Intellectual Merit: Describing a cell as enigmatic is an understatement. Since Robert Hooke first discovered the cell in 1665, nations have risen and fallen. Mankind has harnessed electricity, split the atom, and built machines to conquer the skies and explore worlds beyond our planetary confines. Yet in over three hundred and fifty years since the discovery of the cell, we have overturned a mere pebble from the mountain of mysteries harbored by these building blocks of life. I have long been intrigued by the complexities that make life possible, and the way I think has been profoundly influenced by the seven years I have spent doing benchtop research.

My first exposure to research was during my undergraduate studies at SUNY College of Environmental Science and Forestry (ESF), where I worked under the supervision of Dr. Stephen Teale from 2014-2016. My project focused on the invasive parasitic fly *Philornis downsi,* which is a great threat to indigenous birds of the Galapagos, particularly the endangered Darwin's finch. I hypothesized that *P. downsi* detects volatile fatty acids (VFA) using olfactory cues, which enables them to locate the finches' nests. I examined VFA produced from embryonic Zebra finches, a closely related species, using solid-phase microextraction and gas chromatography mass spectrometry (GC-MS), and used GC-electroantennographic detection to measure *P. downsi's* sensitivity to the VFAs. My results were written up in an honors thesis titled "The Relative Importance of Acetone Production as a Result of Ketogenesis in Embryonic Zebra Finches (*Taeniopygia guttate*)". I also developed a behavioral bioassay that tested the use of *Psidium galapageium* as a potential natural insect repellent, which led to my first co-authored paper titled "Darwin's finches treat their feathers with natural repellent". My experience at ESF helped to develop my creativity and written communication skills and gave me an even greater appreciation for scientific discovery.

I graduated from ESF in 2016 with an even deeper resolve to pursue research. I found my next opportunity at the National Cancer Institute (NCI), where I worked as a post-baccalaureate in the Laboratory of Cell and Developmental Signaling under the supervision of Dr. Christopher Westlake. I engaged in independent research, focused on the molecular mechanisms that regulate primary ciliogenesis, and phenotypes that arise from abnormalities in their formation or function. Specifically, my project investigated the effect of loss-of-function (LOF) and gain-of-function (GOF) of ciliary genes, in both non-ciliated and ciliated human tumor cell lines. To evaluate the effects of the genetic screens, I used a combination of confocal microscopy, transmission electron microscopy (TEM) and western blotting techniques. Furthermore, I actively analyzed membrane docking and fusion steps, and the localization of ciliary proteins for multiple projects using 3D-TEM and immunogold labelling. The combination of genetic screens and microscopy analysis provided insights into the phenotypes and the molecular pathways underlying ciliopathies, and led to publications in *Nature Communications, Cell Reports,* and *Developmental Cell,* all of which I am co-authored on. My work at the NCI steered my research deeper into the realm of the microscopic; I found myself captivated by the amazingly complex and unseen world that enables life as we know it.

I acquired a particular interest in human genetics while working at the NCI. I was determined to continue studying this new frontier, which led me to work under the world-renowned geneticist, Dr. George Church. One of my major projects involved the use of CRISPR-mediated genome editing to confer porcine resistance to Porcine Epidemic Diarrhea Virus (PEDV) and Porcine Reproductive and Respiratory Syndrome Virus (PRRSV). Both PEDV and PRRSV cause devastating effects on pig production worldwide due to their high pathogenicity and lethality. Cellular entry of PEDV was believed to be facilitated by the aminopeptidase N receptor (CD13), and the entry of PRRSV is primarily through the scavenger receptor (CD163).

Preliminary evidence from our research suggested that excision of CD163 exon 7 prohibits entry of PRRSV, while still preserving the other receptor functions. Using CRISPR-Cas design tools, I helped design guide RNAs that target sites flanking CD163 exon 7, and knockout CD13 expression, with limited off-target activity. Using electroporation, I transiently expressed the CRISPR components in porcine fetal fibroblasts cell lines and used fluorescent-assisted cell sorting to generate single colony clones. I then validated the colonies using Next-Generation Sequencing and processed the raw sequencing files using an in-house pipeline. After testing for multi-viral resistance, the engineered cells were shipped to a collaborator to be subsequently cloned via somatic cell nuclear transfer to produce multi-viral resistant pigs.

Another major project of mine investigated the effects that genome-wide changes in DNA methylation profiles had on aging. I cultured isogenic primary fibroblast cell lines from healthy donors ranging between 20 and 90 years old (y/o). These cell lines were cultured in human embryonic, young (27 y/o) or old serum (68 y/o) for 3 weeks and then processed for RNA and DNA isolation. Prediction of DNA methylation age was carried out using DNA methylation array technologies, and I used RNA sequencing and bioinformatic methods to examine the correlation between methylation patterns and gene expression. This work required me to learn new computational tools, and helped me understand the need for customized algorithms in the field of omics research. I enrolled in several workshops dedicated to learning strategies for handling large genomic data that are suited for R programs. Seeing the complexities of software design made me realize the crucial importance of a collaborative and multidisciplinary research environment. When individuals from diverse backgrounds pursue a common goal, their unique skill sets combine in a gestalt to tackle problems that would otherwise be insurmountable.

At Vanderbilt, I have had the incredible opportunity to work alongside experts from a diverse range of scientific fields. I am currently in the lab of Kasey Vickers, who was the first to discover the transport of non-coding RNAs (such as microRNAs) on high-density lipoproteins. I am collaborating with John Karijolich, who has been instrumental in the field of RNA modifications. I am also working side-by-side with members of a bioinformatics team to analyze sequencing datasets. I have been inspired to become more self-proficient in bioinformatics, and am actively taking computer science workshops at Vanderbilt, and plan on enrolling in Biomedical Informatics classes at Vanderbilt Next Fall. With the multidisciplinary environment Vanderbilt has to offer, and with an exceptional student-mentor relationship, Vanderbilt has allowed me to succeed not only as an individual, but as an integrated member of the scientific community. Ultimately, the emphasis on collaboration is the reason why my research in the Vickers lab will be a success. I will certainly face many challenges throughout my research, but I have the support of a formidable problem-solving machine composed of brilliant minds from diverse backgrounds.

Broader Impacts: I grew up in a household with significant financial burdens, and neither of my parents had ever received a bachelor's degree. The economic hardship instilled me with a strong appreciation for volunteerism, as I learned to recognize the importance of food banks and goodwill. As a first-generation graduate and as a woman in science, I have seen firsthand how social stigma and gender roles can impact one's self-identity, often discouraging women and minority groups from pursuing STEM careers. **My mission is to promote diversity in the scientific community through volunteerism, and to bring science to a wider audience.**

Throughout high school I looked for opportunities to contribute to the community near my hometown of Elmira, New York. I helped stock and prepare food at local soup kitchens, and worked as a volunteer at the Arnot Ogden hospital. My passion for altruism led me to take a gap

year with the organization Carpe Diem Education before pursuing my undergraduate degree at ESF. The program focused on environmental conservation in Australia and New Zealand, and placed an emphasis on volunteerism and cultural exchange. Over the duration of the year I recorded data on populations of several endangered species in Australia, and performed a broad range of volunteer work on organic farms. My work with Carpe Diem had a real impact on conservation efforts for Australian wildlife, and directly supported local farming communities.

I had to pay my own tuition when I went to college, so when I started my undergraduate education at ESF I was also balancing a full-time job as a waitress. Even with the heavy workload, I continued to demonstrate my passion for helping others whenever I could. I assisted one of my professors in teaching organic chemistry labs, which involved fielding questions from new lab students and helping with experimental setup and demonstrations. I also tutored many friends and classmates outside of the lab, and found sincere fulfillment in helping others grasp technical concepts. My experience at ESF was my first time as a mentor in a scientific context, and I discovered a new personal passion for teaching others.

As a graduate student at Vanderbilt, I am excited to soon begin with Vanderbilt Student Volunteers for Science (VSCS), an outreach program with the Metro Nashville Public School System. The program provides hands-on science lessons and after-school activities to both inner-city and rural school students in Nashville between 5^{th} and 8^{th} grade. The focus during Covid-19 has been on virtual outreach with remote teaching and online demonstrations. I look forward to volunteering with VSCS, and am excited for all future opportunities to contribute to my community while at Vanderbilt. I will do all that I can to fulfill my goal of promoting interest in science, and I will continue pursue this objective as I develop my career as a researcher.

Future Goals: As a graduate student at Vanderbilt, I am expanding my technical repertoire with new techniques, while continuing to pursue a path of professional development. My current vision is to work as a lead scientist in industry or a government agency, but I remain open to a career in academia. Whichever path I choose, I will carry my mission with me: to promote diversity in the sciences, and to make meaningful contributions back to my community. I believe that as a woman in science and as a first-generation student, I can provide guidance to others from similar walks of life and help make STEM more approachable. Obtaining my PhD is the next step for me to achieve my future goals, and the NSF GRFP scholarship will help me to distinguish myself and turn my mission into a reality. With your help, I can forge a new legacy for my family where education is a core value, and turn over a few more stones from the mountain of mysteries that make life possible. Thank you for your consideration.