STUDENT POSTER PRESENTATIONS

1. MODELING APTAMER BEHAVIOR WITH UPDATED MOLECULAR DYNAMICS METHODS

*Alan Arizmendi **Almaraz**, Iowa State University*

Aptamers are single-stranded RNA molecules that behave similarly to anti-bodies in that they bind to certain target molecules. There are several key differences between aptamers and antibodies that make them an interesting molecule to model. The most important is that they have tunable properties and are more chemically resistant to changing environments. Therefore, we can study how their characteristics change when introduced in different systems of varying temperature, pH, or other parameters. One obstacle is that carrying out these studies in a lab can get very expensive and time-consuming. A very common alternative is to carry out a Molecular Dynamics simulation. This computational method involves taking the molecule of interest and putting it through a simulation that gives a very good prediction of how the molecule will behave in real life. Given the rapid development of technology and computing power, it is of interest to take a second look at aptamers that have been last modeled years ago to see the differences in predictions. Our chosen aptamer is the malachite green aptamer (MGA) which binds to its target molecule: Malachite Green. Malachite Green is an organic molecule mainly used in dyes. We focus on using updated programs and parameter settings to possibly get an even better prediction of how MGA behaves in water while bound to malachite green and while it is not.

2. LANDSCAPE GENOMICS OF IOWA'S THREATENED BLACK REDHORSE

*Peter **Berendzen**, Department of Biology, University of Northern Iowa*

The Black Redhorse is a freshwater fish found across the eastern United States; however, in Iowa it is considered a species of greatest conservation need and is listed as threatened. To better direct conservation efforts and funding, we aim to determine the degree of fragmentation of Black Redhorse populations. To achieve this, we will use RADseq, a Next Generation Sequencing technique, to sequence and compare DNA from individuals across Iowa. Whole genome SNPs will be used to compare four populations from Northeast Iowa. Samples were collected from the Volga, Turkey, Maquoketa, and Upper Iowa rivers. With this data we aim to: i) characterize genetic diversity, ii) determine the level of connectivity between fish populations, and iii) identify current and potential barriers to fish dispersal. We predict disjunct population structures resulting from increased sediment load in streams, pollution, and dam construction. This study will help guide management strategies to conserve genetic diversity of the species.

3. EXPLOITING DEPENDENCY ON GPX4 TO TARGET CELLS IN AN EMT-LIKE STATE

*Natalie M. **Figueroa-Félix**, Department of Mechanical Engineering, Iowa State University*
Derrick K. Rollins, PhD, Department of Chemical & Biological Engineering and Statistics, Iowa State University

Measuring the glucose level for diabetes subjects helps monitor and track many important components such as: understanding the different factors that affect the blood glucose levels, tracking low and high blood glucose levels within the body, and monitoring the major effects that might have an impact on the overall blood glucose levels. For this project, carbohydrates, fats, and protein consumption, as well as activity variables, stress, and other inputs were logged in addition to blood glucose readings from a diagnostic chip sensor called Guardian Sensor 3 which samples at 5-minute intervals, over a 2-week period. The talks reports on the effectiveness of obtaining this information as compared to data collection 10 years ago using different equipment. Ultimately, the objective of this project is to develop a mathematical relationship between these inputs and the output, blood glucose concentration (BGC). The success of the work will improve the representation of the fully coupled relationship between blood insulin concentration (BIC) and BGC for people with type 1 diabetes.

4. GASOLINE TO ELECTRIC CONVERSION

*Kendricks **Kemp**, Doane University*
Cale Stolle, Doane University

Electric cars are the vehicles of the near future, but the gasoline powered car industry still has the majority of automobiles on the road today. However, the demand for EV's is increasing year after year, and the need for vehicle conversions is becoming more and more noticeable. Throughout this project it became very clear that there was no set methodology for doing this type of conversion. Prior to initiating this project, an informative, detailed document was created to assist individuals in decisions involved in electric vehicle conversion, and this guided the direction of this project. There were three main focuses for this project that include figuring out a way to find the best solution on performing a gasoline to electric conversion, creating an instructions manual that gives a step by step breakdown on how to undergo the conversion, and finally converting a gasoline powered all-terrain vehicle into a fully electrically powered vehicle. The conversion could be broken down into three main sections: (1) removing gasoline related components from the vehicle, (2) determining power flow specifications, and (3) integrating electrical components into the vehicle. The final aspect of this project is to create a fully functional, electric ATV. This section of the project is still underway and is expected to be complete prior to the end of the spring semester.

5. IMPACT OF HEART-SPECIFIC CAVEOLIN-3 OVEREXPRESSION ON CIRCADIAN EXOSOME SECRETION AS A FUNCTION OF AGE

*Han **Le**, Nebraska Wesleyan University*
Dr. Hemal Patel, University of California San Diego
Dr. Juan Zuniga Hertz, University of California San Diego

Caveolins are critical structural membrane proteins which regulate the formation, regulation, and organization of lipid-rich membrane microdomains called caveolae. Caveolae are structural and functional platforms in the cellular membrane and are implicated in a variety of conditions including metabolic dysfunction, type II diabetes, and heart disease. Caveolins are involved in

several cellular processes which encompass structural and functional membrane regulation, vesicle formation, temporal and spatial regulation of signal transduction, membrane mechanotransduction, transmembrane diffusion, and exosome biogenesis and transcytosis. It is understood that numerous cellular processes, including sleep, locomotor activity, blood pressure, body temperature, and blood hormone levels, operate in a circadian rhythm and ultimately may impact disease pathophysiology through disruption of circadian rhythms in transcription. Besides the cellular central time oscillator, a 24-hour biological rhythm in behavior, biological, and cellular processes, some organelles demonstrate unique time oscillations. Recent studies in our lab suggest that the membrane may possess a specific oscillation pattern that regulates the exocytosis of secretory membrane vesicles such as exosomes. Exosomes are involved in multiple physiological and pathological mechanisms, including cellular crosstalk, especially in the heart. In cardiovascular pathophysiology, this communication may be disrupted. We hypothesize that caveolin is a key regulator of this rhythmicity. Caveolin-3 (Cav-3) is one of the three caveolin genes coded for caveolae forming proteins. Current investigations in the lab also show that mice with Cav-3 overexpression have enhanced life span. Using a model of Cav-3 overexpression, our study investigates the relationship between caveolin, caveolae, and the circadian secretion of exosomes in the heart in the context of aging. We will assess the physical quantity and size distribution of particles secreted into blood of young and aged mice with and without heart specific caveolin-3 overexpression at different times of day. We predict a unique pattern of exocytic material will emerge, in which more exosomes will be detected in the Cav-3 overexpression model.

6. MULTIDISCIPLINARY DESIGN OPTIMIZATION OF UNMANNED AIR VEHICLES FOR WILDFIRE MONITORING

Dr. Leifur Leifsson, Associate Professor, Department of Aerospace Engineering, Iowa State University
*Sharice M **Locke**, 2nd Year Student, Iowa State University*

The objective of this project is to create a fast-multidisciplinary analysis and optimum design framework for unmanned air vehicles (UAVs). The framework should be capable of analyzing and optimizing UAVs in level-flight in cruise condition. The approach taken is to approximately model the aero structural behavior of the UAVs using OpenAeroStruct. The expected outcomes include (a) open-source python-based aero structural model of UAVs, (b) a GitHub page hosting the code, description of the code, tutorial of how to run it, and example results, and (c) a presentation describing the modeling and outcome.

7. A SUBJECT-SPECIFIC DYNAMIC MODEL FOR THEIR BODY WEIGHT VARIATION OVER TIME FOR MULTIPLE INPUT CHANGES

*Gracie **Mutungi**, Iowa State University)*
Dr. Marit Nilsen-Hamilton, Iowa State University
Dr. Derrick K. Rollins, Iowa State University

The second author collected weight data, which is normalized in the presentation, over a six (6) year period along with eight input variables that could impact her weight variations. The input

variables are calories, activity, carbohydrates, salt, fat, sugar, saturated fat, and protein. The data sampling frequencies are daily and monthly. This work takes a dynamic modeling approach that considers both time delay and lag for the effect of each input on the response (i.e., weight). The dynamic modeling approach follows the work in Rollins, et al. (2010) where a discrete-time modeling approach was applied to modeling blood glucose variation for a subject with type 2 diabetes from nutrients, activity and stress variables. Results of this work is presented using formal and informal analysis.

8. GENETIC AND BEHAVIORAL FACTORS IMPLICATIONS ON COVID-19 INFECTION

*Germain **Nkoue**, Iowa State University*
Natalie Figueroa-Felix, Iowa State University
Sonyta Ung, Iowa State University
Yekaterina Vang, Iowa State University

They have been limited research carried out concerning the COVID-19 and peoples' susceptibility to developing this disease. That is why this study seeks to determine genes associated with increase susceptibility of COVID-19 infection. The data were collected from GSE994 Series compose of over 22,217 genes of smokers, non-smokers, and former smokers. This data ran through a Principal Component Analysis (PCA) which effectively provides differential gene expression by ranking genes by the significance of their contribution they bring. It was observed that the top gene expression led to the development of cancer. The results of this study and its relevance will be further discussed.

9. IMPACT OF STREAM DISCHARGE ON MASS TRANSPORT OF SEDIMENTS AND NUTRIENTS IN DRY RUN CREEK

*Deandre **Presswood**, Environmental Science, University of Northern Iowa*

The Purpose of this study was to better understand discharge rates throughout the Dry Run Creek Watershed and how they influence water quality. To do so field measurements and calculations were conducted that consisted of calculating discharge in urban, rural, and transition sites all while sampling for Nitrates (NO3), Total Suspended Solids (TSS), and Total Dissolved Solids (TDS). At peak rates urban sites of Dry Run Creek were discharging a total of 4000 liters of water per second which carried 22729 kg of NO3, 20804 kg of TSS, and 126831 kg of TDS per day. After July 23rd, which is when majority of the values peaked, NO3 and TSS steadily dropped as the study continued. This drop in concentration is attributed to a drought the Dry Run Creek watershed experienced over the summer of 2020. Spatial and temporal trends were discovered, that are most likely due to differences in vegetation surrounding urban and rural sites. There were also trends that suggest NO3 concentrations are being influenced and possibly controlled by agricultural practices in and around the Dry Run Creek watershed. To find a conclusive answer more research is needed, and a similar study of the DRC watershed is required to better understand the findings of this study.

10. A DATA-DRIVEN FRAMEWORK FOR SMART DECISION-MAKING IN SMALL AND SHRINKING COMMUNITIES

*Ana Sofía **Ramos**, Iowa State University*

The research observes seven (7) small towns and rural communities along the state of Iowa that have been successful in smart shrinking. This study puts a new understanding to rural towns that want to remain small rather than expanding. The research documents how some communities protect their quality of life. The project uses different type of methods to gain data with the goal to gather this information/knowledge and share it with other small communities.

11. MULTI-FUNCTION DISPOSABLE PAPER-BASED PIEZOELECTRIC DEVICES

*Yahriel **Salinas-Reyes**, Iowa State University*
Andrew Martin, Iowa State University
Martin Thuo, Iowa State University

In an era where electronic devices are becoming rapidly more complex and expensive. High efficiency (i.e. performance/cost ratio) in devices becomes harder to achieve as fabrication costs escalate as the assemblies of elegant high-performance devices require more sophisticated material systems. Conceptually, however, devices such as piezoresistors simply create connections between mechanical stimuli and electrical resistance changes, which, can be achieved through simple, well-designed device architectures. Piezoresistive micro-electro-mechanical systems (MEMS) sensor devices are examples of elegant, simple, efficient architectures that can be utilized to create various, more complex devices using a plethora of material selections. Here, we use material that is abundant, green and low-cost such as paper for a platform to build these devices. Utilizing the fundamentals of piezoresistive effects, paper-based devices can proof to be a highly efficient and facile option for electronic devices. Furthermore, the deformability of papers leads to easier access to wider, more unique form factors, without increasing the cost of fabrication significantly, leading to simple assemblies of 2- or 3- dimensional devices and wide range of applicability.

Through my research with disposable paper-based piezoelectric devices, I strive to diminish inequities in STEM fields by increasing the affordability of high-performance sensors while, conceptually, sustaining a frugal approach to allow users more versatility in design aspects and usability. These affordances attempt to erase many barriers which cage in the minds of innovators by increasing accessibility to such technologies.

12. DISCOVERING UNKNOWN GENES ASSOCIATED WITH THE ELEMENTAL TRAITS OF ROOT LENGTH AND DIAMETER USING IMAGE PROCESSING TECHNIQUES

*Lilly **Shatford-Adams**, Doane University*
Momo Xie, Doane University
Tessa Durham Brooks, Doane University
Alexander Bucksch, Doane University

Phenotyping is important in understanding the behavioral mechanisms and physical traits of an organism. Quantifying phenotypic traits across large populations results in the identification of hundreds and sometimes thousands associated genes that contribute to the phenotype. Elemental traits, called phenes, may be associated with small clusters of genes that regulate them. Arabidopsis thaliana is a model organism with a fast growth cycle, and large natural variation in plant biology with a well-annotated genome to study basic biology. Open imaging and sequencing data of Arabidopsis allows for the data to be repurposed in order to discover unknown phenotypic relationships. This research focused on creating a new image processing pipeline to computationally analyze Arabidopsis thaliana root traits from existing open-source imaging and Single Nucleotide Polymorphism (SNP) datasets. 1440 images covering 252 accessions of Arabidopsis thaliana were analyzed using Python scripts that extracted the morphological traits of root length and diameter. Two loci were found associated with root traits in a Genome Wide Association Study, HK1 (hexokinase) and WSD1 (wax ester synthase).

13. EIGENASSAY CONTRIBUTION APPROACH ON COVID-19 GENES INFECTION

*Sonyta **Ung**, Iowa State University*
Derrick Rollins, Iowa State University

This research extends the principal component analysis (PCA) approach of Rollins et al.(2010) to the development of ranking genes of microarray data sets that express most differently between two biologically different groupings of assays, to develop rank-order lists of important genes of Covid-19 from a very large set of genes from microarray data studies, the data has 22,216 genes from 75 different people (Wang et al. (2020)) involving three groups, consisting of the smoker, non-smoker and quitted smoker, then computing PCA contribution different and applying statistical analysis to observe genes behavior expression.

Wang et al. (2020)6 “Susceptibility Analysis of COVID-19 in Smokers Based on ACE2.”
Rollins et al. (2010), “An Extended data mining method for identifying differentially expressed assay-specific signatures in the functional genomic study.”

14. VENTRICULAR ASSIST DEVICE (VAD) ACTIVITY TRACKER DATA COLLECTION AND MODELING

*Allison **Wilson**, Nebraska Wesleyan University*
Derrick Rollins, Iowa State University

A ventricular assist device (VAD) is a mechanical heart pump that helps the heart to function and guides blood flow in those with weakened hearts. Tubes are used to carry blood away from the heart to blood vessels while a power source and control unit monitor device function outside of the body (Ventricular Assist Device, n.d.). The device aids the left, right, or both ventricles and surgery is required to connect it to the heart. For this project, heart rate data was collected from a new VAD activity tracker over a one-week period. The Hurd Health group seeks to develop a control system that will mimic an intelligent control system that is used by the body and that will regulate oxygen throughout the body through blood flow (Hurd, n.d.). This new activity tracker is to regulate and measure how disturbances, such as stress, regulate blood flow and determine

how to manipulate blood flow (Hurd, n.d.). This objective of this research is to help to determine if the use this intelligent controller will be able to manipulate the blood flow to keep the SPO2 levels constant no matter the disturbances inside or outside the body. The collected heart rate data was used to construct a model to represent the relationship between blood flow rate and SPO2. Results will be presented using formal analysis.