Carnegie Mellon University
Mellon College of Science | **Physics**

Department of Physics Virtual Outreach

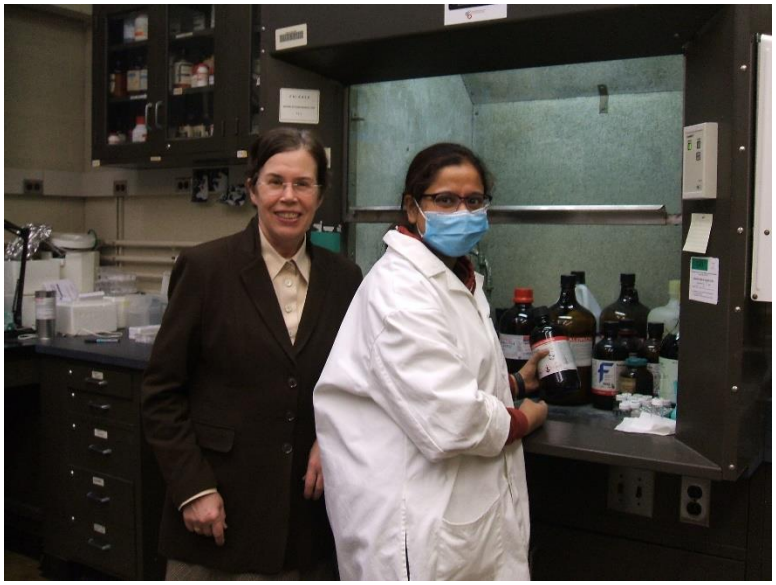
On October 21st, 2021, Professor Stephanie Tristram-Nagle and postdoc Dr. Saheli Mitra appeared virtually to students of Dr. Waldeck's class at Taylor Allderdice High School. What would normally be in the busy labs of Wean Hall was presented over Zoom to accommodate Covid-19 protocols. Professor Tristram-Nagle and Dr. Mitra showcased their research through PowerPoint presentations and a short movie (https://cmu.box.com/s/ndbcn906pziezicwiabe4ke8sq0wacfq) filmed with the help of Physics Department undergraduate student Tim Mahoney.

The movie features Professor Tristram-Nagle explaining the rotating anode X-ray instrument and the history of X-rays and their use. Her group uses X-rays to research antimicrobial peptides and how they interact with lipid membranes that are mimics of bacterial membranes. Antimicrobial peptides exist in nature and help with the immune system, and lipid membranes are an important outer barrier of a cell. Dr. Tristram-Nagle explains what it looks like when lipid membranes mimic bacterial membranes, "Bacterial cell membranes have an underlying structure of lipids with a water-loving headgroup and grease-loving tails. They self-assemble into a bilayer arrangement with the headgroups facing outwards and the tails facing inward towards each other."

The X-ray machine sits on top of a heavy table ready to be used by students who have prepared their own samples. Once a tool for Professor Robert Suter's lab, it has been operated and repaired by Professor Tristram-Nagle for the last decade. Dr. Tristram-Nagle adds, "X-rays are used to determine the lipid bilayer thickness". Students will get to see if "the antimicrobial peptide thickens or thins the

membrane". The X-ray diffuse scattering (XDS) data also "tells us about rigidity of the membrane and the ordering of the lipid tails." By using XDS, students find out firsthand, "if the antimicrobial peptide goes into the headgroup region or the tail region at the molecular level. These are all details that tell us about the mechanism of how these peptides kill bacteria at angstrom level resolution" (Tristram-Nagle). Tactile experiences like sample preparation allow students to have an in-depth experience in an area otherwise not in their direct studies.

Stefanie Garcia, who coordinated the virtual field trip, shared: "I personally wish that I had seen a presentation like this when I was in 11th grade in high school, which was when I became very interested in studying physics in college. Despite Dr. T-Nagle's faculty talk having a lot of technical vocabulary that I may not have understood at that age, I would have hung onto every word of her presentation because she is someone that I personally would have aspired to be like."



Dr. Mitra's presentation showcased her Ph.D. research conducted in India: "Interaction of Ionic Liquids with Lipid Model Membranes". Her interest in this subject grew during a small project she participated in after completing her M.Sc. She enjoyed exploring how biological interactions can be explained by basic principles of physics, and this eventually led her to her current research with Professor Tristram-Nagle at Carnegie Mellon University.

Dr. Mitra set aside some time to talk about her process of becoming a physicist and steps to consider as a young person dreaming of entering the scientific community. Meeting with successful women in the sciences can be an inspiring experience for others: “It is very powerful for young women in High School, especially those interested in predominately male fields like Physics, to hear from mentor figures like Professor T-Nagle and Dr. Mitra,” Stephanie Garcia remarked.

Ms. Garcia wrote, “[…] I would like to highlight all of the time and effort that the T-Nagle lab put into the event in regards to planning their presentations, and working through the Act153 clearance process. They always had time to email and meet with me in regards to problem-solving any issues that arose. I would be honored to work with them again on future outreach events, and I appreciate the enthusiasm and excitement that these two individuals have for 9-12 STEM education and outreach".

With the National Science Foundation’s continued support of outreach experiences, the program was repeated on May 11th, 2022, with high school students from Eden Christian Academy joining Professor Tristram-Nagle and Dr. Mitra in person along with several other professors. Vivian, a visiting student, reflected, “My favorite part of the day was when we were able to see the machines that they used and when we conducted an experiment ourselves.” While the video was used again explaining the X-ray instrument so participants could hear the specially recorded audio carrying Professor Tristram-Nagle’s soft voice over the loud machinery, the Wean Hall labs were now busy with the smiling faces of visiting students making their own lipid membrane samples.