I am applying to the NSF Graduate Research Fellowship for support in my graduate studies at Harvard University as I work towards my goal of being a university professor. **As an NSF Graduate Research Fellow I will continue to work towards making a substantial contribution to science, to encourage young students, especially females, to become involved with science research, and to represent the NSF with distinction**.

Intellectual Merit: While I was exposed to science research at an early age, it was my work in the lab of Dr. Luciano Marraffini during my junior year of college that truly affirmed my interest in pursing a graduate degree and career in academia. As a **Rockefeller University Summer Undergraduate Research Fellow**, I entered into the emerging field of CRISPR-Cas biology. My project was to biochemically identify interactions between Cas proteins required for new spacer immunity acquisition in an endogenous type-II CRISPR system. Through co-purification experiments, I identified the novel Cas9-Cas1 protein interaction. This unexpected discovery triggered substantial follow-up studies by the Marraffini lab that determined Cas9 is mechanistically required for spacer acquisition. We **published our findings in *Nature***, for which I am the fourth author. My work contributes to the field of bacteriology as we begin to understand how bacteria defend their genomes from invading DNA elements. It also has **broader impact on the use of the CRISPR/Cas9 system** for genome editing. As this technique is becoming a standard approach in molecular biology, it will be essential to understand the functions of the Cas proteins involved. My work has contributed to humanities understanding of life at the molecular level; this empowering fact drives me to continue investigating interesting biological questions through science research.

My experiences in the Marraffini lab expanded upon an underlying interest in molecular biology that I had developed in high school and early college experiences. I enrolled in a **three-year high school science research course** in which I independently set up and conducted a research project investigating an antibiotic resistance system in *E. coli*. Despite spending many hours of my summer in a hot lab that reeked of bacteria and bleach, I came home every day with a huge smile on my face. Inspired by this positive experience, I continued to explore my diverse biological interests through science research during my time at the University of Rochester (UR). I earned a merit-based **University of Rochester Research and Innovation Grant**, which I used to fund summer research at Weill Cornell Medical College with Dr. Kirk Dietsch as a sophomore. I tested the transfection selection efficiency of a new drug resistance selection system in *Plasmodium falciparium* (a parasite that causes malaria). This work had broader application for being able to better manipulate *Plasmodium* in the lab. During this experience, I learned the **value of determination and persistence** in science research as I spent my summer troubleshooting the new system.

My foremost research experience thus far was at UR with Dr. Eric Phizicky. This experience was my first substantial exposure to working independently in a research environment and taught me the **importance of thoughtful experimental design**. My work focused on the crucial post-transcriptional anticodon loop modifications of $tRNA^{Phe}$ catalyzed by yeast Trm7. This work highlights the **conserved nature of posttranscriptional tRNA modifications and their role in neurological disorders**. During my time in the Phizicky lab, I worked on two independent research projects. First, I focused on defining the role of Trm7 binding partners in the modification mechanism. I found that binding between Trm7 and one of its protein partners may not be required for functional modification by the protein pair. Secondly, I worked to define the role of an alpha helix in Trm7 that has been genetically implicated in

human non-syndromic X-linked intellectual disability (NSXLID). My results demonstrated that the corresponding yeast mutant of this disease-associated mutation is specifically defective in one of the two modifications catalyzed by Trm7. This latter project was in collaboration with a human genetics lab investigating familial NSXLID and **resulted in a recent publication in *Human Mutation***, for which I am the third author. I successfully defended my senior thesis work on the role of Trm7 in modification of $tRNA^{Phe}$ anticodon loop. Presenting at lab meetings, writing and defending my senior thesis, and participating in a productive collaboration was excellent practice in how to effectively communicate my research to members within the scientific community, a skill I will continue to use and develop in graduate school and throughout my career in academia.

To augment my practical research skills, I took an interdisciplinary curriculum at UR. In addition to my **BS in Biochemistry**, I earned a **Minor in Mathematics** and took several computer science courses. I have continued this academic approach during graduate school at Harvard University where I take intensive courses. Additionally, I regularly sharpen my critical analysis skills by presenting and evaluating peer-reviewed articles during a Harvard departmental journal club. Combined, these aspects of my curriculum further my skills as a scientist as they allow me to identify meaningful questions, creatively design efficient experiments, and better interpret my results.

During my diverse undergraduate research experiences, I **developed an interest in the noncoding genome**. I joined the lab of Dr. John Rinn to pursue this interest as I conduct my doctoral thesis work. To support my graduate tuition during my second year, I have been awarded the **Michael and Anna Vranos Graduate Fellowship Fund in the Life Sciences**, a merit-based fellowship awarded by the Harvard Department of Stem Cell and Regenerative Biology. My work in the Rinn lab focuses on understanding the molecular mechanisms regulating a nuclear long noncoding RNA termed Functional Intergenic Repeating RNA Element (*FIRRE*). Interestingly, the lncRNA *FIRRE* is has been associated with the human neurological disorder Polymicrogyria, escapes X inactivation, and facilitates inter-chromosomal interactions in mammalian cells. Since joining the lab, I have begun interrogating the DNA elements of the *FIRRE* locus for enhancer activity through a classical luciferase enhancer screen. I identified several regions of the mouse *Firre* locus with enhancer activity and am working to evaluate the human *FIRRE* locus. This work has been incorporated into a **manuscript currently under review**, for which I am the third author. I am also interested in characterizing the inter-chromosomal interactions mediated by *FIRRE.* Combining my undergraduate experiences with noncoding RNA and CRIPSR-Cas biology, I will use a novel CRISPR-Cas based imaging technology pioneered by the Rinn lab to interrogate the role of lncRNAs, such as *FIRRE*, on nuclear architecture. This work will expand a technique to **interrogate chromosomal interactions in four-dimensions** and will expand our limited understanding on how lncRNAs facilitate nuclear architecture and the resulting gene regulation.

I have had various research experiences to explore my curiosity about how life works at the molecular level and each continues to renew my love of science research. **The support of the NSF through a Graduate Research Fellowship will allow me the freedom to continue to pursue my scientific interests and tackle meaningful questions throughout my graduate career as I work towards becoming a university professor.**

Broader Impact: My personal achievements would be impossible without the influence of teachers and mentors throughout my scientific career. They challenge my understanding of

biology, encourage my involvement with research, and develop my research skills to advance in academia. My experiences have instilled in me the strong desire to pay forward those inspirations, to teach and mentor young scientists. Equally important, I hope to be the strong female role model absent in my own experiences.

My early exposure to science research left me awe-struck and eager to pursue molecular research, motivations that still resonate with me today. Unfortunately, many students do not have the same opportunity. To that extent, I have joined the **Life Science Outreach Spring Student program** as a graduate student at Harvard University. This program invites high school classes to explore science research during a morning lab course we teach in the Harvard Teaching Laboratories. I think my excitement about science and my relatable life experience make me well suited to engage and inspire high school students to participate in science research.

As an undergraduate at UR, I found my **passion for teaching.** I was a teaching assistant for Principles of Genetics and Introduction to Biochemistry as well as a Writing and Speaking Fellow (a peer-tutor for written and oral assignments). I continue to teach at Harvard where I am currently a teaching fellow for Graduate Biochemistry. As a teacher, I emulate professors who dared to show me the unknowns that still remain between the pages of textbooks. These professors opened my eyes to what we still have to learn and gave me the tools to begin to start answering these questions. To more effectively teach my students, I have taken several courses on educational methodology. I am on track to earn a **Teaching Certificate through the Derek Box Center for Teaching and Learning** at Harvard, a similar program to the one I have completed at UR that earned me a Citation for Achievement in College Leadership. Teaching allows me to challenge and support the scientific education of young scientists, an indispensible aspect of advancing science into the future.

While I was fortunate enough to have supportive mentors in my scientific career, they were predominantly male. My experiences have left me wanting strong female role models, a role I hope I can fill as I mentor young female scientists. I am a member of **Harvard Graduate Women in Science and Engineering (HGWISE)**, a program that facilitates the development of women in STEM fields. I have attended several peer-tutoring events through HGWISE in which I advised female undergraduates interested in applying to graduate programs. This past summer I was a **peer mentor for the Harvard Summer Research Opportunities Program**, a program that brings minorities and students from underrepresented backgrounds to Harvard to conduct scientific research. I mentored a female undergraduate from a small liberal arts college. We met weekly to discuss a variety of topics ranging from my decision to pursue a career in academia to how to write an impactful abstract. I have continued to support my mentee as she prepares to apply to graduate school this fall. I am also a **peer mentor for Women in Science Technology Engineering and Mathematics (WISTEM).** The goal of WISTEM is to expand the number of female undergraduates majoring in STEM fields. I meet monthly with a Harvard female undergraduate interested in pursuing science research to discuss how to manage her course load, how to get involved with research on campus, and how to approach a career in STEM. It is extremely rewarding to form a strong relationship with a young scientist and to be a support system for her as she enters into academia. I plan to continue mentoring for these programs to help inspire and guide the next generation of female scientists.

Receiving a NSF Graduate Research Fellowship will not only provide me the support for my scientific goals, but will also allow me to be the teachers I had and the role models I wanted for the next generation of scientists.