I attribute my professional success to the 10 years I spent as a competitive gymnast: by age 13, I was balancing full-time studies with rigorous 4-hour daily practices, battling stubborn injuries and disappointing competition results. I earned **grit, resilience and discipline** that continue to benefit me as I pursue my goals, especially when that pursuit becomes arduous.

Gymnastics tested my tenacity during my final undergraduate semester of Chemical Engineering at the University of Texas at Austin, where I was a member of the Texas Gymnastics Club. I suffered a concussion during practice, and I was forced to miss the last month of classes on medical recommendation of brain rest, a protocol that prohibited me from studying. I had missed a critical window of time to help my team complete our capstone project for Plant Design. To graduate, I spent three weeks after my graduation ceremony designing, writing up and presenting an entire capstone project - a task intended for a team of three over a semester. I concurrently made up missed final exams and lab reports. I was determined to realize my dream of going to graduate school at Georgia Tech, and I was not going to let anything stand in my way.

Intellectual Merit: I am now a 2nd year graduate student in Bioengineering at Georgia Institute of Technology, where I am designing a microfluidic device that models lung inflammation with applications to inflammatory airway diseases such as COPD and cystic fibrosis. My ambition to dedicate my career to medical research has coalesced from years of experience in a breadth of technical fields. My first internship in summer 2015 was at a pipeline fittings manufacturing company where I worked with the CEO and GM to secure a contract with a large energy company. As the only woman in a technical role, I had to correct an employee who initially thought I was a secretary. Although I acquired communication skills as I coordinated with employees ranging from CEO to machine operator, **I felt powerless to address impactful, motivating problems**. Research would offer me the intellectual freedom to address society's unmet needs with innovative solutions- all while making use of my strengths in fundamental science and engineering.

Beginning Fall 2015, I applied my aptitude for organic chemistry to synthetic polymers research in the Lynd Lab, where I worked for 3 semesters. First, I aided in the development of novel catalysts for polyether synthesis. Once I was familiar with polymerization and catalysis methods, **I developed an independent project** focused on improving the molecular recycling of lactones, a class of "green" plastics that is an attractive alternative to traditional petroleum-derived, non-degradable plastics. **I wrote a project proposal that won an Undergraduate Research Fellowship** at UT, which I used to conduct experiments determining whether the Vandenberg catalyst could depolymerize lactones. I presented the results at UT's Fall 2017 Undergraduate Poster Competition.

I expanded my knowledge of advanced materials research during Summer 2016, when I studied mussel-inspired adhesives at UCSB's Materials Research Laboratory that is widely recognized as of the top 5 materials research centers in the world. Wet adhesives that mimic the shellfish's natural adhesive are desirable for applications from degradable surgical sutures to antifouling coatings for ships. In Dr. Herbert Waite's lab, I investigated the properties of L-dopa, the amino acid responsible for adhesion in mussel proteins. Briefly, my results suggested that several chemical redox routes allow mussel proteins to remain adhesive despite oxidation by sea water. At my REU, I learned to design experiments, analyze data, optimize laboratory protocols, and work with scientists with varied expertise. I presented a **poster** at UCSB's undergraduate poster competition, and in October 2016 **I gave an abstract and 15-minute talk that were awarded *Outstanding Presentation Materials* at Rice University**'s Gulf Coast Undergraduate

Research Symposium. My REU refined my knowledge of the chemistry of advanced materials, but I had always been interested in medicine, so I gravitated towards research in biomaterials because it applies materials to medical challenges like drug delivery.

At Georgia Tech, I entered the Bioengineering program where I was selected as a trainee on the **NIH Biomaterials Training Grant** (BioMAT) with only two other incoming students. I was also awarded the **President's Fellowship** that goes to the top ten percent of graduate applicants to Georgia Tech. BioMAT afforded me the opportunity to rotate labs before selecting a permanent adviser. I first chose Dr. Julie Champion's biomaterials lab, where I studied recombinant proteins for applications in drug delivery. During my Champion lab rotation, I took an Immunology course that ignited my interest in the subject, steering me away from drug delivery towards an emerging field called Immunoengineering which is the application of engineering principles to immunological systems. An example is CAR T-cells that modulate the immune system to fight cancer. I therefore chose a second rotation in Dr. Krishnendu Roy's Immunoengineering lab, where I studied murine bone marrow-derived dendritic cell (BMDC) signaling in response to different adjuvant combinations. I measured cytokine signaling with Luminex assays that helped piece together the cascades leading to dual-adjuvant synergistic cytokine expression[2]. I presented the results of both rotations with a **poster at the NIH** during the T-32 Trainee conference. In the Roy lab, I did my first Immunoengineering research and **I became even more interested in studying immunopathology using engineering approaches.**

After my rotations, I found a permanent position in Dr. Shuichi Takayama's organ-on-a-chip lab, where I am designing a microfluidic device that recapitulates neutrophil transmigration through stressed lung epithelium to reveal novel mechanisms of chronic inflammation in airway diseases such as COPD and cystic fibrosis. These mechanistic studies will inform new therapeutic strategies. As a chemical engineer, I am guided by my training in fluid dynamics and process design and control. My lab's expertise in microfluidic organs-on-a-chip will be advantageous for designing and fabricating devices. I am collaborating with Dr. Rabindra Tirouvanziam, an **airway immunologist at Emory** University who works directly with IAD physicians and has access to patient samples of lung fluids and blood. Finally, to map out novel inflammatory mechanisms from my data, **I initiated a second collaboration** with Dr. Kelly Arnold's computational systems biology lab at U. Michigan. I am excited to bring together experts in microfluidics, immunology and systems biology, while leveraging my own background in chemical engineering, to work on IAD immunopathology.

Broader Impacts: Sharing my love for STEM with the public is the most rewarding aspect of being a graduate student. I am currently developing STEM curriculum and teaching twice-monthly **classes for incarcerated men through Common Good Atlanta**, an organization that provides incarcerated people with access to higher education. According to the Georgia Dept. of Corrections, "offenders who participated in education programs while incarcerated showed lower rates of recidivism after three years… and their wages were higher[3]". As a graduate student who has experience teaching STEM from the elementary to college level, **I have the teaching and communication skills to increase scientific literacy in the incarcerated population** and help inmates return to society as productive citizens. I am partnering with another graduate student to teach seminar-style classes that weave fundamental scientific education into the context of contemporary research topics, including our own projects. Out of 28 courses, only 2 STEM courses are currently offered through the program, so I am recruiting more graduate students to teach through my position as **Service Chair for AChEGS** (Association of Chemical Engineering Graduate Students). I am also working with Common

Good Atlanta to establish a STEM class for incarcerated women and increase class frequency to once a week. I am thankful that my education has enabled me to make STEM accessible to individuals who, on average, did not graduate high school.

I developed my teaching and K-12 STEM communication skills during Fall 2016 when I co-taught **UTeach**, a biweekly after-school science club at a middle school where over half of students were identified as economically disadvantaged and over 70% of students were of minority status. UT's College of Education provided curriculum and 3 hours of weekly training that taught me how to present science to young audiences. I continued outreach in graduate school with one year as a **Project Leader for STARS**, a similar science club for minority 6th-12th grade girls. Building relationships with students in the classroom helps me understand how I can improve STEM outreach. For example, many students did not have parents who were able to help with homework, so to address this need, I used my position as Service Chair for AChEGS to **start a group that tutors high school students at the Metro Boys & Girls Club** weekly.

My mentorship and technical teaching skills were refined this summer when I was the **teaching assistant** for the first engineering fundamentals class in the Chemical Engineering curriculum, ChBE 2100. As I led weekly problem solving sessions and taught five lectures, I learned to explain complex material effectively, but I primarily enjoyed teaching because of the mentor-mentee relationships I built with students. One student even stated in reviews that they had "never had a TA that cared so much and put so much effort in."

Finally, I am a **Grand Challenges Facilitator**: I am mentoring a group of first year undergraduates as they design a device to measure soil nutrient levels in low-resource areas to reduce fertilizer runoff. I am developing **team leadership skills** as I create an environment for my team to succeed without doing the work for them; I provide support and encouragement but urge them to think independently and take ownership of their project. Leading this team is helping me prepare for my future goal of becoming a Principal Investigator at an academic institution or pharmaceutical company.

Future Goals: I will use the skills I earn in graduate school to complete a postdoctoral fellowship and become a principal investigator, remaining in applied immunoengineering research with the aim of investigating therapeutic approaches for autoimmune diseases. In the short term, I am eager to execute the aims I outlined in my Proposal. I will disseminate my work through publications, conference talks, the Immunoengineering seminar series at Georgia Tech, and in lessons with incarcerated men and women. More importantly, my work could lead to the development of transformative anti-inflammatory therapeutics that **improve patient outcomes** in IADs, reducing the need for lung transplants and extending lifespans and quality of life.

Finally, if awarded the GRFP, I plan to participate in the **GROW program** that allows Fellows to collaborate at international institutions. Cultural and intellectual diversity are vital to my professional growth as a researcher. In addition, I will continue to develop my professional skills by mentoring undergraduates and, through GT’s **Project ENGAGES**, underrepresented minority high schoolers. I will also complete a **Teaching Practicum** for ChBE 2100, where I teach half of the lectures and write the exams.

My track record of using my education to benefit others - not only through medical research that will lead to therapeutic breakthroughs, but through teaching, mentorship, and extensive community outreach - makes me well suited to represent the NSF as a GRFP Fellow. I will continue using my education to make a positive impact on the world through research and community involvement, throughout graduate school and in my career.

Refs: [1]Mirshafian *et al.* (2017) *Biochem.* 55:743–50. [2]Madan-Lala *et al.* (2017) *Sci. Rep.* 7:1. [3]Dennis (2016) “Education.” Dept. of Corrections.