

Undergraduate Research Conference

Spring 2020

College of Science and Engineering

SHAHAD ABDULSAHIB

Biochemistry

Molecular Determinants of Immunogenic Cell Death Elicited by Nanoparticle-Mediated Dual Chemo- and Photothermal Therapy

Abstract:

To address the pitfalls of current anti-cancer treatments such as low response rate and many side effects, we are working on the development of nanoparticle-mediated dual chemo and photothermal therapy (PTT) utilizing poly(lactic acid-b-ethylene glycol) (PLA-PEG) nanoparticles loaded with doxorubicin (DOX) and indocyanine green (ICG). MDA-MB-231 human breast cancer cells were used in these studies. This treatment is expected to result in low side effects as a result of passive nanoparticle targeting and localized activation with the use of a near infrared laser. The goal for this treatment is to elicit immunogenic cell death (ICD) through PTT- and chemotherapy-mediated release of tumor-specific antigens and presentation of damage-associated molecular patterns (DAMPs) including adenosine triphosphate (ATP), high mobility group box1 (HMGB1), calreticulin (CRT), and heat shock proteins (HSP70 and HSP90). ICD will alert the body to fight remaining tumor cells that the treatment was not able to eradicate. I was able to conduct the first set of studies to show that ATP release and surface presentation of CRT in fact do occur with the proposed treatment. Compared to the single DOX and ICG treatment, combinatorial therapy mediated by nanoparticle treatment resulted in the highest DAMP translocation/secretion. The results show sufficient DAMPs presentation after exposure to low dosage of nanoparticles (0.3mg/mL) and short laser irradiation time (3 min). I am working on conducting experiments for detection of heat shock proteins (HSP70 and HSP90) and HMGB1.

ALEX GUZMAN & CAITLIN GABOR

Biology

Effects of Acute Thermal Stress on Physiology, Growth, and Reproduction in Gambusia Affinis

Abstract:

A combination of climate change and land-use conversion has resulted in rising air and water temperatures. Fish may not be able to escape warmer water, and this may stress fish dysregulating their primary stress hormone, cortisol. Higher temperatures may also affect growth and reproduction. We explored the consequences of increased temperature on cortisol, stress response, growth and reproduction of the livebearing Western Mosquitofish, *Gambusia affinis*. We hypothesized that increasing temperature would alter cortisol levels and affect growth and reproduction of female mosquitofish. We exposed females to 25°C or 31°C water. Fish in heated water had a greater change in mass than the control. However, females exposed to higher temperatures were more likely to drop underdeveloped offspring. Cortisol did not differ across treatments and fish from both treatments showed a significant stress response. Females that had

higher baseline cortisol before being exposed to the treatments dropped their offspring sooner than females with lower cortisol when exposed to the heat treatment. There was no such effect in the control treatment. Mosquitofish maybe able to persist in warmer urban streams because of their lack of a stress response to warmer waters, but they do still show costs to life in warmer water.

RENYA MAKU

Biology

Paper Microfluidics: Cheap, Quick and Easy Platform for Point-of-Care Diagnostics

Abstract:

Cryptosporidium is a waterborne parasite that causes gastroenteritis, it is found mostly in drinking water of remote regions where diagnostic testing and treatment are difficult to obtain. The purposes of this project are to capture and isolate cryptosporidium using hollow silica microspheres, known as molecular buoys, and to optimize a paper microfluidic device for colorimetric detection. Our approach tested different paper materials for optimal flow rate, wax printing, and 3-D assembly. While we were able to demonstrate cryptosporidium was successfully captured and isolated by the antibody tagged hollow molecular buoys and that the flow rate of the paper microfluidic was enhanced to reduce overall diagnostic time, the presence of high, non-specific binding between the detecting enzyme and the paper did occur generating a high background signal. These effects were slightly reduced through use of bovine serum albumin in phosphate buffered saline as a blocking agent yet further optimization is needed to eliminate non-specific binding, so that the combined molecular buoy/paper microfluidic detection system could serve as a low-cost tool in rapidly diagnosing patients in remote regions with limited access to care.

CODY RODRIGUEZ

Biology

Investigating Aging and Alzheimer's Disease in Zebrafish (Danio Rerio)

Abstract:

Aging is a normal part of life; however, it is also associated with certain pathologies. Zebrafish have been identified as one of the most promising model organisms used to study aging. We are interested in using zebrafish to investigate normal and potentially pathological changes to the brain during aging. Aging is accompanied by cellular senescence, a marker for which in humans is p16/INK4A. P16 is a tumor suppressor protein which is encoded by the CDKN2A gene in humans. Studies locating this protein in adult zebrafish have not yet been accomplished in spite of the fact that the zebrafish version of the gene has been identified as cdkn2a/b. For the first part of the study, we used a rabbit monoclonal anti-CDKN2A/p16INK4a antibody to label brain and retinal sections taken from adult zebrafish; Hoechst was used to label nuclei. Preliminary results suggest localization of p16 in the brain and retina. Further experiments are underway to corroborate this initial finding. The second part of this study concerned examining the brain for changes associated with Alzheimer's disease. Alzheimer's disease is marked by accumulations of beta-amyloid, the precursor for which is amyloid precursor protein (APP). We used western analysis to determine whether a mouse monoclonal anti-APP antibody could be used to detect APP in zebrafish brain. We found that our anti-APP antibody detected a doublet band at the molecular weight predicted for APP (~110 kD). Immunohistochemistry experiments using this antibody are currently underway.

DIANA EMELY WIEBE

Biology

ABCC4 Affects Pigment Granule Migration in RPE of Mice

Abstract:

ABCC4 is an ATP-binding cassette protein that exports signaling molecules present in the retina, including cyclic adenosine monophosphate (cAMP). In mammals, cyclic AMP accumulates in photoreceptors in the dark conditions. If cyclic AMP is exported from the photoreceptors into the sub-retinal space, then it may be available for uptake by the retinal pigment epithelium (RPE), consequently activating the process of pigment granule aggregation. It is hypothesized that ABCC4 in photoreceptors mediates cAMP-export and is needed for pigment granule migration in the RPE of mice. To investigate the involvement of ABCC4 in pigment granule movement, pigment granule density was measured along the basal microvilli in the RPE for both wildtype and *Abcc4* knockout mice that were light- or dark-adapted (N = 3 for each treatment). Dark-adapted wildtype mice differed significantly in pigment granule density compared to light-adapted wildtype mice (p-value = 0.03). No significant difference was seen between light-adapted and dark-adapted *Abcc4* knockout mice (p-value = 0.19). A polyclonal antibody to ABCC4 will be used to test for the presence of ABCC4 on photoreceptors by immunohistochemistry, and a Western blot analysis verified the specificity of this antibody. Results are consistent with the hypothesis that ABCC4 plays a role in the regulating pigment granule position in RPE of mice.

MAGDALENA BARNES

Chemistry

Between and Within: Biochemistry and General Chemistry Students' Classification of Attractions

Abstract:

Chemistry is a highly abstract topic that requires students to understand interactions between molecules at both the macroscopic and microscopic levels. Particulate representations are often used to help depict intermolecular and intramolecular interactions. These interactions can be found in macrostructures like proteins and DNA as well as in smaller molecule systems such as sodium nitrate solutions. This study explores how general chemistry and biochemistry students classify intermolecular and intramolecular interactions when given a variety of particulate diagrams. A survey using 6 different particulate diagrams were given to 108 Biochemistry and 775 General Chemistry II students. Students were given approximately 15 minutes to write the name of the type or types of bonds/attractions, both within and between structures. Student responses were coded by types of identified interactions and the accuracy of their responses was evaluated. It was found that many students across both general chemistry and biochemistry struggled to identify covalent and ionic forces correctly. Common student errors include ignoring water molecules within solutions, labeling a single ammonia molecule as containing hydrogen bonding and mislabeling covalent and ionic bonding. Similarities and differences between general chemistry and biochemistry student responses will be presented.

HANNAH CASTRO

Chemistry

Analyzing Interviews with Team Members: A Deep Dive into Instructional Change Teams

Abstract:

Instructional change teams can help redesign and improve STEM courses. There is existing research about business teams and teams in general but limited research about how teams can effectively make instructional changes. The goal of our overall project is to develop guidance for leaders of instructional change teams through research involving interviews and surveys. A postdoctoral researcher and I have been conducting interviews with team members. We have been asking them to react to our existing model of instructional change teams and consider how the model applies to their own teams. The main parts of the model include 5 team inputs, 5 team processes, 3 emergent states, and 4 team outcomes. We will eventually use these interviews to develop a survey for teams. A sub-goal of the research that I will be focusing on is to explore how individuals' perceptions of their teams vary by analyzing interviews with team members from the same teams. This analysis will also consider possible explanations for why differences across team members' perceptions may have emerged and how these findings can support future research about instructional change teams. This research is being conducted with Dr. Alice Olmstead in the Department of Physics, and supported by funding from NSF #1525393 and NSF #1914857.

FRIDA LOPEZ

Chemistry and Biochemistry

Exploring the Validity of the Revised Approaches to Studying Inventory as a Measurement of Success for General Chemistry Students

Abstract:

The aim of this study is to examine approaches to learning chemistry within the unique demographic of Texas State University. General Chemistry courses are often considered gateway courses to STEM majors due to the high level of difficulty for students with varying degrees of previous preparation, study habits, and overlying expectations. In order to understand the relationship between individual study habits, student demographics, and the success in chemistry coursework, the students' approaches to learning General Chemistry were explored through the Revised Approaches to Studying Inventory (RASI). The shortened form of the RASI is an 18-item Likert scale inventory which was incorporated as one of three sections on Entwistle's Approaches and Study Skills Inventory (ASSIST). The RASI inventory introduces questions separating students' study habits into three types: deep, strategic, and surface. Cronbach- α , factor analysis, and t-tests were then utilized as methods to analyze the underlying structure of RASI along with the validity and reliability of data collected on with the RASI. This study found a relationship between "deep" and "strategic" learners and high standardized test scores. In addition, this study will also display a significant correlation between "surface" learners and lower standardized test scores within under-represented minority population at Texas State University.

GABRIELLA GUZMAN-JOYCE

Chemistry and Biochemistry

Stability of Student Learning Approaches and Impact on Student Success in General and Organic Chemistry

Abstract:

General chemistry and organic chemistry are challenging courses for students to learn. These courses tend to have large numbers of students who are not able to pass and continue to their next courses. Some students struggle in these classes because they are less prepared to study efficiently. We wanted to explore how stable or malleable students study habits are as they progress through lower level chemistry classes in terms of their ability to successfully perform on a common final exam for their courses. We surveyed students both at the beginning and end of the semester using a shortened form of the Revised Approaches to Studying Inventory (RASI). The same students were surveyed across multiple semesters as they enrolled in General Chemistry 1 through Organic Chemistry 2. The survey consisted of 18 Likert-scale items that measured students deep, strategic, and surface approaches to learning. Sub-scores for each scale were generated and nonparametric t-tests were used to explore changes in scores over time. Sub-scores of deep and strategic scores were compared to their common final exam for general chemistry students using k-mean clustering of the surface scores. Preliminary results will be presented.

ARIANNA BIVINS

College of Science and Engineering

1990s vs. Today: The Degradation and the Empowerment of Women in Rap and Pop Music

Abstract:

Current research discusses how women are being sexualized and are being portrayed in a negative way. My will discuss how women are being viewed through music and why they are being viewed in these particular ways. My original contribution is that I am going to focus on the comparisons and contrasts of the music between two decades: the 1990s and the 2010s. The methods I will use to research are, looking up interviews with the artists I choose to look into, and I will find different studies about both degradation and empowerment. I will furthermore analyze different song lyrics of the artists that I have chosen from each decade and use them to make comparisons. The songs I have chosen are Tupac Shakur's "Keep Ya Head Up" and Megan Thee Stallion featuring Dababy's "Cash S**t". I intended to answer two research questions: Has there been a dramatic change in how women are viewed? and, Do women empower or exploit themselves in music? My poster will include information pertaining to the individual artists, an analyzation of lyrics from two different songs by men, comparisons and contrasts of the decades, and then conclude with trends of female artists.

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SHIVESH JADON

Computer Science

Detecting Exercise And Calories Burned Using Human Pose Estimation

Abstract:

The overarching idea of this research project is to develop a mobile application that can independently track the human body, detect exercise and workout, and count calories burned while doing various activities without any external devices. With the use of the Human Pose Estimation technique, we can track different joints and their position in real-time. A machine learning classifier algorithm will be used to predict the exercise being performed using these joint positions. Then calories burned can be calculated using various factors like what joints are being used, the duration of the workout, its intensity, etc. The main idea of the research is to perform all these tasks in a mobile device without the use of devices like smartwatches, heart rate sensors, and depth cameras. The research also comprises of in-depth study in differences between machine learning algorithm and their accuracy in predicting (classifying) the correct workout being performed by the user. Both, the research and practical applications stretch from- future development in mobile phone's capabilities in health and medical fields like joint therapy, correcting exercise posture, to a commercial ready application that can be used by millions of people who cannot afford expensive tracking devices.

ROBERTO MOLINA

Department of Biology

Western Mosquitofish Behavior Across an Urban Gradient

Abstract:

High urbanization corresponds with an increase of impervious cover, and alters freshwater communities, which can lead to urban stream syndrome. In this study we focused on the effects of urbanization on the behavior of populations of Western Mosquitofish, *Gambusia affinis*, a generalist species with a worldwide distribution and often locally high abundance. We tested the hypothesis that fish from more urbanized streams, surrounded by higher levels of impervious cover will behave differently from fish from less urbanized streams. We collected female fish from four streams varying in levels of urbanization, determined by the percentage of impervious cover, agricultural development, and undeveloped land within a 2.2 km buffer radius of each site. The fish acclimated in the lab for a period of 42-48 hours, and then we placed individuals in a small enclosure holding tub with an opening to a larger tub. We recorded if the fish left the enclosure, individual boldness, and exploration duration in the large tub. We then put individuals into a group of four and recorded the shoaling behavior of a randomly selected focal individual, its relative distance to the center point of the other fish, and the duration they were within a 2 cm radius of the other fish. Urbanization level did not have a significant effect on the individual behavior of fish across populations; however, it did affect their shoaling behavior: fish from the rural sites shoaled closer together and stayed within 2 cm of each other for a longer duration. We suggest that fish found in higher levels of urbanization may be less social than those found in more rural streams.

URIEL LUA CERVANTES, MACK STARNES, LUCIA SORTO, & MICHAEL

Ingram School of Engineering

IEEE Robotics Autonomous Recycling Robot

Abstract:

Our team has designed an autonomous robot that can identify, collect, and dispose of litter.

NICOLAS EASTEP & ERIKA NAVA

Physics

The Nature of X-Ray sources of the open cluster NGC-3532

Abstract:

We present preliminary multi-wavelength results of the open cluster NGC 3532. We use archival X-ray data from the Chandra X-ray Observatory and ground-based optical data from Cerro Tololo Inter-American Observatory (CTIO) to study the X-ray source population in the star cluster. We identify optical counterparts for over 300 X-ray sources. We combine the the X-ray information, color-magnitude diagrams and theoretical models to study the open cluster. We will discuss the implications of our findings.

ALEXANDER VASQUEZ

Physics

How Can We Teach Ethics Using a Current STEM Controversy?

Abstract:

It is important for STEM students to develop ethics knowledge. This is rarely taught in STEM classes and there are few instructional resources focused on ethics in STEM. We are incorporating ethics knowledge into curricular units for physics classes at Texas State University. Here, we focus on teaching about the ethics of building the Thirty Meter Telescope (TMT) in Hawaii for an observational astrophysics class. We developed ample resources for students to make informed decisions about this complex issue. The unit will encompass an introduction of the TMT, a local perspective in San Marcos, a history of Hawaii, and perspectives about the TMT relative to formal ethical frameworks. This semester, we are observing and video-recording students' engagement with each other during this unit and collecting their written work. This summer we will analyze this data to better understand what worked well in our design and what could be improved. The results of our analysis can support the community of STEM educators and education researchers in teaching about ethics in STEM classes.