MONMOUTH UNIVERSITY | SCHOOL of SCIENCE

15TH ANNUAL SUMMER RESEARCH SYMPOSIUM

AUGUST 10, 2023

Dear Friends and Colleagues,

I would like to take this opportunity to thank the supporters and university partners who contributed to the success of the 2023 Monmouth University School of Science Summer Research Program (SRP) and other summer research opportunities offered to our students. Their contributions allow us to provide research opportunities for undergraduate students by funding their summer salaries as research assistants, acquire the supplies and equipment necessary to complete their research projects, and providing opportunities for students to travel to conferences and professional meetings to present their research. Without their collective philanthropy and support, the Summer Research Program would not be possible.

I would also like to acknowledge the faculty from the School of Science who dedicated their time and offered their expertise to mentor participating students.

Lastly, I offer congratulations to the student research assistants for their efforts and enthusiasm in completing their projects that are highlighted at today's Summer Research Program Symposium.

John A. Tiedemann, Assistant Dean
Monmouth University School of Science

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2023 Summer Research Symposium

SRP – 1 Water Quality at a Coastal Lake and Adjacent Ocean Outflow Compared Over Three Sampling Seasons

Christopher Reigel
Monmouth University Department of Biology

Faculty Mentor: Dr. Jason Adolf, Department of Biology

SRP – 2 Comparing Visual Sightings of Marine Mammals With Environmental DNA (eDNA) Samples Along the New Jersey Coastline

Brooke van de Sande
Monmouth University Department of Biology

Faculty Mentors: Dr. Jason Adolf and Dr. Sam Chin, Department of Biology

SRP – 3 Series Solutions for Dynamical Sir Systems

Ella Gigante
Middletown High School North

Faculty Mentor: Dr. Joseph Coyle, Interim Dean - School of Science

SRP – 4 Modeling the Spread of Infectious Diseases With Dynamical Systems

Brooke Tortorelli
Department of Mathematics

Faculty Mentor: Dr. Joseph Coyle, Interim Dean - School of Science

SRP – 5 Using Natural Language Processing to Predict The Success of National Institutes of Health Grant Applications

Jason French and Zaccery Tarver
Monmouth University Department of Computer Science & Software Engineering

Faculty Mentor: Prof. Gil Eckert, Department of Computer Science & Software Engineering

SRP – 6 Distinguishing Between Turtles and Water in a Proof-Of-Concept Study for Counting Terrapins in Aerial Drone Imagery

Michael Kazigian
Monmouth University Department of Criminal Justice

Faculty Mentor: Dr. Geoffrey Fouad, Department of History and Anthropology

SRP – 7 Residential Real-Estate Pricing Relative to Flood Zone Designation in Monmouth County, New Jersey

Julianna Rubinetti
Monmouth University Department of Computer Science & Software Engineering

Faculty Mentors: Dr. Geoffrey Fouad, Department of History and Anthropology; Dr. Tjeerd Boonman, Department of Economics, Finance & Real Estate

SRP – 8 Analysis of the Effect of Wave Action on Clam Cove Island in Barnegat Bay New Jersey

Tyler Barkey
Monmouth University Department of Biology

Faculty Mentor: Dr. Thomas Herrington, Urban Coast Institute

SRP – 9 The Analysis of Sediment Movement Around Clam Cove Reserve

Alexis Baumgartner
Monmouth University Department of Biology

Faculty Mentor: Dr. Thomas Herrington, Urban Coast Institute

SRP – 10 Analyzing the Frequency of Inundation of Clam Cove Island, Holgate, NJ With Sea Level Rise

Nicole Cappolina
Monmouth University Department of Biology

Faculty Mentor: Dr. Tom Herrington, Urban Coast Institute

SRP – 11 Monitoring the Local Conformations of G-Quadruplex Structures Using Cd-Active Fluorescent Base Analogues

Andrea Freije and Miriam Abecasis
Monmouth University Department of Chemistry and Physics

Faculty Mentor: Dr. Davis Jose, Department of Chemistry and Physics

SRP – 12 Investigating Local Conformational Changes from Ligands on G-Quadruplex Complexes Using Fluorescent Base Analogues

Alexa Houseknecht and Maxwell Rosen
Monmouth University Department of Chemistry and Physics

Faculty Mentor: Dr. Davis Jose, Department of Chemistry and Physics

SRP – 13 Manuka Essential Oil Activates JNK and Causes Apoptosis of Normal Fibroblast and HT-1080 Fibrosarcoma Cells

Noa I. Bass
Monmouth University Department of Biology

Faculty Mentor: Dr. Dorothy Lobo, Department of Biology

SRP – 14 The Effects of Essential Oils (Eos) on the Growth of Vancomycin-Resistant Bacterium *Enterococcus faecalis*

Ileana Plummer, Nico Santorelli and Gillian Sepp
Monmouth University Department of Biology

Faculty Mentor: Dr. James Mack, Department of Biology

SRP – 15 Preparation, Characterization, & Cytotoxicity of Carboxylate-Stabilized Rhenium(I) Complexes

Lyndsey Buren
Monmouth University Department of Chemistry and Physics

Faculty Mentors: Dr. Greg Moehring and Dr. Datta Naik, Department of Chemistry & Physics
Dr. Jeffrey Weisburg, Department of Biology

SRP – 16 Isolation of an Aptamer Selective to Glucose

Deirdre Campbell
Monmouth University Department of Chemistry and Physics

Faculty Mentor: Dr. Jonathan Ouellet, Department of Chemistry and Physics

SRP – 17 Search for an Aptamer to Bind to 2-Hydroxyglutarate

Maxwell Massaro
University of North Carolina

Faculty Mentor: Dr. Jonathan Ouellet, Department of Chemistry and Physics

SRP – 18 Plasmid Production for Theophylline Riboswitch Ratiometric Fluorescence Assay

Blake Cregg-Wedmore
High Technology High School

Faculty Mentor: Dr. Jonathan Ouellet, Department of Chemistry and Physics

SRP – 19 Evaluating Diamond-Backed Terrapin (*Malaclemys terrapin*) Nesting and Reproductive Vulnerabilities at Sandy Hook National Recreation Area

Kathryn Marshall and Rebecca Berzins
Monmouth University Department of Biology

Faculty Mentor: Dr. Sean Sterrett, Department of Biology

SRP – 20 Movement and Thermal Ecology of Eastern Box Turtle I a Multi-Purpose Suburban Area

Christopher Meehan and Richard Robinson
Monmouth University Department of Biology

Faculty Mentor: Dr. Sean Sterrett, Department of Biology

SRP – 21 Evaluating the Predation Risk of an Eastern Box Turtle (*Terrapene carolina*) Population Inhabiting a Suburban Island

Madison Patterson
Monmouth University Department of Biology

Faculty Mentor: Dr. Sean Sterrett, Department of Biology

SRP – 22 A Comparison of Dog- And Human-Based Surveys for Spatial Capture-Recapture of Eastern Box Turtles (*Terrapene carolina carolina*) in Suburban Monmouth County, New Jersey

Adriana Simancas, Christopher Meehan, Richard Robinson & Madison Patterson
Monmouth University Department of Biology

Faculty Mentor: Dr. Sean Sterrett, Department of Biology

SRP – 23 A Population and Distribution Analysis of the Invasive Asian Shore Crab (*Hemigrapsus sanguineus*) in Upper Barnegat Bay

Diederik Boonman Morales
Monmouth University School of Science

Faculty Mentor: John Tiedemann, Assistant Dean - School of Science

SRP – 24 Reinforcement Learning for Optimizing Delivery Path in a Hospital Setting

Anna Nardelli[1], Luke Shao[2], Brandon Hu[3]
[1] Monmouth University Department of Computer Science and Software Engineering; [2] Department of Computer Science, Cornell University;
[3] Biotechnology High School

Faculty Mentor: Dr. Jiacun Wang, Department of Computer Science and Software Engineering

SRP – 25 Use of Pomegranate Juice Extract to Inhibit Chronic Inflammation in Cancer Cells of the Oral Cavity

Joseph Torkieh
Monmouth University Department of Biology

Faculty Mentor: Dr. Jeffrey H. Weisburg, Department of Biology

SRP – 1

WATER QUALITY AT A COASTAL LAKE AND ADJACENT OCEAN OUTFLOW COMPARED OVER THREE SAMPLING SEASONS

Christopher Reigel
Monmouth University Department of Biology
Marine and Environmental Biology and Policy Program

Faculty Mentor:
Dr. Jason Adolf, Monmouth University Department of Biology

Funding Source:
Monmouth University School of Science; Department of Biology; Urban Coast Institute; NJDEP / EPA

Abstract

New Jersey is home to a unique collection of coastal lakes connected to the ocean which are historically known to exhibit elevated levels of both pollution and Harmful Algal Bloom (HAB) activity. Poor water quality and HABs impact the lake negatively and limit its use by people. Warming water and changing precipitation patterns associated with climate change are anticipated to exacerbate these problems.

Despite what is known about HAB activity in these coastal lakes, little is known about the impact that this activity has on the ocean, where many of these lakes have direct outflows. The aim of this research was to gather data on water quality and HAB abundance at a coastal lake and its adjacent outflow to explore the relationship that these polluted lakes have with the ocean. As an extension of the Coastal Lakes Observing Network (CLONet), the ocean outflow at Deal Lake was sampled for a variety of water quality criteria. Samples were also collected from the Deal Lake side of the outflow, as well as from the beach next to the outflow pipe at the shoreline, parallel to the outflow, and beyond the rock groin where the outflow pipe is housed. Student researchers have now completed this set of sampling for three summers. As such, a comparison of the data collected across these three sampling seasons can be used to examine how freshwater HAB events in coastal lakes affect the water quality of local beaches.

SRP - 2

COMPARING VISUAL SIGHTINGS OF MARINE MAMMALS WITH ENVIRONMENTAL DNA (eDNA) SAMPLES ALONG THE NEW JERSEY COASTLINE

Brooke van de Sande
Monmouth University Department of Biology
Marine and Environmental Biology and Policy Program

Faculty Mentors:
Dr. Jason Adolf and Dr. Sam Chin, Monmouth University Department of Biology
Danielle Brown, Rutgers University Department of Ecology, Evolution and Natural Resources

Funding Sources:
Monmouth University School of Science; Department of Biology; Urban Coast Institute

Abstract

Over the last decade, there has been an apparent increase in marine mammal sightings, specifically humpback whales (*Megaptera novaeangliae*), along the New Jersey coast. To maintain effective conservation parameters for these and other cetaceans in the area, it is crucial to track and understand how they move about and use the New Jersey coastline as their habitat for large periods of the year. Although visual surveillance is commonly used to track marine mammals, the use of environmental DNA (eDNA) holds promise as a supplementary surveillance methodology. This research aims to compare visual sightings of humpback whales with detections by eDNA metabarcoding. Samples for eDNA detection will be taken within 100 feet of whales then be compared to the eDNA from the control samples that were taken when there were no visual sightings of whales in the area or on a given day. It was hypothesized that DNA would always be detected in the water for humpback whales and any other marine mammals that were visually observed from 100 feet away or less. It was also hypothesized that DNA would continuously be detected in the control water samples without any visual sightings due to whales residing along the coast for several months at a time. To assess how other factors affect eDNA signals, variables such as whale behavior, location, water temperature, sea state, and other marine animal sightings were recorded for each sample. The information gained from this research will allow for a greater understanding of how cetaceans utilize the New Jersey coastline during the summer months while providing support for ongoing visual sightings.

SRP – 3

SERIES SOLUTIONS FOR DYNAMICAL SIR SYSTEMS

Ella Gigante
Middletown High School North

Faculty Mentor:
Dr. Joseph Coyle, Interim Dean - School of Science

Funding Sources:
Monmouth University School of Science; Department of Mathematics

Abstract

SIR models are created based on three nonlinear and coupled differential equations in a fixed population that represent the susceptible, infected, and recovered populations to model the progression of a disease. Oftentimes, solutions to these mathematical models have to be approximated and forecasting extreme values and inflection points as well as analyzing how they depend on parameters can be difficult. In this work, power series are used to represent the differential equation solutions for each state of the population.

The accuracy of the series solutions depends on a reliable measure of the associated radius of convergence. Furthermore, the radius of convergence does not typically extend to cover the entire time frame and a scheme that resets the center of the series at a select time value periodically is essential so that the solution remains accurate for the longer time frame of interest.

We investigated a variety of methods to determine the radius of convergence for the series solutions that would yield a time value to reset the center of the series including a ratio test. Ultimately, comparing the series to a known convergent series based on exponential regression analysis proved to offer a process that lead to a reliable choice of radius to reset the series. Here we provide a summary of the tests for the radius of convergence and demonstrate the process and accuracy of employing the comparison/regression scheme.

SRP – 4

MODELING THE SPREAD OF INFECTIOUS DISEASES WITH DYNAMICAL SYSTEMS

Brooke Tortorelli
Department of Mathematics

Faculty Mentor:
Dr. Joseph Coyle, Interim Dean - School of Science

Funding Sources:
Monmouth University School of Science; Department of Mathematics

Abstract

The goal of our project is to model the spread of an infectious disease by utilizing dynamical systems. Dynamical systems contain differential equations that change due to time. In this project, we utilize an SIR model, in which S, I, and R represent the percentage of susceptible, infected, and recovered individuals in a given fixed population, respectively. Parameters, β, γ, and η are essential modeling parameters in the system of differential equations, where β represents the likelihood of infection, γ represents the recovery rate, and η represents the rate at which a recovered individual becomes susceptible again. We generate series solutions to each of the differential equations to establish recurrence relations for each coefficient in order to determine what role time plays in the equation. This leads to the question, at what point does time not play as critical of a role? To that end, we analyze the stability of the constant or equilibrium solutions to the dynamical system. In addition, we use these values to validate the accuracy of the series solutions.

SRP – 5

USING NATURAL LANGUAGE PROCESSING TO PREDICT THE SUCCESS OF NATIONAL INSTITUTES OF HEALTH GRANT APPLICATIONS

Jason French and Zaccery Tarver
Monmouth University Department of Computer Science & Software Engineering

Faculty Mentor:
Prof. Gil Eckert, Monmouth University Department of Computer Science and Software Engineering

Funding Sources:
Monmouth University School of Science; Department of Computer Science and Software Engineering

Abstract

The National Institutes of Health (NIH) is one of many organizations that award research grants to qualifying institutions to fund large-scale research projects. Millions of dollars are awarded to grant recipients every month, but few applications get accepted from the large pool of applicants. It would be valuable to a prospective researcher to know whether their application has a good probability of being accepted.

The purpose of this project was to design a tool that can predict the success of a sample NIH application using information about previously accepted submissions. To gather enough information, our team exported large amounts of data directly from the NIH data tool: Reporter. The team developed a web scraper to harvest data stored as links to maximize the amount of pertinent data for analysis. Data such as the project abstract, tags, and funding amount were all collected and stored in a database to be used in the analysis. Our team used language processing techniques like latent semantic indexing (LSA) to determine the similarity between two text documents. A project application that received funding was compared to its Request for Application (RFA) to look for similarities between the two and received a better similarity score if the documents were more relevant. Similarity scores were compared to funding amounts to see if there was a correlation between the two. An interface was then developed to make this analysis interactive, allowing researchers to submit their own applications. Prospective researchers will now be able to check over their applications using this tool and know whether they need to improve their application to have a greater chance of receiving funding.

SRP – 6

DISTINGUISHING BETWEEN TURTLES AND WATER IN A PROOF-OF-CONCEPT STUDY FOR COUNTING TERRAPINS IN AERIAL DRONE IMAGERY

Michael Kazigian
Monmouth University Department of Criminal Justice

Faculty Mentor:
Dr. Geoffrey Fouad, Monmouth University Department of History and Anthropology

Funding Source:
Monmouth University Office of the Provost's Summer Scholars Program

Abstract

Terrapins (*Malaclemys terrapin*) are a subject of conservation management as they face a number of threats, such as harvesting operations and climate change. The conservation management of terrapins is dependent on knowing how many turtles are in a given area. Turtle counting is often done visually from shore or boat, and is prone to a great deal of error. For that reason, it is proposed that an aerial drone survey of terrapins in brackish water (their native habitat) can be done for an accurate count of turtles. It is first required that the turtle can be distinguished from a backdrop of water in an aerial drone image. A proof-of-concept study is performed here to show that in fact turtles are distinct features as they float in water. This is illustrated in Lake Takanassee of Long Branch, New Jersey using ten 3D-printed and painted turtle "decoys," including six larger female decoys and four smaller male decoys. A "spectral profile" (red, green, and blue light reflectance) is developed for the purpose of showing the difference between the decoys and the surrounding water. It is shown that the spectral profile of the decoys is on average 52% brighter in each form of visible light, and the decoys are clearly distinguishable from the backdrop of water. Not only this, but we also show that measurements of size can be done using the aerial drone imagery. Thus, not only should we be able to count turtles, but also note their size and sex in drone aerial image surveys of turtles. This proof-of-concept study paves the way for future studies of machine learning ("artificial intelligence") methods for counting turtles in drone imagery.

SRP – 7

RESIDENTIAL REAL-ESTATE PRICING RELATIVE TO FLOOD ZONE DISIGNATION IN MONMOUTH COUNTY, NEW JERSEY, USA

Julianna Rubinetti
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Faculty Mentors:
Dr. Geoffrey Fouad, Monmouth University Department of History and Anthropology
Dr. Tjeerd Boonman, Monmouth University Department of Economics, Finance and Real Estate

Funding Sources:
Monmouth University Urban Coast Institute Heidi Lynn Sculthorpe Scholars Program

Abstract

It is thought the United States (US) housing market is currently in a "bubble" (overvalued) due to its widespread exposure to flood risk. Homes of a similar variety are either similarly priced or priced more in flood zones compared to their counterparts not in flood zones. This is the prevailing hypothesis leading to headline-grabbing news that about a quarter of the US housing market is overpriced, translating into an overvaluation of $200 billion. This is called the next "big short" of the housing market mirroring the collapse of the 2008 housing market. Given the weight of this hypothesis, a number of studies are needed to evaluate its relevance under different contexts. Here, the hypothesis of home overvaluation is evaluated relative to the event of Hurricane Sandy in 2012 and the Federal Emergency Management Agency's flood designations of homes in Monmouth County, New Jersey, USA. The findings presented are "conservative" (underestimates) of differences in prices of homes in and out of flood zones as flood damages of Sandy extended beyond the federally recognized flood zones used here. This study is distinguished from others in applying a longitudinal analysis of changes in the difference of home prices in and out of flood zones over three years leading up to Sandy and three years following the event. We expect to find that people have a short-term memory of the damage wrought by Sandy. In the years immediately following the event, home prices in flood zones will be depressed relative to their non-flood-zone counterparts, but in the following years, as memories wane, home prices in and out of flood zones will become more similar, showing that in fact many homes in flood zones may be overpriced, overexposed to risk, and the prevailing hypothesis of the housing market bubble should be taken more seriously.

SRP – 8

ANALYSIS OF THE EFFECT OF WAVE ACTION ON CLAM COVE ISLAND IN BARNEGAT BAY NEW JERSEY

Tyler Barkey
Monmouth University Department of Biology

Faculty Mentor:
Dr. Thomas Herrington, Monmouth University Urban Coast Institute

Funding Source:
Monmouth University Urban Costal Institute

Abstract

Tidal marsh islands are essential elements of the coastal bay ecosystem. These islands provide much needed habitat for many species and reduce wave attack and erosion along coastal community shorelines. The effects of global warming as well as sea level rise have put new pressures on the islands, exacerbating erosion and altering the local ecology. Biotic as well as abiotic changes to these islands have increased the rate at which they are eroding. Tidal marsh islands require restoration to continue to be able to provide habitat for local ecology and protection for coastal communities. Many methods of restoration are available but the most effective way to reduce wave energy is still debated.

The objective of the current research is to analyze the factors impacting sediment transport and wave driven erosion at Clam Cove Island, Long Beach Township, NJ in order to better understand which restoration techniques will be the most effective. A collaborative field data collection campaign was undertaken by Monmouth and Stockton Universities during July 2023 to measure waves, currents, and water levels at Clam Cove Island. This research specifically focuses on the analysis of the effect of wave action on the island. Wave action was studied by first calculating anticipated waves using fetch, duration, and speed of wind traveling over Barnegat Bay. These predictions were then compared to the measured wave heights during the field campaign. This comparison showed the accuracy of predictions and deviant trends found in observed data. Knowing the source and strength of wave action effecting Clam Cove Island provides vital information that can be used to decide how to implement restoration techniques that can mitigate wave driven edge erosion.

SRP – 9

THE ANALYSIS OF SEDIMENT MOVEMENT AROUND CLAM COVE RESERVE

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Faculty Mentor:
Dr. Thomas Herrington, Monmouth University Urban Coast Institute

Funding Source:
Monmouth University Urban Coast Institute

Abstract

Tidal marshes are unique environments supported by sediment to maintain and further vertical elevation growth. Without sediment deposits, marshes could potentially collapse, leaving barrier islands more vulnerable to sea level rise and storm surge events. Tidal marshes in Barnegat Bay are also home to many forms of wildlife. Due to human and environmental factors, certain tidal marshes in Barnegat Bay have deteriorated. To fully understand how sediment moves on and around tidal marshes, a three-week study was conducted to calculate the tidal current generated seabed shear stress to determine the frequency of fine grain sediment transport around the tidal marsh comprising Clam Cove Reserve in Long Beach Township, NJ.

Over several years the western edge of Clam Cove has collapsed allowing water to split the once cohesive tidal marsh into two. To determine if tidal currents are capable of transporting sediment into the cut, a Nortek Eco Acoustic Doppler Current Profiler (ADCP) was deployed immediately south of the cut in a mean water depth of approximately 1.0m between June 1 and June 28, 2023. The Eco ADCP was configured to sample at a frequency of 1MHz over 10-minute sampling intervals. Current measurements collected 0.35m above the seabed were used to calculate the above bed shear stress. Shear stress values were used to determine if the threshold for sediment motion was exceeded during each 10-minute interval using the median sediment grain size at the site (0.125 – 0.25mm) and the non-dimensional Shields Parameter. The results show that flood current velocities are strong enough to initiate sediment motion while peak ebb currents are just below the velocity threshold to initiate motion. Measured data indicates an asymmetry in the current structure that leads to flood tide dominance and net sediment transport to the north along the western edge of Clam Cove Reserve.

SRP – 10

ANALYZING THE FREQUENCY OF INUNDATION OF CLAM COVE ISLAND, HOLGATE, NJ WITH SEA LEVEL RISE

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Monmouth University Department of Biology
Marine and Environmental Biology and Policy Program

Faculty Mentor:
Dr. Tom Herrington, Monmouth University Urban Coast Institute

Funding Source:
Monmouth University Urban Coast Institute

Abstract

As global sea levels continue to rise, there are growing concerns about the frequency of tidal flooding and its impacts in the near future. Frequent inundation of marshes disrupts the natural balance between salt and freshwater. This imbalance will likely cause a change in vegetation, favoring salt and flood tolerant species. For example, a shift in species of marsh grasses, *Spartina patens* to *Spartina alterniflora*, is expected to be seen. Marshes are important ecosystems to conserve as they serve a large role in protecting coastal communities from flooding and possible destruction. A regime shift in marsh ecosystems could result in less resilience and protection.

Clam Cove Island is one of several barrier marshlands that borders Long Beach Island, New Jersey. In recent years, it has suffered significant erosion. The aim of this research was to analyze the frequency of inundation of Clam Cove with sea level rise. Historic water levels recorded at the Rutgers Field Station in Tuckerton, NJ from 2003-2017 were used to determine how frequently the water elevation was above the surface elevation of Clam Cove, which is about 1.5 ft above the North American Vertical Datum of 1988 (NAVD88). The results show that water elevations currently exceed this threshold of about 18 high tides per year. Expected sea level rise rates under moderate emission scenarios provided by Rutgers University were then used to predict future frequency of inundation events. This analysis found that by 2030, Clam Cove would experience inundation for 138 high tides per year. This number exponentially increases to about 360 times per year by 2050, 614 times by 2070, and 717 times by 2100, which is about 358 days of the year. This research can be used to develop sea level rise management strategies and marsh restoration to ensure safety to surrounding coastal communities.

SRP – 11

MONITORING THE LOCAL CONFORMATIONS OF G-QUADRUPLEX STRUCTURES USING CD-ACTIVE FLUORESCENT BASE ANALOGUES

Andrea Freije and Miriam Abecasis
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Faculty Mentor:
Dr. Davis Jose, Monmouth University Department of Chemistry and Physics

Funding Sources:
Monmouth University School of Science; Department of Chemistry and Physics

Abstract

Stable G-quadruplex (GQ) structures can inhibit increased telomerase activity which is common in most cancers. Usually, spectroscopic methods and thermal denaturation properties are used to evaluate the global structure and the thermal stability of the GQs. The conformational changes to GQ structures during protein and small molecule interaction are more prominent at the local rather than the global structural level. This is because, in spectroscopic methods, signals from the global structures hinder those from the local structure. In this study, we monitored the local conformations of individual G4 layers in GQs using 6-methylisoxanthopterine (6MI) chromophores, which are circular dichroism (CD)-active fluorescent base analogues of guanine, as local conformational probes. A synthetic, tetramolecular, parallel GQ with site-specifically positioned 6MI monomers or dimers was used as the experimental construct. Analytical ultracentrifugation studies and gel electrophoretic studies showed that properly positioned 6MI monomers and dimers could form stable GQs with CD-active fluorescent G4 layers. The local conformation of individual fluorescent G4 layers in the GQ structure can be tracked by monitoring the absorbance, fluorescence intensity, thermal melting, fluorescence quenching, and CD changes of the incorporated probes. Overall, these studies showed that site-specifically incorporated fluorescent base analogues could be used as probes to monitor the local conformational changes of individual G4 layers of a GQ structure. In the future, experiments will be performed on natural GQ-forming sequences to explore the details of small molecule–GQ interaction at the level of the individual G4 layers.

SRP – 12

INVESTIGATING LOCAL CONFORMATIONAL CHANGES FROM LIGANDS ON G-QUADRUPLEX COMPLEXES USING FLUORESCENT BASE ANALOGUES

Alexa Houseknecht and Maxwell Rosen
Monmouth University Department of Chemistry and Physics

Faculty Mentor:
Dr. Davis Jose, Department of Chemistry and Physics

Funding Sources:
Monmouth University School of Science; Department of Chemistry and Physics

Abstract

DNA sequences rich in guanines readily fold to form quadruplex structures, which are bound by Hoogsten-type hydrogen bonding of four guanine nucleotides (G4). These G-quadruplexes (GQs) make up many aspects of structural DNA, including the telomeres which function as a protective barrier to uphold the integrity of the chromosome. This complex offers physiological benefits including limiting telomerase activity which is active in 85-90% of human tumor cells. Telomerase activity can be influenced by local conformational changes of the GQ at the guanine tetrad level.

To identify changes in the local conformations of the telomeric sequence upon interaction with small organic molecules, 3 types of DNA sequences were used, 22AG, 22AG6MI, and 22AG6MIup. The human telomeric sequence is parodied using 22AG, while two modified sequences include 6-methylisoxanthopterine (6MI), a circular dichroism (CD)-active fluorescent base analogue of guanine in place of guanine in distinct positions at the G4 level. Past studies investigated binding of (5,10,15,20-Tetrakis-(N-methyl-4-pyridyl)porphine (TmPyP4), a telomerase inhibiting ligand, to the GQ but only addressed their interaction in a global conformational perspective. Our study used the fluorescent base analogue to track the local conformation at individual G-tetrad levels.

The results demonstrated destabilization of the 22AG DNA sequence with increasing ratios of TmPyP4. However, 22AG6MI and 22AG6MIup GQ stabilization was observed since the melting point increased. 22AG6MIup showed a greater stabilization than 22AG6MI. The results suggest by using site-specific fluorescent probes we can monitor the structural and stability changes in GQs. This method of studying ligand interactions with fluorescently active base pairs can be used to further understand small molecule interaction at individual G-tetrad levels. We hypothesize that this new approach might help to identify more targeted drugs to treat cancer and other telomere-related diseases.

SRP – 13

MANUKA ESSENTIAL OIL ACTIVATES JNK AND CAUSES APOPTOSIS OF NORMAL FIBROBLAST AND HT-1080 FIBROSARCOMA CELLS

Noa I. Bass
Monmouth University Department of Biology

Faculty Mentor:
Dr. Dorothy Lobo, Monmouth University Department of Biology

Funding Sources:
Monmouth University School of Science; Department of Biology; and Kevin Young

Abstract

Manuka essential oil is popular in many skincare products because of its antibacterial and anti-inflammatory properties that treat several skin conditions. However, manuka oil also contains an active ingredient that is commonly found in herbicides and is potentially toxic to human cells at certain concentrations. Results were previously ascertained on the effects of the oil on cell proliferation and viability through direct cell counting and MTT assays. As the concentration of manuka oil increased, proliferation and viability were reduced in both normal CUA-4 fibroblast cells and HT-1080 fibrosarcoma cells. This led to the question of whether manuka essential oil causes apoptosis, which can be measured through cleavage of the PARP protein since this happens early in the process of cell death. By performing PARP cleavage assays, manuka treatment was found to cause apoptosis in both CUA-4 fibroblast and HT-1080 fibrosarcoma cells. The JNK mitogen-activated protein (MAP) kinase signaling pathway has been implicated in the cellular response to stress. To see if this pathway was also activated, western blot analysis was performed to detect the levels of phosphorylated (active) JNK. Manuka essential oil treatment increased the activation of JNK in both cell types. Future work will include determining if increased JNK activation is due to down-regulation of phosphatases that regulate JNK activity, including MKP-1 and MKP-2, and if other MAPK pathways may also be activated.

SRP – 14

THE EFFECTS OF ESSENTIAL OILS (EOS) ON THE GROWTH OF VANCOMYCIN-RESISTANT BACTERIUM *Enterococcus faecalis*

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Funding Sources:
Monmouth University School of Science; Department of Biology; and
Mr. Kevin Young, dōTERRA

Abstract

Due to the overuse and misuse of antibiotics, multidrug-resistant bacteria have become a growing global healthcare issue. Healthcare professionals are finding it harder to treat many multidrug-resistant bacterial infections with current antibiotics. Bacterial infections are an increasing health threat, especially healthcare-associated infections (HAI). This may be due to a multitude of patients who are immunocompromised, and the high rate of antibiotics being used to treat those patients, which could be causing them to develop a resistance to antibiotics. Natural medicinal products such as essential oils (EOs) are being studied to test the effectiveness of treating multidrug-resistant bacterial infections compared to current antibiotics.

119 essential oils were tested against the multidrug-resistant bacterium, *Enterococcus faecalis (E. faecalis)*. The carrier oil, jojoba oil, was used to dilute the EO's concentration and to determine the EO's effectiveness in inhibiting the growth of *E. faecalis*. There were 72 essential oils that inhibited the growth of this bacterium at 100% concentration (no carrier oil). The best EOs that were still effective after being diluted in inhibiting *E. faecalis* thus far are: Abode, Arborvitae, Oregano, Cinnamon Bark, and Cassia. These EOs displayed high success rates in inhibiting *E. faecalis* during the initial testing of all the 119 total EOs at 100% concentration and at much lower concentrations as well. Antibiotic discs were used to observe the zones of antibiotic inhibition to *E. faecalis* compared to those of the EOs. The traditional antibiotics that are currently used to treat *E. faecalis* include Ampicillin, Streptomycin, and Vancomycin, and therefore were utilized in our research to be used for comparison. Of the effective EOs used, our research will be continued to determine the Minimum Inhibitory Concentration (MIC) for each essential oil. The MIC will be determined using the Kirby-Bauer Disk Diffusion Susceptibility Method. Overall, we found that out of the 119 essential oils we tested, Abode, Arborvitae, Cassia, Cinnamon Bark, and Oregano were more effective thus far in inhibiting the growth of *E. faecalis* compared to the antibiotics currently used.

SRP – 15

PREPARATION, CHARACTERIZATION, & CYTOTOXICITY OF CARBOXYLATE-STABILIZED RHENIUM(I) COMPLEXES

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Funding Sources:
2023 Provost's Summer Scholars Program; Dr. Moehring & Dr. Naik's Lab; Department of Chemistry & Physics; Monmouth University Creativity and Research Grant Program

Abstract

Rhenium complexes in the form of $Re(CO)_3$(bipyridine)X (where X =a pentylcarbonate group or a carboxylate group) have been found to be selectively cytotoxic, or cause cell death, for cancer cells compared with normal human cells. Research in our group has explored a variety of carboxylate groups with the intent of identifying key characteristics that lead to selective cytotoxicity towards cancer cells. To date, that research has found simple straight chain carboxylate groups impart the most selectivity and cytotoxicity to such complexes. The specific research completed in this project includes the preparation and characterization of several new carboxylate-stabilized complexes of the form. $Re(CO)_3$(bipyridine)X along with a study of the effect of such complexes on the viability of cancer and normal human cells lines. The selective cytotoxicity of the rhenium complexes are examined based on the variations in the composition and structure of the carboxylate groups.

Two separate methods were used to prepare $Re(CO)_3$(bipyridine)X complexes. The rhenium carboxylate complexes were prepared by refluxing $Re_2(CO)_{10}$ and bipyridine (or 1,10-phenanthroline) in an ester containing the desired carboxylate group. Some of the complexes were synthesized by acidolysis reaction of $Re(CO)_3$(bipyridine)(pentylcarbonate) with the appropriate carboxylic acid. Recrystallization experiments were carried out to purify some complexes. Nuclear magnetic resonance (NMR) spectroscopy and infrared (IR) spectroscopy were used to characterize the complexes. Combustion analysis for the percent carbon, hydrogen, and nitrogen in the new complexes determined the purity of the new rhenium complexes. Pure samples of new complexes are being tested for their effect on the viability of both cancer cell lines and normal cell lines.

SRP – 16

ISOLATION OF AN APTAMER SELECTIVE TO GLUCOSE

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Funding Sources:
Monmouth University School of Science; Department of Chemistry and Physics

Abstract

Diabetes is a disease that hundreds of million people live with daily throughout the world. Although this is disease is typically not fatal, it can be if not treated properly. The day to day life of a person with diabetes consists of blood sugar monitoring by finger pricks, insulin injections and strict diet. The research for a glucose aptamer would be the first step to eliminate the need for all of this. This project uses Systematic Evolution of Ligands by Exponential Enrichment, or SELEX, to select RNA that binds specifically glucose. The process is a cycle beginning with a PCR from a pool of millions and billions different DNA sequences, then transcription to RNA, negative selection, positive selection, and reverse transcription back to DNA. The conclusion of the reverse transcription is the beginning of the next generation where each generation becomes more selective to glucose. Eventually the RNA would be sequenced and converted to a riboswitch. A riboswitch is a sequence of untranslated mRNA that can bind a specific ligand, in this case glucose, and transmit a signal to the expression platform to start the reaction to make a protein. For this project the riboswitch would begin the production of insulin only in the presence of glucose. By making insulin outside of the pancreas, diabetes patients would no longer need insulin injections or constantly monitor their blood sugar levels. The project is currently on its 25^{th} generation and is continuing to move forward. Once we obtain a high ratio of positive over negative cleavage percentages we will begin the process to clone DNA and individually test sequences to find an aptamer that cleaves only in the presence of glucose.

SRP – 17

SEARCH FOR AN APTAMER TO BIND TO 2-HYDROXYGLUTARATE

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Funding Sources:
Monmouth University School of Science; Department of Chemistry and Physics

Abstract

The research at hand is the search for an RNA aptamer through Systematic Evolution of Ligands by Exponential Enrichment (SELEX). The aptamer will eventually be transformed into a riboswitch and be used as a biomarker to detect the presence of 2-Hydroxyglutarate. 2-Hydroxyglutarate (2-HG) is a molecule that has been discovered to have significantly elevated levels in a large proportion of patients with gliomas and glioblastomas. 2-HG is an intermediate product in a faulty Tricarboxylic Acid Cycle, commonly referred to as the Citric Acid Cycle or Krebs Cycle, which is only produced when there is a mutation in the genes of Isocitrate Dehydrogenase or IDH which alternatively leads to the production of modified enzyme IDH1 or IDH2. Both enzymes fail to properly do their role in the Krebs Cycle and have a gain of function producing 2-HG. α-Ketoglutarate is a necessary intermediate product of the Krebs Cycle which increases protein synthesis, and when 2-HG is produced instead, 2-HG acts as a competitive inhibitor to α-ketoglutarate. Detection of 2-HG allows for exploration of the opportunity to detect certain gliomas and glioblastomas in their early stages. The purpose of this research is to attempt to find an aptamer that has the ability to detect the presence of elevated 2-HG. Aptamers are small RNA and DNA strands that bind to molecules with high specificity and selectivity. Through the process of SELEX, it is possible to filter through many RNA and DNA strands of different sequences while only keeping ones that have the potential to detect levels of 2-HG. The overall goal of using SELEX is to find an aptamer that only detects the presence of 2-HG and not any molecules similar. With the use of the hammerhead ribozyme, a ribozyme that has the ability to self-cleave, possibility to obtain high specificity aptamers suited to only cleave in the presence of 2-HG is explored with this research.

SRP – 18

PLASMID PRODUCTION FOR THEOPHYLLINE RIBOSWITCH RATIOMETRIC FLUORESCENCE ASSAY

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Funding Sources:
Monmouth University School of Science; Department of Chemistry and Physics

Abstract

Plasmids are small, circular, double-stranded DNA molecules found in bacterial cells. Due to their ease of genetic manipulation and ability to be produced abundantly in bacteria, they are crucial tools in genetic engineering for the cloning, amplification, and expression of genes. The production of plasmid DNA (pDNA) consists of five steps: plasmid vector selection, host strain selection and transformation, production in shake flasks/fermenters, culture harvesting, and purification.

This cloning research project applies the plasmid production process to the fluorescent assay of a theophylline riboswitch. First, a chemical transformation inserted pUC18 plasmid containing the genes of mCherry_TheoRS_GFP into BL21(DE3)pLysS *E.coli* bacteria. After incubation with SOC medium, selection was conducted on an agar plate containing ampicillin. Furthermore, IPTG was present to activate the lactose operator, initiating transcription of the inserted genes. Isolated bacterial colonies were placed into vials containing LB solution and ampicillin (100mg/ml) for cultivation. Following a Mini-Prep procedure, the concentration of the isolated pDNA was measured using a NanoDrop Spectrophotometer at 260 nm. Moreover, instead of transforming an intact plasmid, a ligated plasmid was used. An insert from pUC18_Mcherry_TheoRS_GFP was amplified by PCR, and the plasmid pBR322 was digested by PvuII, a blunt-end cutting enzyme. The digested plasmid and PCR fragment were then ligated and transformed. Subsequent steps of this project included developing a ratiometric fluorescence of the riboswitch activation. Bacteria from the remaining vials were plated on a 6-well plate and placed into vials containing LB solution, all treated with ampicillin and varying amounts of IPTG and theophylline. The riboswitch triggers the production of green fluorescent protein (GFP), causing the otherwise pink bacteria to also fluoresce green.

The goal of this research is to establish proof-of-concept for successful aptamer-to-riboswitch development and, ultimately, to create aptamer-based biosensors as therapeutic tools for diabetes, AML, and gliomas.

SRP – 19

EVALUATING DIAMOND-BACKED TERRAPIN (*Malaclemys terrapin*) NESTING AND REPRODUCTIVE VULNERABILITIES AT SANDY HOOK NATIONAL RECREATION AREA

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Funding Sources:
National Park Service; Monmouth University School of Science; Department of Biology

Abstract

The Diamond-backed Terrapin (*Malaclemys terrapin;* DT) exhibits a geographic distribution ranging from Cape Cod, Massachusetts to Corpus Christi, Texas. DT spends most of its time in estuaries, but relies on coastal, terrestrial environments for reproduction. Over time, the critical nesting areas of DT have been increasingly encroached upon by suburban development, roads, recreation and the effects of climate change (i.e., sea level rise, increased frequency and intensity of storms, flooding, increased temperature). Population monitoring is crucial for identifying trends and to inform management of imperiled populations. For DT, nesting females are a conspicuous and approachable life history stage that allows for monitoring this important component of a population. To evaluate the status of and impacts of DT in the Mid-Atlantic region, we initiated a follow up study of spatial nesting ecology on Sandy Hook National Recreational Area, a National Parks Service (NPS) property in coastal New Jersey. We used intensive visual nest surveys, repeated headcount surveys and camera traps to identify the primary nesting areas and to identify trends between former reports (i.e., 2005) and current day conditions. The 2002 study documented the presence of 203 DT nests in three principal areas within Sandy Hook. The primary objective of this study is to inform NPS management on the spatial distribution of nests (i.e., active nesting females, depredated nests) within significant nesting hotspots, quantify the number of nesting individuals, and to identify the relative impact of recreational human and dog use of nesting beaches at Sandy Hook Recreational Area.

SRP – 20

MOVEMENT AND THERMAL ECOLOGY OF EASTERN BOX TURTLE IN A MULTI-PURPOSE SUBURBAN AREA

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Funding Sources:
Monmouth University School of Science; Department of Biology; Urban Coast Institute

Abstract

Suburban landscapes are widespread across the Eastern U.S. and can dramatically decrease the quality and connectivity of critical wildlife habitat and threaten the long-term resiliency of regionally important populations. Suburban development significantly changes the landscape which can negatively impact the survivorship of various wildlife as it fragments habitat, creates low-quality habitat patches and increases direct wildlife mortality via roads. Although wildlife with limited home ranges and dispersal may initially survive dramatic habitat loss and fragmentation, populations may not have the capacity to adapt to low quality habitat conditions to ensure their long-term survival. To better understand the relationship between suburban landscapes and wildlife, a study of the Eastern Box Turtle (*Terrapene carolina)* living within a suburban area in Monmouth County, New Jersey was initiated. Twenty-three turtles, of even sex ratio, were affixed with radio transmitters and iButton temperature loggers, for bi-weekly tracking and to record temperatures experienced by each individual, respectively. Additionally, 30 HOBO temperature and light loggers were staked at ten different habitat types, known to be used by individual turtles, within the study area to describe the thermal characteristics of each habitat. In this study, we report on the minimum convex polygon and kernel density home range estimates, seasonal movement patterns and thermal ecology of this suburban Box Turtle population. We hypothesize that seasonal movements between forested and old field habitats will be tied to thermoregulation and nesting purposes, further emphasizing the needs for management of both habitat types.

SRP – 21

EVALUATING THE PREDATION RISK OF AN EASTERN BOX TURTLE (*Terrapene carolina*) POPULATION INHABITING A SUBURBAN ISLAND

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Funding Sources:
Monmouth University Urban Coast Institute

Abstract

Suburban development fragments habitats and can create small suitable habitat patches surrounded by unsuitable human development, leaving behind what is called suburban islands. For less mobile reptiles, this fragmentation decreases survival rates of individuals that move between patches. Remaining undeveloped habitat patches may also be inhabited by suburban-adapted mesopredators, which can influence prey population stability. Eastern Box Turtle (*Terrapene carolina;* EBT) is a terrestrial turtle species that is declining across its range due to anthropogenic threats, including loss of upland habitats, disease, and road mortality. Little is known about the effects of mesopredators on EBT populations relegated to small suburban habitat patches, but it is well known that specific mammalian and avian species are among the top predators of EBT nests and juveniles. It was hypothesized that mesopredators present in our sample area like foxes, raccoons and corvids would affect the persistence of an already sensitive EBT population. We conducted this study in a suburban island in Monmouth County, New Jersey. We used 10 motion and heat activated camera traps, deployed using random point sampling across 68 ha, to learn about the mesopredator community present within this area. Data collected from camera traps will be assessed monthly with images sorted, predators identified and data visualized in a GIS to determine the spatial distribution of predators across this area. Data from the first month suggests that raccoon, eastern coyote, and red fox were the predominant mesopredators present, with virginia opossum and domestic cats also found to be in the area. More monthly data from camera traps, in combination with future artificial nesting experiments, will be used in a population model to assess the risk of predators to the nesting success and persistence of this EBT population and to inform species management.

SRP – 22

A COMPARISON OF DOG- AND HUMAN-BASED SURVEYS FOR SPATIAL CAPTURE-RECAPTURE OF EASTERN BOX TURTLES (*Terrapene carolina carolina*) IN SUBURBAN MONMOUTH COUNTY, NEW JERSEY

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Funding Sources:
Monmouth University School of Science; Department of Biology; Urban Coast Institute

Abstract

The Eastern Box Turtle, (*Terrapene carolina*; hereafter EBT), is a highly vulnerable species that inhabits a variety of forested areas in the Eastern United States, including New Jersey, but is at high risk due to anthropogenic pressures, such as road mortality, habitat loss and poaching. Despite these pressures, EBT is able to survive in highly suburban environments, albeit with increased mortality risks. Due to the increased awareness of and reported decline in turtle populations globally, there is an increased need for rapidly assessing population parameters (i.e., density) to inform conservation and management plans. Ideally, continuous monitoring of population abundance across space and time would allow for mitigating population vulnerability; however, resources for this work are highly limited. EBT is particularly cryptic (i.e., challenging to see) and seasonally elusive (i.e., behaviorally hard to find), making detection of this turtle challenging. Therefore, the use of trained, working scent dogs has revolutionized the ability to find EBT at a much higher rate compared to traditional human-based surveys. In this study, we compared human- and dog-based survey approaches based on total number of individuals captured, size class distributions and logistics of completing each survey type. The objective of this research is to develop a working spatial capture-recapture framework, while also comparing human- and dog-based survey approaches, to estimate EBT population densities in suburban New Jersey Monmouth County with the intentions of using these estimates to inform management at the local and state levels.

SRP – 23

A POPULATION AND DISTRIBUTION ANALYSIS OF THE INVASIVE ASIAN SHORE CRAB (*Hemigrapsus sanguineus*) IN UPPER BARNEGAT BAY

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Funding Sources:
Monmouth University Provost's Summer Scholars Program; School of Science

Abstract

The Asian Shore Crab (*Hemigrapsus sanguineus*) is an aquatic invasive crustacean in the United States. This crab is native to rocky intertidal habitats along the Western Pacific, mostly found in China, Korea, and Japan. It is believed to have been introduced to waters in the Mid-Atlantic through ballast water in the 1980s. Since then, shore crab populations have increased rapidly in quantity and geographic distribution, having spread as far north as Maine and south to the Carolinas.

Field surveys between 2013 and 2015 at sites in upper Barnegat Bay characteristic of adult Asian Shore Crab habitat revealed their presence inhabiting several rocky intertidal shorelines. These records of the presence of adult *H. sanguineus* provided the first evidence of an extension of the species' range in the region. In order to update the status of populations of the Asian Shore Crab in upper Barnegat Bay, sites previously surveyed were revisited, as well as new potential suitable habitats. Field surveys were conducted during low tide by randomly placing a 1 m^2 quadrat every 10 m along a transect and haphazardly overturning rocks within. All organisms were captured and identified, and were also measured and sexed.

It is important to understand their place in this new ecosystem. Understanding the distribution and abundance of this non-native species and how it interacts with the environment will help determine appropriate control methods to reduce, or potentially eradicate Asian Shore Crabs.

SRP – 24

REINFORCEMENT LEARNING FOR OPTIMIZING DELIVERY PATH IN A HOSPITAL SETTING

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Funding Sources:
Monmouth University School of Science; Department of Computer Science and Software Engineering

Abstract

Reinforcement learning (RL) is a type of machine learning that has many applications in real-world industry. RL intends to "teach" a model best-decision practices through exploration and trial-and-error. This project explores an application of RL in the medical field, creating a model that can efficiently navigate a space and complete tasks in a sample hospital environment. We created a simulation of a hospital floor and programmed an agent to learn the fastest route to a destination while completing tasks and avoiding obstacles. We envision our agent to be a robot that can optimally pick-up and deliver supplies/medication to specific rooms on the floor, which would make hospital practices more efficient and keep patients happier and healthier. Our model was created through a Python program and OpenAI's Gym library. We modified a Gym environment called GridWorld, adding custom obstacles, actions, and desired locations to reach. The Python program was created to model our RL mechanism which is fundamental to the success of the project. The program creates a state-transition system using Q-learning, simulating all of the possible movement decisions the agent can make. For each of these movements, the agent receives a "reward" of some numerical value. During training, the agent is allowed to explore the environment, calculating a Q-value for each movement, which is then stored in its own matrix. The Q-value is a mathematical estimation of the immediate and long-term value of an action. The model thus learns which actions produce the highest reward through the Q-table's analysis, and the agent learns to take the most efficient path to complete its tasks by seeking the highest possible long-term reward. Ultimately, the potential applications of this RL model are endless, with significance across industries in decision-making systems to simulate optimal outcomes.

SRP – 25

USE OF POMEGRANATE JUICE EXTRACT TO INHIBIT CHRONIC INFLAMMATION IN CANCER CELLS OF THE ORAL CAVITY

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Funding Sources:
Monmouth University School of Science; Department of Biology

Abstract

Previously, we have demonstrated that pomegranate juice extract (PJE) selectively targets and kills cancers of the oral cavity, using the human squamous carcinoma cells, HSC-2, as compared to normal gingival fibroblast cell, HF-1. NF-kB, a vital transcription factor in inflammation, is known to upregulate gene expression of other pro-inflammatory cytokines, such as interleukin-1 beta (IL-1β), Tumor Necrosis Factor alpha (TNF α), and interleukin-6 (IL-6). Increased NF-kB activation is thought to be one of the links between chronic inflammation and cancer. Previous research groups have shown that NF-kB activation can occur in most cell types. Treating the cells with PJE, we want to observe if this nutraceutical, a food which has medicinal benefits, could inhibit or decrease NF-kB activation, preventing the inflammatory process and the generation of cancer. Secretion of these pro-inflammatory cytokines further amplifies the immune response. We want to examine if PJE treated cells can decrease/inhibit the secretion of IL-1β, TNF α, and IL-6. The activation of NF-kB and the secretion of the aforementioned pro-inflammatory cytokines is initiated by the epidermal growth factor (EGF) cascade. Determining epidermal growth factor receptor (EGFR) expression levels on these cells will also be done as signaling through these receptors initiates and maintains inflammation. We did indeed see a reduction in IL-6 and NF-kB activity upon addition of PJE.