As a young adult, my scientific interests were propelled by my outdoor endeavors in rock climbing and SCUBA diving, which ultimately led me to my career as a scientist. These activities showed me fossils in rock walls and vibrant aquatic animals in lively reefs. This sparked a desire to learn more about what underwater organisms were like millions of years ago. By reading journal articles, I realized that I could combine my interests in neuroscience, aquatic life, and evolution by studying the neurobiological mechanisms of behavior. Now, as a neuroscientist who is driven to understand the convergently evolved visual system of the octopus, I am passionate about discovering phenomena in cephalopod cognition, perception, and neural circuitry. Concurrently, through mentoring the next generation, I aim to inspire them to make discoveries by following the drive of curiosity.

My career in research began as a McNair scholar at the University of Missouri (UM) in Dr. Manuel Leal's lab. My research focused on cognitive abilities and survival rates of anoles. Throughout this project, I learned about data collection, coding, and expanded my understanding of cognitive evolution. My paper, "Problem-solving abilities and survival probability in *Anolis sagrei*", was published in the University of Missouri 32nd annual McNair Journal. This paper included a literature review on the benefits of performing research in both the field and the lab. My main finding was that our population of *A. sagrei* was capable of learning how to solve a simple cognitive problem, the cylinder task, wherein the animal must avoid the instinct to lunge at a prey through a transparent cylinder by entering through the sides of the apparatus. However, we were unable to draw any conclusions on survival probability due to an unexpected cold spell that most lizards did not survive. Through this line of research, I became more focused on the underlying neural circuits of the octopus, another problem-solving animal. After graduating, I elected to pursue a Ph.D. at the University of Oregon (UO), known for its strong neuroscience program and established octopus research faculty.

In my first year at UO, I rotated in Matt Smear's systems neuroscience lab and Judith Eisen's developmental neuroscience lab. In the Smear lab, I worked on a project to study how neurons in the mouse olfactory bulb respond to presented odors. I learned how to build a rig to present different odors while recording neural data and sniff rates in mice. In the Eisen lab, I worked on a project studying how being raised in a germ-free environment affected superficial interneurons in the optic tectum. To do so, I ran behavioral assays to address visually guided behavioral differences associated with a germ-free microbiome in zebrafish. I found that the behavioral assay was not appropriate for the questions at hand. These projects gave me analytical skills – I am able to creatively address neuroethological questions in model organisms with well-developed genetic lines and scientific procedures.

My third rotation was in Cristopher Niell's visual processing lab, where I first had a chance to work with octopuses. The aim of the team project is to determine how neurons in the octopus visual system respond to different visual stimuli, which has never been measured. My goal throughout the rotation was to learn how to perform 2-photon calcium imaging in the optic lobe of the octopus and apply this method to a novel set of stimuli. Initially, I tested different parameters for recordings of visually evoked responses, such as dye injection locations and solution temperatures, until I achieved consistent results. Afterward, I launched a new project to study how the octopus optic lobe processes polarized light, because the octopus photoreceptor organization allows them to see polarized light. To accomplish this, I altered our stimulus apparatus to present stimuli not only in luminance contrast but also in polarization contrast. Previous studies have documented the electrophysiological response properties of their photoreceptors to polarized light, and behavioral studies have looked at the abilities of octopuses to distinguish between different polarizations. However, the extant literature reveals scant information on how their optic lobe processes this information.

I am now a graduate student in the Niell lab, where I study the visual system of the octopus, a cognitively advanced invertebrate. The octopus has a camera-like eye, similar to that of humans, which allows me to address how perception and cognition are neurologically programmed from an interesting evolutionary perspective. Currently, I am collecting data using the original stimulus apparatus to document retinotopy, response to various spatial frequencies, and visual acuity in the octopus. Thus far, our data has revealed that the octopus optic lobe is retinotopically organized, and the cells are size-selective. I will be a coauthor on the forthcoming paper “Visual response properties and functional organization of the octopus optic lobe,” which we aim to submit to Neuron by early 2023. This paper will be the first to map the functional organization of visual pathways in a cephalopod and will establish a powerful tool for researchers to reveal functional circuits in complex central nervous systems.

Simultaneously, for my Ph.D. thesis, I am collecting data on optic lobe responses to polarization and luminance stimuli to address my hypothesis that polarized information is processed separately but in parallel with luminance information in the octopus’ brain. I will present my methods and preliminary findings at the 2023 Society of Integrative and Comparative Biology conference.

Intellectual Merit: Since 2019, I have worked as a team member in neuroscience labs at two different research universities. During that time, I completed one team and one independent research project. Beyond three campus presentations and a McNair Journal article, I am a co-author of an article that will be submitted to Neuron in early 2023. As an undergraduate, I presented my poster on problem-solving and survival rates in anoles at the McNair conference, which was then chosen to be published in the McNair Journal. Investigating cognitive abilities taught me about behavioral neuroscience, but I yearned to learn how the brain functions on a neuronal level. To do so, I enrolled in the only neuroscience course offered at the university. Throughout this course, I found myself posing probing questions about how math and physics applied to the bigger picture of neural circuitry.

In graduate school, my cellular neuroscience course addressed my math and physics questions. In my next course, systems of neuroscience, I gained knowledge about classic sensory systems such as vision and taste, as well as unusual ones such as electroreception and sonar. This class helped me conceptualize my research interest in perception and taught me how to design experiments to test specific sensory capabilities. I earned an A in both classes and realized sharp gains in my neuroscience comprehension that will lead to the successful completion of my doctoral research project.

I also completed a coding course in Python. In one project I learned to identify and visualize neural spikes in data sets. For my final project, I analyzed the data from my rotation in the Eisen lab. I earned a 4.0 in this class, and I will confidently apply these skills in my doctoral program.

I have also grown as a neuroscientist through presenting and participating in journal clubs and attending weekly neuroscience seminars. Presenting neuroscience papers in journal clubs and giving quarterly talks on my rotation projects to the entire neuroscience department has helped me master the delivery of neuroscience presentations. During the past year, I devoted much effort and energy to advance from a biologist to a neuroscientist. For example, discussing primary literature with my peers and listening to seminars offered by established post-docs and professors have given me the vocabulary to enhance my engagement in departmental seminars.

Broader Impacts: I first started mentoring my senior year of high school. Building on those skills at UM, I became a CASE (center for academic success and excellence) mentor. This role allowed me to help underrepresented first and second-year students learn about research and was the first time I truly realized that I wanted to engage in scientific outreach.

My first experience in formalized science education was through teaching three different undergraduate discussion courses during my first year of graduate school. As a teaching assistant for the course ‘Psychology and Neurology of Happiness’ I worked with diverse undergraduate students, most of them with no scientific background. It was a rewarding experience to teach them the fundamentals of the brain. In the second and third quarters, I taught ‘Animal Behavior’ and ‘Conservation ecology’. I was excited to dive deep into primary literature to help students develop biologically feasible studies that could inspire them to pursue animal research. From teaching these courses, I learned how to make neuroscience feel approachable to people with no scientific background; how valuable it is to view neuroethological research from an ecological perspective; and how policymakers and scientists can work together to save vulnerable species.

As a black scientist who has been inspired by other black scientists; I have developed a strong desire to spark others’ interest in neuroscience. I contacted university and community organizations to offer outreach activities with their students, targeting organizations that serve underrepresented communities. Since then, I have conducted octopus demos for three undergraduate classes, two high school events, and two middle school girl summer camps. I delivered a demo for a course called DucksRise, which engages under-represented undergraduates in research and career development opportunities, where I was invited to receive formal mentorship training during my second year of graduate school to mentor an undergraduate in the course. After my octopus presentations, I always invite the students to come up and observe an octopus swim around. This always inspires new questions, some of which I respond with, ‘” that is something that scientists do not know, but that is something that you could study one day if you want.”’ I did not have any scientific role models that represented minorities throughout high school or college; being able to present my research in an approachable setting to minority students and all-female classrooms has felt special and fulfilling.

Professional Development: To build my neurobiology skills and professional network, I will spend the next two summers taking advanced courses outside UO. During summer of 2023, I intend to enroll in Neuromatch Academy, an online computational neuroscience course, to further develop my understanding of neural modeling and computation analysis. In the summer of 2024, I aspire to attend the Marine Biological Laboratory (MBL) Neural Systems and Behavior advanced research training course. This course will broaden my understanding of neuroscience by using an array of model organisms and techniques while receiving instruction from experts in the field. To enhance my mentoring skills, I will work with DucksRise, a course at UO that offers formal training to graduate mentors who are then paired with undergraduate students to get one-on-one research experience.

Educational and Career Goals: As a member of the Niell lab, I will continue to pursue discoveries about the unique neural physiology and circuitry of cephalopods, building skills in mechanistic neuroscience methods and quantification of behavior. After publishing my findings from our ongoing 2-photon experiments, I will investigate behavioral responses to polarized light to address neuroethological questions. My timeline includes completing courses by 2024, passing comprehensives, and defending my dissertation by 2026.

I will achieve those goals by completing a post-doc abroad, where I will study cephalopod neurobiology and mentor undergraduates. Following that, I will pursue an MBL fellowship, such as the E. E. Just Endowed Research Fellowship for under-represented minorities or the Ann E. Kammer Memorial Fellowship for young women neuroscientists. These positions will prepare me to build my own lab at an R1 institute, where I can study cephalopod systems and behavior, mentor students, and present cephalopod demos for my university’s community. This NSF Fellowship will, ultimately, help me accomplish my dual career goals of (a) contributing to the literature with exciting new discoveries about how cephalopods’ neural circuitry gives rise to behavior, and (b) motivating children, especially minorities, to become the next generation of curious scientists.