Imagine robots that could crawl up any surface like cockroaches, run over sand like lizards or climb upside-down like spider monkeys. Evolution has provided these animals with diverse and efficient methods to navigate the harshest environments, and these fascinating evolutionary traits are what have inspired me to become an engineer. My passion is biomimetics: the study of using biological innovations to inspire novel engineering designs that will save and improve human lives.

I am currently a graduate student at UC Berkeley, where I am pursuing a Ph.D. in mechanical engineering. UC Berkeley, as a leading institution in bio-inspired robotics, will provide me with the resources to push the boundaries of biomimetics. As a graduate student, I am already taking diverse classes in both mechanical engineering and integrative biology that will serve as a foundation to make successful and impactful bio-inspired technology. Additionally through working at CiBER's (Center for Interdisciplinary Bio-inspiration in Education and Research) lab with programs unique to UC Berkeley, I will have the extraordinary opportunity to conduct interdisciplinary research projects with integrative biologists and engineers to find novel animal adaptations and integrate them into engineering solutions. I also have the opportunity to collaborate with other researchers in biomimetics at conferences such as the IROS (International Conference on Intelligent Robots and Systems) and perform research in partner universities overseas, such as ETH in Zurich, Switzerland. With all these resources at UC Berkeley, I am perfectly poised to help push the boundaries of biomimetics and ultimately improve our quality of life.

I first realized my passion for biomimetics in high school. As a 17-year-old, I created a ladybug-like design instead of using the pre-ordered skeleton we were given for my high school's walking robot competition. This robot optimized its balance and maneuverability by alternating its legs and swinging them in specific increments. Following this competition, I knew I wanted to continue my involvement in robotics. A few months later, after extensive designing, machining and programming, I went on to compete in the 2008 International Robogames, the world's largest open robot competition. There, I saw more animal-like robots, including ones with smashing jaws like crocodiles and low centers of gravity like beetles.

Through these experiences, I began to realize the great potential for biologically-inspired engineering and decided to continue my passion for biomimetics as an undergraduate in mechanical engineering at the University of California, Santa Barbara. In my robotics design class at UCSB, the final project's goal was to collect more foam cubes than another team. My partner and I spent many late nights rebuilding a more robust Lego-body, debugging the Arduino program to make the attacking process more efficient, and experimenting with various sensors and motors to fine-tune the skill set of our robot. We settled on a design with elements drawn from sharks and lobsters: its shark-like ingestion system churned gears in one direction, similar to the way shark's teeth angle backward, and its lobster-like claw grabbed hanging cubes. This biologically-derived design earned us a first place prize in the course, and further strengthened my resolve to study biomimetics in the future.

Preparation: Through a key industrial internship and an undergraduate research position, I have gained experience and expertise that have successfully prepared me for the rigors of graduate school. During my internship at Intouch Health, I worked with remote presence robots that allowed doctors to talk to their patients across the country. This experience not only expanded my knowledge of robotics, but it also reinforced my appreciation for robotics that can help people. There are only a handful of specialists in the country that can diagnose a heart attack within minutes; the faster doctors can help patients, the lower probability of brain damage. These remote presence robots allow these specialists to “beam” into multiple hospitals per hour, saving more people per day than they could have if they were only operating in one hospital. Working at this company, I was able to see directly how the robot I was fixing and developing would help people in the real world. This job also taught me how to work independently because Intouch Health was a fairly young company at the time, and I had to take the initiative to creatively find solutions to problems that were never see before. I was assigned to trouble shoot the robots that ran into problems in the field and test new designs for the next generation of robots. Because I was an intern working on projects with a diverse set of challenges, I also learned how to work with people from a wide range of disciplines such as electrical engineering and computer science. This experience involved both independent and collaborative work, and I have found these skills to be fundamental building blocks for my graduate school career.

Through my position as an undergraduate research assistant at UC Santa Barbara in Dr. Kimberly Turner’s Mechanics Microscale Systems (MEMS) Lab, I began to understand the hierarchal nature of bio-inspired adhesion and friction. I used microfabrication techniques to create centimeter sized polydimethylsiloxane (PDMS) patches with micro-scale columns. These columns easily conform to the contact surface, utilizing van der Waals interactions to mimic the adhesive fibers that allow geckos to traverse vertical and inverted surfaces. All previous work performed in the lab was done at the micro scale, and I was tasked with investigating the patch’s performance at the macro scale, a critical step towards integrating it onto a functional robot. I designed and created a macro-scale weight and pulley testing station and protocol to determine the patch geometry with optimal weight-bearing ability. I varied the surface area, thickness, and initial shear force used when applying them to a surface. By the end of my term at UC Santa Barbara, I demonstrated that a square centimeter patch 400 micrometers thick could support over 100g, or the weight of a small hand-sized robot. From my first experience performing biomimetic research in Dr. Turner’s MEMS Lab, I knew I wanted to pursue graduate school as I thoroughly enjoyed pushing the boundaries of the field of gecko adhesives, which includes doing novel work and changing the way people think about approaching robotic problems. Because I was given a goal that was different from the rest of the lab, I gained experience in thinking creatively and independently. Additionally, my experience in making my own testing station has given me a foundation to make testing stations as a graduate student at UC Berkeley to demonstrate the success of my own biomimetic designs. Overall, through my past internship and research experience I have done hands-on research, learned to work independently and creatively, and collaborated with a diverse array of people - all skills that will help me succeed in graduate school.

Broader Impact: After graduate school, I intend to become a research professor to continue pushing the boundaries of biomimetic robotics and to teach others about the benefits of using bio-inspired technology. While my current research project focuses on robotic feet with directionally dependent collapsible micro-claws that allow robots to access places that are dangerous for people, I want to continue to take advantage of the natural abilities of animals to improve robotics designs that will both save and better peoples' lives.

In addition to research, I want to make a difference through teaching and mentoring. I have always been excited to share my passions and through various teaching and outreach experiences, and I have found that I especially love teaching math and science. My passion for teaching started at age 11 while volunteering at the San Francisco Zoo. The most exciting part of my day was watching a child's face light up when he/she fully understood a new idea. As a junior at Lick Wilmerding High School, I taught science and math to junior high students from underprivileged areas through a summer school program called Aim High. That year, I also acted as a teacher's assistant for multiple electronics classes and pioneered the robotics program with my own lesson plan based on my experience at the 2008 Robogames, which helped students who wanted to compete in the future. Later as an undergraduate research assistant in Dr. Turner's research lab, I served as outreach chair. I gave lab tours to local junior high kids in the area and brought my research to a local science fair at Girls Inc., which is an after school program that fosters young girls from ages 6-18 to be creative and independent. Additionally as the tutoring chair for Tau Beta Pi at UC Santa Barbara, I had my first experience as a mentor to undergraduates by sharing my knowledge and using my experiences to help others succeed in the future.

At UC Berkeley, I am currently part of the Electrical Engineering outreach group that works with Bay Area Scientists in Schools (BASIS). We have brought lesson plans on electromagnetism, generators, circuits, sound waves, and robots to local schools and the Lawrence Hall of Science. In the future, I hope to bring the students I am teaching in these classrooms into the CiBER lab with lesson plans that directly tie into my research. I plan to show them an animal that exhibits a fascinating evolutionary trait using high speed cameras and allow them to do experiments with a robot that directly mimics that trait. Since these robots can be rapidly prototyped, students in the classrooms could make their own robot and learn the benefits of experimental robotics. With these outreach events, I hope to help them realize the potential for biomimetic robots. I love showing people the possibilities that bio-inspired technology and robotics offers us, and academia uniquely allows me to combine my interests in both research and outreach to push the boundaries of robotics and influence the future of robotic solutions.

Looking Forward: I intend to pursue a Ph.D at UC Berkeley in order to be well-trained and experienced in the biomimetic robotics field. The NSF GRFP would truly make me a better professor by providing me with the flexibility to explore several different projects, take a wide array of interdisciplinary courses, and collaborate with both integrative biology and engineering labs. I will be able to focus on expanding my teaching experience through courses I have a strong interest in and better mentor students in my lab. The financial support offered by NSF GRFP will give me the independence to work with both biologists and engineers and pursue an innovative and ambitious research agenda to improve our quality of life by expanding our current knowledge about existing biomimetic robotics.