Statement of Purpose, Michael Blazanin, mb57828

My classmates and I were hiking up a narrow trail in the Andes, a few hours from our study abroad center in Mérida, Venezuela. As our path leveled out, I paused and surveyed the landscape. I was struck by an undeniable pattern across the slopes of the opposite mountains: each altitude had its own set of characteristic plant life. While I knew the textbook biogeography on those slopes, it failed to convey the imposing magnitude of life's diversity that I felt standing on that mountain. As my semester progressed, I found myself reflecting on that field trip and on the conditions in the developing country around us. At the time, a medical supply shortage was leading to outbreaks of infectious disease. I began to recognize that the same evolutionary forces shaping alpine plant physiology also drove successful pathogens, reinforcing to me the importance and utility of understanding of how microorganisms evolve.

Two years earlier, when I entered the University of Minnesota, I could not decide which subject to pursue. I found my answer by surprise freshman year at an activities fair, where I encountered an undergraduate presenting his research experimentally evolving *Escherichia coli* in the laboratory of Dr. Mike Travisano. The possibility of observing and manipulating evolution as it happened ousted my previous conception of evolutionary biology as solely historical. My curiosity piqued, I soon began volunteering in Dr. Travisano's laboratory. Working with guidance from that same undergraduate, I designed an assay to measure bacterial motility to show how it had evolved, then set about running it for all our isolates. After investing a lot of effort, I learned my first lesson: always pilot an experiment. Because the design failed to control for population size, the results varied wildly between replicates and were unusable. Working through the setback, I revised and ran the assay on a small scale, then retested everything, seeing success. My experience inspired me to prepare an undergraduate research grant proposal extending this project. As I wrote my application, I found myself reading the literature and synthesizing those ideas into something new with relish. These experiences had ignited an interest in biological research, especially in experimental microbial ecology and evolution. I was proud of the ideas I had produced, so when I learned that it had been rejected, I was deeply disappointed. Nevertheless, I began thinking about new directions to take my research.

The spring of my sophomore year, I did a research project on plant biodiversity while studying abroad in Venezuela. This project exposed me to science outside of a laboratory. At the same time, classes and immersion were solidifying my Spanish fluency, which I have always seen as a tool to build personal and professional connections. After I returned, I spent the summer working as a laboratory technician, where I managed a tissue bank database and performed molecular biology experiments. On my own initiative I began learning and writing code to manage the records, and as the appeal of using computation to analyze and understand biological data grew, I realized I had kindled a new interest in bioinformatics. These two experiences exposed me to new scientific fields, and led me to strengthen my interest in microbial ecology and evolution.

Accordingly, in my junior year, I returned to the Travisano lab, and also began a new research fellowship in the laboratory of Dr. Satoshii Ishii. Dr. Ishii and I conceived of a project to measure and model in real-time the rate of denitrification, an important microbial ecological process in runoff pollution. This project used microsensors to measure chemical concentrations, a setup that produced large quantities of data for each experiment. Spurred on by my nascent bioinformatics interests, I wrote several scripts to automate the analysis of this data. Writing these was a new challenge for me, but I enjoyed breaking the problem down into computational

tasks, and it was greatly rewarding when my scripts allowed us to more effectively understand the experiments. At the same time, I began a project in the Travisano laboratory with bacteria and phages (viruses which exclusively attack bacteria), studying the conditions and mechanisms for the evolution of bacterial resistance to phage. I consulted published papers, extracted relevant procedures, and piloted them on a small scale. Enthralled by successful results, I prepared another undergraduate research grant proposal, using the work I had done as a proof-of-concept. Learning from my previous proposal, I identified an unaddressed question, crafted a precise hypothesis, and proposed experiments to explicitly test it. While I continued to work, I received the fantastic news that my research project would be funded for the spring of my junior year.

As both the projects continued, new complications required me to learn and adapt. In the Ishii laboratory, as I tried to improve my precision, the protocols became more and more time-intensive, constraining the progress I could make. Realizing the necessity of balancing rigor with practicality, I developed ways to run experimental steps in parallel, which improved time efficiency and spurred new advances. In the Travisano laboratory, the literature-based assays I was utilizing began providing inconsistent results. This presented a significant challenge, but I continued testing different protocols to improve their reliability. Through this, I learned both never to trust that experiments will turn out as expected and the value of persistence through such surprises. Meanwhile, I was also expanding my academic experiences, taking several courses with bioinformatics components. These classes were demanding, pushing me to improve and expand my programming skillsets. At the same time, I enjoyed the process of thinking logically through an analysis and of the ability to find otherwise-invisible patterns in copious and messy biological datasets. Through these experiences my interests narrowed to experimental microbial evolution with a strong interest in incorporating bioinformatic approaches.

This past summer I led a project on the evolution of cooperation in a bacterial plant pathogen as a participant in the National Science Foundation Research Experience for Undergraduates (REU) at Kansas State University. We used experimental evolution under different conditions, followed by phenotypic characterization, to understand when and how cooperation persisted. This project entailed multiple lines of parallel investigation, which required me to learn how to schedule my time so that I would never have too much or too little to do. As the summer progressed, I developed a system for tracking the timeline of each individual sub-project, and I was able to consistently and efficiently allocate my limited time. I continue to use those time management skills today, and this fall I was able to present the results of my work at the Ecological Genomics Symposium with the support of two undergraduate travel grants.

This fall I am applying the lessons I have learned throughout my career as I continue my work on bacteria-phage coevolution in the Travisano lab. My experiences with a wide range of research environments have shaped and defined my current scientific interests. Broadly, I am passionate about the study of microbial evolution. Studying microbial evolution in model systems can reveal fundamental evolutionary paradigms while also informing applications to human health and biotechnology. These systems are highly tractable, and can be utilized to ask an incredible diversity of questions. I also have a nascent interest in studying microbial evolution in the real world. I am particularly intrigued by the potential of genomic and bioinformatic approaches to understand how pathogens are evolving in real-time. By leveraging experimental and bioinformatic approaches in model and real-world systems, we can make concrete progress towards a better understanding of the microbial world, and how to improve human welfare through it.