In my scientific career, I've found that there are three important aspects to pursuing science: devotion toward doing research, the willingness to educate the next generation of scientists, and a strong desire to promote the sciences. It takes talent to be able to make new discoveries, but it takes devotion and dedication to pass on these discoveries to the public and next generation of researchers. Thus, a scientist has three jobs: a researcher, a teacher, and an ambassador.

Researcher: During my time at the University of Michigan (U of M), I worked on five separate research projects. My first one dealt with constructing and counting Feynman diagrams (advised by Dr. Henriette Elvang) in theoretical physics and the second one dealt with analyzing light curves (advised by Dr. Carl Akerlof) from supernovas. Although I enjoyed these two small independent projects and gained valuable programming experience (Mathematica, Python, and IDL), I quickly realized that physics research was not personally fulfilling. I wanted my research to address something more relevant to a broader range of people, such as linking basic biology to disease and industrial applications.

Around that time, I was informed of a summer internship opportunity to pursue biophysics research at the University of Science and Technology of China for 9 weeks. This seemed like the perfect way to transition from physics to biology research. I proceeded to spend the summer before my junior year in China where I predominantly worked with cryo-electron tomography to study synaptic plasticity. I was advised by a local graduate student and helped optimize the gold bead solution used for aligning tomography slices of synapses. I served as a microscope operator, but was also able to design and execute several experiments myself. My optimization parameters are still being implemented by the lab today[1]. Given the success of this internship, I decided to pursue biology research back at U of M.

During the final two years of my undergraduate career, I worked in Dr. Ursula Jakob's lab to characterize a newly identified chaperone, inorganic polyphosphate (polyP). When I joined the lab, it was known that polyP levels were upregulated under stress conditions, but it was not known why. I collected data using several varied methods, including circular dichroism, fluorimetry, tryptophan fluorescence, and luciferase activity assays, to show that polyP acts as a non-specific chaperone *in vitro* and *in vivo* under heat and oxidative stress conditions. At physiological concentrations, polyP was able to prevent protein aggregation of most proteins in cell lysates. These findings were published in *Molecular Cell* with me as the third author[2]. Subsequent experiments showed that polyP also protects proteins under chemical stress conditions and extreme pH values. Furthermore, I found mutated proteins to be significantly more stable and active in the presence of polyP. These results allowed me to write an extensive senior thesis last April and prepare a draft of a first author publication to be submitted to *The Journal of Biological Chemistry*[3]. The current goal is to elucidate exactly how polyP protects proteins against aggregation and how polyP can be utilized outside of academia. This is the topic of my research proposal. During my time in the lab, I was supervised by a postdoc and Ursula, but planned and executed experiments on my own.

As I wanted to spend some time with my family in Germany, I asked Ursula if she had any collaborators there. As a result, I spent the summer before my senior year in Dr. Jan Riemer's lab at the Technical University of Kaiserslautern. While there, I completed a small independent project on the mitochondrial unfolded protein response (mtUPR) and gained valuable experience in working with human cell lines. In particular, using Western blots and

RT-PCR, I identified YME1, a serine protease, as a potential mediator of the mtUPR. This was a small, but significant, step in elucidating the mtUPR signaling network.

This internship was funded by a Beckman scholarship, which also funded my research during my senior year and the summer thereafter. With this scholarship, I was also able to attend three separate conferences around the country. At all three conferences I had the opportunity to present posters on my research and received countless new ideas on how to pursue my project.

Since research had made such a large impact on my life, I wanted to help others get involved. As president of the Student Astronomical Society (SAS), I set up a program for undergrads to be able to meet with professors informally over lunch and discuss research. My program has helped many undergraduates find research positions. This past summer, I also had the opportunity to mentor two new undergraduate students in lab. This allowed me to smoothly pass on my research and gain mentoring experience. I look forward to being a mentor during graduate school, guiding and advising undergraduates on life as a researcher.

Teacher: This past winter term, I had my first opportunity to teach. Late last December, the astronomy department at U of M approved an optional honors discussion section for introductory classes to be designed and taught solely by me. I had several goals for this section: expand upon classroom material, teach students valuable scientific skills (e.g. reading and writing scientific papers), increase interest in astronomy, and allow students to explore topics of their own. Furthermore, I wanted this class to not be run in a lecture style. Rather, I wanted students to learn from each other, through discussions and presentations, and by hands-on activities. Some of the activities that were included in the final syllabus were student-run planetarium shows, observing assignments, presentations on exotic astrophysical phenomena, and student-led paper discussions. Overall, this class was a great success, gaining praise from all levels within the department and leading to a small, but noticeable, boost in astronomy majors. Due to its success, this honors section is being offered again this year with minimal modifications from my inaugural syllabus.

I also gained one-on-one teaching experience by being a grader in the physics department for five semesters. Although my main job was to grade problem sets, I was also able to help plan lectures, write homework problems and solutions, and hold office hours. It was during office hours that I gained the most teaching experience. Just knowing how to solve the problem was not enough- I needed to be able to figure out exactly where students were having trouble and find a way to guide them through the problem without giving away the answer. As difficult as it was, holding office hours was also quite fun. I got to know some of the students very well and often found myself helping 20+ students well over the allotted time. It was incredibly rewarding to see that moment when things clicked for the students and they started asking questions that went beyond the scope of the homework. I already look forward to next year when I begin teaching and can implement these skills again.

Ambassador: I was heavily involved in scientific outreach as the outreach chair and president of the Society of Physics Students (SPS) at U of M. While most events involved bringing several demos to local elementary schools, we had a large annual event called Physics Palooza. During this event, we took over the Ann Arbor Hands-On Museum for a weekend and set up hands-on demos for kids of all ages to enjoy. I coordinated about 30 volunteers & 20 demos and gave 4 on-stage live demo shows. During my senior year I also started a project to bring

interactive demonstrations to the physics department's weekly "Saturday Morning Physics" talks. These talks were attended by up to 500 members of the community, many of whom looked forward to visiting our demo table before the talks.

Another outreach project I founded and in which I played a heavy role was a nationally funded pen pal program between our chapter of SPS and underprivileged, minority sixth graders. The highlight of this year-long program was when all 99 pen pals came to U of M for a campus visit. In addition to meeting their pen pals for the first time, the kids were treated to various activities around campus, including lab tours and a planetarium show. To top off their visit, we entertained them with an exciting demo show filled with the most exhilarating demonstrations we had to offer. We made pop cans explode, lit a jet engine, played with electricity, and as a final highlight, set their teacher's hand on fire. In addition to connecting the kids with college students, we were at the same time working on a larger goal by impressing upon them the importance and wonders of science. The ultimate goals were to have the kids finish high school and apply to college and to have them pursue a degree in science, increasing diversity in the scientific community.

Finally, as part of SAS, I helped out at countless astronomy open houses. At these events, I gave planetarium shows, set up telescopes, and answered general questions. We had biweekly events that were open to the general public, but also gave shows upon special request to local students and campus groups.

At Harvard, I plan on engaging in three separate outreach activities: the Journal of Emerging Investigators (JEI), a departmental outreach program, and Harvard's chapter of SPS. JEI is a newly established journal in which K-12 students can publish their original research. In addition to serving on the paper review committee, I am very interested in traveling to science fairs across the country to not only promote the journal, but also to continue raising interest in original research at an early age. Next, there is an outreach program encompassing the various life sciences programs at Harvard. I plan to participate in their lab workshop series where high school teachers and students are invited to participate in themed courses on conducting original research. My role in these workshops will be to help create lesson plans, supervise the events, and serve as a general contact person.

Lastly, I would like to get involved with Harvard's chapter of SPS. With my previous experience, I can make large contributions to outreach in the club, which is currently lacking. One specific goal I have in mind is to set up relations with local elementary schools and bring physics demos to them. A longer term goal is to set up a pen pal program similar to the one I had created at U of M. Given the large influence science has played in Boston, I am in the right place to make these goals happen and continue my greater goal of spreading the love of science to the next generation of students.

By pursuing a graduate degree in biology, I hope to better fulfill my goal of making significant contributions to scientific progress. In addition to research, I plan on remaining involved in teaching and public outreach, as those are the main avenues for recruiting and training the future generation of scientists. The NSF graduate research fellowship program will give me the independence, flexibility, and support needed to turn these goals into reality over the next three years.

References: [**1**] Tao *et al.* (2012) *Neurosci. Bull.* 28: 321. [**2**] Gray *et al.* (2014) *Mol. Cell* 53: 689. [**3**] Wagner *et al.* (2014) *in prep.*