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Great Neck South High School

Great Neck Breast Cancer Coalition Student Research Internship

Rensselaer Polytech University; Summer 2014

Big, glass, and sleek would be the way I would describe Rensselaer Polytech Institute's Center for Biotechnology and Interdisciplinary Studies building, where I was fortunate enough to spend half my summer working on a chemical engineering project. I was mentored by Dr. Richard Gross along with his post-doctoral students. For six weeks, I lived, breathed, and sweat science.

The very first time I met Dr. Gross was on a Monday morning. I was a bit anxious to speak with a leading scientist who also happened to have a Ph.D. however, Dr. Gross was not the least bit intimidating; he was calm, collected, professional, and very eager to speak with young scientists who were interested in learning and performing experiments in his field of green chemistry. We talked about what I was interested in doing as well as what his students were currently working on. After having a general idea of how his lab ran, I was invited to "shadow" his students while they explained what they were working on to get a visceral feel of the goals they were pursuing. By the end of the day, I had chosen who I wanted to work with for the duration of the summer. The day after, I began planning out my project: This included determining what materials I wanted to work with, what my goal would be, as well as how I would set out to achieve my goal.

I chose to do a chemical engineering project using paraffin oil and Cellulose Nanocrystals in order to formulate an optimized paraffin oil emulsion. Emulsions are, essentially, a suspension of minute particles of a liquid within another, immiscible liquid. Normally, two immiscible liquids would not mix; even if shaken up with extreme force, they would eventually separate into two layers (like salad dressing). In order to emulsify these two liquids then, I must introduce a surfactant, which acts as a "middle-man" between the two liquids, preventing them from separating. The specific emulsion I focused on was an oil in water Pickering emulsion, which just means the emulsion is stabilized by solid particle surfactants. Cellulose Nanocrystals (CNCs) are nanosized fibrils of cellulose. The beauty of them is that we can add organic acid groups (citric acid, levulinic acid, acrylic acid, etc.) onto them via acid hydrolysis and Fischer esterification. The entire summer, I worked with three materials: CNC (unmodified CNC, citric acid CNC, and levulinic acid CNC), water, and paraffin oil, all of which are green and natural materials. After determining what CNCs I would use, I began designing how I would optimize my emulsion. I defined "optimal" as a one-phase emulsion that had an average droplet size as small as possible (ideally around 400nm) and did not have flocculation, coalescence, or oil separation. Flocculation and coalescence occurs when the previously minute suspended droplets join and stick to each other, causing larger droplets to form. Oil separation is when oil floats to the top, a bad sign because the whole point of my research was to prevent the liquids from separating. In order to achieve my goal, which I did, I manipulated factors such as weight% composition of oil and CNC, duration and temperature of homogenization and incubation, homogenizer type, etc.

I chose my project because the FDA does not regulate many lotions and cosmetic on pharmacy shelves. This is because these products are topical, meaning they are placed on the skin only, not injected or ingested. The skin however, is not solid, but rather porous, allowing an exchange of materials. Many of the aforementioned products contain toxic, carcinogenic, or unsafe ingredients that are cheap, easy to produce, and small enough to pass through the skin. Lotions and oils are mainly mixtures of water, oil, surfactant, and aromatic compounds. By targeting three of the four main ingredients (paraffin oil is a chief ingredient in many lotions), I hoped to produce a safe, green alternative to current products. Cellulose Nanocrystals are biodegradable and non-toxic. Cellulose itself is safe if ingested, as it passes right though the human digestive tract.

A typical day in the lab lasted about 10 hours. When I first arrived at RPI, I thought I'd be in the lab for 8 hours a day max. I soon learned that science is not a 9 to 5 job. No, not at all. Work started as soon as I planned my day and ended when I analyzed my last sample. There were times I was the last one out of the lab. I remember seeing the entire hallway as a line of black workrooms—everyone had left and the lights had auto-turned off. Once, I recall, I put in approximately 14 hours of straight lab work, from 9 til 11. Lunch and dinner often had to wait until after I finished analyzing or making an emulsion; sometimes, that did not happen until after 2 or 8 pm. My life was breakfast, work, lunch, work, dinner, work. Repeat. If I got lucky, I finished before dinner, if not, well, that meant more lab hours. But I loved every minute of it. I thrived off caffeine and artificial light because every minute I put in meant that I was one step closer to achieving what I set out to accomplish.

In the end, I was successful at optimizing a paraffin oil emulsion using levulinic and unmodified CNC. Citric acid CNC emulsions did not yield as good characteristics as the previous two, which I suspect is due to the morphology of citric acid itself. The surface chemistry of the CNCs themselves had an impact on my emulsion results, which may explain why each behaved the way it did.

In November 2014, I was fortunate enough to be given the opportunity to travel to the Breast Cancer and the Environment Research Program's (BCERP) annual conference in San Francisco, California. There, I listened to researchers discuss their innovative findings. Later, I presented my poster to them, and they asked me many questions about the research I conducted. What struck me the most was how the researchers, people with Ph.Ds and years of experience, treated me as a contemporary, a colleague. None of the researchers I spoke with "dumbed down" their explanations or questions because I was a high-school student. It made me realize that I am part of a larger community working towards the same goals: We share the same drive- to reduce, prevent, and educate people about breast cancer.

I would like to thank Mrs. Laura Weinberg, Mrs. Lisa Levine and the entire Great Neck Breast Cancer Coalition, without whom, my enlightening and wonderful experiences would not have been possible. I would also like to thank Dr. Gross and his students for all their help inside and outside of the lab. Although I was able to optimize two emulsions, my work is only the foot-in-the-door. The research I conducted was one of the first ever on its topic and there remains so many more experiments, trials, and tests that can be built upon my results. However, despite the immense amount of research that has yet to be done, I believe that with the support or the entire community of breast cancer researchers, we will one day finally be able to prevent and cure breast cancer.