MONMOUTH UNIVERSITY
SCHOOL OF SCIENCE

MONMOUTH UNIVERSITY
STUDENT SCHOLARSHIP WEEK

20th ANNUAL
SCHOOL OF SCIENCE
STUDENT RESEARCH CONFERENCE

APRIL 22, 2022

Featuring Poster Presentations of Student Research
From the

Department of Biology
Department of Chemistry & Physics
Department of Computer Science & Software Engineering
Department of Mathematics

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SCHOOL OF SCIENCE

ANNUAL STUDENT RESEARCH CONFERENCE

APRIL 22, 2022

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Faculty Mentor: Dr. Jason Adolf

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Ella Worrell
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Olivia Enny, Henri Thomas, and Nawwaf Kharma
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Alyssa Piesco
Faculty Mentors: Dr. Gregory A. Moehring, Dr. Datta V. Naik, and Dr. Jeffrey Weisburg

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Shannon Coyle and Rachel Kempter
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Kyle Anderson, Odalys Barriento and Abby Eck
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Emily Tumbaco, Kasey Wilson and Julia Panebianco
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Emma DeSantis, Veronica Marquez and Holly Probasco
Faculty Mentor: Dr. Richard Bastian

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Allison Stark
Faculty Mentor: Dr. Joe Coyle

DEPARTMENT OF BIOLOGY

BY-1

PRECIPITATION AND FECAL CONTAMINATION IN MONMOUTH COUNTY COASTAL LAKES

Christine Gabbidon
Department of Biology

Faculty Mentor: Dr. Jason Adolf

Abstract

Enterococcus is a type of fecal indicator bacteria (FIB) that is present in the gut and bowel of humans, other warm-blooded animals, and birds. They are typically not considered harmful to humans, but their presence in the environment may indicate the presence of other disease-causing agents such as viruses, bacteria, and protists. Significant amounts of enterococci in a water body can negatively affect the recreational and economic value of the aquatic resource. An overabundance of fecal bacteria in the water can cause beach closures, swimming, and boating bans, and closures of fishing areas. Monmouth county coastal lakes are known to be prone to high FIB levels because fecal contamination in recreational waters is associated with an increased risk of gastrointestinal (GI) illness and less often identified respiratory illness. In the lab, I have been testing the fecal contamination that is present in coastal lake water collected from Monmouth Coastal lakes. 18 different groups of samples have been collected and bacteria food was poured into each water sample. Each solution sample was then poured into fluorescent wells plates. Quantitray sealer plus machine used to sealed plates and were incubated for 24 hours. The goal of this study was to compare the fecal contamination in Monmouth Coastal lakes and to assess the relationships between rainfall and fecal contamination.

BY-2

CULTURE GROWTH CURVE REPRESENTATION OF THE DIATOM *Chaetoceros gracilis* AND THE BIO-LUMINESCENT DINOFLAGELLATE *Pyrocystis sp*.

Logan Murphy
Department of Biology

Faculty Mentor: Dr. Jason Adolf

Abstract

Phytoplankton are minute photosynthetic organisms typically at the lowest trophic level of an ecosystem, providing nutrients for countless other organisms. Their study is important to many aspects of conservation, species management, and possible applications in anthropogenic processes. This study concentrates on establishing growth curve data for two species of phytoplankton: the diatom *Chaetoceros gracilis* (*C. gracilis*) and a bio-luminescent dinoflagellate from the family *Pyrocystacae. C. gracilis* is a rectangular colony forming species with native ranges including the North Atlantic off the coast of New Jersey. *Pyrocystacae* is a crescent shaped dinoflagellate with a special ability to bio-luminesce when under stress occurring in coastal, tropical waters along the equator. Using the original sample, both species were allowed to grow diluted in a sterile media maintaining the population below the carrying capacity of the container. Biomass of the cultures were measured daily using a fluorometer in relative fluorescence units (RFU). This data was then plotted in a line graph for each species respectively in a comprehensive way with corresponding growth rates. This growth curve data will allow for future cultures to effectively be grown with minimized error, providing further opportunity for research. Following the completion of this study, stabile cultures will be established at Monmouth University for future examination and education.

BY-3

INTERACTIVE GEOSPATIAL REPRESENTATION OF RARITAN AND SANDY HOOK BAY WATER QUALITY AND PHYTOPLANKTON ABUBANCE

Nicholas Box
Department of Biology

Faculty Mentor: Dr. Jason Adolf

Abstract

Raritan and Sandy Hook Bay are two components of a larger system known as the Hudson Raritan Estuary (HRE). The HRE encompasses Raritan Bay, Sandy Hook Bay, the Navesink and Shrewsbury Rivers as well as influence by the Hudson River plume. The data for this project was collected as part of a much larger ecosystem assessment project funded by Achelis and Bodman that looked to analyze benthic invertebrate and fish populations as well as ecosystem conditions within Raritan and Sandy Hook Bay. This project strictly focuses on the water quality data and preserved phytoplankton samples collected between June 2020 and January 2021. The aim of this project was to utilize the Leaflet package in R Studio to attach images of phytoplankton and other water quality data to a web-based map of Raritan and Sandy Hook Bay. A total of six sampling stations underwent replicate sampling across six different days. The preserved phytoplankton samples from each station were placed under a microscope and photographed. These photos were then processed into a collage and imported to R Studio. The interactive web-based map that was produced in this project allows for a unique georeferenced representation of phytoplankton communities with the potential to represent more data collected within the ecosystem assessment. This project utilizes a HTML coding format that will allow of the maps created to be embedded onto any webpage to display the data collected in an easy to understand and easy to access format. This project hopes to take seemingly complex data and present in a plateable way.

BY-4

ENVIRONMENTAL CONTROL ON HARMFUL ALGAL BLOOM (HAB) TOXICITY IN MONMOUTH COUNTY COASTAL LAKES, NEW JERSEY

Ariel D. Zavala
Department of Chemistry and Physics

Faculty Mentor: Dr. Jason Adolf

Abstract

Reports of harmful algal blooms (HABs) in freshwater environments have been surfacing more and more nationwide in news, leading to concern among researchers, environmental managers and citizens. Monmouth County's coastal lakes, small lakes adjacent to ocean beaches in coastal communities, often experience summertime HABs due to nutrient pollution and climate change. These lakes benefit the surrounding communities economically and environmentally, but when HABs occur they pose a serious health hazard, resulting in state regulatory action and a loss of a valuable community resource. The purpose of this research is to gain insight on local HAB characteristics and their relationship to cyanotoxin abundance through qPCR and ELISA analysis. Cyanobacteria is the phytoplankton that causes HABs and are known to produce cyanotoxins e.g., microcystin, saxitoxin, and cylindrospermopsin. Microcystin, a common cyanotoxin, are especially concerning for their contribution to illnesses in humans and animals. HAB toxicity can be influenced by the environment in which they are growing, therefore, microcystin is not always produced by HABs and can only grow if the HAB contains a microcystin producing species. The coastal lakes of Monmouth County, NJ offer an opportunity for comparative studies on the relationship between freshwater HABs and cyanotoxins, which will be the focus of this study. Evidence indicates that global change to aquatic ecosystems such as rising temperatures, nutrient loads, and CO_2 concentrations will affect the dominance and toxicity of *Microcystis*.

BY-5

EXPLORING GHOST FORESTS: ASSESSING THE IMPACT OF STORM SURGE AND SEA-LEVEL RISE ON COASTAL FORESTS

Ashley Pastore
Department of Biology

Faculty Mentor: Dr. Pedram Daneshgar

Abstract

Ghost forests, or areas of dead trees that were once a coastal forest, are becoming more and more common along the coastline of New Jersey. This is due to numerous flooding events with salt water, typically due to an increase in storm surge frequency/intensity or salt marsh encroachment. Both events are associated with sea level rise induced by climate change. Currently, the ecology of ghost forests has not been described, and very few scientific publications discuss the relevance of ghost forest formation, especially in New Jersey. Specifically, plant and microbial community composition and ecological function of ghost forests are not known. The purpose of this project was to compare the floral and microbial composition of a ghost forest in Cattus Island County Park to the coastal forests they once were and the salt marshes they may become, in order to better understand ghost forest ecological function. The park features several ecosystems including our four study treatments: healthy coastal forest, ghost forest, salt marsh, and transitional areas. Utilizing mathematical analysis to quantify plant community diversity along with genomic sequencing and R programming to characterize microbial community diversity, a better picture of these communities within a ghost forest was better able to be described. Ghost forest plant diversity was considered to be much higher than anticipated, and microbial community composition was fairly typical of what was expected. With a full picture of the species found in each treatment and an understanding of their functional role, predictions can be made on the future of these ecosystems and their ecological significance. As climate change ultimately begins to leave its mark on New Jersey, this project can help ecologists and coastal engineers alike in planning for what is to be expected in coastal forests should the anticipated projections continue on their given course.

BY-6

SPATIAL AND TEMPORAL OCCURRENCE OF THE ENDANGERED ATLANTIC STURGEON (*Acipenser oxyrinchus*) IN RARITAN AND SANDY HOOK BAY

Hannah Craft
Department of Biology

Faculty Mentor: Dr. Keith Dunton

Abstract

Sandy Hook Bay (SHB) and Raritan Bay (RB) are highly urbanized waterbodies located within close proximity of known Atlantic sturgeon coastal aggregation and freshwater spawning sites in the Hudson River. While Atlantic sturgeon have been historically documented to occur in SHB and RB, no formal surveys have been conducted to identify their presence or occurrence within the bays. The purpose of this project was to determine the presence and seasonality of Atlantic sturgeon within this area through the use of acoustic telemetry. Working cooperatively with Naval Weapons Station Earle, six acoustic receivers were deployed in spring of 2016 in SHB and expanded to RB in 2018 to monitor for previously tagged Atlantic Sturgeon. A total of 304 uniquely tagged individual Atlantic sturgeon were detected (n=240,033 detections). Detections showed a presence of Atlantic Sturgeon in both Sandy Hook and Raritan bays with strong temporal and spatial patterns with some fish displaying high residency times. Atlantic sturgeon largely came from the NYB Distinct Population segment but some came as far as south as Chesapeake Bay (MD) and Edisto River (SC), indicating that multiple DPSs utilize the area. This acoustic detection data indicates that the region may represent an important late spring – early summer habitat, therefore spatial and temporal management may be needed to protect this region against localized threats within this shallow urbanized bay (e.g. commercial fishing, high speed ferries, and large ship traffic) during these periods.

BY-7

EFFECT OF CYPRESS ESSENTIAL OIL ON HT-1080 CELL PROLIFERATION

Dianelys Garcia, Noa Bass and Michael Catalfumo
Department of Biology

Faculty Mentor: Dr. Dorothy Lobo

Abstract

Cypress oil is an essential oil derived from evergreen coniferous trees native to Southern Europe and Western Asia. Cypress oil exerts anticancer properties due to their natural terpenes which induce apoptosis and cell cycle arrest, in turn limiting tumor growth and metastasis. The components of cypress essential oil include a total of 20 constituents which represent 98.1% of the oil. These include: α-pinene (48.6%), δ-3-carene (22.1%), limonene (4.6%) and α-terpinolene (4.5%) which are the main components comprising 79.8% of the oil. A cell line of HT-1080 (fibrosarcoma) cells were treated with cypress essential oil at different concentrations and the effects were determined. Proliferation was measured by direct cell counting using trypan blue dye exclusion and MTT assay. Proliferation of HT-1080 fibrosarcoma cells decreased with increased concentration of cypress essential oil. In addition, high concentrations of cypress essential oil also decreased MTT activity which therefore confirmed a decrease in viability due to essential oil treatment. Western blot analysis will be used to ascertain if the decreased viability is a result of apoptosis by detection of PARP cleavage. The effects of cypress essential oil will also be tested on normal fibroblast cells to compare differences in signaling. The signaling of normal-contact inhibited cells treated with cypress will be compared to the cancerous cell line

BY-8

EVALUATING THE DETECTION OF DIAMOND-BACKED TERRAPIN (*Malaclemys terrapin*) FROM AN UNMANNED AERIAL SYSTEM USING 3D PRINTED MODELS

Rebecca J. Berzins
Department of Biology

Faculty Mentor: Dr. Sean C. Sterrett

Abstract

Diamond-backed Terrapin (*Malaclemys terrapin;* DT) is the only brackish-adapted turtle species in North America and a species of greatest conservation need throughout most of its range. The biology of DT, including seasonal breeding aggregations, presents an exciting opportunity for revolutionizing the way wildlife populations are monitored. Unlike traditional approaches, drones offer a non-invasive and potentially unbiased sampling method with the added advantage of committing data to virtual memory. However, we know little about how drones detect DT or influence behavior; therefore, a sampling approach should determine a height detectability threshold while also maximizing distance from DT to decrease disturbance. In this study, we experimentally evaluate DT detection by drones according to drone height, DT size, independent observers, and habitat complexity. We used 3D printed DT in three biologically realistic sizes; small (i.e., juvenile), medium (i.e., male), and large (i.e., female). We randomly selected numbers of different DT sizes into trial sets. For each experimental trial, we set 3D printed DT in a standardized sampling arena and flew the drone from 18 to 60m above the arena, taking standardized drone images at 5m intervals. Then, the images were presented randomly to independent observers, which were asked to mark DT of various sizes from randomly drawn images using the program iTag. Unsurprisingly, we found that drone height and DT size were important factors for accurately counting DT in trials sets. We also expect that habitat complexity (i.e., open water vs. presence of surficial debris) will influence the ability of observers to accurately count DT.

BY-9

BENTHIC MACROINVERTEBRATES OF RARITAN BAY

Elizabeth Gill
Department of Biology

Faculty Mentor: Assistant Dean John Tiedemann

Abstract

As the foundation of many marine systems, benthic macroinvertebrates typically have a high biodiversity and are easily sampled, making them an ideal indicator for judging the health of coastal ecosystems. For this study, we are focusing on the Raritan Bay and collecting data on the distribution and abundance of benthic macrofauna. Our project entails seasonal collection of grab samples at six stations along a transect from the mouth of Raritan Bay west to the mouth of the Raritan River. After collection, each grab sample is rinsed and sieved onboard the research vessel and the resultant organisms are preserved in formalin stained with rose Bengal for processing in the lab. In the lab, samples are sorted and specimens are identified to the lowest taxonomic level practicable and enumerated. The data collected in our surveys will be used to characterize the benthic community in the reaches of the estuary sampled and allow for future comparisons with historical surveys of the area that will aid in determining if changes in the biodiversity of the area have occurred over the years and provide insight into the overall health of the system.

BY-10

MICROPLASTIC EFFECTS ON DEAL BEACH REPLENISHMENT

Jeannette T. Lombardi[1] and Jaime Castrillon[2]
[1]Department of History and Anthropology; [2]Department of Biology

Faculty Mentor: Assistant Dean John Tiedemann

Abstract

The abundance of microplastics present on beaches pollutes the environment and can be detrimental to the health of wildlife. In the spring of 2022, beaches along the New Jersey coastline in Deal, Allenhurst, and Loch Arbor were being widened as part of a regional beach replenishment program. The source of the sand being used in the current project is a borrow site located several miles off Sea Bright. By pumping new sand on these beaches, they are protected against erosion and the amount of microplastics present may initially be minimal compared to beaches that have not recently been renourished. To test this theory, a baseline study was conducted at the Hathaway Avenue beach in Deal, NJ. Using the US EPA's microplastic beach sampling protocol, sampling was conducted along two 100m transects over two field days to determine the relative amount of microplastics present. Sampling was conducted at four randomly selected points along each transect and three samples were collected: one from the high water line, one mid-beach, and one at the back beach from a $1m^2$ quadrat. Each quadrat was excavated to a depth of 1 inch and the excavated sand was sieved and bagged for future analysis in the lab. In the lab, the samples were re-sieved and float tested to separate any microplastics from sand and debris. Any plastics in the samples were subsequently sorted by size and type and data were recorded in an Excel file. Results will document the types and quantities of microplastics on this newly renourished beach and be available for comparison to other beaches sampled in Monmouth County by local environmental groups.

DEPARTMENT OF
CHEMISTRY AND PHYSICS

CE-1

A NOVEL APPROACH TO CHARACTERIZE THE LOCATION CONFORMATION OF G-QUADRUPLEX STRUCTURES USING FLUORESCENT BASE ANALOGUES

Chloe Bryan and Leona Thomas
Department of Chemistry and Physics

Faculty Mentor: Dr. Davis Jose

Abstract

The formation of G-quadruplex (GQ), a non-canonical nucleic acid secondary structure, can inhibit the elevated telomerase activity that is common in most cancers. The global structure and the thermal stability of the GQs are usually evaluated by spectroscopic methods and thermal denaturation properties. However, most of the biochemical processes involving GQs involve local conformational changes of GQs at the guanine tetrad (G4) level. These local conformational changes of individual G4 layers during protein and drug interactions have not yet been explored in detail because the spectroscopic signals of these layers are concealed in the total signal of GQ. Here we report a method to study the local conformations of individual G4 layers in GQs that uses 6-methylisoxanthopterine (6MI), a Circular Dichroism (CD)-active fluorescent base analogue of guanine. A synthetic, tetra molecular, parallel GQ with site-specifically positioned 6MI monomers or dimers were used as the substrate and the CD and fluorescence properties of the G4 layers were characterized. Analytical ultracentrifugation and gel electrophoretic studies showed that properly positioned 6MI monomers and dimers in a GQ forming sequence can form stable GQs with CD-active fluorescent G4 layers. The local conformation of individual fluorescent G4 layers in the GQ structure was then monitored by following the fluorescence intensity and circular dichroism changes of the incorporated probes. The results showed an increase in fluorescence intensity upon the formation of the GQ, which is caused by the partial unstacking of the 6MI base with the neighboring bases. This suggests that the guanine-guanine stacking observed in GQ structures is less effective than the guanine-guanine stacking in single-strand DNA constructs. Further, fluorescence quenching experiments showed that destabilization of the GQ structure enhances the accessibility of the solvent towards the interior of the GQ structure.

CE-2

EXPLORING THE LOCAL CONFORMATION OF INDIVIDUAL G4 LAYERS IN A G-QUADRUPLEX CONSTRUCT USING SITE-SPECIFIC FLUORESCENT BASE ANALOGUES

Dayana Khalil, Riya Ajmera, and Julian Rebelo
Department of Chemistry and Physics

Faculty Mentor: Dr. Davis Jose

Abstract

The formation of G-quadruplex (GQ), a non-canonical nucleic acid secondary structure, can inhibit the elevated telomerase activity that is common in most cancers. The global structure and stability of the GQs are usually evaluated by spectroscopic methods and thermal denaturation properties. Most of the biochemical processes involving GQs involve local conformational changes of GQs at the guanine tetrad (G4) level. These local conformational changes are difficult to follow as it is impossible to isolate spectroscopic signals of individual layers of a GQ structure. To overcome this problem, we developed a method where individual G4 layers in GQs are composed of site-specifically incorporated 6-methylisoxanthopterine (6MI), a Circular Dichroism (CD)-active fluorescent base analogue of guanine. Experiments were performed with human telomeric 22AG sequence (5′-AGGGTTAGGGTTAGGGTTAGGG-3′) where guanines at the positions 3,9,15 and 21 were site-specifically replaced by 6MI monomers. The CD and fluorescence properties of the GQ structures with and without the ligands were characterized under various conditions. Thermal denaturation studies showed that properly positioned 6MI monomers and dimers in a GQ forming sequence destabilize the GQs with CD-active fluorescent G4 layers. The local conformation of individual fluorescent G4 layers in the GQ structure was monitored by following the fluorescence intensity and circular dichroism changes of the incorporated probes. The results showed that the local conformation of individual G4 layers in a GQ can be monitored using fluorescent base analogues. This method can be used to understand the details of GQ-protein and GQ-drug interactions at the individual G4 layer that will help in designing new drugs for the treatment of GQ-related diseases.

CE-3

VISCOSITY DEPENDENCE ON PARAMECIUM SWIMMING SPEED AND IT'S GRAVIKINESIS

Chelsea Dee and Jonah Resnick
Department of Chemistry and Physics

Faculty Mentor: Dr. Ilyong Jung

Abstract

Paramecium is a unicellular protozoan covered by thousands of cilia. It is commonly studied in biology as a template representation of ciliates due to its widespread presence in nature and its relatively large size. Motile cilia of swimming microorganisms at low Reynolds number have been under scrutiny due to their multi-functional roles; including sensing extracellular signals, nutrient uptake, and exertion of propulsive force and torque for locomotion. Paramecium show clear quantifiable responses to environmental stimuli such as magnetic field, electric field, temperature, light, chemical gradients, and gravity. Aspects of particular interest pertaining to their membrane behavior have been its response to gravity and viscosity; mechanisms which play an important role in cell life. Despite its importance, in addition to extensive research invested in analyzing responses to those external stimuli, some crucial properties such as ciliary motor characteristics have not been clearly elucidated. This study will investigate in detail the ciliary behavior of swimming paramecia and their response to gravity under varying viscosity. A chamber was designed to observe swimming paramecia under a high-speed camera. This controlled setting allows for the examination of ciliary responses between paramecia and gravitational forces under selectively managed levels of viscosity.

CE-4

EXPLOITING OR STOPPING THE DYNAMIC PROPERTIES OF RHENIUM POLYHYDRIDE COMPLEXES

Azeez Adedokun, Roxy Aguilar, Kirsten Brasch, Karin Ordonez Vega, Olivia Hiers, and David Kraftmann
Department of Chemistry and Physics

Faculty Mentors: Dr. Datta V. Naik and Dr. Gregory A. Moehring

Abstract

There is a continuing interest in the ability of rhenium polyhydride complexes to serve as precatalysts for the transformations of a variety of organic molecules. Despite reports of several different catalytic transformations attributed to rhenium polyhydride complexes, little is known of the mechanisms for such transformations. The dynamic properties of rhenium polyhydride complexes contribute, at least in part, to the lack of insight into the mechanisms of catalytic transformations by rhenium polyhydride complexes. Room temperature NMR spectra from solutions of rhenium polyhydride complexes provide little information on chemical properties of the individual rhenium-bound hydride ligands due to a rapid exchange of the hydride ligands caused by dynamic processes with small activation energies.

This research group has a continuing interest in the identification and characterization of dynamic properties of rhenium polyhydride complexes. Recently our efforts have expanded to include attempts to both identify applications for the dynamic behavior of rhenium polyhydride complexes and identify structural features of such complexes that will slow or stop the dynamic behavior of such complexes. This report describes our attempts to use a dynamic rearrangement of a rhenium polyhydride complex to provide periodically alternating chemical environments for an adduct BH_3 or BF_3 group. This report also describes our attempts to use chelating tertiary phosphine ligands, including a PCP pincer ligand, to eliminate one of the pathways by which many rhenium polyhydride complexes rearrange.

CE-5

DEVELOPMENT OF A METHOD FOR THE COMPLETE CHARACTERIZATION OF DYNAMIC PROCESSES OF RHENIUM(V) COMPLEXES SUPPORTED BY FIVE HYDRIDE LIGANDS, TWO TRIPHENYLPHOSPHINE LIGANDS AND A CHIRAL AMINE LIGAND

Sarah M. Tadros and Marina Mansour
Department of Chemistry and Physics

Faculty Mentors: Dr. Datta V. Naik and Dr. Gregory A. Moehring

Abstract

Rhenium polyhydride complexes serve as precatalysts for transformations of organic molecules. While several reports of rhenium polyhydride complexes serving as precatalysts have appeared, little has been reported on the mechanisms for these transformations. The "fluxional" nature of rhenium polyhydride complexes contributes to the lack of reports on the mechanisms for the observed catalytic transformation. The "fluxional" nature of rhenium polyhydride complexes is exemplified by a complex such as $ReH_5(PPh_3)_3$ which has four different hydride ligand environments and two different phosphorus atom environments in the solid state. In room temperature NMR spectra of $ReH_5(PPh_3)_3$, however, only one resonance is observed for all five hydride ligands and only one resonance is observed for all three phosphorus atoms of $ReH_5(PPh_3)_3$. This characteristic of rhenium polyhydride complexes of producing deceptively simple NMR spectra from complex chemical environments is what gave rise to the description of such compounds as "fluxional".

While the atoms bound to rhenium in polyhydride complexes are "fluxional", the dynamic processes are not random. Only a few specific atom exchange pathways are needed to account for the observed NMR line shapes of fluxional rhenium polyhydride complexes over a range of temperatures. This research group has characterized the dynamic pathways for several different classes of rhenium polyhydride complexes. This work describes a method for identifying and characterizing the dynamic pathways of fluxional rhenium polyhydride complexes.

CE-6

BABY SPINACH RNA FLUORESCENCE WITH A PRESCENCE OF DFHBI TO MEASURE G-QUADRUPLEX STABILITY

Ella Worrell
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Faculty Mentor: Dr. Jonathan Ouellet

Abstract

In Baby Spinach RNA there is a G-quadruplex made up of 3 tetrads and a triple base pair. This Baby Spinach RNA will fluoresce when it is combined with DFHBI, a fluorescent compound derived from the green fluorescent protein found in jelly fish. The green fluorescence will occur strictly when DFHBI is stacked between the G-quadruplex and the triple base pair.

This project is designed to study the stability of the Baby Spinach RNA through temperature scans of the RNA observed under a spectrofluorometer. When the G-quadruplex is denatured, the DFHBI will relax its energy with internal rotations and will not fluoresce. After each temperature scan a Tm is gathered. The Tm measures the halfway point between the folded and unfolded RNA. The average Tm for baby spinach is 39°C. This is the temperature that will be used as a baseline for future projects.

The 5,10,15,20-Tetrakis-(N-methyl-4-pyridyl) porphine, also called TMPyP4, will be added to the baby spinach RNA mixture to determine its Tm. This will be compared to the Tm without compounds of 39°C. TMPyP4 and its analogs are the key to finding a compound that can either stabilize or destabilize the RNA G-quadruplex.

In the presence of a stable RNA G-quadruplex, the ribosomes that translates the RNA to protein will get blocked, resulting in the protein not being produced. Viral proteins often contain G-quadruplexes. Stabilization of the RNA G-quadruplex with a small chemical compound could be a potential treatment against viral diseases.

CE-7

CLONING FOR APTAMER ASSAY BY RATIOMETRIC FLUORESCENCE AIDED BY PRIMER SEQUENCE PREDICTION SOFTWARE

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Faculty Mentors: Dr. Jonathan Ouellet, Dr. Henri Thomas and Dr. Nawwaf Kharma

Abstract

Cloning is a central tool for bioengineering. Many computer software have been developed to predict the sequences of the desired primers to be used in the experiment that the user is performing.

This research project uses a new software "Smithy" designed by our collaborators to obtain the sequences of DNA primers that will be used in the insertion of various fragments of DNA into a larger backbone plasmid. It is a design automation web application that is used for complex DNA assembly experiments such as Golden Gate Assembly and Gibson Assembly. Smithy not only provides a solution that includes the sequences of the primers needed to properly assemble all of the parts, it also advises the user of which method would be the least costly and most efficient.

The plasmid being constructed with the primer sequences provided by Smithy in this experiment contain the lactose operator, mCherry, a theophylline riboswitch, and GFP-UV as inserts and use pBR322 as the backbone plasmid. Once in the bacteria, the aptamer without theophylline, only the fluorescent protein mCherry will be expressed. Once theophylline is bound to the riboswitch, both of the fluorescent proteins mCherry and GFP-UV will be expressed. The ratiometric fluorescence measurement between mCherry and GFP-UV will measure the efficiency of the riboswitch. Such ratiometric fluorescent measurements can be used to assess the efficiency of other riboswitches.

CE-8

ASTRONOMICAL OBSERVATIONS

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Abstract

An international system of remotely operated telescopes was used to study astronomical objects. Observations of the solar system, interstellar and deep space objects will be presented with a description of the objects, the telescopes and the observation sites. The steps for the image processing techniques will be presented as well as those methods used to identify the moons of planets, asteroids and other objects.

One problem encountered during observations is the timing of the Earth's rotation, night/day, and the target's elevation relative to the telescope position. Another problem is determining the telescope parameters in order to capture images. Once the images have been captured, there are problems with analyzing images of the objects that are small or very far away, in addition to reducing noise in the image, such as being able to identify the object in the image.
Results have included imaging the solar system planets and small bodies; the identification of Jupiter's, Uranus's and Neptune's moons; imaging diffuse nebulae; imaging galaxies; and imaging super novae.

CE-9

BIOGEOCHEMISTRY OF MICROPLASTICS WITHIN AQUATIC ENVIRONMENTS IN REGARDS TO EXTRACTION, TRANSPORT AND INTERACTIONS WITH ORGANISMS

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Department of Chemistry and Physics

Faculty Mentor: Dr. Tsanangurayi Tongesayi

Abstract

Each year, over 300 million tons of plastic are produced and added to our planet. Comprehensive research on how microplastics are extracted, transported, and interact within their ecosystems, has not been conducted. Microplastics, defined as plastic fragments less than five millimeters in diameter, contribute to significant pollution to both plants and animals in aquatic environments, and are a human health hazard. Due to their size, the ability to extract microplastics from soap samples has proven difficult. Multiple methods of separation and their limitations are discussed in this study, along with interactions amongst heavy metals. Density separation using different salt solutions and digestion methods were carefully analyzed and examined for highest extraction yield. The results of this project will include the most effective methods, chemicals, and procedures for extracting microplastics found in consumer and commercial soap products. In addition, the interactions between how microplastics interact with heavy metals such as lead (Pb) and chromium (Cr) will be discussed. This study will allow for further investigation to occur regarding the biogeochemistry of microplastics, as well as provide separation methods that can be applied to large scale operations, such as waste water treatment plants.

CE-10

PREPARATION AND CYTOTOXICITY OF RHENIUM(I) COMPLEXES SUPPORTED BY A CHIRAL CARBOXYLATE LIGAND

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Faculty Mentors: Dr. Jeffrey Weisburg, Dr. Gregory A. Moehring, and Dr. Datta V. Naik

Abstract

Chemotherapeutic agents such as the *cis*-Platin family of compounds are highly effective against several types of cancer. Unfortunately cancers have shown an ability to develop resistance to chemotherapeutic agents. Chemotherapy resistance drives a search for new and more diverse such agents.

Several rhenium-based compounds have shown a cytotoxic effect. An interesting compound of rhenium which includes a ligand that forms from the combination of carbon dioxide with an alkoxide moiety, *fac*-Re[OC(O)OC_5H_{11}]$(CO)_3$(bipyridine), has been shown to be cytotoxic for cancer cells. Our group has investigated both the acidolysis reactions of the alkylcarbonate-containing molecule and the cytotoxicity of some compounds derived from that acidolysis reaction. Results show that the hexanoate-substituted compound, *fac*-Re[OC(O)C_5H_{11}]$(CO)_3$(bipyridine), is both cytotoxic and that it selectively attacks cancer cell lines over normal cell lines. Herein we report our findings with respect to the formation of chiral carboxylate-stabilized rhenium compounds and cytotoxicity studies of such compounds.

DEPARTMENT OF COMPUTER SCIENCE AND SOFTWARE ENGINEERING

CSSE-1

MONMOUTH UNIVERSITY CAMPUS MAP APPLICATION

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Department of History and Anthropology

Faculty Mentor: Dr. Raman Lakshmanan and Dr. Geoff Fouad

Abstract

When people visit, live, or work on college campuses, there exists some uncertainty about where things like buildings, parking, departments, services, and other components are located. The Monmouth University Campus Map application aids its users in finding the places they need while on the university campus. The application idea was originally formulated a few years prior by Dr. Geoffrey Fouad, Director of the GIS program at Monmouth University, project sponsor. He mentored the project along with Dr. Lakshmanan. By working with ArcGIS online, Google cloud services, the developed iOS application will help students and visitors quickly find the resources on campus.

The online ArcGIS website was used to build the Monmouth University map - its building layers, data points, and attributes. The map layers and the information built through ArcGIS is accessed from the mobile app through mapping application programming interfaces (APIs). Campus resource data, locations of printers, computers, etc., are stored in Google cloud database services. Visitors, residents, and staff will now be able to find their wants and needs throughout Monmouth University using the map app on their mobile devices.

AbodeMD is a secure cloud-based software service integrated with an iPad mobile application for remote access and gathering of data. It uses Google's cloud service for user authorization. Additionally, it uses a Document store NoSQL database to capture all data relating to the patient, scheduling providers, and provider checking in and checking out. The mobile app is developed using Swift programming language and UIKit framework, and asynchronous interfaces to cloud services.

CSSE-2

ABODEMD

Isabella Chiaravalloti and Ethan Riedel
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Faculty Mentor: Dr. Raman Lakshmanan

Abstract

AbodeMD provides a mobile, diagnosis-driven treatment approach that allows providers to treat patients in the patient's home or any secure location they desire, revolutionizing care by relaying the data recorded during patient visits to health plans and providers. After registering for an account, healthcare providers input the hours that they are available to work and are assigned patients who fit their availability. Providers check into each scheduled visit, review data recorded during prior visits, input data regarding the patient's symptoms, record observations. Providers also have the option to interact with AbodeMD operations from the app.

AbodeMD is a secure cloud-based software service integrated with an iPad mobile application for remote access and gathering of data. It uses Google's cloud service for user authorization. Additionally, it uses a Document store NoSQL database to capture all data relating to the patient, scheduling providers, and provider checking in and checking out. The mobile app is developed using Swift programming language and UIKit framework, and asynchronous interfaces to cloud services.

CSSE-3

HAWKSCAN: A GIS SOFTWARE PIPELINE FOR IMAGE STITCHING AND DETECTION

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Department of Biology
Department of History and Anthropology

Faculty Mentors: Dr. Raman Lakshmanan, Dr. Sean Sterrett and Dr. Geoff Fouad

Abstract

Ongoing research in the GIS department of Monmouth University requires an in-depth toolset involving use of drones to capture images, and software for mapping technology, and analysis of data. These tools currently are decentralized, manual in each step, increasing input and output time for multiple projects sponsored by the department. Alongside this issue, the use of deep learning in image processing is still relatively new, making it difficult to streamline the process of scanning images to detect objects from datasets quickly. The web application HawkScan seeks to resolve both these issues by creating a hub for the GIS project pipeline and scanning for objects in image datasets.

The full-stack web application was built utilizing the several software technologies and framework – a relational database to model the data, a web application portal developed using CodeIgniter stack in php, and a web portal built with HTML, CSS, and JavaScript. The stitching of images is done using scripts and an API interface to image stitching libraries and detection algorithm is structured around the Grabcut and background-foreground model tools within OpenCV libraries, developed in Python. Image datasets are collected by drones provided through the Monmouth University GIS department. This web application is intended for educational purposes, and currently secured for Monmouth University GIS and Biology faculty to experiment with their datasets.

CSSE-4

IMPERIAL HEALTH: A SELF-DIAGNOSIS ASSISTANT/TOOL WEB APPLICATION

Ian Krempa and Tom Clappsy
Department of Computer Science and Software Engineering

Faculty Mentor: Dr. Raman Lakshmanan

Abstract

Imperial Health is a web-portal to assist users in identifying healthcare issues they could possibly be experiencing and quickly find resources to get assistance. The main functionality allows our users to select from a wide range of symptoms, and get information based on their input. This information can help users self-diagnose, along with verifying if they need to see a doctor or need a specific medication. If that is the case, Imperial Health also has a built-in feature to locate the nearest specialist or pharmacy for the user, if need be. Upon creating an account, users will have access to all of these above features as well as the access to a list containing their recent search history.

This web-based application was developed using the React framework for the front end and Node/Express JS for the backend. All information regarding users is utilized through a MySQL relational database. External APIs (APImedic for medical information, MapBox for mapping) are used to help give the web application all the tools it needs to be functional.

CSSE-5

POKÉTEAM APP: A FUN AND EASY WAY TO MAKE POKÉMON TEAMS

Shawn Lewis and Anthony Orechio
Department of Computer Science and Software Engineering

Faculty Mentor: Dr. Raman Lakshmanan

Abstract

The Pokémon game franchise is beloved by many fans, from every age demographic. The PokeTeam Builder social network app allows a variety of users the ability to create hypothetical teams of Pokémon to be used in the Pokémon video game franchise, or for their own personal collection. These team "builds" are then able to be commented on by other users, as well as liked by other users, giving those who like the build a copy of the team on their own profile. Teams can be kept private or made public to be seen by other users. While the intended demographic of the application is players of the Pokémon franchise at large, the Pokémon database that can be searched and clicked on for more information makes the application usable by those who may want to break into the series and gain more information about the characters therein. The application as a whole allows users to mix and match the Pokémon they find interesting or competitively viable, add them to a team, and have their team be able to be viewed and commented on by other users doing the same thing, while also commenting on others' teams. Users have the option to make their team public or private. While we expect that most users will be doing a mixture of private and public work in the app, the application itself lends itself to both types of use.

The application is built natively for Android mobile platform and coded in Kotlin language. Use an open source PokeAPI for access to current Pokémon characters list. We use Google's Firebase cloud services for user authentication and a Document DB NoSQL data service for content storage and search.

CSSE-6

MODELING AND SIMULATION EMERGENCY EVACUATION BASED ON STOCHASTIC TIMED PETRI NETS

Meghan Granit and Jordan Strobing
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Faculty Mentor: Dr. Jay Wang

Abstract

Emergency management and evacuation efficiency is important to ensure the safety of faculty and students in a college. Teaching buildings are typically of multiple stories. When classes are on session, a teaching build may have a large number of students inside. In case of an event like a fire, people have to be evacuated as soon as possible. Due to panic, people may not use good judgement to choose optimal evacuation path, which can further cause congestion in a path to an exit.

This study attempts to leverage the recent advances in information technology to dynamically guide evacuees. We use stochastic timed Petri nets (STPN) to model the evacuation process of people in a teaching building. The layout of the building, sizes of classrooms and hallways, number of people in each room, and people's decision pattern in choosing a direction to move are all parameters of the model. With simulation we can estimate evacuation timespan. Moreover, by observing the state of the STPN model, we can analyze the congestion status of each pathway, and based on that we can dynamically notify people to select right path that lead them to an exit with the least amount of time.

CSSE-7

A SMART AND SIMPLE TIME PLANNER FOR STUDENTS

Zachary Andrews, Kevin Jennings, Spencer Johnson and Sahil Patel
Department of Computer Science and Software Engineering

Faculty Mentor: Dr. Cui Yu

Abstract

Time management is one of the most valuable skills to have in academic, professional, and personal sense. While crucial for the average person, obtaining good time management skills takes discipline and patience, making it a difficult practice to master. Some students can especially feel overwhelmed when having to juggle between school, work, and other priorities in their busy lives. How can we help them avoid slipping important things through the cracks? Time planning can be difficult, especially for students who are already stressed out or who lack time management ability. Most ordinary calendars require events to be created based on schedules. Strictly speaking, they are not time planners, and they can often overwhelm students who are already stressed out. How can the planning process be made easier? This project creates a solution, which is a web-based application that helps users generate daily time plan. It automatically assigns free time to tasks that ought to be worked on and works like a daily reminder to give a broad overview of what needs to be accomplished for the current day. The whole process does not overwhelm students, as the stress of actual time planning is taken out from the users. The application delegates free time to tasks that must be completed, such as homework with a deadline, tests to study for, and anything that requires time to work on with a time limit. This time planner can also serve as a training tool for students who need help and practice with time management. This project requires a neat interface to achieve friendly user experience, a sophisticated database for flexible user time recording, and an efficient algorithm for instant time calculation.

DEPARTMENT OF MATHEMATICS

MA-1

DOES TAKING REMEDIAL MATH PREPARE STUDENTS FOR THEIR LEVEL 2 MATHEMATICS COURSES?

Shannon Coyle and Rachel Kempter
Department of Mathematics

Faculty Mentors: Dr. Richard Bastian and Dr. Joseph Coyle

Abstract

Prior to a student's first semester at Monmouth University, a mandatory math placement exam must be completed, with the goal of placing students in a mathematics course appropriate for their skill level. Students who receive the lowest score (1), are enrolled in Pre-Algebra Math (MA-050), a course that cannot be used to satisfy graduation requirements. Since MA-050 does not count toward graduation requirements, students are required to take an additional mathematics level 2 course, which will satisfy their general education mathematics requirement. Level 2 courses are those that are one step above the MA-050 course, which include College Algebra (MA-101), Foundations of Elementary Mathematics (MA-103), Mathematical Modeling in the Social Sciences (MA-105), and Mathematics in the Arts (MA-107).

To aid the Mathematics Department Chair - Dr. Joseph Coyle - it is important to see how successful MA-050 is in preparing students for their level 2. Student success is defined as receiving a final grade of C- or higher, which is often the minimum grade needed for prerequisite courses. By using data from the last 22 years that includes student major, all mathematics courses they have taken, and their respective grades in those courses, data analyses are performed to measure the frequency of student success.

MA-2

STATISTICAL ANALYSIS OF SALT FLOODING ON JUVENILE MARITIME TREE SPECIES

Kyle Anderson, Odalys Barriento and Abby Eck
Department of Mathematics

Faculty Mentor: Dr. Richard Bastian and Dr. Pedram Daneshgar

Abstract

The proximity of coastal forests to the ocean makes these trees more vulnerable to climate change. Because of the rising sea level and more frequent storms, flooding has been a relevant topic in the impact on maritime trees. To determine this impact, two greenhouse experiments were conducted where eight tree species of juvenile trees were given different treatments such as levels of salinity and frequency of salt flooding. It is hypothesized that as the level of salinity increases, the health index of the juvenile trees will decrease. Also, for the frequency experiment, as the frequency of salt flooding increases, the health index of the juvenile trees will decrease.

Health index is a number the over health of the tree, numbered from zero to five. These scores were taken biweekly throughout the experiment period by the same individual. Through the use of survival analysis, we will determine whether salinity levels and frequencies of salt impact the juvenile tree's health. At the end of the experiment, the biomass of each tree was collected. This data will be used in ANOVA to test if there is a difference in biomass by the type of treatment each tree received as well as what species each tree is classified as. This will be done for the frequency experiment as well as the salinity experiment. If we see a difference in biomass by these factors, we will continue our analysis to see if the levels of salinity and frequency of salt result in lower biomass numbers by species.

MA-3

CREATING A STATISTICAL MODEL TO PREDICT THE DETECTION OF DIAMOND-BACKED TERRAPIN TURTLES IN DRONE IMAGES

Emily Tumbaco, Kasey Wilson and Julia Panebianco
Department of Mathematics
Department of Biology

Faculty Mentors: Dr. Richard Bastian and Dr. Sean Sterrett

Abstract

Drones are offering a non-invasive sampling method to monitor wildlife populations. Diamond-backed Terrapin (DT) is a turtle species in North America that seasonally breeds. This study focuses on the statistical analysis of data collected on drone pictures of different heights and habitats of 3D-printed turtles in different sizes (small, medium, and large). Images were randomly presented to independent observers which were asked to mark DT of various sizes from randomly drawn images using the program iTag. Our research question is how does habitat complexity and height of the drone influence the ability to count and identify a turtle? First, we calculated detection of small, medium, and large turtles as total counts divided by total true. We then looked at descriptive statistics of detection by both height and habitat. Next, three robust regression models were created to predict small, medium, and large detection from habitat complexity and height of the drone. These models will be trained and tested to find the best-fit model. With that we can predict detection based on size from the predictor variables. A potential benefit from this study is to maximize detection of turtles at a specific height and habitat complexity. This will allow for managers to increase turtle detection in their ongoing research.

MA-4

STATISTICAL ANALYSIS OF THE EFFICACY OF FORWARD-LOOKING INFRARED THERMAL IMAGING IN DETERMINING CRANIAL CRUCIATE LIGAMENT DISEASE IN DOGS

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Department of Mathematics

Faculty Mentor: Dr. Richard Bastian

Clients: Dr. Garrett J. Davis and Dr. Alison Cain
Red Bank Veterinary Hospital, Department of Surgery

Abstract

Cranial cruciate ligament (CCL) disease is a prominent cause of pelvic limb lameness, pain, and osteoarthritis in dogs. In veterinary medicine, CCL ruptures are typically diagnosed by signalmen and history collection, gait evaluation, orthopedic examination, and diagnostic imaging including radiographs, arthroscopy, and magnetic resonance imaging (MRI). Drs. Davis and Cain of Red Bank Veterinary Hospital, used a Forward-Looking Infrared (FLIR) thermal imaging camera to determine the temperature of a stifle with a surgically confirmed CCL rupture and of the opposite healthy stifle in the same dog. The ability of a thermal imaging camera to detect a temperature difference between normal stifles and a stifle with a CCL rupture in the same dog was evaluated in this study. It was hypothesized that the stifle with a CCL rupture will have a higher maximal temperature than that of the unaffected stifle, and the FLIR camera will be able to reliably detect which stifle had the injury. We used an independent one sample t-test with a bootstrap to examine if there was a difference in temperature between the injured and unaffected leg. Additionally, we plan to use a repeated measures analysis of variance to test the temperature difference between the legs. With this analysis we plan to test the interaction of dogs on non-steroidal anti-inflammatory drugs and dogs with meniscal tears.

MA-5

MODELING AN EMERGING VARIANT OF AN INFECTIOUS DISEASE

Allison Stark
Department of Mathematics

Faculty Mentor: Dr. Joe Coyle

Abstract

Compartmental modeling is a framework often used when the members of a set can be grouped into distinct categories or *compartments*. One such situation is modeling the spread of infectious diseases within a (fixed) population. The most basic of these models is the so-called SIR model where the population falls into one of the three states: susceptible (S), infected (I), or recovered (R). In this model as well as other more complicated models, the rate of change in the number of individuals in each compartment is modeled by a derivative leading to a coupled system of differential equations. Of particular interest is the flow of individuals from S to I. This flow is typically driven in part by the average number of new infected individuals generated each day by current infected individuals. Several factors contribute to this rate including a measure of a few factors: the level of contagiousness, average number of people an infected individual encounters each day, and the incubation period. Each of these are commonly represented by a fixed value. In our study, we investigate the impact of modeling an emerging variant over a shorter period of time by varying these parameters which are no longer constant. We consider the implications that arise in generating numerical approximations using both Euler's method and a series solution. We also investigate the subsequent changes to the estimation of the basic reproduction number.