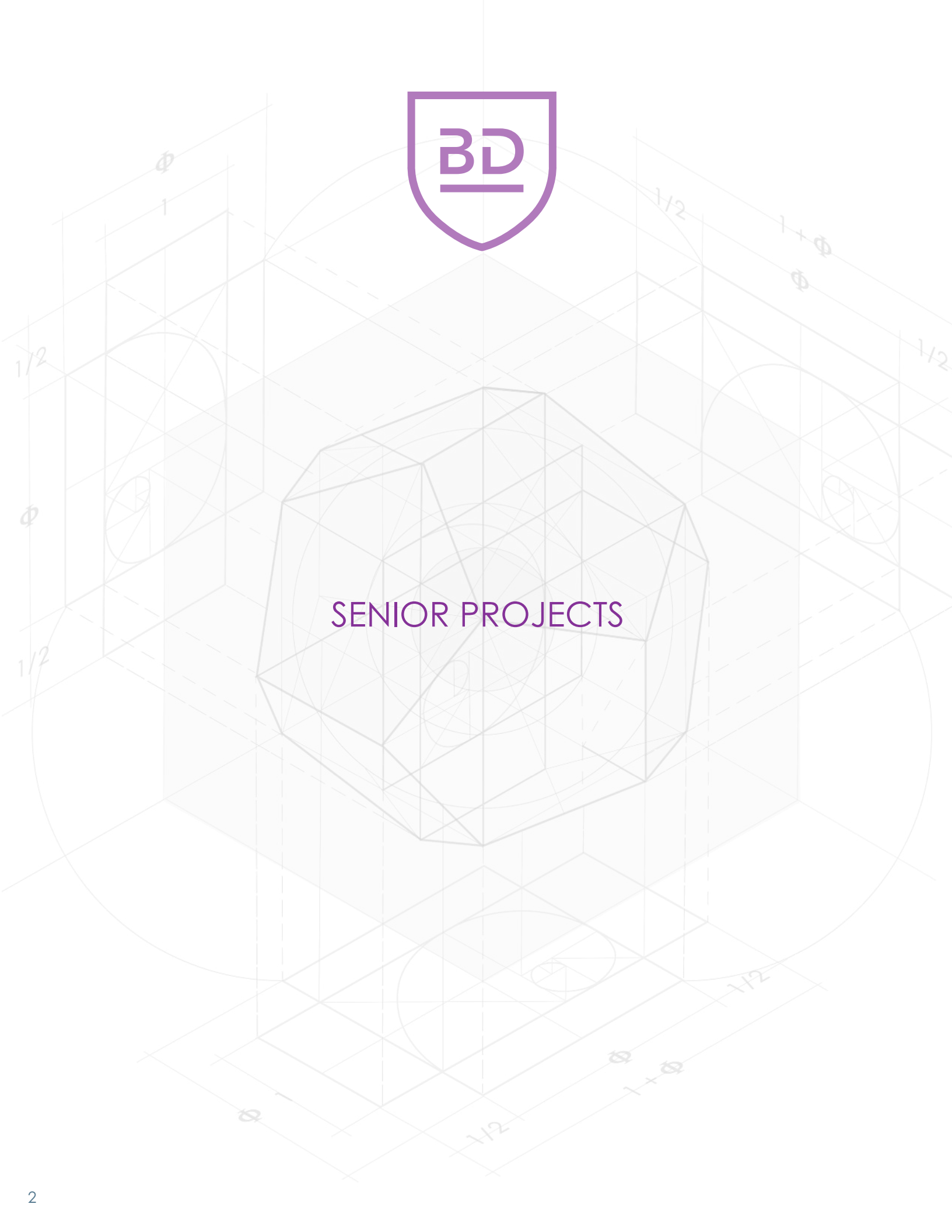
Senior Projects
2022–2023

BASIS ORO VALLEY



SENIOR PROJECTS

At this point in their senior year, BASIS Charter School students have completed a set of four BASIS Capstone classes to earn their BASIS Honors Diploma. In addition, many students are in the process of completing the prestigious College Board's AP Capstone Diploma™, a challenging, two-year sequence of AP Seminar™ and AP Research™, plus four other AP® Exams, all of which require extensive research, writing, and oral defense. The BASIS Diploma Senior Project marks the culmination of this hard work and perseverance.

Completed in the third trimester of a student's senior year, the Senior Project is unique, self-designed, and reflective of the students' varied academic interests and passions. Regardless of the discipline —business, art, humanities, science, engineering, social work, medicine, or law — each senior must develop and explore a research question. Creating an abstract that sets the tone of the research, participating seniors must submit a project proposal, and later, orally defend their methodologies.

Under the guidance of an external advisor who is a professional in their field, as well as a faculty advisor from their school, students dedicate 10–15 hours per week to the completion of their Senior Project. To document their journey, students post weekly blog entries about their experiences, successes, and challenges as they explore their guiding question. This journaling provides a unique viewpoint on the student activities and adds a reflective layer to their research process.

Throughout the development of the Senior Project, BASIS Charter Schools support their seniors every step of the way as they develop investigative skills and their own individual scholarly pursuits. The project summaries in this publication clearly illustrate each senior's ability to apply the knowledge, and intellectual curiosity they have acquired in the classroom to professional research methods and learning. At the successful conclusion of this project, students are eligible for a BASIS Diploma with High Honors, the most distinguished accolade offered by BASIS Charter Schools.

Each member of the BASIS Charter Schools network commends our seniors for their dedication, and motivation, not only for completing this Senior Project, but for their commitment to the BASIS Charter School Curriculum. Congratulations to them on this powerful achievement, and our best wishes as they move forward on their educational journey.

Carolyn McGarvey
Chief Executive Officer
BASIS Ed AZ+

Patti Bezanson
Chief Executive Officer
BASIS Ed Texas

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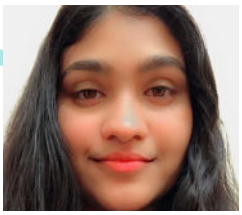
Oro Valley SENIOR PROJECTS

DAVEENA B.

DOES THE SPMSP1D1 PROTEIN HELP CREATE MORE CIRCULARIZED NANODISCS?

SUMMARY: Membrane proteins play a vital role in our bodies; they influence almost all biological processes. They are also a target for virus attacks, like we saw with the spike protein from the Sars-Cov-2, thus they remain a research area of interest. Membrane proteins often change shape or function when they contact the lipid bilayer, making it extremely difficult to fully understand the membrane protein in isolation. However, we can solve this issue using nanodiscs. Nanodiscs are synthetic models we can use to mimic the structure of a lipid bilayer along with its internal conditions. This can help us to understand how the membrane protein functions in its natural environment. My senior project aimed to focus on a component that is used to make nanodiscs known as the membrane scaffold protein (MSP). The MSP that I focused on is believed to create more stabilized and circularized nanodics, making it much easier to analyze the protein-nanodisc interactions. Working with Dr. Odenkirk at the University of Arizona, I was able to create my nanodiscs analyze them using native mass spectrometry. Then, we exposed our nanodiscs to a membrane protein, known as Daptomycin, which is used to treat endocarditis, complicated skin, and soft tissue infections that do not respond to first-line treatments, septic arthritis, etc. With further analysis of the properties of these MSPs, and the discs that they help to create, it will be possible to expand on the types of MSPs that are used when making nanodiscs in the future, and it may transform the nanodiscs that are typically used in research.

• **BASIS ADVISOR:** Tommaso Cioni • **ON-SITE MENTOR:** Melanie Odenkirik • **LOCATION:** University of Arizona



SHREYA C.

THE IMPORTANCE OF RAINWATER CONTAMINATION

SUMMARY: Did you know that our environment is exposed to many contaminants? Environmental contaminants are small, inorganic or organic chemicals that could be toxic and harmful to human beings. One of the major environmental concerns today is rainwater contamination, since we use rainwater for many purposes including watering plants, drinking, etc. If we consider that rainwater could be industrially contaminated with chemicals, then any harvested water with these possible pollutants might impact the soil, cause food chain problems, and negatively impact human health. Since Tucson is a desert and experiences water scarcity, it is even more important for us to be aware of rainwater contamination. My Senior Project focuses on rainwater contamination at the University of Arizona with the Arizona Laboratory for Emerging Contaminants (ALEC). I collected rainwater samples in Tucson and analyzed their contaminant status. Using these samples, I analyzed water for contamination in order to inform the Tucson community about the importance of monitoring water quality and supply. By monitoring the level of contaminants and making the community aware of the dangers of contamination, I hope that my research can lead to a better environment and better health for everyone.

• **BASIS ADVISOR:** David Stropka • **ON-SITE MENTOR:** Leif Abrell
• **LOCATION:** Arizona Laboratory for Emerging Contaminants (ALEC)

MATTHEW K.

SLOWING DOWN ICE MELTING FROM THERMAL RADIATION VIA SUSTAINABLE, ECO-FRIENDLY EGGSHELLS

SUMMARY: The polar regions of the earth are losing sea ice due to the increasing solar radiation reaching its surface. This increase is caused by the accumulation of carbon emissions in the atmosphere, which absorbs, stores, then releases additional thermal radiation back into the earth. As a result, increased ice melting has raised the atmosphere's temperature and resulted in more natural disasters that threaten human health and the environment. Therefore, safe and immediate solutions to slow the ice melting are necessary until permanent solutions are developed. In 2020, approximately 86.7 million metric tons of eggshells were produced as waste worldwide. By repurposing those eggshells, an eco-friendly, sustainable, and feasible thermal barrier can be prepared, which may slow down ice melting. If proven effective, the eggshell layers could be a potential candidate in slowing down ice melting in the polar regions, reducing natural disasters such as wildfires and protecting human health and the environment. My Senior Project sought to prove this theory by exploring eggshells as an eco-friendly thermal barrier to delay ice melting. With the help of Dr. Minkyu Kim, an Assistant Professor of Biomedical and Materials Science Engineering at the University of Arizona, I used an environmental chamber that measures in-water and ambient temperatures to test the effectiveness of variations of eggshell arrangements in limiting seawater heating to slow ice melting.

• **BASIS ADVISOR:** Eric Fetkenhour • **ON-SITE MENTOR:** Minkyu Kim • **LOCATION:** University of Arizona

ELOISA M.

COMICS AS A STORYTELLING MEDIUM

SUMMARY: Comics play a large role in popular media, from the Marvel Cinematic Universe to political critique. Why are comics so effective at appealing to the public? It goes beyond the epic action scenes and jaw-dropping art. The storytelling medium often polarizes readers, with many viewing comics as just picture books for adults. So, what really goes into the lengthy process of creating comics, and how are decisions made to communicate a complex story in picture format? By utilizing practiced methods of visual storytelling, such as flow, energy, and planning, I created an original short comic. The aid of digital software and an extra set of eyes was invaluable in bringing the project to completion. Working with Linda Ahearn, a studio artist, I gained valuable insight into how comics tie back to even the simplest fundamentals of art. I also gained a greater understanding of how comics communicate meaning through art and storytelling to create a respectable piece of work that goes beyond being a picture book for adults.

• **BASIS ADVISOR:** Dallin Bundy • **ON-SITE MENTOR:** Linda Ahearn • **LOCATION:** Toscano Art Studio and Gallery

KEYA P.

AMERICAN EDUCATION: A TANGLE OF INSTITUTIONS AND POLICY AND THE STUDENT PERSPECTIVE

SUMMARY: The American education system struggles to provide most students with an education to prepare them for their futures and to be educated citizens of the world. Schools face many challenges, such as standardized examinations, gerrymandering of school districts, financial barriers to education, and minimal federal expenditure on education. As a student in a charter school, I have seen how different educational standards and experiences affect students' lives and futures. For this project, I studied the American education system, researching the causes and effects of school district gerrymandering on the public high school education system in relation to other educational avenues like charter schools. In addition, I studied the effects of different educational avenues on the students' perspective of high school by interviewing students and educational professionals. Working with Dr. Megan Figueroa, a Research Scientist at the University of Arizona in the Department of Psychology, I shared my findings in a self-produced podcast. This project helped me process my own high school experience in relation to those of my peers and demystified the United States education system. I hope this project will allow people to see the bigger picture of American education and how it affects them personally, thereby enabling them to create change.

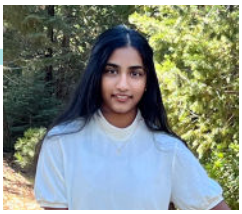
• **BASIS ADVISOR:** Kolb Ettenger • **ON-SITE MENTOR:** Megan Figueroa • **LOCATION:** University of Arizona

SHAELA P.

ENCOURAGING POSITIVE ELEPHANT BEHAVIOR IN ZOOS THROUGH CARE AND CONSERVATION

SUMMARY: If you have ever seen an elephant at a zoo hop into a pool for a cool bath, you are observing enrichment. Enrichment is key in the proper care of animals in captivity and can help the conservation of species in the wild by maintaining natural animal behaviors within a zoo setting. This project compared the behaviors of African elephants at the Reid Park Zoo to those of wild African elephants and elephants at other zoos to determine how different types of natural enrichment encourage wild behaviors. Stephanie Norton, my external advisor and an Animal Welfare Specialist with the Reid Park Zoo, helped me analyze the elephants' behavior using the Zoo Monitor system. Using the data collected from the Zoo Monitor system, I compared data to previous research done on elephant behavior to help design enrichment experiences for the elephants that encouraged positive, natural elephant behaviors. These enrichment experiences could better elephant welfare by more closely matching and encouraging the behavior of wild elephants.

• **BASIS ADVISOR:** Christine Henderson • **ON-SITE MENTOR:** Stephanie Norton • **LOCATION:** Reid Park Zoo



NISHA R.

COMPARING THE EFFECTIVENESS OF HOME-BASED ELECTROCARDIOGRAPHY TECHOLOGIES FOR DIAGNOSIS AND MONITORING OF ATRAIL FIBRILLATION

SUMMARY: According to data from the Framingham Heart Study, the prevalence of Atrial Fibrillation (AF) has increased three-fold over the last 50 years. Digital diagnosis and management are possible solutions to AF-related complications and mortality, allowing patients to take preventative measures and reduce AF-related deaths. Currently, there are a plethora of electrocardiography (ECG/EKG) home-based technologies to diagnose and monitor AF. However, the accuracy of these technologies varies. Moreover, at-home AF technologies may differ in their ease of use for each patient. This Senior Project compared the accuracy and ease of use of different home-based technologies used to diagnose AF. With the help of Austin Johnson, my research mentor at the Polygence Research Program, I used systematic reviews to find resources on various AF at-home technologies. Then, I learned about how these AF technologies are operated, analyzed their ease of use for different patient lifestyles, and examined these technologies' accuracy by seeing each diagnostic test's specificity and sensitivity in diagnosing and monitoring AF. I then created a procedure to help patients identify the most balanced and effective method of home-based AF diagnosis for their lifestyle.

• **BASIS ADVISOR:** Tommaso Cioni • **ON-SITE MENTOR:** Austin Johnson • **LOCATION:** Polygence Research Program

SAHARA T.

IN VIVO TESTING OF NOVEL COMPOUNDS TO PREVENT RESPIRATORY DEPRESSION DUE TO FENTAYL OVERDOSES

SUMMARY: According to the CDC, fentanyl overdoses were responsible for over 68,000 deaths in the United States in 2020. Why? Drug traffickers drive addiction by mixing fentanyl with other illicit drugs, like heroin and counterfeit prescription pills. Since fentanyl creates a more effective high, mixing it with other drugs means that dealers can create the same high with fewer materials without disclosing the mix to consumers. Current naloxone-based treatments, like Narcan, do not last very long, and first responders often run out of treatments on the way to the hospital, increasing the likelihood of death. Under the guidance of Kelly Karlage, Laboratory Coordinator at the University of Arizona Pharmacology Lab, I compared the effects of a new compound meant to combat opioid overdoses against naloxone, the current standard, to determine differences in effectiveness in treating opioid overdoses. The goal of this study was to demonstrate how effectively the new compound is able to block opioid receptors to inhibit a fentanyl overdose due to respiratory depression. I tested whether this new compound could block the pain-killing effects of opioids through in vivo testing of mice. Once the effectiveness of the new drug was established, I compared the new compound to naloxone to see if it was longer lasting than naloxone. If this research is accepted, it may prevent a person that has overdoses from having to receive multiple naloxone injections and risk the possibility of running out of naloxone, possibly saving more lives.

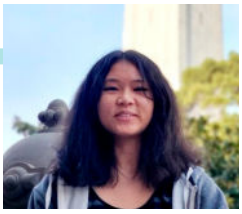
• **BASIS ADVISOR:** Tommaso Cioni • **ON-SITE MENTOR:** Kelly Karlage • **LOCATION:** University of Arizona

SHIRLEY X.

MINIATURE CAMERA DEVELOPMENT FOR IN VIVO CONFOCAL MICROSCOPE IMAGING OF THE CORNEA

SUMMARY: Imagine something growing in your eye, and the only way of fixing it is by having a stranger dig around your eye with sharp instruments again and again. This is the reality for patients who suffer from corneal fungal infections. Fortunately, in vivo confocal microscopy (IVCM) offers a non-invasive alternative to cornea fungal infection diagnosis. IVCM is a rapid optical imaging technique that can provide information on various tissue layers. However, current technology can be improved to be faster and cheaper while maintaining comparable image qualities. The Translational Optical Imaging (TOI) Lab aims to accomplish this. In the TOI Lab, the microscope can image less than 1mm regions of the eye, but the lab would like to track where the image falls on the whole scope of the eye. My project aimed to develop a camera system that could capture images of the whole eye and help doctors pinpoint the position of eye fungal ulcers. This project found the focal length and optimal imaging distance of the objective lens to understand the objective lens's limitations and aid camera lens development. Utilizing Solidworks and Matlab, I modified a camera system to be compatible with the IVCM and to help pinpoint the position of eye fungal ulcers. With the aid of Dr. Dongkyun Kang and graduate student Momoka Sugimara, I worked to assist in the advancement of eye disease diagnosis technology and expand the reach of such technology to underdeveloped regions of the world through the development of accessible eye imaging technology.

• **BASIS ADVISOR:** Rick Smith • **ON-SITE MENTOR:** Dongkyun Kang • **LOCATION:** University of Arizona



HANNAH Z.

CLASSIFICATION OF SOYBEAN DISEASE WITH LASSO REGRESSION USING PHENOTYPIC AND ENVIRONMENTAL FACTORS

SUMMARY: The soybean plant is an important food and oil cash crop – soybean products are the most-traded agricultural commodities, contributing more than 10% to global agricultural trade. Crop losses sustained by the onset of disease can lessen yield and product quality. In the United States alone – the world's primary soybean producer and second-largest exporter – economic losses due to soybean disease amounted to more than $95 billion. However, few efforts have been conducted using statistical analysis and machine learning methods on the extraction of phenotypic parameters and analysis of growth patterns to diagnose and predict soybean diseases. The most common method is still the traditional manual measurement of phenotypic features, combined with molecular methods, which requires excess time and effort. The goal of this study was to develop a statistical method via machine learning that accurately differentiates between five soybean diseases. LASSO regression was used to classify 160 observations of diseased soybean plants. In addition, Dr. Helen Zhang and I assessed which physiological and pathological phenotypic and environmental factors most influence the onset of each disease. By working on this project, I contributed to developing dependable technology that will aid farmers in building a more sustainable world.

• **BASIS ADVISOR:** Chad Longoni • **ON-SITE MENTOR:** Helen Zhang • **LOCATION:** University of Arizona

The teachers, administrators, staff, and executive leadership of the BASIS Charter Schools network **commend all of our seniors for their perseverance** in their research, and for their hard work throughout their BASIS Charter School journey. We give **our most heartfelt congratulations** to them for their achievements thus far, and these projects are only the beginning!

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