrium called homeostasis. Furthermore, appropriate localization and concentration of proteins in time and space are fundamental. Liquid-liquid phase separation phenomenon describes the condensates arising from the protein-protein interaction or the RNA-protein interaction. Those structures exhibit liquid properties – they are dynamic, able to fuse and wet the surface. Our goal is to regulate condensates using chaperones – a special group of proteins that assist other proteins in folding, during stress and physiological conditions. Recent studies reveal that the condensation of proteins takes part in cancer formation or neurodegeneration. Tuning condensates may constitute the foundation of future therapies.

***Towards optimizing cortex-wide neural coordination in Parkinson's disease***
***Siva Venkadesh***

Parkinson's disease (PD) is a neurodegenerative disorder that impairs cognition in addition to motor skills in many affected patients. Electrical stimulations targeting deeper brain structures such as the subthalamic nucleus are known to improve motor features in PD patients. However, there is a lack of reliable stimulation designs to improve cognitive performance in PD patients.

PD-related cognitive impairment is associated with network abnormalities that span several cortical structures. My research aims to identify an optimal set of cortex-wide targets for electrical stimulation and their perturbational parameters to improve neural coordination in PD patients. My research models cortex-wide neural coordination dynamics in PD and designs

stimulation experiments in virtual brains. This approach integrates MRI observations of brain networks with the mathematical principles of neural oscillations that underlie cognition.

***Loss of Membrane Asymmetry Facilitates Membrane Vesiculation Through Decreasing Membrane Stiffness***
***Hong-Yin Wang, Kandice R. Levental, and Ilya Levental***

Extracellular vesicles (EVs) play critical roles in intercellular communications. Almost all EVs and membrane blebs were observed to expose phosphatidylserine (PS) on their outer leaflet, implying the loss of membrane asymmetry which is caused by lipid scrambling due to activation of scramblases (i.e. TMEM16F). However, the biophysical role of loss of membrane asymmetry in the formation of EVs is still unknown. Through fluorescence lifetime imaging microscopy (FLIM) using a reporter of lipid packing (Di4), we found that PS exposure leads to a decrease of plasma membrane packing, potentially make the membrane softer for bending and thus facilitating membrane budding. Our finding of membrane softening effect after membrane scrambling could potentially be implicated to explain many vesicle-budding and vesicle-fusion related biological events, including apoptotic cell removal, bone mineralization, fertilization, viral infection and blood coagulation, etc.

***Developing a Sex-Specific Treatment Recommendation for Non-Obstructive Coronary Artery Disease***
***Kelsey Watts, Ashlyn Cowan, Patricia Rodriguez-Lozano, Mete Civelek***

Cardiovascular disease (CVD) is the leading cause of death for both men and women. However, biological sex can influence the development and presentation of CVD. For example, males likely present with obstructive coronary artery disease (CAD), which involves plaque formation and artery blockage. Conversely, females are three times more likely to have non-obstructive CAD than obstructive CAD. Non-obstructive CAD involves inflammation and dysregulation at the microvascular level, which can result in narrowing vessels and reduced blood flow. Non-obstructive CAD is harder to diagnose, and no direct treatments target it. This is likely because women have been historically underrepresented in clinical trials and animal research, which makes sex-specific treatment recommendations for the pathological differences between male and female CVD elusive. My research is in collaboration with clinicians from the UVA Women's Heart Program to investigate if SGLT2is could be used as a targeted treatment for non-obstructive CAD in women.

***Global declines in lake water storage***
***Fangfang Yao***

Lakes store the largest amount of accessible freshwater on Earth. They function as regulators of climate change through the cycling of carbon and provide indispensable water supply, hydropower generation, and aquatic ecosystems for meeting natural and human needs. The potential goods and services from lakes are largely modulated by lake water storage. Human activities and a changing climate increasingly threaten lake water storage, as evidenced by record-low water levels in some of the world's largest lakes, such as Aral Sea in Central Asia. Yet, trends and drivers of lake water storage over decadal scales remain poorly constrained at large geographical scales, which impedes sustainable management of surface water resources. Here, I will present my work on quantifying and attributing decadal variability of lake water storage at a global scale using satellite observations, hydrological models, and statistical-learning techniques. I will also discuss how this research can inform sustainable water resources management.

***What does environmental justice look like for "climate change deniers"?***
***Jonna Yarrington***

Tangier Island is one square-mile of land, barely above sea-level in the middle of the Chesapeake Bay. It is one of two remaining bay islands—of scores that were once inhabited. Home to over 1,000 at the beginning of the 20th Century, there are now around 360 full-time residents. Tangiermen self-identify as white, middle- and lower-income, fundamentalist Christians, Donald Trump superfans, and science skeptics. While they understand subsidence as "erosion," with anthropogenic causes and consequences, most Tangiermen profess a skeptical creed toward climate science. What does environmental justice look like for so-called climate change deniers? This question has a wider significance, as much of coastal North America—and other coasts far beyond—is or will be considering sociocultural implications of sea-level rise. The implications I am most interested in revolve around how the state mediates value and what the profession of creed has to do with perceived just desserts.

***Biogas-to-Renewable Natural Gas Via Catalysis***
***Weijie Zhang, Sen Zhang***

There is a growing interest in using CO2, a major greenhouse gas, as a feedstock for producing commodity chemicals. Biogas is a mixture of gases, consisting of biomethane and CO2, produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, wastewater, and food waste. A study examined that by 2030, the usage of biomethane in vehicles for compressed natural gas and liquified natural gas will increase to 30 billion m3/yr. Additionally, biomethane will be used in maritime and inland waterway transportation. My research is to upgrade biogas to biomethane via catalytic methods. Catalysis involves the heterogeneous catalytic CO2 hydrogenation reaction in conjunction with renewable H2 and energy sources, which is a promising approach to producing biomethane ($CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$).