Senior Projects
2022–2023

BASIS CHANDLER

SENIOR PROJECTS & SENIOR RESEARCH 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.

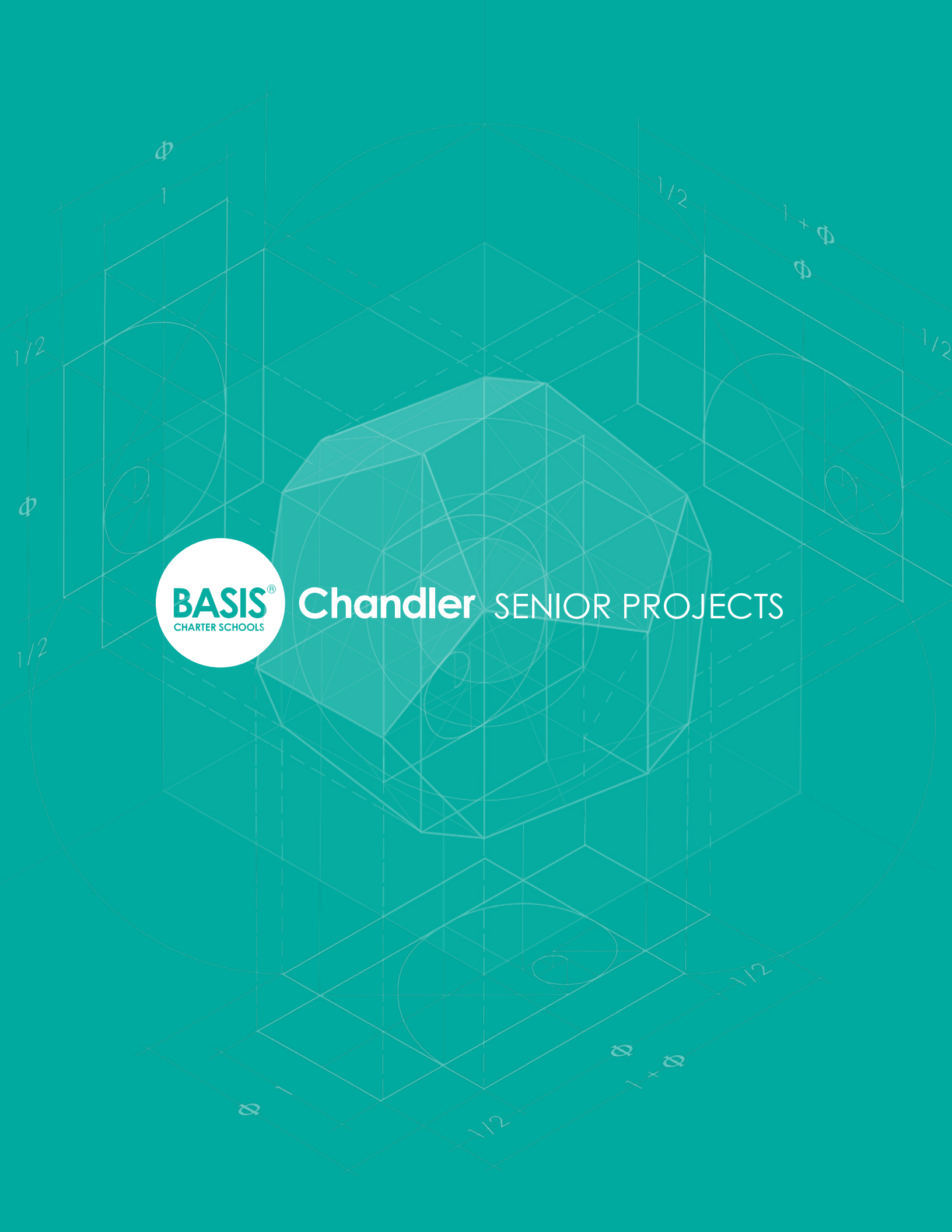
Under the guidance of an external advisor who is a professional in their field, as well as a faculty advisor from their school, students dedicate 10–15 hours per week to the completion of their Senior Project. To document their journey, students post weekly blog entries about their experiences, successes, 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



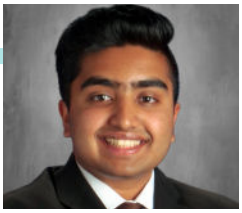
Chandler SENIOR PROJECTS

HELENA B.

BE PRECISE WITH DIRTY ICE: THE ISSUE OF LIQUID WATER ON MARS

SUMMARY: Despite water being discovered on Mars decades ago, the idea that liquid water could still exist today is widely contested. The main argument is that, given our current models, there is no reason to believe that temperature and pressure could fluctuate enough to allow liquid water. While logically sound, geologists and astronomers have found that, even in recent years, new gulley– valley– formations are developing, which could only occur given the presence of liquid water. In the same way that water runs under ice caps in Antarctica, some researchers believe that this could be the reason for the formation of those valleys. The models we use, called Mars Global Climate Models (or GCMs for short), are notoriously finicky even on good days, though. The large amounts of computations being run, coupled with hard-to-understand code, often means that retrieving even a single data set could take days. To streamline this process, some variables are fixed to minimize computations, and one of these values is called albedo. Albedo is a value indicating the reflectivity of ice, with pure snow being set at a value between 0.9 and 1, and pure dust being closer to 0. The issue presented by Mars GCMs is that all ice is assumed to be pure. Dust mixes in to create "dirty" ice, making it nearly invisible to detect. This parameter is all but a fixed value, and by taking inspiration from Earth GCMs, which are more developed and accurate, I worked on developing a new parameter that would consider fluctuations in albedo. Through this, I established evidence that could account for temperature and pressure fluctuations and contest the belief that liquid water is not responsible for gulley formations.

- **BASIS ADVISOR:** Curtis Canaday • **ON-SITE MENTOR:** Steve Ruff, PhD
- **LOCATION:** Mars Space Flight Facility, Arizona State University



PRANAV C.

PROFESSOR "RAT-IGAN'S" RACE TO INTELLIGENCE

SUMMARY: Behavioral Neuroscience often accumulates large data sets to study complex behaviors, which aid in understanding fundamental neurological functioning. While important, this data takes time to quantify and ensure reliability between scorers. Consequently, Artificial Intelligence may help minimize the workload and improve reliability in data quantification. My role involved implementing a Machine Learning-based classifier to automate the quantification of behavior using previously collected data from the Behavioral Neuroscience in Stress Laboratory at ASU, run by Dr. Conrad. Memory can be assessed in rodents using a procedure termed, "Novel Object Recognition (NOR)". NOR involves swapping out a familiar object with an unfamiliar object and increased time spent with the unfamiliar object can be used as one metric for rodent recognition memory. Collaborating with Dr. Verpuet, I used the Janelia Automatic Animal Behavior Annotator (JAABA) to investigate times spent with each object to interpret whether chronic stress disrupts recognition memory. To do this, I manually instructed the classifier instances of accurate interactions and let it score the sample based on the initial instruction. Then, I showed the classifier mistakes in its attempt, and repeated this process until the classifier reached high accuracy. The final trained classifier was cross-referenced with manual scoring to observe the efficacy of the trained classifier to this specific task. A paired t-test and Wilcoxon test (normality violation) was used. This project demonstrates that the JAABA is efficacious to score NOR and, theoretically, other similar tasks to provide researchers expedited access to their data.

- **BASIS ADVISOR:** Suba Rajasekaran • **ON-SITE MENTOR:** Cheryl Conrad
- **LOCATION:** Arizona State University Psychology

ALYSSA F.

NATURE VS NURTURE: EPIGENETIC CHANGES ASSOCIATED WITH ADOLESCENT DEPRESSION AND ANXIETY

SUMMARY: The rate of adolescent depression has been increasing over the past 10 years. In attempt to address this issue, biological and psychological researchers alike are asking the age-old question: what is the contribution of nature and nurture in the development of adolescent depression? One approach, on which my project is based, was to compare monozygotic twins discordant for adolescent depression. This created a controlled environment that highlighted the true epigenetic alterations caused by Early Life Stress (ELS) that can lead to the development of depression. My research used buccal cell data from pediatric monozygotic twins who participated in the Arizona Twin Project - an ongoing longitudinal study to better understand the connection between genetics and mental/physical health. I completed my project at Dr. Candace Lewis' Brain, Epigenetics, and Altered States of Consciousness (B.E.A.R.) Lab at Arizona State University. Dr. Lewis is the co-investigator for the Arizona Twin Project and is specifically researching the epigenetic changes related to childhood PTSD. My primary goal was to answer the question: Is there a difference in DNA methylation between monozygotic twins with and without adolescent depression? And if so, which specific gene regions show the most significant differences? I focused on genes that control serotonin reuptake (SLC6A4) and the HPA axis (NR3C1). Identifying new genes of interest, or verifying previously identified genes, could be valuable in helping formulate new, more targeted treatments for depression.

• **BASIS ADVISOR:** Matthew Cole • **ON-SITE MENTOR:** Candace Lewis, PhD
• **LOCATION:** B.E.A.R. Lab, Arizona State University

DIVYA G.

ALGORITHMIC RECONSTRUCTION OF DAMAGED DENDRITES TO PREVENT FOOD CONTAMINATION

SUMMARY: Have you ever awoken feeling nauseous because of last night's food? Sadly, accidentally buying contaminated food happens too often and can lead to consequences like vomiting and even death. In fact, an annual average of 600 million people are negatively affected by food contamination. Fortunately, research is being developed at Arizona State University to synthesize dendritic tags that can be stamped onto any produce. This method allows each leaf in a head of lettuce or banana in a bunch to be stamped and individually traced back in a database to their origin, therefore minimizing the spread of food contamination. What's wrong with existing methods like barcodes and QR codes? Well, these methods are easily hackable, and their information proved to be unreliable in the scanning process. With these dendritic tags, their stored information is secure and individually unique, just like our fingerprints. However, in the common tussle of the packaging process, these tags can get damaged. Damaged dendrites cannot produce accurate readings and are therefore rendered useless. My role in this research consisted of creating an algorithm with computer science to scan a damaged dendrite and reconstruct what it once was in the hopes that it can be re-scanned accurately. This is significant because while the percentage of those who may receive a damaged tag might be small, a small percentage of 600 million people is still very prevalent. I hoped to determine whether a high entropy figure, like a dendrite, can be tackled with the power of machine learning.

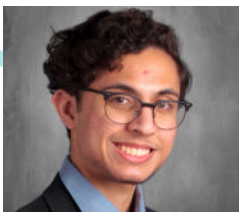
• **BASIS ADVISOR:** Joe Bostaph • **ON-SITE MENTOR:** Michael Kozicki • **LOCATION:** Arizona State University

HANSIKA G.

THE EFFECTS OF DIGITAL MARKETING ON SMALL BUSINESSES POST-COVID

SUMMARY: In the spring of 2022, Visual Objects surveyed over 1000 small businesses to understand their digital marketing and learned that two-thirds utilize social media. The number of social media users globally grew from 4.2 billion in January 2021 to 4.62 billion in January 2022. This accounts for a 10.1% growth (Year-over-Year) in global social media usage. As everything was shut down it became a challenge for companies to produce social, interactive, and "face-to-face" ads and promotional content. So, in the COVID-based, lockdown environment, did we adapt? Well, that's what I was trying to figure out at AniCell Biotech, as a small business the company knows firsthand how social media is beneficial to attracting customers and new audiences. My role was to determine if it makes sense to change a company's social media interface due to current societal changes or to keep an existing one. By analyzing digital marketing data and AniCell's we can understand the dramatic increase in online media and its effect on marketing. By conducting this research, I can change/ provide solutions and adjustments for the digital marketing platform at AniCell to be well supported in the quick advancements of biotechnology.

• **BASIS ADVISOR:** Shawn Gathas • **ON-SITE MENTOR:** Brandon Ames • **LOCATION:** AniCell Biotech



ZEESHAN K.

SHOULD WE REDESIGN ARIZONA'S PUBLIC SPACES?

SUMMARY: Have you ever wondered why cities like New York, Barcelona, and Tokyo are so romanticized in popular media? From TV shows like "Friends" to movies like "La La Land," these cities are ingrained in popular culture. But what makes these cities so special? The answer lies in the urban planning of those cities. From the architecture of the buildings to the zoning laws that create various districts and neighborhoods within the city, every aspect of how a city is planned gives it a distinct atmosphere and look. But how does that relate to Arizona's public spaces? By creating public spaces that encourage social interaction and community, we can create the community that so many suburbs in Arizona desperately need, while retaining the unique benefits of suburbia. By working with Professor Paul Coseo at ASU and surveying current public spaces around the Phoenix Metro Area, we can understand what differentiates a great public space from one that is subpar. By analyzing the types of activities people engage in within the space that keeps them there, we can better understand what is needed to create a welcoming public space that begets a strong sense of community. The goal of this project was to create a set of guidelines that can be used when planning future public spaces or renovating and updating existing areas. This research is extremely important as Arizona begins to expand and develop more of its land for human usage, as well as combatting the various issues that have arisen in the 21st century, specifically the lack of personal connection between people.

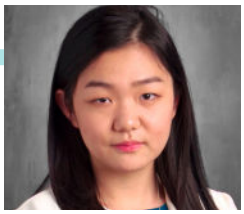
• **BASIS ADVISOR:** Brittany Defoe • **ON-SITE MENTOR:** Dr. Paul Coseo
• **LOCATION:** The Design School, Arizona State University

ANIKA L.

NOW YOU SEE ME, NOW YOU DON'T: THE IMPLICATIONS OF AI DERMATOLOGY ON SKIN OF COLOR

SUMMARY: How do dermatologists diagnose a patient? Visual examination is a critical component of dermatology, opening the door for potential biases to influence decisions. The underrepresentation of darker skin in dermatologic education, namely textbook diagrams, is at the root of the problem. The underrepresentation of darker skin tones in dermatological education contributes to the undertreatment and misdiagnosis of patients with darker skin. For example, while skin cancer is more prevalent in lighter skin tones, research suggests that skin cancer patients with darker skin tones have a higher mortality rate because they are less likely to be diagnosed in the early stages of the disease. With the introduction of AI technology to help dermatologists make diagnoses, disparities in dermatological prognosis across skin tones are escalating. The representation in AI training datasets is consistent with the representation in dermatology textbooks - both suffer from a lack of representation of diverse skin tones. My research methodology is two-part: I (1) analyzed dermatological educational literature and (2) trained an AI model to subsets of data with varying skin tone representation and tested its accuracy across skin tones. These two endeavors established the necessary groundwork for me to substantiate the assertion that better representation in dermatological datasets will improve the accuracy of AI assessments across skin tones. By working with Dr. Agarwal on the SeVA project team, I gained insight into AI technology in diverse spheres of medicine and contextualize technology in clinical settings. Through this project, I hoped to take strides toward closing the overwhelming gap in dermatological prognosis through a technological lens.

• **BASIS ADVISOR:** Shelby Kilmer-Webb • **ON-SITE MENTOR:** Dr. Nimit Agarwal
• **LOCATION:** Banner University Medical Center



HIYUN L.

MAYBE, BABY?

SUMMARY: Welcoming a baby into the world is a process that is full of surprises and the stress that comes along with it, starting with the surprise of the specific day that the baby decides to leave the mother's womb. For horses, tests that look at colostrum, calcium, and pH of a mare's milk have been developed to achieve a better estimation of the due date. However, due to influences such as environmental and physical changes, the actual delivery date of a foal can be drastically different from the date predicted by these tests. Through my research at AniCell Biotech, I analyzed data that was recorded on past tests, estimated due dates, and actual delivery dates while also improving existing milk tests and creating a clear color scale that will allow for more accurate calculations of due dates. Current milk tests are conducted by applying milk to a paper strip and estimating calcium or pH levels using a color scale. My research studied the components of equine milk to discover if there are other measurements that can be taken to decrease the difference in estimated and actual delivery date along with finding connections between equine and human milk. Because the birthing material collected with the foal and a safe delivery is so important, being able to accurately predict the birthing date will bring benefits to the production of AniCell and ensure that the mare and foal will have the support they need during the birthing process.

• **BASIS ADVISOR:** Alessia Alessi • **ON-SITE MENTOR:** Brandon Ames • **LOCATION:** AniCell Biotech

NANDINI M.

FAKIN' IT: ALGORITHMICALLY DETECTING COVID-19 MISINFORMATION

SUMMARY: In our increasingly technology-dependent world, our ability to spread and consume information has expanded endlessly. In recent years, Arizona has become home to this growing spread of information, as our political swing state status has brought on hordes of media coverage and large-scale information dispersal. With this new level of information exchange, comes a myriad of false claims and misinformation, often going unnoticed and freely spread on internet platforms. This has severely dampened the general public's trust in media institutions. In our modern day, tumultuous landscape, having reliable and trusted news sources enables us to make well-founded decisions – and is critical to a well-functioning society. However, controlling misinformation is not an easy task, as it can require thousands of hours of laborious, manual fact-checking. Through this project, I aim to address these issues by dissecting general patterns of COVID-19 misinformation, with the goal of developing an algorithm that detects instances of false information relating to COVID-19 in the media. Through researching with the iVoices Media Lab at the University of Arizona, my study will highlight potential points of improvement in communication between the science world and the general public, as well as raise awareness about noticing common patterns of misinformation in our own media intake. Additionally, through my development of a misinformation detection algorithm, I hope to help provide efficient, computational solutions to the misinformation crisis, and contribute to the larger ongoing fight to restore trust in our media institutions.

• **BASIS ADVISOR:** Joe Bostaph • **ON-SITE MENTOR:** Dr. Diana Daly • **LOCATION:** University of Arizona

SARAH N.

SECURING HOME SECURITY! WITH AI

SUMMARY: Although home security alarms do help keep households safe, there's more that can be done to keep our homes more secure. For instance, while the Ring alarm does alert the owner and shows what's outside their house, it doesn't help when physical force is being used to enter the door. And while the Sabre Door Stop Alarm does stop doors from opening, how is it useful for doors that don't have a gap at the bottom to insert the alarm into? With my research project, I wanted to enhance home security and create an alarm that prevents a door from opening from a physical threat, calls authorities or a specific phone number depending on the type of threat presented, accurately uses a motion sensor to detect threats, and operates a camera to let a homeowner view what's going on outside their door. In my project, I started with research on the programs and AI used to make these pre-existing alarms. Using that research, I coded a program featuring the ideas I wanted the alarm to have. Most of the program contains code provided by the companies/open-source code with my own personalized alterations from the added features. I want to attempt to create the physical alarm itself using robotics and connect it to the program, so it understands what response to give when an action is carried out. To test the alarm, I would experiment with different scenarios against a door and see if the desired result is provided.

• **BASIS ADVISOR:** Patrick Kilmer-Webb • **ON-SITE MENTOR:** Saumya Debray
• **LOCATION:** University of Arizona, Computer Science Department

ABHINAV P.

REDUCING INVENTORY RECORD INACCURACY: A BEHAVIORAL APPROACH

SUMMARY: Inventory record inaccuracy (IRI) is a significant problem for the retail industry, causing stock-outs, overstocking, lost sales, and customer dissatisfaction. Retailers worldwide lose $1.75 trillion annually due to inventory inaccuracies. The problem is further exacerbated by the rise of e-commerce and omni-channel retailing, which require accurate and timely inventory information to fulfill orders and meet customer expectations. This project aims to explore potential solutions to the issue by taking a behavioral approach, focusing on the employees behind the system. I worked with Professor Craig Carter at the ASU Behavioral Lab where we put college students through a simulation called "Warehouseville". Through this, we gathered data on the likelihood of employees making inventory mistakes as well as employee stress while sorting inventory in low vs high time pressure scenarios. Along with this, I looked at the effects of visual complexity on IRI. This was analyzed by looking at the SKU ids on products (typically seen near the barcode) and analyzing whether more complex numbers are more likely to be misplaced. In recent years, the role of employees has been overlooked for a more technological approach. This creates ignorance towards mental health impacts on employees which I hypothesized leads to higher IRI since an employee that is more stressed may be more likely to misplace or mislabel a product. The implications of this project include creating a healthier work environment along with accurate inventory records.

• **BASIS ADVISOR:** Peter Heitzinger • **ON-SITE MENTOR:** Craig R. Carter, PhD
• **LOCATION:** Arizona State University , Supply Chain Management Behavioral Lab

DHRUVI P.

LIFELATELY: A ONE-STOP APP USING COGNITIVE-BEHAVIORAL TECHNIQUES TO BUILD HEALTHIER HABITS

SUMMARY: Few apps integrate time management and schedule planning with the reflective and mindful aspects of health apps. With the discounted few that exist, they often don't target the underpinning stressors that stem the anxious and depressive symptoms responsible for procrastination and maladaptive behaviors or come with a busy-looking interface that detracts from the experience. A great demographic of adolescents and adults reliant on devices to track numerous tasks from school, work, and personal lives produces great demand for a concise application. LifeLately will assist with this task management through cognitive-behavioral and rational-emotive introspection and an approachable interface. Much of my project will be developed remotely with the support of ASU faculty, Dr. Srividya Bansal, and a few students from her software development lab. The university is well-equipped to feed my inquiries related to programming. Algorithms that feed questions about emotional perceptions of tasks and provoke the dismantling of irrational processes would provide formulated steps to approach tasks assigned by the user. Through guided introspective practice, I hope users are able to take back control of their habits.

• **BASIS ADVISOR:** Anna Mae Almeida • **ON-SITE MENTOR:** Dr. Srividya Bansal
• **LOCATION:** Arizona State University Polytechnic — Hybrid Internship

SATHYA P.

SICK OF STAGE FRIGHT? REDUCING COGNITIVE DISSONANCE DURING A PUBLIC SPEECH

SUMMARY: Are you sick of stage fright? If so, then don't worry, around 75% of the population agrees with you! The haunting idea of being put on the spot in front of a huge audience and forgetting the words to your speech as you awkwardly stand with anxiety has plagued humanity for a long time. Public speech is not easy, which is why my project seeks to tackle that issue. Through the scientific idea of cognitive dissonance, this project attempts to reduce, even eliminate, stage fright allowing people to voice their thoughts with ease and confidence, putting them en route to becoming leaders in society. With more voices and leaders in society, advancement is sure to flourish, creating a better world for us all. I will be performing this research remotely, through the Aspiring Scholars Directed Research Program (ASDRP). I have been at this place for over one year now, and I will be working with an ex-Stanford neuroscience professional to help me navigate the complexities of cognitive dissonance. Through a survey, this project will gauge people's levels of cognitive dissonance to figure out which variables/factors contribute to their cognitive dissonance the most. By analyzing these factors, we can figure out which ones most directly affect cognitive dissonance, which we can then try to eliminate in hopes of reducing cognitive dissonance levels. I expect that this project will find important factors that affect cognitive dissonance, which will then help people reduce stage fright successfully and consistently.

• **BASIS ADVISOR:** Brian Bradley • **ON-SITE MENTOR:** Sahar Jahanikia
• **LOCATION:** The Aspiring Scholars Directed Research Program (ASDRP)

ADVAIT R.

NAVIGATING THE POST-COVID YEARS: PSYCHOLOGICAL DEVELOPMENT WITHIN THE ELEMENTARY EDUCATION SYSTEM

SUMMARY: While the COVID-19 pandemic devastated our nation, prematurely robbing over one-million people of their lives, its effects were not limited to mass casualty. Due to health-safety concerns at schools, remote learning was employed for over thirty-million children in the private and public education sectors. Research studies conducted directly after the pandemic have confirmed significant deficiencies in the educational and social skills of students in their prime period of social and emotional development–Jean Piaget's Concrete Operational Stage of Development (7–11 years old); some studies have even stated this gap as irreversible. Social and emotional education is a founding tenet of what it means to be a human, and if our nation doesn't act fast to bridge these notable gaps in youth education, our children will forever be disadvantaged by the pandemic. Engaging in a research internship at BASIS Primary will allow me to observe children in grades 2-4 and interact with teachers responsible for navigating post-COVID education, helping me identify fissures in elementary social and educational development that arose as a result of the pandemic. I will apply the learnings from my internship to propose improvements to the existing educational models employed post-COVID, enriching our educational resiliency in the face of future COVID-like pandemics, and identifying corrective actions to overcome the long-term effects of COVID-19. As we exit the pandemic, our nation's highest priority should be to focus on bridging the elementary educational and social gaps left in COVID-19's wake, because children are our future.

• **BASIS ADVISOR:** Kayla Karl • **ON-SITE MENTOR:** Christen Wolcott • **LOCATION:** BASIS Chandler Primary South

ARIA R.

INTERLOOKING FOR INTERLEUKIN-15 IN THE EQUINE CERVICAL MUCUS PLUG

SUMMARY: The equine cervical mucus plug (CMP) plays a role in preventing vaginal infections and bacteria from getting to an unborn foal. There is almost no information about the equine plug's composition or origin. Currently, the CMP provides no purposes post-birth, so it's typically thrown away. At the AniCell Biotech startup company, we collect pregnant mares' amniotic tissues, cervical mucus plugs, and umbilical cords. We use the amniotic tissue as a regenerative product to heal wounds in other animals. However, the CMP and umbilical cord aren't of any use as of now. Discovering what exists in the CMP can help answer the question of how big of a role it plays as a defense against pathogens and if it can serve as a benefit to the medical field post-birth. Can it be used to serve the same purpose of discouraging infection and bacterial growth after the baby is born? The project, InterLOOKING for Interleukin-15 in the Equine Cervical Mucus Plug will identify whether IL-15 is in the CMP, providing more information on its use. IL-15 is a pro-inflammatory cytokine that is known to serve as a protective immune response against bacteria. The main benefit of this protein includes helping immune system cells grow, which ensures that its defensive against viruses and microbes. By using extractions and protein analysis methods with the equine CMP, the identification of IL-15 could be confirmed, providing more insight into the importance of the CMP as a defense against pathogens.

• **BASIS ADVISOR:** Matt Cole • **ON-SITE MENTOR:** Christopher Boblett • **LOCATION:** AniCell Biotech

SHRIYA R.

AYURVEDIC HOLISTIC MEDICINE'S DUALITIES WITH PERSONALITY TYPES

SUMMARY: As more natural remedies open to the pharmaceutical world, it's a great time in medicine to seek out into the Ayurvedic world. Ayurvedics is the Indian science of natural medicine. Within this science are the studies of Ayurvedic body types: also known as doshas. Each dosha is categorized by the element of nature it's defined by and simple characteristics that tend to be seen in that dosha. My research demonstrates the duality of Doshas and Myers-Briggs Cognitive Functions (Te, Fe, Ni, Ti, etc.). They both study basic reasons for human behavior and their details. Myers-Briggs Cognitive Functions were first introduced by Carl Jung and depict the nuances in how people make decisions, react to certain situations, and the way they act on certain thoughts. These are outlined through Intuition, Sensing, Thinking, and Feeling. These are also broken down into whether they are seen as extroverted or introverted in a person. My study delves deeper into a single body type and its duality with a single cognitive function. I did surveys of patients during my time as an intern at Sattva Integrated Healthcare. With their answers, I ran statistical tests and defined their connections more profoundly with a deliverable research paper detailing the data and their meanings to Ayurvedic science. My research not only brings more light to the significant medicine discoveries in Ayurvedics, but also delves deeper into more nuanced remedies that have relevance to personality and body type connections.

• **BASIS ADVISOR:** Liane Kerkman • **ON-SITE MENTOR:** Dr. Lakshmi Malini Govindan
• **LOCATION:** Twin Tree Integrated OBGYN

AKAASH S.

ADVANCES IN CANCER TREATMENT: ASSESSING THE EFFECTS OF RIBOCICLIB (CDK4/6 INHIBITOR) ON TARGET MODULATION IN GLIOBLASTOMA PATIENT-DERIVED TUMOR CELLS

SUMMARY: Glioblastoma Multiforme (GBM) is the most aggressive primary brain cancer in adults with a 15-month median survival period and 0.71% of patients surviving past 10 years of initial diagnosis. With roughly 250,000 annual GBM diagnoses, treatment options are limited to the standard of care consisting of surgical resection followed by administration of temozolomide (a chemotherapeutic agent) and ionization radiation. Many tumors, however, become treatment resistant and ultimately recur, hence the need for finding targeted therapeutic agents for GBM. One such agent called ribociclib was developed by Novartis Pharmaceuticals and inhibits CDK4/6 proteins. Through phosphorylation, CDK4/6 proteins activate retinoblastoma (Rb) proteins that regulate cell proliferation at the G1/S cell cycle transition. Ribociclib has been FDA approved as a treatment in certain instances of breast cancer so, to assess ribociclib's efficacy in GBM, a Phase 0 clinical trial at the Ivy Brain Tumor Center was conducted (Tien et al., 2018) where they found that ribociclib penetrates the blood-brain barrier. One question that remains is if targeting the CDK4/6 pathway has specific effects on cell subsets and states. At the Ivy Center, my project addressed this by gathering in vitro data to observe changes in phosphorylated Rb levels in patient-derived cells after ribociclib treatment. Successful analyses will provide critical information to improve clinical trial designs and advance global GBM patient care. This research on ribociclib could not only help GBM patients, but also the NIH's projected 29.5 million cancer patients by 2040.

- **BASIS ADVISOR:** Suba Rajasekaran • **ON-SITE MENTOR:** Dr. Shwetal Mehta, Leonel Elena, James McNamara
- **LOCATION:** Ivy Brain Tumor Center at Barrow Neurological Institute

ARNAV S.

A PROTEOMIC ANALYSIS OF EQUINE BIRTH TISSUES

SUMMARY: Amnion is widely known for its growing success and applications in regenerative medicine, reversing serious conditions in both animals and humans and even showing promise with putting advanced cancer in remission. However, its healing mechanisms are anything but clear, and many researchers are trying to understand the proteome in birth tissues and their relation to the treatment of neurological disorders and cancer, among other ailments. I chose to work with AniCell BioTech, a company focusing on effective treatment of injuries using equine amnion, on this topic. My research in their lab entails analyzing matrix metalloproteinases (MMPs) in equine birth tissues that are linked to cancers as well as the onset of neurodegenerative diseases such as Alzheimer's and Parkinson's. I hope to reliably show the presence of these proteins in these birth tissues as well as analyze differences in overall protein concentration due to donor variability. This has implications for additional research that focuses on influencing or controlling the proteins in conjunction with the rest of the proteome to increase the efficacy of the healing process or to target a wider variety of ailments in countless animals both today and in the future. Additionally, it would mean taking an extra step towards understanding these proteins' role in developmental biology and tissue regeneration, and much later, could be used to understand their role in neurodegeneration and develop a product to combat such diseases.

- **BASIS ADVISOR:** Suba Rajasekaran • **ON-SITE MENTOR:** Christopher Boblett and Dr. Christopher Bradley
- **LOCATION:** AniCell Biotech

NAVYAH S.

INCLUSIVE EDUCATION AND THE DISABLED POPULATION

SUMMARY: The education system currently splits students into 3 groups: gifted/honors, general, and special needs. This model argues that students are separated to accommodate their needs and provide an equal educational experience. However, research shows that the opposite could be true; students in all three groups may be disadvantaged by the split in both academic and emotional manners. Honors students are provided with curricula that encourages curiosity and the discipline to succeed but are held back by the rigidity and lack of flexibility from their educators. General education students are provided fundamental educational materials and discipline but are held back by a system that values compliance and the lack of flexibility from their educators. Special education students are provided modified assignments for their strengths and flexibility and understanding from their educators but aren't exposed to the discipline that helps other students succeed. While the data clearly shows that some systems are more successful than others, each of them has strengths that would benefit every student. For example, modifying assignments or giving a choice between assignments would help everyone yet it is only consistently done in special education classrooms. Combining the strengths of each type of classroom and focusing on the strengths of students rather than their weaknesses will make education a much better and more successful experience for everyone involved and this change can happen through co-taught, inclusive education. Co-teaching reduces the pressure and workload on one teacher. Inclusive education promotes curiosity and learning for all students. The unfortunate truth of the matter is that these concerns have been around for decades but haven't come close to being resolved. Each generation of teachers simply makes a small step of progress for the next. For my research project, I observed both the current model and a model of inclusion at a school that is currently transitioning into a completely inclusive model to answer the questions: "How are co-teaching methods utilized in a successful inclusive classroom? To what extent can we use inclusive education as a model when it comes to disabled students? What is the process that should be followed when switching a school to an inclusive model?"

• **BASIS ADVISOR:** Curtis Canaday • **ON-SITE MENTOR:** Courtney Porter • **LOCATION:** Mountain View High School

RASHIV S.

ARE "SMART" CARS SMART ENOUGH FOR THE ROAD?

SUMMARY: Self-driving vehicles are finally becoming a thing of the present. Unfortunately, it still has many flaws especially regarding what sensor is used to scan the surrounding area. The two most common sensors are radar or light detection and ranging, or LiDAR. The former, which uses radio waves, is commonly used in tesla vehicles, and can easily detect what is in front and on the side, but it is not always accurate as it cannot easily determine the shape of an object. LiDAR, on the other hand, is used by many other companies, particularly Waymo, and uses infrared light to scan its surroundings. Despite the enhancements these sensors have received, it still has some flaws as it cannot prevent accidents. This is important to know about because self-driving cars are starting to appear everywhere and eventually will become fully autonomous or will not allow human intervention. The Design Informatics Lab at ASU is currently doing research on this field which is what made it a perfect place to conduct this experiment. This was accomplished by analyzing diagrams and videos of LiDAR being used in action and riding in a Waymo to get a general idea about the technology on the road. Although it is not likely that LiDAR can prevent accidents, it is important to conduct this experiment so that people know whether they are ready to take their hands off the wheel.

• **BASIS ADVISOR:** Michael Vedder • **ON-SITE MENTOR:** Max Yi Ren
• **LOCATION:** Goldwater Center, Arizona State University

RHEA S.

THE ISSUES ARIZONA TEENS FACE

SUMMARY: Teens go through many experiences throughout their adolescent years, so they reach out for hope and intervention from professionals. Teen Lifeline is a teen crisis hotline in Arizona that can provide the hope and help teens are looking for. It is a place where peers can work through problems in a comfortable and confidential environment. What are the issues that majority of teens face? My project discusses topics that teens face and how they can have a significant impact on their life. These topics are sensitive as they delve into one's life and feelings. Understanding what issues teens face can help parents and schools understand what resources and attention is needed to address their teens' additional needs.

• **BASIS ADVISOR:** Michael Santana • **ON-SITE MENTOR:** Hailey Settle • **LOCATION:** Teen Lifeline

SHREYA S.

THE GUT FLORA: YOU ARE WHAT YOU EAT

SUMMARY: During the process of fermentation, the gut microbiome produces Short-Chain Fatty Acids, SCFAs. There are many types of short-chain fatty acids, some examples are Acetate, Butyrate, and Propionate. SCFAs aid the body in several ways. Butyrate, for instance, is the main source of energy for the colonocytes to maintain the gut lining by making tight junctions. After being produced by the gut microbiome, SCFAs are then transported to various organs by traveling through blood. Food rich in fibers and resistant starches produce more SCFAs, and previous research shows that there is a possible link between a higher amount of short-chain fatty acids and lower blood pressure levels. Possible explanations for the connection between the amount of SCFAs and blood pressure are G-protein coupled receptors, immunoregulation, the autonomic nervous system, and metabolism. In this research project, participants were asked to take a survey which asked questions about their diet and blood pressure to study the connection between the amount of SCFAs produced and how this has an influence on the blood pressure of a person. Studying whether the amount of SCFAs can affect blood pressure is crucial to future research. If people have high or low blood pressure, there is a likelihood that changes in their diet, or in other words, short-chain fatty acid production, could improve their health.

• **BASIS ADVISOR:** Anna Mae Almeida • **ON-SITE MENTOR:** Dr. William Paterson • **LOCATION:** OrthoArizona

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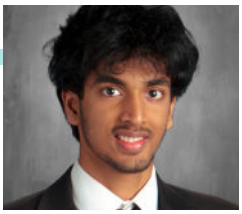

ADVAIT B.

PREDICTING THE PROGRESSION OF MULTIPLE SCLEROSIS THROUGH MACHINE LEARNING

SUMMARY: Multiple sclerosis (MS) is a chronic, autoimmune disorder that impairs coordination, balance, visual acuity, and speech, affecting 2.8 million individuals worldwide. One of the key features used to predict the progression of MS is the destruction of nerve coverings resulting in slower nerve signal transduction. A common method used to measure this is through motor evoked potentials (MEP), which are recordings of electric signals between motor neuron pathways. However, data from MEPs depends on radiology expertise to use and involves a laborious and time-consuming process to diagnose and model progression. Fortunately, machine learning offers an efficient solution by streamlining the process of using such data to obtain meaningful results. Thus, this study evaluates which machine learning algorithms have the best performance in predicting the progression of MS based on MEP data. This study uses a corrected resampled t-test to compare the performance of various machine learning algorithms, such as Linear Kernel Support Vector Machine, RBF Kernel Support Vector Machine, k-Nearest Neighbors (KNN), Random Forest (RF), Logistic Regression (LR), Naïve Bayes (NB), and Gradient Boosted Decision Trees (GBDT). My process involves working with Dr. Ajay Bansal, a professor at ASU, to train the models on a six-year dataset tracking the progression of multiple sclerosis in patients. This study's findings can serve as valuable benchmarks for model performance for future research, as well as demonstrate the possibility of using such models in clinical settings to aid in the development and modification of treatment plans for patients with MS.

• **BASIS ADVISOR:** Jesse Nims • **ON-SIMENTOR:** Ajay Bansal • **LOCATION:** Arizona State University

ABHINAV C.

MACHINE LEARNING DETECTION OF CANCER PRECURSORS IN THE SMALL INTESTINE

SUMMARY: Gastrinomas are a rare type of cancer that originate in the digestive system, mainly in the duodenum tissue of the small intestine. Duodenal gastrinomas (DGASTs) are extremely small tumors oftentimes being less than half a centimeter in diameter. Being this small, conventional diagnostic procedures like MRI screenings do not identify DGASTs as effectively as other types of cancer. Moreover, it is extremely important to detect DGASTs in their early stages because of the severe medical consequences and limited treatment options once the tumor has progressed. Additionally, certain populations are genetically predisposed to gastrinomas, making them increasingly susceptible to this disease and its effects. Fortunately, recent optical innovations like Multi-Photon Microscopy (MPM) have been more accurate by capitalizing on autofluorescence (natural light emitted by tissues) and light scattering that can highlight minute structural differences. Working at the Arizona Cancer Evolution Center at Arizona State University under the guidance of Dr. Maley, I investigated how to use optics to detect DGASTs better. With the heightened accuracy of this technology, I wanted to see if machine learning (ML) models can effectively learn to detect gastrinomas in their early stages from tissue images retrieved through MPM. A pre-curated collection of MPM tissue images from 12 patients diagnosed with gastrinomas was used in this project. The images were quantified through the image analysis software ImageJ. Machine learning models like CNNs and PCA were trained on and used to analyze the images and extract quantitative data respectively.

• **BASIS ADVISOR:** Jesse Nims • **ON-SITE MENTOR:** Dr. Carlo Maley
• **LOCATION:** Arizona Cancer Evolution Center — Remote

CHIAMAKA C.

APPLE CHIPS, BANANA CHIPS, CYANOBACTERIA CHIPS?

SUMMARY: Fossil fuels are the leading fuel source in the U.S. and are responsible for roughly 80% of the U.S. domestic energy production, powering everything from cars to power stations. However, as it stands fossil fuels have many limitations, including depleting supply, and adverse health effects caused by toxic emissions. Because of this, I investigated cyanobacteria as a sustainable alternative to producing biofuels, discovering their capable, yet imperfect ability to substitute coal. Most experiments involving the use of cyanobacteria as a fuel source rely on it as a form of wet biomass, because as a marine strain they carry high water content. Evaporating all this water is an energy costly process and leads to increased carbon emissions to circumvent them. I found myself curious about how effective solar drying, particularly homemade solar drying, a process that has long been used to dehydrate fruits and vegetables among other foods, as a low-cost energy efficient method of preserving foods, could be for cyanobacteria, a photosynthetic organism. In this project I worked at ASU's Biodesign Institute, because of its vast number of resources, alongside an associate professor and graduate student, to produce large quantities of biomass, and worked at home to build a solar dehydrator, and set up the calorimetry experiment. The primary stages of this experiment included collecting large quantities of the Synechococcus PCC 7002 strain, among other cell waste, centrifuging these cells, and pouring off as much liquid as possible. The next step was to build the solar dryer and dry the cells inside of it, under open sunlight for up to two days. The final step was burning the dried cells in the calorimeter to calculate the amount of energy contained in the pellets. Engineering this model was possible because it has already been applied to fruits and vegetables which also have high water contents, making it easy to apply.

- **BASIS ADVISOR:** Jesse Nims • **ON-SITE MENTOR:** Sydney Parrish
- **LOCATION:** Arizona State University Biodesign Institute

RAIYAN C.

THE ALS MYSTERY UNVEILED: CAN THE SPINAL CORD EXPLAIN WHY EACH CASE IS SO DIFFERENT?

SUMMARY: Amyotrophic Lateral Sclerosis (ALS) is a neurodegenerative disease that significantly hinders an individual's motor function. During the progression of ALS, motor neurons begin to degenerate in the motor cortex and nervous system resulting in muscles losing function and eventually dying. Typically, this loss of function is progressive, becoming more severe over time, and will result in an individual's death from respiratory failure within 2–5 years. Unfortunately, the cause of ALS is currently unknown. While there have been ~20 genes identified to be associated with ALS, the clinical heterogeneity of ALS is widely varied amongst patients. Thus, this goal of this project was to address this disparity by analyzing genes in the spinal cord as potential molecular subtypes and biomarkers that are associated with the progression of ALS. By discovering these molecular subtypes and biomarkers, this research will help us to better understand ALS, potentially providing information to develop treatments for ALS. This project took place at the Imaging and Biomarker Discovery Lab at Arizona State University and at the Smith Research Group under Jarrett Eshima. Here, I conducted a patient stratification analysis using RNA-sequencing (RNA-seq) expression data from the spinal cord. This method was chosen because irregularities in this data can often capture disease mechanisms of ALS. Through this project, I expected to find results in the spinal cord data that confirm previously identified molecular subtypes that were found in the frontal and motor cortex that were glial activation (ALS-Glia), oxidative stress and altered synaptic signaling (ALS-Ox), and transcriptional dysregulation (ALS-TD).

- **BASIS ADVISOR:** Jesse Nims • **ON-SITE MENTOR:** Jarrett Eshima
- **LOCATION:** Imaging and Biomarker Discovery Lab, Arizona State University

ADITYA G.

EFFECT OF IMPLANT-TO-PROSTATE VOLUME RATIO IN PATIENTS UNDERGOING PROSTATIC URETHRAL LIFT

SUMMARY: Benign prostatic hyperplasia or BPH is a condition many males must go through. Approximately 50% of men between the ages of 51 and 60 get BPH, and this number rises to 70% among men 60–69, and around 80% among men over 70 (Yale Medicine). So, what is BPH? Essentially, it refers to when the prostate becomes enlarged but not in a cancerous way. Although BPH sometimes doesn't lead to problems, many times it leads to an urgent need to pee, even at night. It also can make it difficult to pee, and, even after starting, it's very weak, there is dribbling, and the bladder can't be completely emptied (Mayo Clinic) resulting in what can be a very bothersome condition for most. This has led to many types of treatment being developed in response to this condition. One of the most notable ones that has gained a lot of traction lately is Prostatic Urethral Lift or PUL. By using implants or small metal bands, the enlarged prostate is lifted and held out of the way, therefore, clearing the urethra. Typically, 4 implants are used on the enlarged prostate in this procedure. However, is the typical number of implants a one-size-fits-all type of situation? When getting a PUL, prostate volume or size of the enlarged prostate will vary from patient to patient. So, does 4 implants have the same effect on someone who has a prostate volume of 70 mL versus someone who has a prostate volume of 40 mL? Well, that's the question I wanted to answer with this project.

• **BASIS ADVISOR:** Jesse Nims • **ON-SITE MENTOR:** Dr. Emil Annabi • **LOCATION:** East Valley Family Practice

THALIA G.

AN ENVIRONMENTALLY FRIENDLY SOLUTION FOR PREVENTING FLOOD DAMAGE

SUMMARY: Since the 1980s there have been more storms and extreme hurricanes each year in the North Atlantic Ocean. These storms move water from the ocean to land, filling neighborhoods with water and debris, roughly causing $1.9 trillion in flood damage to the 8 million homes impacted in 2021. Sandbags are one of the most widely used barriers to prevent water damage caused by storm flooding. While sandbags are used frequently during natural disasters, they have only had one improvement since the Civil War. This was the use of polypropylene bags, instead of burlap sacks. However, it takes 20–30 years for polypropylene to break down in a landfill. The goal of this project was to solve this problem by using Enzyme Induced Calcite Precipitation (EICP). EICP is a novel technique that is used to strengthen soils by extracting the urease enzyme from jack beans and adding calcium chloride (CaCl2), urea, and dry milk to fill the pore spaces with calcium carbonate (CaCO3) precipitation. This makes the soil cemented and the process is eco-friendly. The ASU lab team at CBBG laboratories focuses on using sustainable engineering and had the tools for me to perform my experiment. I hypothesized that EICP-treated sand compacted into burlap bags would significantly improve the strength characteristics and seepage resistance of burlap sandbags. This would create a reinforcement for sandbag strength that is biodegradable and establish a pathway to make more sustainable solutions available using EICP.

• **BASIS ADVISOR:** Jesse Nims • **ON-SITE MENTOR:** Dr. Emmanuel Salifu
• **LOCATION:** CBBG Laboratories, Arizona State University

ELLENA J.

SAVING WASTEWATER FROM PFAS

SUMMARY: Per- and Polyfluoroalkyl Substances (PFAS) can resist grease, oil, water, and heat. These substances are used extensively to manufacture consumer products. However, these substances are toxic chemicals, and prolonged exposure can be harmful. PFAS is found in the blood of 97% of Americans, as it is predominantly found in drinking water, atmosphere, soil, and wastewater sites. My research examined wastewater because it is a major source of contamination for everyday water usage. One remediation method for PFAS is adsorption through Graphene. Graphene is an inorganic carbon material in which all atoms are surface atoms, ultimately increasing the surface area for adsorption. The porous structure of graphene allows a faster rate of diffusion. Graphene costs less than other purification methods and can treat multiple pollutants simultaneously, making it an economically effective adsorbent. With labs in ASU and the U.S. Department of Agriculture - Arid Land Agricultural Research Services, my goal was to address the effectiveness of graphene on PFAS removal. I measured the effectiveness of PFAS adsorption using different concentrations of PFAS based on typical PFAS concentrations in wastewater. Different concentrations are poured down the soil columns with a certain GCS concentration. For analysis, I used LC/MS/MS to determine the final PFAS concentration. This research will ultimately contribute to the development of a graphene effectiveness model, which allows the simulation of creating an effective method of PFAS remediation.

• **BASIS ADVISOR:** Jesse Nims • **ON-SITE MENTOR:** Rebecca Logsdon Muenich
• **LOCATION:** ASU School of Sustainable Engineering and the Built Environment

AKSHAY M.

GENETIC PREDICTORS IN THE EPIDEMIOLOGY OF LEWY BODY DEMENTIA AND RELATED DEMENTIAS

SUMMARY: Lewy Body Dementia (LBD) is the second most common neurodegenerative disease after Alzheimer's Disease (Mueller et al., 2017). Among senior citizens, the risk of LBD is much more defined. This risk of brain disease and prognosis served as the motivation for this study. Through years of experimental research, scientists have found genetic correlations in the epidemiology and progression of the disease. However, this genetic basis of LBD is not well understood (Chia et al., 2021). This study hopes to analyze variants in genetic material and evaluate them for their prevalence in LBD-diagnosed patients. As a thorough meta-analysis study, we combined several previous Genome-Wide Association Studies (G.W.A.S.) to create a comprehensive set of genetic loci and identified candidate genes that may be responsible for the onset of LBD. Following further analysis, we 1) studied how the candidate genes work together to create LBD-like symptoms and 2) compared relevant genes for Alzheimer's Disease (A.D.) and LBD. In conclusion, future research will be sought to apply this into potential treatment and medication development for this growing disease. Through my experience at Lifeline Internal Medicine clinic (LIM) and remote experience in the Polygence Research Internship (PRI), I wanted to learn about disease prevention and treatment under LIM and how to research and present the data under PRI.

• **BASIS ADVISOR:** Jesse Nims • **ON-SITE MENTOR:** Dr. Ravi Gupta • **LOCATION:** Lifeline Internal Medicine

YASHAS R.

ANALYZING DIFFERENCES BETWEEN FUNCTIONAL CONNECTOMES CREATED USING PEARSON'S CORRELATION VERSUS COHERENCE

SUMMARY: A functional connectome is a construct used to show all the functional connections between different regions of the brain. For my project, I conducted an analysis of certain methods used to create functional connectomes. Working under the guidance of Dr. Samadrita R. Chowdhury from Massachusetts General Hospital, I investigated whether using two different methods of mapping the functional connections in the brain, specifically, Pearson's correlation (PC) and coherence, led to significantly different results. I used the coding language Python in order to analyze the specific signals produced by different parts of the brain and map them, thereby creating these functional connectomes. I analyzed the brains of 15 adult human subjects suffering from Major Depressive Disorder both before and after receiving a treatment known as electroconvulsive therapy (ECT). I conducted this process using both PC and coherence and then conducted statistical tests between the connectomes created by both methods in order to analyze whether they produce significantly different results. Through this project, I attempted to find out whether the way the brains of individuals affected by neurological disorders or brain abnormalities are analyzed is dependent on the method used to analyze their brains.

- **BASIS ADVISOR:** Jesse Nims • **ON-SITE MENTOR:** Samadrita R. Choudhury, PhD
- **LOCATION:** Massachusetts General Hospital — Remote

JENNIFER V.

COURTING THE LAW: A SENTIMENTAL ANALYSIS OF FEDERAL ABORTION CASES

SUMMARY: In the wake of the Dobbs v. Jackson Women's Health Organization Supreme Court Decision, the debate surrounding abortion contributes to a public divide in conversations surrounding America's 6.1 million annual unintended pregnancies. As abortion remains a highly divisive issue with a roughly even split among the general public, it is important to evaluate factors that influence the direction of future legislation regarding this issue. Litigation lawyers in federal-level abortion cases, who are typically affiliated with reproductive rights and anti-abortion movements, have engaged in disputes surrounding abortion laws and what constitutes an undue burden on abortion access. The rhetoric and language used in these court arguments can affect the perception of how the public views abortion and judges' decisions. Hence, this study employs sentiment analysis to examine semantic structures of federal abortion cases that both protect and restrict abortion. Sentiment analysis is a Natural Language Processing technique that uses automation to extract indications (emotive language) from textual data. Evaluating these indicators can help reduce judges' preferences toward specific target groups (e.g. Republicans, Democrats, pro-choice, and pro-life) and identify which mechanisms litigators use that help shape judges' decisions. In particular, the study draws on recent embedding methods to analyze works where locations and directions of language will encode meanings and associations. At a sentence level, the algorithm will measure the relevance to each of the groups and the level of sentiment (positive/negative and emotional/neutral). Thus, the goal of this project was to better understand the factors that contribute to court decisions to help provide methods for estimating judicial sentiment and analyzing its impact on other judges and the path of the law.

- **BASIS ADVISOR:** Jesse Nims • **ON-SITE MENTOR:** Dianne Post • **LOCATION:** Dianne Post Law Office

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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