

Welcome!



12TH ANNUAL
UNDERGRADUATE RESEARCH COLLOQUIUM
MAY 3, 2023, 1:30-3:30PM



George Mason University

If we knew what we were doing, it wouldn't be called research. - Albert Einstein

The College of Science (COS) at George Mason University is committed to excellence in undergraduate research. Every day, students from across COS create new knowledge and produce novel results that make a difference in their disciplines. To culminate their research experiences, students need an opportunity to communicate their findings to the broader community of scholars; this is the mission of the COS Undergraduate Research Colloquium. Whether you participate in this event as a presenting undergraduate student, mentoring faculty, judge or guest, we hope you enjoy and are invigorated by the exchange of new knowledge here.

The College of Science thanks the research mentors who have invested their time to guide and support these undergraduate students. This investment helps student researchers become competent and creates an institutional culture in which peers, graduate students, faculty, and administrators continue to learn and grow.

This 12th Annual Colloquium is the third 100% virtual event. The students here are change agents who enhance ongoing interaction among scholarly communities and serve as catalysts to reinforce and enhance STEM education at Mason. Thank you for joining us in celebrating and elevating them.

Dr. Rebecca M. Jones (rjones22@gmu.edu)

VIRTUAL COLLOQUIUM SPACE

Using Firefox or Google Chrome, join the colloquium at this URL:

<https://app.gather.town/app/rvrmYHnYoxVRI095/COS%20URC%202023>

SET-UP and NAVIGATION

- Use your real name and select an avatar.
- Please turn on your camera
- Use arrow keys to walk around, posters are surrounding the space station hub, see map on next page.
- Type x to view a poster.
- To leave, navigate to one of the Exit signs.

COLLOQUIUM TIMELINE

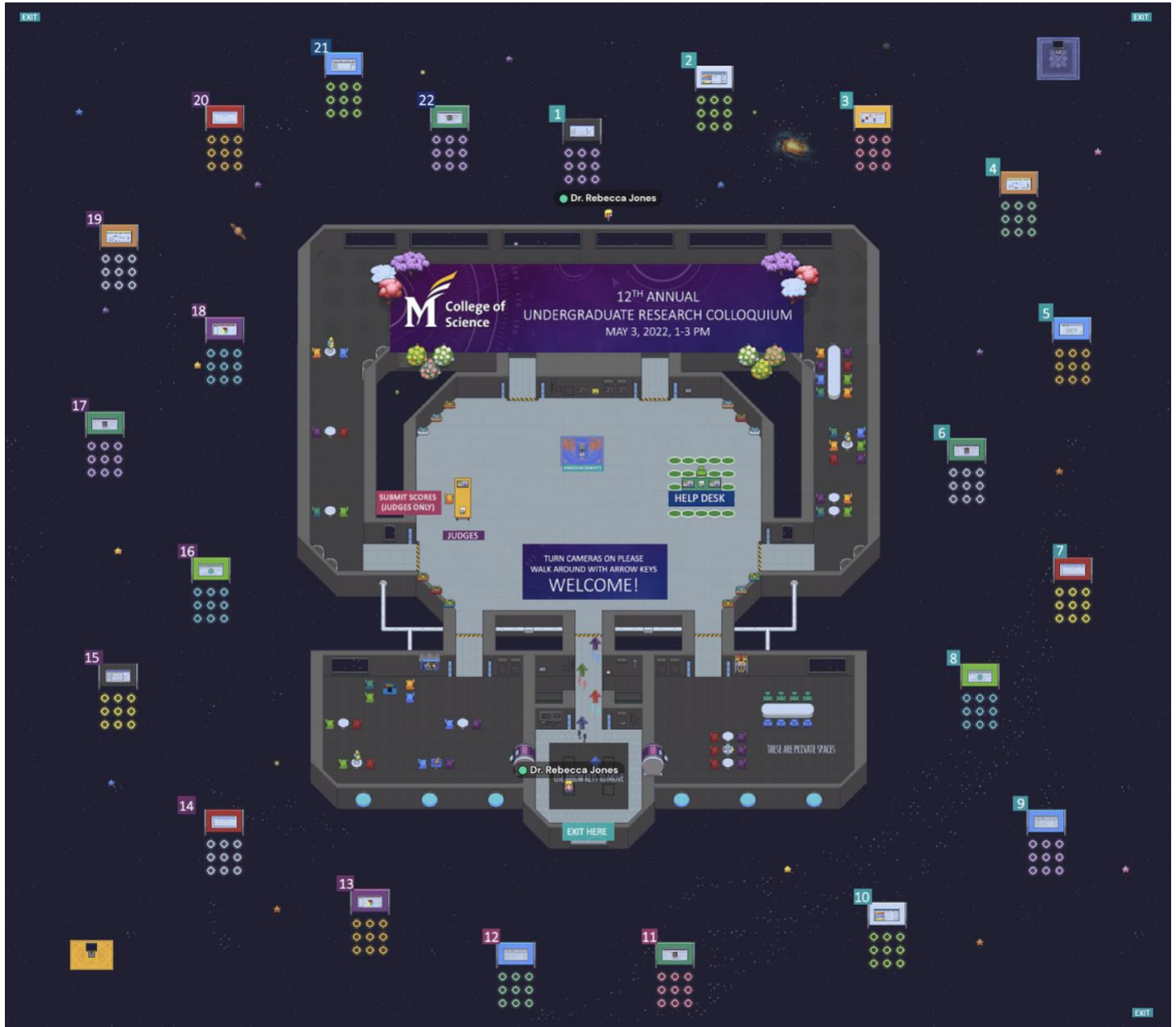
1:30pm Welcome and Opening Remarks

1:30-2:30pm Odd Numbered Posters

2:30-3:30pm Even Numbered Posters

3:30pm Closing Remarks

COLLOQUIUM 2023 MAP



VIRTUAL COLLOQUIUM SPACE

Using Firefox or Google Chrome, join the colloquium at this URL:

<https://app.gather.town/app/rvrmYHnYoxVRI095/COS%20URC%202023>

SUMMARY OF POSTERS

Poster Number	Presenter(s)	Major	Mentor(s)	Poster Title	
Environmental and Earth Sciences (Geology, Geography, GIS, Environmental Sciences)	1	Spencer Harman	Environmental Science and Policy	Katherine Mertes	Mapping Shade for Endangered Ungulates in the Ouadi Rimé-Ouadi Achim Wildlife Reserve in Chad
	2	Lauren West	Atmospheric Science	Zafer Boybeyi	How Average Temperature Trends Are Affecting the Spatial Distribution of Tornado Occurrences and Magnitude
	3	Piper Thacher	Environmental Science	Kathleen Hunt	Calving intervals inferred from progesterone patterns in historic baleen of female fin whales (<i>Balaenoptera physalus</i>)
	4	Steven Tai and Victoria Gonzales	Biology	Hamdi Kavak, Taylor Anderson, Andreas Zufle, Minh Tri Le	Estimating The Path of COVID-19 Using Phylogenetic Techniques
	5	Layla Hasanzadah	Neuroscience	Laina Lockett	Switchbacks and Salinity: The Effects of Environmental Degradation on Tadpole Defense Mechanisms
	6	Kai Barner and Alexandra Diaz Merida	GGs	Taylor Anderson	Spatial variation in factors that contribute to female breast cancer mortality across US counties
Life Sciences (Biology, Neuroscience, Forensic Science)	7	Gwendolyne Fields	Biology	David Luther	Comparing Growth Rates of Somaliland and Namibian Cheetah Cubs
	8	Autumn Gray	Environmental Science and Policy	Klaus-Peter Koepfli	First complete mitochondrial genome of the Saharan striped polecat (<i>Ictonyx libycus</i>)
	9	Fae Jensen and Diya Sabareesh Meethaleveettil	Neuroscience	Greta Ann Herin	The Effect of Ethylene Glycol on α 1 Glycine Receptor Function in <i>Xenopus Laevis</i> Oocytes
	10	Naomi Alemayehu	Medical Laboratory Science	Emanuel F. Petricoin, PhD	Analyzing the Effect of an HIV Protease Inhibitor Drug, Ritonavir, in Women Undergoing Surgery for Newly Diagnosed Breast Cancer
	11	Nadia Gray	Environmental and Sustainability Studies	Kathleen Hunt	Assessing reproductive hormones in adult female blue whales (<i>Balaenoptera musculus</i>) by analyzing historic baleen samples from the 1940's
	12	Sanskruthi Sreepangi	Department of Biology	Ramin M Hakami	Purification and Characterization of RIG-I Inducing RNA Species within Small Extracellular Vesicles Released from Cells Infected with Rift Valley Fever Virus
	13	WITHDRAWN			
14	Gerald Flores	Chemistry	Robin Couch	Evaluating Potential Inhibitors of 1-deoxy-D-xylulose 5-phosphate Reductoisomerase in <i>Pseudomonas aeruginosa</i>	

Poster Number	Presenter(s)	Major	Mentor	Poster Title
15	Oliver Yu, Ali Khalid, Raz Jair Feldens, Ferrari, Michael Hieb, and Harsh Rangwala	Computational and Data Sciences / C4i & Cyber Center	Michael Hieb	Multi-Sensor Fusion with Geospatial Mapping for Unmanned Aerial System (UAS) Airspace Tracking and Detection
16	Cicely Motamedi	Physics	Karen Sauer	Magnetic Jones Vector Detection with RF Atomic Magnetometers
17	Lauren L Young	Biology	Greg Petruncio	Synthesis of Homoseongomycin
18	Ian Helm	Astronomy	Peter Plavchan	Photometric Ground-Based Follow-up of TESS Transiting Exoplanet Candidates with George Mason Observatory
19	Amirul Patwary	Computational Data Science	Sharmin Abdullah and Abdullah Shahwan Almalki	Arabic Sentiment Analysis on Twitter: A Hybrid Lexicon and Machine Learning Approach
20	Arshia Halavatkar	Physics	Mario Gliozzi	Indirect Mass Measurements of Supermassive Black Holes in Type 1 (Unobscured) Active Galactic Nuclei
21	Daniel James Heilman	Physics	Karen Sauer	Quantum Means of Measurement: Atomic Magnetometer
22	Kashmala Mahmood	Biology, concentration in Bioinformatics and minor in Computer Science	Ron Mahabir, Olga Gkountouna, Patrick Ballantyne	ChatGPT: Bridging the Gap between Human and Machine Communication - A Survey of Its Multifaceted Applications

ABSTRACTS

George Mason University
College of Science
Undergraduate Research Colloquium 2023

ENVIRONMENTAL AND EARTH SCIENCES (GEOLOGY, GEOGRAPHY, GIS, ENVIRONMENTAL SCIENCES)

1. Mapping Shade for Endangered Ungulates in the Ouadi Rimé-Ouadi Achim Wildlife Reserve in Chad

by Spencer Harman
Major: Environmental Science and Policy
Mentor(s): Katherine Mertes

Abstract

In the Réserve de la Faune du Ouadi Rimé-Ouadi Achim in central Chad, trees are an invaluable shade resource for recently reintroduced Scimitar Horned Oryx (*Oryx Dammah*), Addax (*Addax Nasomaculatus*), and critically endangered Dama Gazelle (*Nanger dama*). However, global remote sensing products do not accurately capture the small, scattered trees found in this savanna landscape. A previous pixel-based study predicted tree presence and density with low accuracy. To overcome these issues, we developed an alternative tree classification approach for this landscape using high-resolution imagery in a Geographic Object Based Image Analysis (GEOBIA). We selected Worldview imagery due to its extremely high resolution (2m) and availability across the RFOROA. First, I mosaicked and composited six Worldview-2 images that overlapped locations of trees previously collected in the field. I then calculated 5 vegetation indices (e.g., the Normalized Difference Vegetation Index) to emphasize vegetation features, and calculated texture metrics (e.g., entropy and angular second moment) to characterize the frequency of different pixel value combinations and spatial relationships. Using a simple non-iterative clustering algorithm, I segmented the WorldView-2 composite into spectrally similar multi-pixel clusters. Finally, I combined these layers with field and visually interpreted training data for “trees” and “not trees” in a Random Forest classifier to produce a binary classification across the composite. I assessed the accuracy of this classification at 91.7%. Based on this result, this workflow could be used to predict trees across the entire RFOROA (using additional Worldview Images) and support the ongoing antelope reintroductions.

2. How Average Temperature Trends Are Affecting the Spatial Distribution of Tornado Occurrences and Magnitude

by Lauren West
Major: Atmospheric Science
Mentor(s): Zafer Boybeyi

Abstract

The United States experiences the most tornadoes of any country in the world. Due to their severe, destructive nature, there is growing concern about the impact of increasing global temperatures on the occurrence and magnitude of tornadoes across the US. We analyzed daily tornado data provided by the Storm Prediction Center from 1950 to 2011 to assess the spatial variability of tornado occurrences and tornado magnitude. We analyzed the data in two time periods: 1950 to 1980, in which the US experienced a negative trend in average temperature, and 1981 to 2011, in which the US experienced a positive trend in average temperature. The study found that the increase in average temperatures correlates with an increase in weak tornado occurrences, ranging on the Enhanced Fujita Scale from F0 to F2. This relationship is still being investigated to determine if there is a correlation between the temperature trends and the spatial distribution of tornado occurrences.

3. Calving intervals inferred from progesterone patterns in historic baleen of female fin whales (*Balaenoptera physalus*)

by Piper Thacher
Major: Environmental Science
Mentor(s): Kathleen Hunt

Abstract

Baleen hormone analysis offers a tool to evaluate how ecological and anthropogenic pressures impact whale physiology. We investigated progesterone patterns in historic WWII-era baleen of four female fin whales (*Balaenoptera physalus*) to (1) develop the first longitudinal hormone profiles of fin whales and (2) evaluate gestation periods and calving intervals in a time period when commercial whaling was absent and global climate change minimal. Historic baleen plates from the Smithsonian were drilled every other centimeter to obtain a pulverized powder for hormone extraction. Enzyme immunoassays were run to measure progesterone concentrations of each whale over ~3-4 years. Results indicate a likely one- to two-year calving interval in fin whales, but with notable individual variation. This pilot study helps provide a baseline of female fin whale progesterone patterns, which can be used to help assess the influence of modern anthropogenic stressors and climate change.

4. Estimating The Path of COVID-19 Using Phylogenetic Techniques

by Steven Tai and Victoria Gonzales

Major: Biology

Mentor(s): Hamdi Kavak, Taylor Anderson, Andreas Zufle, Minh Tri Le

Abstract

Genetic data provide a wealth of information about the evolution of organisms and their unique features. When it comes to viruses, genetic data is crucial for surveillance and vaccine development efforts. The COVID-19 pandemic led to the collection of large amounts of genetic data on the coronavirus. With such data, the evolution of COVID-19 has been documented since the onset using phylogenetic trees. Strains that are sampled and sequenced can be placed as leaf nodes in these trees. These strains contain spatio-temporal data about where and when the strain was discovered. Internal nodes connecting each branch represents a relationship between the sample and its ancestor. The collected sample data represent the leaf nodes in the tree and have location of testing embedded. The internal nodes of the tree represent the location of initial infection for all children of the node, but the location of internal nodes can never be known exactly. The goal of this research is to estimate the locations of internal nodes using ancestral character state reconstruction and find the full evolutionary path of COVID-19. We obtained genetic data through GISAID which is a large database focused on collecting and sequencing samples from viruses related to influenza and COVID-19. Our sample size is over 8 million, containing spatio-temporal data and other metadata. GPS coordinate data were extracted by processing the location names. To estimate internal node locations, we used ACCTRAN, a form of ancestral character state reconstruction algorithm that annotates internal nodes using characters from leaf nodes and the tree paths. The results provide a novel estimation of the locations of internal nodes and the full spatial path of the phylogenetic tree.

5. Switchbacks and Salinity: The Effects of Environmental Degradation on Tadpole Defense Mechanisms

by Layla Hasanzadah
Major: Neuroscience
Mentor(s): Laina Lockett

Abstract

Salinization of freshwater habitats in North America, often caused by wintertime runoff containing road salts, has caused degradation of freshwater habitats (home to vulnerable wildlife, such as tadpoles). Tadpoles have been found to experience higher predation rates after chronic exposure to increased salinity. Tadpoles may perform switchbacks when confronted with stressful stimuli (i.e., predators), in which they perform 180° turns, rushing toward a source of danger instead of away. In this study, pickerel frog tadpoles (*Lithobates palustris*) were collected from a New Jersey wetland and exposed to varying levels of salinity. Switchbacks were counted in 3-minute trials where they were forced to swim in an O-shaped apparatus after an initial, 15-minute exposure. After an ANOVA analysis and Tukey's HSD test, we found that the number of switchbacks was not statistically significant across varying salinities, suggesting that road salts don't impair tadpoles' ability to avoid predators.

6. Spatial variation in factors that contribute to female breast cancer mortality across US counties

by Kai Barner and Alexandra Diaz Merida

Major: GGS
Mentor(s): Taylor Anderson

Abstract

Breast cancer is the second-leading cause of cancer-related death among US women. Despite decreasing death rates, geographic disparities persist. Global regression models identify social and environmental factors that contribute to breast cancer mortality. However, these approaches assume spatial stationarity, meaning that the effect of different factors on breast cancer mortality is the same across geographic space. Therefore, the objective of this study is to identify spatial variation in the effects of demographic, environmental, and healthcare access on age adjusted breast cancer mortality across the US. Using multi-scale geographically weighted regression, we identify a spatially stationary negative association between obesity and breast cancer mortality. However, modifiable factors that lead to obesity – like food environment index and access to exercise opportunities – have different effects on mortality depending on where the patient lives. This study provides insights for public health practitioners to better understand the local determinants of breast cancer mortality and guide location specific interventions.

**LIFE SCIENCES
(BIOLOGY, NEUROSCIENCE, FORENSIC SCIENCE)**

7. Comparing Growth Rates of Somaliland and Namibian Cheetah Cubs

by Gwendolyne Fields

Major: Biology

Mentor(s): David Luther

Abstract

Cheetahs (*Acinonyx jubatus*) are classified as endangered species by the IUCN, facing major threats of habitat loss, illegal pet trade and human-cheetah conflicts. With approximately 7,500 individuals left in the wild across Africa, research is significant to understanding and ensuring the species' survival. At Cheetah Conservation Fund (CCF), located in Namibia, research has been ongoing since its establishment in 1990, and was once known as the cheetah capital of the world. CCF also has a campus in Somaliland, where currently 86 cheetahs of the "Tanzanian cheetahs" (*Acinonyx jubatus raineyi*) are being cared for, while 29 "South African cheetahs" (*Acinonyx jubatus jubatus*) are at Namibia's facility. Caretaking of young cheetahs is critical to their survival and one of the goals of the Namibia and Somaliland facilities is to facilitate the healthy growth of captive cheetah cubs. This project investigates the comparison of growth rates between Somaliland and Namibian cheetah cubs. Through CCF's data of cheetah cubs rescued between 2006-2022 within Somaliland and Namibia, weights, meat and milk consumption has been recorded from 0-6 months and organized in a new Excel Spreadsheet. 19 individuals are recorded from Namibia, and 46 are recorded from Somaliland. Through preliminary results, we found that growth rates of cubs 0-6 months old indicate males have a higher growth rate than females, and Somaliland has a lower growth rate than Namibian cheetah cubs. As research in this field has not been done, these results could indicate important information to improve caretaking skills and in the long-run, the species' conservation. Further statistics will be conducted to understand more about growth rates and what affects it, as well as the difference between Namibian and Somaliland cheetah cubs.

8. First complete mitochondrial genome of the Saharan striped polecat (*Ictonyx libycus*)

by Autumn Gray

Major: Environmental Science/Department of Environmental Science and Policy

Mentor(s): Klaus-Peter Koepfli

Abstract

The Saharan striped polecat (*Ictonyx libycus*) is endemic to Africa, inhabiting the edges of the Saharan Desert. Little is known about the biology or genetic status of this member of the weasel family (Mustelidae). We present the first complete mitochondrial genome of the Saharan striped polecat, assembled from data generated using a genome skimming approach. The assembled mitogenome is 16,549 bps in length and consists of 37 genes including 13 protein-coding genes, 2 rRNAs, 22 tRNAs, an origin of replication, and a control region. Phylogenetic analysis confirmed the placement of the Saharan striped polecat within the subfamily Ictonychinae.

9. The Effect of Ethylene Glycol on $\alpha 1$ Glycine Receptor Function in *Xenopus Laevis* Oocytes

by Fae Jensen and Diya Sabareesh Meethaleveettil

Major: Neuroscience

Mentor(s): Greta Ann Herin

Abstract

Ethylene glycol is a common environmental contaminant, as it is a primary component of the solution used in fracking. It remains in the soil and groundwater of fracking sites, therefore causing it to have a sustained effect on both human and other biological life in these areas. Ingestion of ethylene glycol inhibits central nervous system (CNS) functioning, though the specific neuronal mechanisms of this depression are currently unknown. To address this gap in knowledge, this project seeks to determine if ethylene glycol modulates glycine receptor function in a concentration dependent manner. This will be done by microinjecting *Xenopus Laevis* oocytes (model cells) with RNA of the $\alpha 1$ subunit of human glycine receptors (GlyR $\alpha 1$). Once the receptors are expressed, Two Electrode Voltage Clamp (TEVC) electrophysiology will be used to record transmembrane current caused by Cl⁻ influx through the ion channel pore of GlyR $\alpha 1$ s. As GlyRs are one of the primary inhibitory neurotransmitter receptors of the CNS, these recordings will potentially identify a method by which CNS functioning is depressed by ethylene glycol.

10. Analyzing the Effect of an HIV Protease Inhibitor Drug, Ritonavir, in Women Undergoing Surgery for Newly Diagnosed Breast Cancer

by Naomi Alemayehu

Major: Medical Laboratory Science/ Department of Biology

Mentor(s): Emanuel F. Petricoin, PhD

Abstract

Introduction: Ritonavir is a protease inhibitor that is currently used to treat HIV. This project aimed to identify changes in expression levels of proteins associated with G1/S checkpoint and inhibition of Apoptosis.

Methods: Pre-treatment (n=6) and post-treatment (n=6) breast tissue sections, from patients who received Ritonavir treatment, and control patients (n=7), who did not receive Ritonavir treatment, were obtained. Reverse Phase Protein Array (RPPA) was performed to investigate the expression of selected endpoints.

Result/Conclusion: Rb (S780) was found to be significantly lowered by Ritonavir (p= 0.035). Ritonavir also decreased the expression of several proteins involved in the inhibition of apoptosis pathway, such as Signal transducer and activator of transcription 3 (Stat3), Stat3 (Y705), and Steroid receptor coactivator (Src). Our results demonstrate that Ritonavir is effective in inducing apoptosis in breast cancer tumors by interfering with the inhibition of apoptosis pathway.

11. Assessing reproductive hormones in adult female blue whales (*Balaenoptera musculus*) by analyzing historic baleen samples from the 1940's

by Nadia Gray

Major: Environmental and Sustainability Studies

Mentor(s): Kathleen Hunt

Abstract

Monitoring reproductive parameters in blue whale (*Balaenoptera musculus*) populations is difficult due to limitations in hormone data collection methods for large whales. Recent studies have shown that hormones like progesterone can be detected in baleen powder of other mysticete whale species like bowhead (*Balaena mysticetus*) and North Atlantic right (*Eubalaena glacialis*) whales. I hypothesized that baleen from female blue whales would contain regions of high progesterone indicating prior pregnancies. To test this, I ran enzyme immunoassays to quantify progesterone from serial samples taken along the length of historic baleen plates of four female blue whales. Most baleen plates had several broad regions of high progesterone, as predicted, with patterns suggesting a 2-year calving interval for all but one female. These findings may clarify historic norms of reproduction in blue whales, and could be helpful for comparisons to modern populations.

12. Purification and Characterization of RIG-I Inducing RNA Species within Small Extracellular Vesicles Released from Cells Infected with Rift Valley Fever Virus

by Sanskruthi Sreepangi
Major: Department of Biology
Mentor(s): Ramin M Hakami

Abstract

Rift Valley fever (RVF) is a highly infectious RNA virus with no clinically approved vaccines or therapeutics. This study aims to identify RNA species responsible for inducing a protective antiviral response in recipient cells using small extracellular vesicles as therapeutics. sEVs are significant in modulating innate immune responses to infectious diseases. sEVs, specifically EXi-RVFFV, released from cells infected with RVFFV carry viral RNA to activate the RIG-I pathway to induce IFN- β , regulating inflammation and inhibiting viral spread. sEVs were purified from RVFFV-infected Vero cells, followed by RIG-I-Immunoprecipitation on U937 cells treated with purified sEVs to recover RNA bound to RIG-I protein. Additionally, the direct recovery of RNA species packaged into sEVs was optimized. The RNA from both approaches was analyzed for yield, quality, and IFN- β activation using RT-qPCR and Western blot. Future work includes RNAseq analysis of the isolated RNAs to identify the RNA species responsible for the RIG-I activation.

13. WITHDRAWN

14. Evaluating Potential Inhibitors of 1-deoxy-D-xylulose 5-phosphate Reductoisomerase in *Pseudomonas aeruginosa*

by Gerald Flores

Major: Chemistry

Mentor(s): Robin Couch

Abstract

In 2019 the Centers for Disease Control and Prevention (CDC) reported that each year over 2.8 million Americans are infected with antibiotic-resistant bacteria, resulting in nearly 50,000 deaths. Furthermore, a recent 2022 report indicates that antimicrobial resistance (AMR) is the leading cause of death globally and due to the COVID-19 pandemic, nosocomial infections caused by AMR pathogens are rising. One of the most common causes of nosocomial infections worldwide are the ESKAPE (Enterococcus faecium, Staphylococcus aureus, Klebsiella pneumoniae, Acinetobacter baumannii, Pseudomonas aeruginosa, and Enterobacter spp) pathogens, a group of multi-drug resistant (MDR) bacteria who are resistant to even the last line of defense, carbapenem. Thus, it is crucial that novel antibiotics and drug targets are elucidated. The methylerythritol phosphate (MEP) pathway serves as an attractive drug target for these pathogens because it is absent in humans. Additionally, this seven-step pathway culminates in the synthesis of the building blocks of isoprenoids, biomolecules necessary for life. In the first committed step, catalyzed by the enzyme DXP reductoisomerase (DXR, IspC), 1-deoxy-D-xylulose 5-phosphate (DXP) is isomerized and reduced to 2-C-methyl-D-erythritol 4-phosphate (MEP). To facilitate antibiotic development, we evaluated a suite of rationally designed inhibitors against the IspC of *P. aeruginosa*, a member of the ESKAPE pathogen family. Herein we present an assessment of these compounds.

**PHYSICAL SCIENCES
(PHYSICS, CHEMISTRY, ASTRONOMY)**

15. Multi-Sensor Fusion with Geospatial Mapping for Unmanned Aerial System (UAS) Airspace Tracking and Detection

by Oliver Yu

Major: Computational and Data Sciences / C4i & Cyber Center

Mentor(s): Ali Khalid Raz, Jair Feldens Ferrari, Michael Hieb, and Harsh Rangwala

Abstract

The increasing use of small Uncrewed Aerial Systems (sUAS) operations introduces new technical challenges such as detecting and tracking a large number of these small UAS. Solving this technical challenge is crucial in ensuring cybersecurity and reliability of UAS operations within Virginia. Tomorrow's airspace will necessitate a system integrating sensor fusion to surveil UAS, to address cybersecurity threats to cooperative drones and from non-cooperative drones. Our team is developing a UAS Sensor Testbed that combines trajectory analysis with drone detection, and geospatial terrain mapping for placement of multiple heterogeneous sensors for the Virginia Commonwealth Cyber Initiative. We have developed an interactive simulation in MATLAB to plan the distribution of active and passive systems within the corridor between Winchester, Warrenton, and Stafford. Our platform is developed on various MATLAB toolboxes such as "Radar Toolbox", "Communications Toolbox", and "Mapping Toolbox" to fuse our sensor outputs and produce simulation. Our simulation results will be verified by real-time sensor data occurring at a later stage. The Testbed will have the capability to compare different sensor placements. We envision the creation of a dashboard-style system that is openly accessible to UAS operators, state, and government agencies (i.e., Federal Aviation Administration (FAA), and Virginia Department of Aviation). Our project will also enable cybersecure UAS operations by supporting development of resilient UAS surveillance infrastructure

16. Magnetic Jones Vector Detection with RF Atomic Magnetometers

by Cicely Motamedi

Major: Physics

Mentor(s): Karen Sauer

Abstract

An optically pumped atomic magnetometer (OPAM) detects magnetic fields within a two-dimensional plane. Previously, radio frequency (RF) magnetometers could not be used to determine the exact direction of the field within the plane. In this experiment, two magnetometers were used to determine the polarization states of test signals created by running current through coils of wire, and the measurements were expressed as a magnetic Jones vector for the RF field. In an OPAM, alkali atoms are made to rotate around an applied static magnetic field. Only components of a magnetic field that rotate in the same sense and at the same frequency as the atoms are detected by the OPAM. The magnetic fields used in this experiment had directions that either alternated linearly or rotated. Since an alternating magnetic field is equivalent to the sum of two oppositely rotating components, a magnetometer detects only the component that rotates in the same sense as the atoms. This experiment used two magnetometers with their applied fields equal and opposite to each other to separately detect both rotating components. The polarization states of the test signals were then determined from the measurements of the two rotating components. Knowing the direction of the detected magnetic field would be useful in applications where noise from radio interference is known to be perpendicular to the signal. In this case, the direction could be used to distinguish between the signal and interference. One such application is the detection of landmines.

17. Synthesis of Homoseongomycin

by Lauren L Young

Major: Biology

Mentor(s): Greg Petruncio

Abstract

VEEV (Venezuelan Equine Encephalitis Virus) is an RNA virus that commonly affects equines (e.g., donkeys, horses, mules) and humans, albeit less commonly. As an alphavirus, VEEV is spread via mosquitoes and can cause flu-like symptoms, encephalitis, and neurological disease. Currently, there are no FDA-approved vaccines for VEEV. Homoseongomycin, a natural metabolite found in a marine sponge bacterium, was shown to be a potent inhibitor of VEEV with an EC₅₀ of 8.6 μ M, making it a potential therapeutic agent for the virus. Its current proposed mechanism involves inhibiting a viral structural protein necessary for viral assembly as well as host factors that allow the virus to enter the host cells. Due to the laborious and low-yielding extraction of the natural product from its source, we developed a synthetic route towards homoseongomycin over 17 total steps and 10 purification steps. This will allow for further study of homoseongomycin's effects and for development of it into a drug.

18. Photometric Ground-Based Follow-up of TESS Transiting Exoplanet Candidates with George Mason Observatory

by Ian Helm

Major: Astronomy

Mentor(s): Peter Plavchan

Abstract

When exoplanets, or planets that orbit other stars, eclipse their star as viewed by us, some light is blocked in an event called a transit. We use the GMU Observatory 32-in telescope to conduct follow-up observations of transiting exoplanet candidates identified by the NASA Transiting Exoplanet Survey Satellite (TESS) mission, which has a lower spatial resolution, and to help validate these TESS Objects of Interest (TOIs). We select TOIs predicted to transit, taking images of the TOI and surrounding stars. We measure the star brightness as a function of time, resulting in a "light curve," comparing against reference stars to isolate changes in light from space vs. effects from Earth. We present two years of cataloged data from 2019-2020 for a total of 116 observations of 98 TOIs, resulting in 10 detections, 28 marginal detections, 38 non-detections, and 40 inconclusive observations. In the future, we will prepare a publication describing our survey and key results.

19. Arabic Sentiment Analysis on Twitter: A Hybrid Lexicon and Machine Learning Approach

by Amirul Patwary

Major: Computational Data Science

Mentor(s): Sharmin Abdullah and Abdullah Shahwan Almalki

Abstract

This study proposes a hybrid approach combining Lexicon method and machine learning to analyze sentiment in Arabic tweets related to an entertainment event. By filtering out irrelevant tweets, such as spam, news, and advertisements, the research aims to accurately gauge public opinion using Retweet and Favorite features. The approach addresses challenges posed by the Arabic language's rich morphology and unique characteristics, and the behavior of Arab users on Twitter. The performance of classifiers is assessed using accuracy, precision, recall, and F-score, with Decision Tree Classifier outperforming SVM on an unbalanced dataset.

20. Indirect Mass Measurements of Supermassive Black Holes in Type 1 (Unobscured) Active Galactic Nuclei

by Arshia Halavatkar

Major: Physics

Mentor(s): Mario Gliozzi

Abstract

Supermassive black holes (SMBHs) millions to billions of times the mass of our Sun occupy the center of all active galactic nuclei (AGN). The mass of a SMBH is its most important property as it defines the time and scale length of the galaxy while also making it possible to constrain the accretion rate of the black hole system. Accurately determining the SMBH mass is consequently crucial for understanding more complex aspects of galaxies, such as SMBH-galaxy co-evolution. The aim of this study is to analyze various indirect methods of measuring the mass of a SMBH to determine their accuracy compared to dynamical methods in type 1 (unobscured) AGN. Preliminary results from the assessed sample show that mass measurements using the popular $M-\sigma$ relation tend to overestimate SMBH values, while measurements using x-ray scaling largely agree with their dynamical counterparts. These results may signal caution for astronomers using the $M-\sigma$ relation to measure black hole masses.

21. Quantum Means of Measurement: Atomic Magnetometer

by Daniel James Heilman

Major: Physics

Mentor(s): Karen Sauer

Abstract

The goal of this project is to facilitate the use of a large- scale, multi-pass, two-chamber atomic magnetometer (AM) for the detection and characterization of magnetic fields with world-record sensitivity. AMs are highly-sensitive quantum measurement devices, which rely on the spin dynamics of atoms to probe magnetic fields on scales 100 billion times smaller than Earth's field. Applications for this technology are numerous, notable examples being dark matter detection, low-field nuclear magnetic resonance (NMR), long-range radio-frequency communication and navigation.

22. ChatGPT: Bridging the Gap between Human and Machine Communication - A Survey of Its Multifaceted Applications

by Kashmala Mahmood

Major: Biology, concentration in Bioinformatics and minor in Computer Science

Mentor(s): Ron Mahabir, Olga Gkountouna, Patrick Ballantyne

Abstract

Artificial intelligence (AI) and related technologies are increasingly becoming embedded in our everyday lives. Examples include the use of recommendation engines that help us with online shopping on Amazon and deciding what to watch on Netflix. Recently, conversational AI technologies have been in debut, and particularly, ChatGPT, a controversial bot that was released by OpenAI in late 2022. ChatGPT allows users to type in queries, on almost any topic, and receive a human-like response within seconds. In healthcare, ChatGPT has been used to diagnose and treat patients, while in education, it has been used to provide personalized learning experiences to students. It's also being used by computer scientists to find bugs in computer code. Despite its many benefits, there are concerns about the potential misuse of ChatGPT, such as the creation of fake news and propaganda. In this paper, we conduct a systematic review of the academic literature on ChatGPT to explore the different ways in which ChatGPT is being used in society, before discussing the potential benefits (e.g., research and development, tech) and drawbacks (e.g., ethical implications, truth validation) of this technology.