# Senior Projects 2022–2023

## **BASIS** PEORIA



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<sup>™</sup>, a challenging, two-year sequence of AP Seminar<sup>™</sup> and AP Research<sup>™</sup>, 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, selfdesigned, 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.

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Carolyn McGarvey Chief Executive Officer BASIS Ed AZ+

Patti Bezanson Chief Executive Officer BASIS Ed Texas



#### CHRISTINE B.



## ANALYZING THE EFFECT OF OXIDATIVE STRESS ON THE VIABILITY OF DEINOCOCCUS RADIODURANS BACTERIA

**SUMMARY:** When students take a biology class, they become well versed in the topic of cellular respiration. They learn about glycolysis, the Krebs cycle, electron transport chain, and oxidative phosphorylation—but what is often missing from the discussion is reactive oxygen species (ROS). ROS are unstable oxygen-containing molecules that easily react with other molecules, leading to DNA and cellular damage. They are known to arise from the lack of enough hydrogen ions and electrons needed to react with oxygen in order to form water in the electron transport chain. Metabolizing oxygen can be a dangerous gamble if ROS are not decomposed by antioxidant enzymes, but can a cell develop a better antioxidant response if it is previously exposed to oxidative stress? In my research, I investigated the effect of the ROS hydrogen peroxide in the bacteria Deinococcus radiodurans to determine the concentration of hydrogen peroxide that yields the greatest survivability. It is important to determine this concentration so the bacteria can then be primed and its antioxidant levels analyzed, in the form of the enzyme catalase. I worked in the biotechnology lab at Glendale Community College, investigating the effect of hydrogen peroxide on the bacteria and the priming response elicited from this exposure. I hope my research can shed some light on the topic of oxidative stress, as it is of valuable importance to not just the microbiology community but also the medical community, since it is suspected to lead to the pathogenesis of many age-related degenerative diseases caused by DNA damage.

• BASIS ADVISOR: Charlotte Hagerman • ON-SITE MENTOR: Dr. James Tuohy • LOCATION: Glendale Community College

#### SHRADDHA D.

#### THE NEUROPREDICTION OF CRIMINAL RECIDIVISM

**SUMMARY:** As of 2022, 82% of individuals incarcerated in the United States were rearrested within 10 years of their release. Defined most broadly as "the tendency for a criminal to reoffend," our nation's criminal recidivism rate has only been rising over the past two decades. With the nation's fourth-highest mass incarceration rate, the state of Arizona has not been immune to these effects, consistently juggling lawsuits about the Department of Corrections' inhumane treatment of its prisoners, from healthcare to abuse of prosecutorial power. These facts make it clear: We've neglected prisoner rehabilitation for much too long. Our re-entry services are lacking precision and care. For my senior project, I sought to determine what exactly constitutes effective rehabilitation programs within Arizona, by first understanding the catalysts of such high recidivism rates. Having proposed and discovered the viability of analyzing neurological and psychosocial risk factors in a predictive model for DUI recidivism through my previous research. I took that knowledge from a scientific setting and applied it in practice with the ACLU of Arizona's Smart Justice Initiative by developing more personalized rehabilitative measures is just the first step in lowering our recidivism rates and reaching people who need effective care most.

BASIS ADVISOR: Andrew Estes • ON-SITE MENTOR: Kara Janssen
LOCATION: American Civil Liberties Union (ACLU) of Arizona



#### JUSREEN K.



## FOOD AS MEDICINE: THE IMPACT OF INTEGRATIVE PRACTICES ON PATIENT HEALTH

**SUMMARY:** The prevalence of chronic health diseases continues to increase person by person in the United States. According to the National Center for Chronic Disease Prevention and Health Promotion (NCCDPHP), 6 in 10 Americans live with at least one chronic illness in their lifetime, such as diabetes, obesity, stroke, and heart disease. Many modern medicines used to target specific health problems cannot always relieve long-lasting conditions, especially without negative side effects. However, what healing mechanisms can be used alongside conventional medicine to alleviate chronic sickness? Well, according to Mayo Clinic, evidence of safety and effectiveness grows for Complementary and Alternative Practice (CAM) within a field known as Integrative Medicine. For my project, I completed a practical research study based on surveys that patients filled out during shared-medical visits. I then used the collected data to analyze the impact of traditional therapeutics on vital signs (weight, BMI, blood pressure, and A1C blood sugar levels). My hypothesis was that if clinical practices began to use more integrative techniques, they would see a positive impact overall on patient health status. As a result, American hospitals and clinics can more widely recognize and thus implement these methods as a permanent solution for relieving chronic illnesses.

BASIS ADVISOR: Chelsea Landin • ON-SITE MENTOR: Dr. Shalini Singh-Karnik
LOCATION: HonorHealth Medical Group at Pima Center Parkway



#### MIKHAELAH K.

#### BEHIND THE SCREEN: UNCOVERING THE DISPARITIES IN ACCESS TO BREAST CANCER SCREENING IN ARIZONA

**SUMMARY:** Breast cancer is the second leading cause of cancer deaths among women in the United States. And as a disease still without a cure, preventative measures have become extremely valuable for women around the world. Mammogram screenings are one of the most commonly used and trusted sources of early detection and prevention; however, not all women have access to these resources, making the fight against cancer much more dangerous and sometimes deadly for them. The field of cancer research has identified a large array of barriers from insurance to race to literacy that prevent women from accessing and using mammograms. In this research project, I sought to uncover the most pressing disparity and its source specifically in Arizona. I then identified the most effective potential solutions. By analyzing Arizona data concerning women's access to mammograms and potential barriers, I was able to uncover trends. My hope is that through this research, our state can grow to make mammograms more accessible to all women to aid in the fight against breast cancer.

BASIS ADVISOR: Charlotte Hagerman • ON-SITE MENTOR: Dr. Kimberli Cox
LOCATION: Comprehensive Breast Center of Arizona

#### PRANAV P.



#### MAXIMIZING PHOTOVOLTAIC EFFICIENCY OF TANDEM GAAS-SI SOLAR CELLS VIA LOW TEMPERATURE NANO-BONDING AND SURFACE ENERGY ENGINEERING

SUMMARY: Solar panels are becoming increasingly more popular. The main issue currently is increasing the efficiency while keeping the cost low. Thus, this project aims to cross bond GaAs and Si to achieve a balance between cost and performance. Theoretically, the maximum Photovoltaic Conversion Efficiency (PV-CE) that can be achieved with GaAs/Si tandem solar cells is 44%. The National Renewable Energy Laboratory reported 33% in 2023. What limits PV-CE are the GaAs/Si heterojunction: heteroepitaxy via Molecular Beam Epitaxy or Chemical Vapor Deposition and Direct Wafer Bonding (DWB). Each uses temperatures ≥ 400°C, which lead to defects at the interface, via the thermal expansions mismatch. Therefore, a new approach to attempt Direct Wafer Bonding at low temperatures ( $T \le 220^{\circ}$ C) via a process we called Surface Energy Engineering (SEE) to activate direct transfer of electrons across the surface has been developed. SEE planarizes GaAs and Si at several lengths scales and nucleates in far-from-equilibrium 2-D molecular phases. Also, SEE reverses the hydroaffinity of GaAs native oxides via a passivation chemical etching process from hydrophobic to hydrophilic and vice-versa for Si. SEE dramatically increases the SE of GaAs, as measured by Three Liquid Contact Angle Analysis. Nano-bonding is measured by Surface Acoustic wave Microscopy (SAM) and Transmission Electron Microscopy. SAM shows that 98% of GaAs nano bonds successfully to Si at low temperatures under light compression at 220°C. This project uses different experiments and procedures to prove that tandem solar is possible and could be the future of clean energy.

#### • BASIS ADVISOR: Melissa Georgi • ON-SITE MENTOR: Dr. Nicole Herbots • LOCATION: Arizona State University

#### NAGASRIYA R.

### REDLINING'S EFFECTS ON ENVIRONMENTAL INEQUITY IN SOUTH PHOENIX



**SUMMARY:** After the Great Depression, FDR needed a way to revitalize the housing market and thus intended to provide housing loans. In order to decide whether or not a community was safe to invest in, the Home Owners' Loan Corporation implemented redlining. Redlining refers to the U.S. government's procedure to implement a neighborhood grading system that dictates the safety of loans. However, the result was that "safer" neighborhoods—graded A or B—would predominantly be white, whereas "unsafe" neighborhoods—graded C or D—would predominantly house people of color. This system created a segregated housing system where only specific communities were getting necessary government investment. It appears that the result of redlining in South Phoenix has compounded into lasting environmental impacts today. In this project, I studied whether there is a statistical environmental difference between redlined neighborhoods of grades A, B, C, and D.

#### • BASIS ADVISOR: Melissa Georgi

#### AKHIL R.



#### DIFFERENTIAL EXPRESSION OF SCN8A IN HUMAN IPSC-DERIVED NEURONS DURING STAGES OF DIFFERENTIATION

**SUMMARY:** What would you do if an artificial timer was placed on your life? While modern medicine is progressing at a faster rate than ever before, a host of fatal diseases remain untreatable with current technologies. One such example is SCN8A encephalopathy, a rare form of early-onset epilepsy. Caused by a single base mutation in the SCN8A gene, most patients diagnosed with SCN8A encephalopathy do not survive past childhood and suffer painful symptoms, including seizures, movement disorders, and intellectual disabilities, during their limited lifespans. For this project, I worked with the Hammer Lab at the University of Arizona, which specializes in epilepsy research and possesses samples afflicted with this rare condition. My methodology was to measure the expression of the SCN8A gene in 6 human stem cell populations over different stages of cellular differentiation. More specifically, I conducted cDNA synthesis and qPCR to obtain my final results, and I performed the Livak (Delta-Delta Ct) method to interpret them. Overall, this study aims to provide insight into the biochemical mechanisms behind epileptogenesis in SCN8A encephalopathy and hopefully reveal potential therapeutic targets for future drug development endeavors.

• BASIS ADVISOR: Melissa Georgi • ON-SITE MENTOR: Dr. Michael Hammer • LOCATION: University of Arizona





#### NAVYA B.

#### ALUM WATER TREATMENTS IN LAKE PLEASANT AND ITS EFFECT ON DRAGONFLIES

**SUMMARY:** I've always loved dragonflies. My grandfather and I used to bond over catching dragonflies in his backyard, and once I found out that dragonflies were starting to disappear from multiple areas that contained large bodies of water, I knew what I wanted to do my research on.

• BASIS ADVISOR: Leslee Briggs • ON-SITE MENTOR: Dr. Jershon Eager • LOCATION: BASIS Goodyear

#### GRACE G.

#### COMPLETING THE STRESS RESPONSE CYCLE: A GLIMPSE INTO STIMMING IN THE CLASSROOM

**SUMMARY:** Stimming, short for self-stimulating behaviors, refers to repetitive or ritualistic movements or sounds that help people self-soothe when stressed or otherwise cope with their emotions. Though stimming is often talked about in relation to the autism spectrum, it can be beneficial to anyone, yet is commonly overlooked or misunderstood. In my project, I aimed to shed light on this often overlooked and stigmatized form of anxiety relief. I studied how stimming in a classroom setting changes depending on age. My hope was that my project could add to the existing body of knowledge surrounding stimming, because as we learn more about stigmatized topics such as mental health, society as a whole can grow to be more accepting of some of the most important aspects of humanity.

#### • BASIS ADVISOR: Leslee Briggs

#### VIDYA I.

#### TRASHY ROMANCE STORIES: PREDICTING POPULARITY ON WATTPAD

**SUMMARY:** Everyone has that one guilty pleasure, that one hobby too embarrassing to tell anyone. For a good chunk of people, that guilty pleasure is reading trashy romance stories. Something about them—perhaps their questionable grammar quality, the unbelievable plot hooks, or the unrealistic expectations of relationships—entices many to read them. As a fellow enjoyer of this hobby, one of my favorite online reading sites is Wattpad, home to such jewels as "My Quirky Love," "The Hoodie Girl," and "The Non-British Princess." Considering its loyal hordes of fans, Wattpad has been able to create movie deals for many of its authors (most famously with "The Kissing Booth" series) and has become a major influencer in the genre of teen romantic fiction. However, despite the platform's rising notoriety, what makes a story a hit on the site still remains a mystery. In my research, I analyzed metadata attached to stories under the Wattpad romance tab and their correlations with those stories' popularity metrics to determine whether there is a trend in popularity of Wattpad stories. By determining these predictors, I was able to predict upcoming trends in literature under the teen romance genre.







#### IAN M.



#### **ESCAPE THE ROOM: STRESS OR SATISFACTION?**

**SUMMARY:** A few years ago, I discovered my passion for the up-and-coming craze known as escape rooms. Not only was I interested in doing them, I was interested in what makes them so fun and popular. Eventually, I decided to get a job working at one of the most popular escape rooms in Arizona, the North Valley Escape Room. While working there, I have seen so many different types of groups go through with almost everyone leaving with a smile on their face. This led me to wonder, what makes an escape room better than the rest? The most popular escape room at the North Valley Escape Room is their Escape From Alcatraz room which is also their most difficult room. This seemed unusual to me, seeing that the hardest game seemed to be the "best" which led me to my question and research. My research delves into the psychology of escape room participants at the North Valley Escape Room to see whether the difficulty of an escape room affects the stress and/or satisfaction of the game. With this research, I was able to determine whether a harder escape room is more enjoyable to customers. To conduct my research, I worked with one of the owners of the North Valley Escape Room to survey customers on whether they felt stressed and/or satisfied throughout their chosen game. Hopefully, my research results can show other escape room owners what difficulty of an escape room is best.

• BASIS ADVISOR: Leslee Briggs • ON-SITE MENTOR: Kristen Rensmeyer • LOCATION: North Valley Escape Room

#### SRIDHANA M.



#### THE EFFECTS OF COLOR PSYCHOLOGY ON TOY ADVERTISEMENTS

**SUMMARY:** Advertising is the practice of bringing attention to a product or service. The three most significant advertisement categories are food, commercial, and politics. The biggest issue today with toy advertisements is gender stereotypes; however, even though there are so many research papers on this topic, there have not been any changes to the advertisements. Is it because they found their perfect color palette that brings in customers or is it because they have heard about the problem? In this paper, I will focus on whether in the last four years Mattel created its advertisements using a similar color palette.

• BASIS ADVISOR: Leslee Briggs

#### **ADARSHINI P.**



#### STEREOTYPICAL GENDER-BASED MARKETING IN CHILDREN'S **BOOKS: ARE MORE BOOKS MARKETED MORE TOWARDS GIRLS?**

SUMMARY: It's a common cliche that reading fiction is a hobby for girls, but the stereotype is based in truth. Statistically, women read more than men. One possible reason for this is that young girls read more than young boys in childhood, and children's reading habits heavily influence adult's reading habits. Which begs the question: Why do girls read more than boys when they are kids? Could it be that children's books are marketed more femininely? All of this led me to ask: Are children's fiction books for first and second graders in Maricopa County aimed more towards female audiences than male audiences? Over the course of my research project, I investigated marketing trends, children's reading habits, and visited libraries and bookstores to answer this question.

#### • BASIS ADVISOR: Leslee Briggs

#### ALBERT R

#### AI IS DISCRIMINITORY AND TERRIBLE. HOW IS THAT CHANGING?

SUMMARY: Most people these days are aware of artificial intelligence. It is used in everything from the YouTube algorithm to customer service. The most visible use of AI to the public is of course image generation. The release of image generators such as DALL-E Mini has brought great awareness to AI and images generated by these have appeared everywhere from memes to professional art shows. With the rise in its popularity came a glaring issue: discrimination. Inputs for a CEO for example lead to images of all white men. The issue of discrimination within AI has led me to explore its manifestation in another medium—writing. As AI writing continues to advance and gain traction, my aim was to discern the nature of the discriminatory tendencies that AI writing currently exhibits and track how it evolves as the technology advances. In this project, I unraveled how AI writing's discriminatory practices are being addressed and altered over time. Furthermore, my research documents improvements in AI writing technology itself, as it develops to become more advanced and sophisticated.

#### • BASIS ADVISOR: Leslee Briggs



#### **REEVA S**.



#### LOOKING AT THE RELATIONSHIP BETWEEN UNIVERSITY PARENTAL LEAVE POLICIES AND FACULTY TURNOVER

**SUMMARY:** Prior research has shown that turnovers in a company are more likely to occur due to work-related demands rather than family-related demands. Additionally, as part of a different study, researchers observed how various lengths of parental leave affected faculty turnover rate. Taking into account the productivity of a school or company and the government-required policies outlined by the Family Medical Leave Act (FMLA), the researchers concluded that the optimal parental leave is 12 weeks. As part of my research, I connected the observations made from these two studies and looked at how certain characteristics of parental leave policies from various West Coast universities may affect their faculty turnover rates. Based on my data, I created an optimal parental leave policy that consists of characteristics more commonly associated with lower turnover rates. I believe this research would be helpful for universities or any other business trying to lower their faculty turnover rates. Although my research was limited to parental leave policies, these policies are important factors that contribute to the work environment and productivity. For universities in particular, keeping low faculty turnover rates can improve the quality of education provided by the university.

#### • BASIS ADVISOR: Leslee Briggs

#### ABIR S.



#### EVALUATING THE INCONSISTENCIES IN COURT DECISIONS FOR U.S. MUSIC COPYRIGHT CASES FROM 2010–2021

SUMMARY: Many scholars and musical artists take issue with the current music copyright system for its inconsistencies in identifying substantial similarity. If substantial similarity is identified to exist between two songs, this means that the elements a plaintiff accuses a defendant of being similar are protected by copyright law, and copyright infringement has occurred. The threshold for what constitutes substantial similarity is low, so its definitions are incredibly vague. This has brought about court decisions that many have pointed to as inconsistent with the law, but no scholar has identified a clear inconsistency within the court opinions themselves. In my research, I recorded the arguments courts have made for substantial similarity across cases from the past decade and arranged these arguments into different models, each with different criteria. Thus, each case has a different model associated with it depending on which arguments are employed by each court. For each individual case, I combined the criteria of the applicable model(s) with the facts of the case in order to form a predicted decision. This way, I was able to determine the frequency at which the predicted decision matched the actual decision over time with quantitative data. I compared the consistencies of each type of argument in identifying substantial similarity and determined where the most inconsistency lies. Ultimately, I was able to determine from these results what type of arguments were the source for the increasingly vague definition of substantial similarity relative to other arguments and how inconsistent they are with the law.

• BASIS ADVISOR: Leslee Briggs • ON-SITE MENTOR: Dr. Dev Gangjee • LOCATION: Oxford University





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