Above: Nivedina Sarma and her group members. Image credit: Hyeongjoo Row.

Undergrad Research Lays Solid Foundation for Grad School

When Nivedina Sarma received a Graduate Research Fellowship from the National Science Foundation in 2020, it came at the culmination of a successful undergraduate research career and was to provide support during a PhD program in Materials Science at the University of California, Berkeley set to begin that Fall. The transition from undergrad at the University of Chicago to grad student at Berkeley ended up coinciding with the early days of the COVID-19 pandemic, so the first year of the program kicked off fully remote.

"My group was developing a strategy to deliver a hydrophobic drug that would induce regeneration in mammalian tissues," explained Sarma. "The technique involved conjugating the hydrophobic small molecule to a polymer chain to make a self-assembling system. That felt like the perfect blend of my interests in self-assembly and regenerative medicine, and since I couldn't get into the lab yet, I built a molecular dynamics simulation to explore what structures we could make if we varied temperature, concentration, and drug load on the molecule."

Last year, those findings and their implications for bioactivity were published in the journal *PNAS*[i]. Sarma credited the project with demonstrating simulation as a powerful and effective tool for visualizing processes that happen at time scales which are too fast and length scales that are too small for people to otherwise probe. By Sarma's own assessment, it's been the experience of learning the statistical mechanics and thermodynamics that underpin building physically realistic models of soft materials that her graduate school career has turned on, in addition to "blending theory, computation, and experiment to understand their behavior."

If these sound like the words of someone who fully grasps the complex nature of their work and is prepared to see it through, it's because Sarma has been confronting a healthy curiosity for learning with an impressive work ethic since time in the Tian and Talapin labs at the University of Chicago, studying chemistry as a Beckman Scholar. Through the Beckman Scholars Program, the Arnold and Mabel Beckman Foundation provides 15-month mentored research experiences to exceptional undergraduates in chemistry, biological sciences, and interdisciplinary combinations thereof.

"I was inspired to apply for the Beckman Scholars Program after my first summer doing research in the Tian lab," explained Sarma. "I thought the application, which involves writing a proposal and presenting it to a panel of professors in various fields, would be a fun way to learn how to write for and speak to a scientific audience. I still look back on those weeks of preparing the application as one of the most intellectually and creatively fulfilling times in college."

The experience introduced Sarma to self-assembly in living and synthetic soft materials and catalyzed a deep interest in material-biology interactions as well as electronic materials and nanoparticle surface chemistry. In the Tian group, the work involved making photovoltaic composites to pace cardiomyocytes, the aim of which was to deliver electric stimuli that could correct for arrhythmias. Results were published in the journal *PNAS*[ii] in 2018. In the Talapin lab, Sarma worked on a team that synthesized and studied crystals with higher conductance per number of particles than any system previously reported and published their results in the journal *Science*[iii] in 2022.

Above: Nivedina Sarma and her group members.

Collectively, Sarma's extensive research work at the undergraduate level, mentored by not one but two science department faculty, positioned her for a successful launch into graduate level work, the results of which are already being seen. Unsurprising, given that during a time when much of the world was understandably still adjusting to new, remote work situations, Sarma was contending with the same and concurrently headlong into building a molecular dynamics simulation – satisfying a curiosity to continuously learn, and a drive to innovate. ■

i (2022) "The influence of molecular design on structure–property relationships of a supramolecular polymer prodrug." https://www.pnas.org/doi/epdf/10.1073/pnas.2208593119

ii (2018) "Optical stimulation of cardiac cells with a polymer-supported silicon nanowire matrix." https://www.pnas.org/doi/abs/10.1073/pnas.1816428115

iii (2022) "Self-assembly of nanocrystals into strongly electronically coupled all-inorganic supercrystals." https://www.science.org/doi/10.1126/science.abm6753?url_ver=Z39.88-2003&rfr_id=ori:rid:crossref.org&rfr_dat=cr_pub%20%200pubmed

Right: Nivedina during her time as a Beckman Scholar at the University of Chicago. Image credit: Kiran Misra.

"Working on the cardiomyocytes project [in the Tian lab] piqued my interests in materials science and regenerative medicine. Heart tissue is a highly specialized material – it's electrically active and it doesn't regenerate, so if the signaling in one area of the tissue goes awry, that has large consequences to heart function and overall human health. Since our approach used photovoltaic silicon nanowires to pace the cells, I started thinking more about material-biology interactions and wanted to learn more about electronic materials and soft materials.

"In the Talapin lab, I studied self-assembly as a path to making ordered, electronically coupled materials from colloidal nanoparticles. With this project, I dove into nanoparticle surface chemistry and how various post-assembly modifications, like ligand exchanges, allow us to realize emergent properties in the materials."