Research Activities

List past and present research activities associated with your interests in mathematics, science, or engineering in which you regularly participate. Explain the duration, degree, and significance of your involvement, including what responsibilities you had in the project. In the absence of formal research experience, describe briefly any other skills or accomplishments, i.e., posters, presentations, publications, etc., significant and relevant to this application.

1. Research activities:

In my first semester of college I accepted a position as a lab technician in Dr. Lee Miller's turf-grass pathology lab. I quickly executed the basis of modern biological experiments like proper sterile technique, DNA isolation, Gel electrophoresis and ITS sequencing preparation. In order to gain the experience of formulating my own research question I transferred into Dr. J Chris Pires' lab where I've grown exponentially as a researcher for the last 18 months. I have very active role in the Pires lab, helping with graduate student projects, and leading my own independent projects. Early on I gained skills in RNAseq analysis, helping a post doc in the lab analyze the differential expression of genes in different species of Brassica oleracea. I also grew plant material of over 20 taxa and collected tissue to be sent to Arizona State University for DNA extraction for our lab's collaboration with the international team contributing to the Brassicales Map Alignment Project (BMAP) (co-author).

After my first summer I was awarded the Monsanto Undergraduate Research Fellowship (MURF) to conduct my the first phase of my own long-term independent project Investigating Convergent Evolution in Underground Storage Organs of Three Species of Brassica for the 2013-2014 academic year. In this program I screened the USDA's collection of Brassica rapa, consisting of over 900 accessions, in order to find fast cycling turnips to compare RNAseq data of Brassica rapa (turnip), Brassica oleracea, (kohlrabi) and Brassica napus (rutabaga) and try to find a molecular basis for the convergent phenotype. While I was screening the diversity set, I analyzed ITS sequence data for RNA secondary structures for a post-doc that resulted in a paper published in PLoS One (Co-author) and poster presentations at the Evolution 2014 conference in Raleigh NC and the Botany 2014 Conference in Boise, ID last summer.

Since May 2014, I have been a Howard Hughes Medical Institute Hughes Research Fellow. In this program I continue to work on my convergent evolution project and assist a graduate student in analyzing, cleaning, and processing transcriptome data from across the tribe Brassiceae. Using the latest phylogenetic methods, we seek to maximize the number of orthologous genes to make phylogeny that can elucidate the evolutionary history of this tribe. Building the phylogeny has provided me with more experience in bioinformatics and we plan to submit our work for publication this spring (Co-author).

My work with the USDA collection resulted in a collaboration with the USDA and Dr. Michael Gore at Cornell University to sequence the Brassica rapa accessions from the USDA and study the genetic basis of nutritional variation across the species. For the last 4 months I've been formulating this project. I'm leading a team of two other undergraduates and a graduate student to self-fertilize the USDA collection, study the morphological variation of the accession, and harvest tissue for DNA isolation to send to Cornell for sequencing. I am also starting to validate a vitamin C assay. I'm currently collaborating with a member of Beth Sattely's lab at Stanford University who specializes in assays of

plant defense chemicals, like glucosinolates. With training from the Sattely lab I will be able to adapt their chemical assay for use in a field setting.

Outside of the lab I've gained experience as president of the Society of Undergraduate Researchers in Life Sciences. In that position I foster community at MU by helping students engage in research, form reading and seminar groups, and mentor new researchers. Some high lights included inviting faculty to speak about issues like science communication, teaching methods to read scientific literature, workshops on making research proposals, and giving short presentation on their research. I also helped create MU Code and Coffee which is a group of graduate and undergraduate students who meet regularly to teach ourselve computer programming. I am also gaining communication skills as an Undergraduate Research Ambassador as I speak to students, and state legislatures about the benefits of research involvement.

2. Career Goals

My primary focus is in biology, and achieving a Ph.D in Plant Genetics from Cornell University with Dr. Michael Gore, with whom I am currently collaborating. Prior to entering graduate school in Biology I may work for a Masters Degree in Philosophy of Biology for a year under Elliot Sober at the University of Wisconsin or Samir Okasha at the University of Bristol . Upon completing my Ph.D in Biology or concurrently, I will work for a Ph.D. in Philosophy of Biology with Elliot Sober. After graduation I intend to get a post-doctoral fellowship at a research-focused university, preferably in another country, or work for the USDA in a Plant Genetics Resource Unit or Agricultural Resource Unit. After that I plan to achieve a professorship at a large research university where I will be able to conduct molecular evolution research in plants to study evolutionary phenomena like polyploidy, convergent evolution and phenotypic plasticity. I also hope to teach classes pertaining to molecular evolution and bioinformatics.

Professional Aspirations

3. What are your professional aspirations? Indicate in which area(s) of mathematics, science, or engineering you are considering making your career and specify how your current academic program and your overall educational plans will assist you in achieving this goal.

(2000 chars)

My life and professional aspirations are to conduct research and teach at a research-focused university Where I will focus on the evolutionary relationship of genotypes, phenotypes and the environment in plants. I want to to tackle these questions through interdisciplinary and collaborative means, drawing from genomics, genetics, philosophy, bioinformatics, and biochemistry. I will research complex phenomena like convergent evolution and phenotypic plasticity using computational, molecular, and quantitative genetic techniques, and work closely with computational biologists and systems biologists in order to gain their expertise in my research program. Through a collaborative ethic I will tackle difficult research questions with varied methods and perspectives. These questions require an exceptional understanding of biology on a conceptual level, which is why I am pursuing not only a B.S. in Biology, but also a B.A. in Philosophy, specializing in Philosophy of Biology. I have also been

training myself in bioinformatics and computational methods by teaching myself the programming language Python and programs like R. To further this, I have founded an interdisciplinary organization of graduate and undergraduate students that practice programming on a regular basis to further hone our skills, and to teach others. I have taken graduate courses in both Biology (advanced plant genetics and molecular and network evolution) and Philosophy (Philosophy of Science) to push my knowledge and understanding of both fields. In Summer 2015, I plan on attending the Molecular Evolution workshop at Woods Hole to train in the latest computational methods from experts in the field. I also intend to take more graduate biology classes pertaining to statistical modeling in biology and bioinformatics as well as a philosophy of biology graduate course. All these activities have prepared me to work at the capacity of a graduate student before I leave my undergraduate institution.

4. Describe an activity or experience that has been important in clarifying or strengthening your motivation for a career in science, mathematics, or engineering.

(2000) I was born with the congenital heart defect aortic stenosis, and at the time of my birth the prognosis was bleak. Multiple heart valve transplants starting before age ten, stunted growth, and continual blood thinners were standard. Luckily, researchers at the University of Missouri made advancements in treatment of my disorder that let me live a relatively normal life and postponed transplants well into my forties. I was so enthralled by the fact that my molecular blueprint could have an error that was so significant that since age twelve I have aspired to be a geneticist because I know how research improves people's lives.

I was able to further focus my goals into academic research after conducting research in high school where I worked in University of Missouri facilities and after winning the regional competition presented my work at the DOD Junior Science and Humanities Symposium. With this focus, I walked into college knowing with a deep conviction that I wanted to be a research scientist, and from my work in high school I was offered a job as a lab technician in Dr. Lee Miller's Turfgrass Pathology lab my first month as a student at the University of Missouri. In this position I learned the value and importance of applied research, and more importantly that I was more interested in basic research. To better fit my passion I moved to Dr. Chris Pires' lab the summer before my sophomore year. It was in Dr. Pires' lab that I shifted my aspiration from human genetics to plant genetics, and truly hit my stride as a researcher. The complex evolutionary questions and interdisciplinary techniques used in plants fascinated me. In the Pires lab I have broadened my horizons beyond genetics to encompass evolutionary biology, phylogenomics, genomics and bioinformatics. I want to use these disciplines to tackle deep biological questions like convergent evolution and phenotypic plasticity.

5. Goldwater Scholars will be representative of the diverse economic, ethnic, and occupational backgrounds of families in the United States. Describe any characteristics or other personal information about yourself or your family that you wish to share with the selection committee.

(2000)

My family has faced much adversity, but these trials and tribulations have been pivotal in making me who I am. My father has continually struggled with various addictions, and my mother was the first in her family to afford college. I was born with a congenital heart defect that put a financial strain on my parents. On top of the medical bills, my mother opted to stay at home and not return to work in order to take care of me. Her decision, while best for my health, put us on food stamps for parts of my early life. In 2005 my father lost his job, and took the risk to start his own business. Getting the business off the ground was financially difficult, but with my parents' hard work they were able to stabilize the business. From watching all of this, I saw the benefits of taking risks and working hard for what you believe in. In 2012 my parents divorced and we faced more financial challenges, this time while I was in college. My mother's decision to stay at home after I was born meant that she missed out on gaining experience in the field of her degree. She has taken numerous part-time jobs to support herself and my sister, and is currently self-employed as a massage therapist and planning to return to school for a master's degree in social work. The sacrifices she made gave me the foundation I needed to be healthy and successful in my life. The community I am from has a high rates of poverty and drug abuse, but because it is a popular resort area it offers great educational opportunities while having over 40% of its students on free and reduced lunch, I have worked since 13, sometimes having 2 jobs to earn money to be self-sufficient in college. I have learned the value of education, work and responsibility from early on, and through all the financial difficulties I have kept my passion for the sciences and hope to be the first in my family to earn a science degree and the first to earn an advanced degree.