Summer @ MSK
Perspectives, Reflections, and More

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Figure 1.1. Chemical Biology Summer Program (ChBSP)

Figure 1.2. Molecular Imaging Summer Program (MISP)

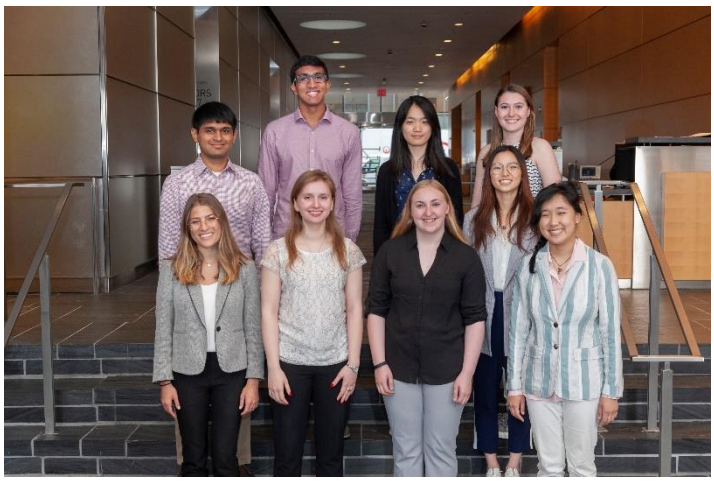

Figure 1.3. Engineering Summer Program (ESP)

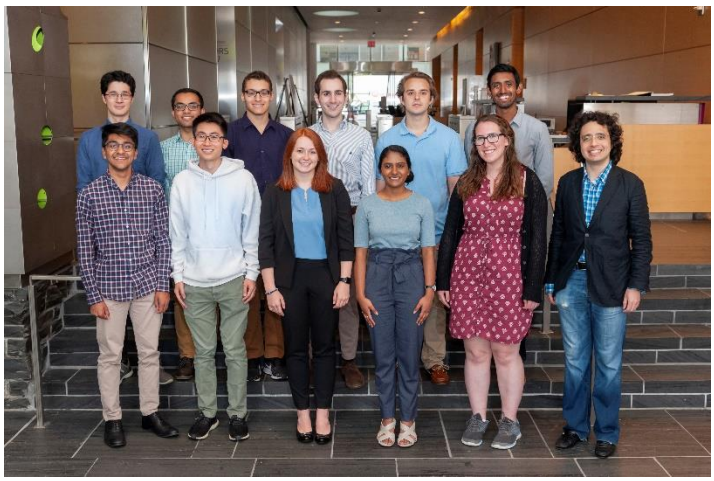

Figure 1.4. Computational Biology Summer Program (CBSP)

1. A Conversation with Dr. Ushma S. Neill

Charlotte Thomas and Catherine Stratis, MISP

Figure 2. Dr. Ushma Neill

Dr. Ushma S. Neill, Vice President of Scientific Education and Training at Memorial Sloan Kettering and Editor-at-Large for the *Journal of Clinical Investigation*, spearheaded the Computational Biology, Chemical Biology, Engineering, and Molecular Imaging undergraduate summer internship programs. Dr. Neill (*Fig. 2*) sat down with us to talk about her perspective on these programs as well as her own experiences through her journeys in science.

MISP Interns, Charlotte Thomas and Catherine Stratis: Can you start by telling us a little about yourself: upbringing, parents, family?

Ushma Neill: I'm a first-generation American of Indian parents, who are both medical professionals. I lived most of my life assuming that was going to be my career path as well. I went to a summer internship program at Carnegie Mellon between my junior and senior years of high school, and that was a tremendously impactful summer for me. Two things happened to me that summer. First, one of my fellow interns, seven years later, became my boyfriend and is now my husband. Second, it exposed me to a lot of engineering-based research, biomedical engineering in particular, and I loved it. That program was six weeks of scientific exploration, then two weeks of writing and producing a scientific magazine for eighth-graders. Little did I know, that's exactly what I would do in my life, which was research and then writing and editing. The more I started thinking about what I was going to

do, I applied to schools that had a biomedical engineering major, which would allow me to satisfy all the prerequisites I needed for medical school but would still tap into the engineering that I really enjoyed. I got to Northwestern University and started doing research in a lab. Early on, I loved it so much that I abandoned all plans of going to medical school, and I embraced research as my path.

MISP: Why did you want undergraduate research programs at MSK, and why should prospective students, in your opinion, be attracted to the ChemBio, Comp Bio, ESP, and MISP programs? When you designed this program, what were your goals?

Neill: All four of these programs are meant to bring talent to the Tri-I that we might not otherwise have. Furthermore, they are all meant to be pipelines into our graduate schools. We want [the students] to come back, so we intend for this to not be a short-term relationship. This is a really great time for college students to be able to figure out, after a summer of doing research, if they really want to do this for a career. We want to have you here for 10 weeks and give you a real sense of what it's like to be a graduate student, so you can make your career decisions with open eyes, be that Ph.D., M.D., M.D./Ph.D., or even a career in industry without graduate school. Our goals were to give people both that opportunity to find that out about themselves, but also for us to be able to have our faculty give you the right advice on what might be the right next steps for you.

MISP: The MISP, Chem Bio, Comp Bio, and Engineering programs are directed towards college students. Can you talk about a particularly formative research experience you had during college?

Neill: When I first got to Northwestern and went to go talk to the chairman of the biomedical engineering program, he could see that I was hungry and interested in doing research, but that I didn't have a ton of necessary skills. One of the main skills that you need to build in research is being really good with your hands. So, he introduced me to a young professor (Dr. Chris Waters) who was doing work on surfactant, the fluid that lines the alveoli of the lungs to decrease the surface tension. This professor really wanted to build a surface tensiometer, wherein you trap a bubble in surfactant fluid, then very slowly push on that bubble and see how it deforms, allowing you to measure surface tension. Recall that at that time there were very specific gender roles: girls took home economics and boys took shop, so when he brought me to the

machine shop, it was my very first exposure to a lathe, a drill press, and saws. It was a challenge, but I loved it. This professor never treated me any different based on my gender. That first eye-opening experience of being treated as an equal and being given the keys to Candyland was phenomenal for me. The confidence he instilled in me was really critical. He believed in me, so I was able to believe in myself and my skills.

MISP: What is something you wish someone had told you while doing research as an undergraduate student?

Neill: You're going to fail 99% of the time. But you just have to keep going. And even when you do have some success, you're going to have to prove your conclusions in a different way before you can truly believe them: one of the most critical things to learn as a scientist is resilience. Science, especially in the biomedical field is not linear or logical, and you might get different results every time. This can be extremely frustrating, but it can also be really gratifying when you do figure out how to prove something. There are a lot of "fishing expeditions" that you go on: "We'll try this. We'll try this. We'll try this. We'll try this." Not all of them are going to work; not all of them are going to yield anything. Oftentimes, especially as you get further and further into a research career, there's such pressure to produce and you have to have integrity and dignity about not looking for an answer when one doesn't exist.

MISP: Having experienced these frustrations with science, would you get a Ph.D. again?

Neill: Yes, absolutely with no hesitation whatsoever. Getting a Ph.D. was absolutely critical for a number of reasons. It taught me to think critically. It gave me team-building experience such that I knew how to work collaboratively with others. It gave me excellent problem solving and multitasking skills. It built resilience. It taught me to deal with failure. It showed me how to navigate different kinds of hierarchies and power structures. The Ph.D. and the graduate school experience were absolutely critical for me to be able to define myself as a scientist and build the skills that I would need for the multitude of careers that I've had since then.

MISP: What advice would you give to someone who is contemplating pursuing a Ph.D.?

Neill: You have to have some amount of laboratory experience, like one of these summer internships, in order to figure out whether or not research is

for you. And you have to experience some failure because not everything is going to work. You have to observe the other people toiling in the lab to evaluate whether or not that's the kind of life you want because it's not a minimal commitment: it's a good three to eight years of your life. You have to want to do it. There's no doing a Ph.D. halfway. You have to go into it with some amount of a commitment and an understanding of what you're getting yourself into, which is part of why I think these internship programs are so critical.

MISP: How do you reflect on your experiences, especially those in science?

Neill: I reflect through commonalities and sharing those with my colleagues, my friends, and foremost with my family. That can occur whether it's over the phone, in a meeting during the day, over a beverage after dinner, or hanging out at the beach with friends on the weekend. I have a wonderfully diverse, large friend and family group that I lean on heavily. Twenty-seven years later, I still keep in touch with at least six different people from that internship program [at Carnegie Mellon]. I build lasting friendships. Coming back from that experience at CMU, it made me reflect on what I wanted to do with my life because I finally got some real-life experience, as opposed to just thinking about what that kind of career could look like. I didn't know any scientists when I was in high school. All I knew were medical doctors, which is a very different thing, and most of the medical doctors that I knew were in private practice. They weren't academic physicians. The internship opened my eyes to what a scientist could actually be and accomplish.

MISP: Many female scientists grapple with established gender roles, such as the home ec/shop dichotomy you mentioned prior. Can you elaborate on your experience as a female in science?

Neill: When it comes to living as a female scientist, I think I've been extremely lucky with the mentors I've picked, who have treated me in a race-blind, gender-blind, age-blind manner. As I grew in my career and had more choices, I chose my mentors extremely purposefully. It has always been very important to me to be treated as an equal. It also taught me, especially in my formative years, what kind of person and mentor I wanted to be to others. However, things did get more complicated once I started my life as an editor and was more frequently going to meetings; I was interacting with people whom I had previously only interacted with by email or phone. Because the in-person interaction can sometimes be influenced by what people look like

> and how they present themselves, I have unfortunately experienced a number of occasions when men have made a pass at me or said something extremely inappropriate. I've learned over the years how to deal with those interactions, how to put people in their place, and how to then temper my further interactions with them. This topic is one I feel very strongly about and have written extensively about in terms of my personal experience, as well as reflecting on other women's experiences.
>
> **MISP:** Finally, what is your favorite part of summer in NYC?
>
> **Neill:** The increased acceptance of having daily ice cream.

While she claims that naming a favorite ice cream parlor would "be like picking from amongst [her] children," Neill's top spots, with notable gelaterias, are Republic of Booza, Taiyaki NYC, Ample Hills Creamery, Oddfellows Ice Cream Co., il laboratorio del gelato, and Amorino.

We thank Neill for her time, wisdom, candor, and enthusiasm in this interview and in empowering undergraduate students on their academic, personal, and professional journeys in science. For Neill's narratives, visit https://www.scientificamerican.com/author/ushma-s-neill/.

2. Stay Connected to Your Values: Twitter??

Noah Lee, CBSP

I have to confess, I didn't update my LinkedIn after getting into the CBSP. And, throughout college, many people told me that Twitter was great for scientists, but I never got around to making an account. And I've attended science conferences just to hover over the snack table during breaks. 😓

I'm not the type of person to get blissfully buried in my work, so why am I a scientist? Do I want to help people? Solve challenging problems? Every time I thought I knew my motivation, it didn't feel strong enough.

This summer I cleaned up my LinkedIn, started a Twitter, asked more questions to presenters and peers, and found what I was missing: a professional network.

Figure 3.1. List out your values and take some time to assess your work. Which emotional or mental needs are fulfilled from this activity? What do other people doing the same work think? Example above: If I value learning and being analytical, I can examine my current project and determine it fits my desire to learn more so than being analytical.

Our values are reinforced when we participate in communities which share those values. By involving myself more in networks which actively address similar struggles and questions, I can better define which values are important to me and why. Connecting with others has made a huge difference in how I see my own science. If you're interested in pursuing the same changes, here is my Twitter advice:

Figure 3.2. Should we police arguments that follow this kind of logic? Twitter is a great place to learn how (and how NOT) to respond.

Browse the feeds of other scientists and look for great retweets and people to follow. Choose people in adjacent fields—design and communication have useful overlap with science—then remember these neat topics as conversation starters with people you meet.

Don't feel like you have to belong to a community to participate: people love to answer questions, so go ahead and be up front, "I love this but I'm not familiar with _____, what does that mean?" Practice to feel more confident about in-person questions for presenters and speakers!

Connect with social justice organizations which match your values and build your identity. It's important to remember that being a scientist doesn't erase who you are as a person or your relationship to the wider community.

Remember to keep your feed professional. Use different social media platforms mindfully—if you want to use Twitter to check in on current events and get exposure to professional discourse, keep it that way.

I'm still figuring out my own journey as a scientist, but being more present on LinkedIn, browsing Twitter, and participating more at seminars helps me feel a few steps further along. I hope anyone who feels in the same boat can explore these resources and make the same kind of progress. If you have any additional questions or suggestions, you can find me on Twitter!

3. On Patience

Tori Rasmussen, ChBSP

"Be patient" is a statement that every child is told, whether they are waiting to for it to be their turn, or if they are just waiting for a loved one's attention. As children, we are constantly told that we need to wait for what we want, but as young adults, this idea of waiting has started to become a foreign concept, especially in a world where every answer that you could ever need is at your fingertips through the 8 ounce device that never seems to leave our sides. Patience is not necessary when you can literally see if someone has read your last text message within seconds of sending. However, despite living in a world where patience is not always necessary, one place where patience is essential is in the lab.

On a daily basis, we run a couple of experiments and often times these experiments can take anywhere from a couple of minutes to multiple hours. And although good time management can help, allowing you to do multiple experiments at the same time, there are still those days where you are stuck waiting three hours with little to do. Throughout my experiences in different labs, there have been times where those three hours went by at the speed of light, and other times when I felt like I was watching a snail race.

More often than not, I was told that I should be doing research and reading scientific articles, and I would. But there were days where unpacking a dense piece of scientific literature was not going to happen, no matter how hard I tried to concentrate.

At the beginning of the summer, I longed for those times in between experiments because I could actually think about what I had just done in order to really understand not only the science behind it, but also the methods. It was important to be able to look at the protocol and unpack each instruction, trying to understand why they were all vital. And by doing this, I truly got a better understanding of everything that was going on. This was perfect

at the beginning of the summer when I was still learning everything, but as the summer went on and I had a better understanding of the research around me, those hours started to become longer and longer. However, even later in the summer I also found that on the days where I was performing miniprep after miniprep, I still longed for a reaction to take an hour, just so I could take a break.

I slowly realized that these hours in between experiments are a blessing and not a curse. They allow for a break, a reminder to slow down and realize what specifically is happening in the research instead of just following protocol after protocol. These times allowed me a time to check in, not only on what I was doing, but also with myself, to make sure that I was comfortable with what I was doing. And although the time in between experiments has tested my patience, I have realized that they are just as necessary as the actual research that you are doing. We scientists need to develop our patience just as much as any bench skill.

4. Working on the Front Lines

Ronit Langer, CBSP

I have always felt that the projects that I work on and the science that I do should not only be interesting, but useful. Therefore, throughout my undergraduate career as a computer science major I have always sought out biology labs working on the treatment of the future. However, all the science that I have done is at least five years away from helping a real person. What was revolutionary for me about coming to MSK was being able to work on the treatments of today.

On the first day of my internship, after my mentor described my project, she told me that once the tool worked they would give it to clinicians to help them diagnose patients. My jaw dropped when she told me this! My tool would be used by actual doctors on actual people?! I could not believe it. I sat down at my desk for the first time with a new sense of responsibility.

My project was to create a computational pipeline for detecting a common mutation in Acute Myeloid Leukemia (AML) from Next Generation Sequencing (NGS) data. The classification of this mutation has been extremely important because the mutation is known to cause lower survival rates and higher relapse incidence. However, today early detection is even more impactful because new drugs are coming to market that inhibit the growth pathway of this mutation. Due to the nature of NGS analysis, this mutation is difficult to

identify and therefore needed its own pipeline. The project was the perfect combination: advanced genomics, personalized medicine and most importantly, saving people's lives.

This summer made me realize that I want to be on the front lines, working on solutions that are relevant to patients today. And there is no better place to be doing that kind of work than at MSK, the best research driven hospital.

5. Knowing Science

Allison Chen, ESP

My mother's laboratory gleamed in the harsh light of fluorescent tube bulbs. Metal instrumentation and glass beakers sat on top of sterile lab benches in a state of organized disarray as machinery whirred softly in the background. Lifted straight from the pages of science fiction, my mother's laboratory was a world of creative freedom, innovation, and experimentation I wanted to one day join. I was seven.

It began with the stories. Every night around the dinner table, my mother would tell us about her day. Her stories of experiments gone awry and research group camaraderie of a merry band of slightly eccentric, rather eclectic, and very human scientists who worked with her captured my imagination and curiosity. Without fail, I'd ask her to further explain an aspect of her work. "What is a HCV Virus?", "How do you create a vaccine?", "Why does it work?"

My mom would pause and rather patronizingly state, "You don't have 'The Science'." By "The Science" she meant a foundation of scientific knowledge build from overpopulated college courses, hazardous chemistry labs, late nights studying molecular biology and Chinese takeout piled next to unfinished research papers. I, ignorant of virus and immunology, couldn't possibly have begun to understand these complicated systems, but I naively believed I could do anything I put my mind to which included reading my mom's 1000 page college textbook on Cell Biology. I had no clue what it meant. Aromatic amino acids sounded more like a spice than a fundamental of biochemistry. My mom was not too keen to explain these scientific mysteries to an eight-year-old who didn't know the science.

It has been my dream that with determination and hard work, that I too would be able to do cutting edge research and be part of a new generation of scientists using novel engineering technologies to cure diseases and help people live better and longer lives. Working at the Memorial Sloan Kettering Engineering Summer Program challenged me to run and design experiments independently and gave me opportunities to learn from expert leaders in their

field. Most importantly, this summer I learned how to think scientifically and to ask critical scientific questions. MESP is unlike any other research institution such that it promoted a unique opportunity to work closely among mentors and students as well as gaining access to an amazing group of world class scientific experts.

In the first two weeks of work, my mentor unloaded more papers for me to read than I'd ever attempted within a relatively short time frame. I later learned she had over 200 journals stored away in her laptop, each labelled with "Title, Authors et al, Journal Name, and Year" for easy reference access. I struggled over those papers for days as I began cobbling the data dump into something that made sense. Sometimes I'd cross reference my garbled thoughts with my mentor's understanding, but more often than not, I was wandering somewhere between explanations of "imatinib" and the "p-selectin" selective properties of specific seaweed polymers.

After a period of information absorption and learning by osmosis, I learn the art of "organization" and "how to learn". Finally, pieces of data flowed together and out emerged a beautiful piece of science. MESP's intellectual community encourages both personal and scientific growth and is set up to give scientists the environment to do the best research they're capable of. My mentor was eager to advise me and the one-on-one chats with my PI gave me insight into a variety of research bridging engineering technology with biomedical sciences to explore novel methods in drug delivery and cancer therapeutics. MSK is a vibrant and diverse environment in which students and scientist from all over the world and with different disciplines come together to do cutting edge science for the betterment of mankind.

Now, nearly twelve years of education separates me from the kid asking her mother questions. Perhaps this entire summer experience could be described as a deeper glimpse. For some, they see a choice about the next four years, for others a potential field of study for the rest of their lives searching for answers to their scientific inquires. Immersed in a collaborative environment of experiments, papers, and analytical data at the Heller Lab at MSK, I grew more confident in my abilities and slowly pieced together ideas of my own future.

I once stood at the foot of the Eiffel Tower, an engineering marvel made of wrought-iron lattice towering over 1000 feet overlooking Champ de Mars in Paris, France. From its base I recognize names of engineers like "Coulomb" & "Ampere" engraved on the sides of the Tower. Isaac Newton said, "If I have seen further, it is by standing on the shoulders of giants." At MSK this summer, I have clearly wandered among many giants and stood on the shoulders of the giants to be.

At one of the many summer seminars, MSK president Dr. Craig Thompson spoke on the topic of cancer research and I got a wider glimpse into the vast amount of work done by past scientists so we in the present moment could "know the science". Dr. Thompson mentioned work done by Rockefeller University's Charlie Rice and his group's success on finding a cure for the Hepatitis C virus. I quickly texted my mom about Dr. Rice's HCV work in hopes of gleaning a bit more scientific insight. My mom texted back a happy face emoji and perhaps this time, I am closer to "knowing the science". And so, it goes.

6. The Twentieth Floor's Cacti

Catherine Stratis, MISP

Gazing out the window of the twentieth floor of Zuckerman, I cannot not help but notice the outstanding number of cacti that line the lounge area's perimeter. There are all different variations of cacti on display — prickly, smooth, tall, small, thin, wide. Some have leaves, while others look like they have arrived straight from the desert, or a cafe on the LES. Most have bright green exteriors, bursting with the verdant pigments of chlorophyll. They stand upright, towards New York City, unapologetically boasting their unique botanical swag.

As a certified science nerd, I can relate the inner-workings of plant cells, the intricate biochemical processes of photosynthesis, and the ingenious function of their cuticles, with slight pain in reminiscing upon enduring BIOL 100. However, seeing these cacti everyday initially perplexed me. They seemed to exist everywhere: a window sill, side table, and bathroom sink counter are all incomplete without the obligatory cactus — or perhaps fish tank, but that's another metaphor. Anyway, what is the deal with all the cacti?!

One day, I had a breakthrough. We have all become acquainted with the penchant of science to exhibit unexplainable phenomena. With no rhyme or reason, some things just happen — one being the eerie, yet charming, omnipresence of cacti on the twentieth floor of Zuckerman. Rather than attempting to rationalize these enigmas, we must relish in the uncertainty. We must look for new ways to appreciate how some things just are. Being comfortable with this uncertainty prompts future thought and creativity. Simultaneously, we can hypothesize and experiment to gauge some closure -- "empirical data" -- in our pursuit of knowledge and sensibility.

Consequently, I attribute this succulent sensation to the desire to beautify and placate the work environment. Incorporating the natural into the industrial reminds us that we are more than multicellular robots and mitigates the day-to-day stresses of research. Incapable of constraining my brainstorm to mere logic, I reached the conclusion that our summers at

MSK are much like these cacti. Each experience is special in its own way. Most are rough around the edges, as time and effort are necessary to adapt to the lab setting, get into a groove, and find one's niche. Some have spikes; as Ushma told us, not all will absolutely love their projects. Some will be smooth, with topics similar to research done during the academic semester on home campuses. Maybe there will be some bumps on the surface, like an ethanol spill, loss of cells that delays your project a week, or an accidental text to your mentor after consuming an alternative sample of ethanol (I have only committed the second!).

Still, all successes and failures serve vital functions in our personal, professional, and personal lives, and in the greater field of research. We soak up new information like a cactus does water, preserving it to sustain our ongoing experiential and intellectual growth. Our passion for science, desire to positively impact society, and ability to think outside the box deem us the next generation of experimental visionaries. We stand upright towards New York City, towards the world, unapologetically boasting our thirst to learn and grow.

(The cacti are actually in the lounge because the FDNY characterized them as a safety hazard and in danger of contamination.)

7. Of Research and Reflection: A Summer at MSK

Caleb Sooknanan, MISP

It was 9:00AM on June 4th, 2019. I had just arrived at the Zuckerman Research Center to begin the first legitimate day of my project. The day before, I had outlined plans for the week with my principal investigator. The first step involved the need to design a functional imaging analysis program. The second step involved using that program to analyze MRI tumor data in an organized and understandable format. Despite having prior experience with MATLAB from my university's programming class, my initial impressions of the upcoming responsibilities could best be described with the following situation: a small turtle must climb up and over a steep hill, unaware of what was lying on the other side. It could accept the task or — just as easily — turn around and go home. Admittedly, I was not new to research, with my school experiences helping me realize how easy it could be to take on research or do something else entirely. I had also come to terms with how unpredictable research was and how fortunate I would be to obtain the slightest hint of results corresponding to my initial hypothesis. The door had opened for me, however, to embrace my summer as a Memorial Sloan Kettering research intern, regardless of what challenges I would have to confront.

To my surprise, my research experiences this summer were more refined and enriching than I ever thought would be possible from this kind of internship. My research group this summer consisted of only three members: me, my principal investigator, and his trustworthy postdoc. The small size of the group allowed me to develop and strength close bonds with two very knowledgeable MRI specialists. At many points this summer, we discussed radiomics followed by unrelated conversations related to television and even video game speed runs. The dynamic I experienced with my research staff was undoubtedly rewarding, and I never felt as if I was falling behind in my work. The small group also opened my eyes to the different kinds of cancer research possible at Memorial Sloan Kettering. Unlike many of the laboratories to which other interns were paired, my laboratory consisted of an office space, with all research being conducted through computers and programs such as MATLAB and SPSS. It may not have been what I was initially expecting, but the unique research setting helped me understand the different, and perhaps more realistic, facets of MRI research and image analysis. So often in the past I have associated research with frizzy hair, chemical concoctions, and oversized goggles, but several forms of data analysis — much like medical data entry — requires the mere use of a computer. This provided more opportunities for me to understand the mathematical and technical perspectives associated with cancer imaging and cancer biology. Beneath the simplicity of my setup was a research project integrating concepts I had learned from my molecular biology course, programming course, and bioimaging course, in addition to concepts I had never explored before.

Some of the ideas associated with research still held true though. A fair amount of reading was involved, but my principal investigator and postdoc were very willing to provide insight towards concepts I did not understand. As a budding researcher, I have come to appreciate the time I have spent at Memorial Sloan Kettering. With my experience here, I have strengthened my understanding of how to present scientific research and communicate such knowledge with different audiences; such a skill will be absolutely vital for my work as I return to college this fall. My time here revealed the importance of asking questions and not being afraid to speak up, even when the desired outcomes are not the ones always received. This has probably been stated several times before, but research is not merely about the outcome. The journey is far more important.

8. Supplemental Information

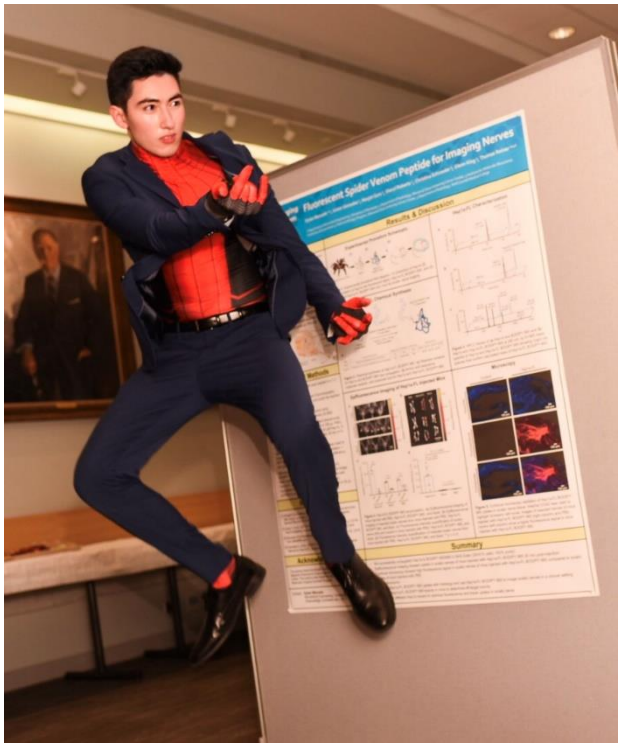

Figure S1. Dylan Manuele (MISP) at the Summer @ MSK poster session.

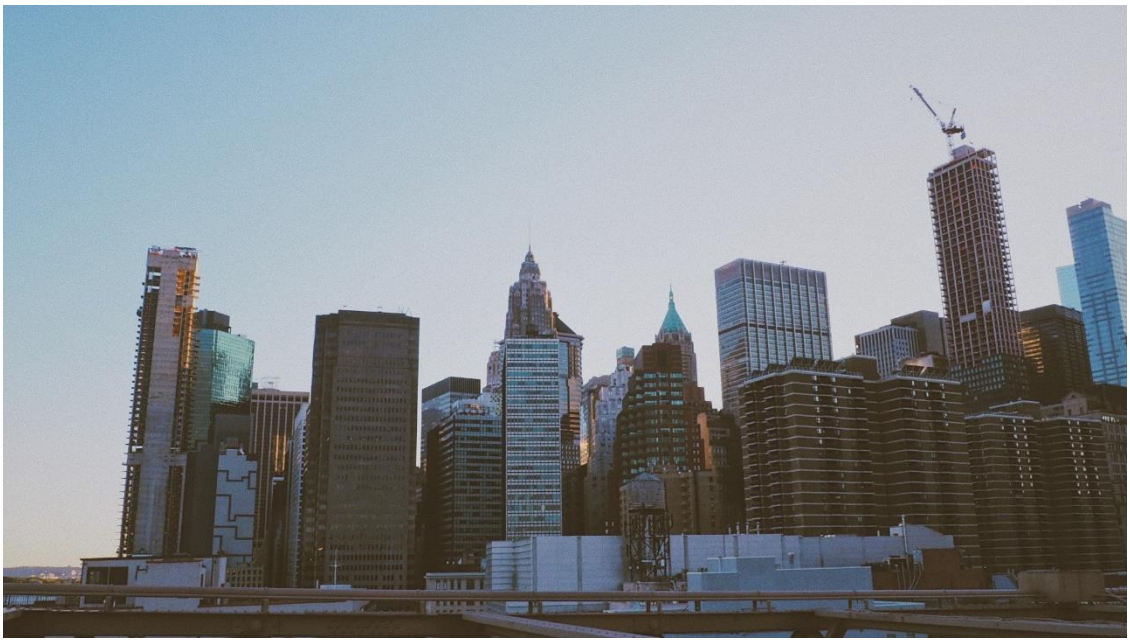

Figure S2. The New York skyline, taken by Evelyn Tong (ESP).

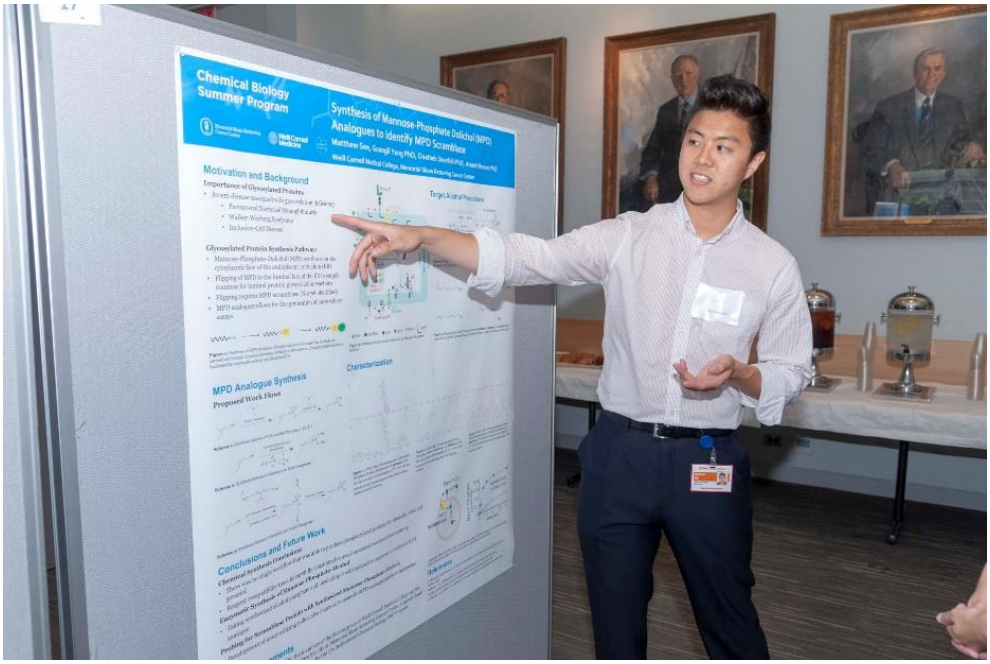

Figure S3. Matt See (ChBSP) at the Summer @ MSK poster session.

Figure S4. CBSP intern Manaswitha Edupalli explores New York City.

Figure S5. Interns enjoying their ride on the Staten Island Ferry.

Figure S6. Interns taking a walk in Battery Park.