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The Interactions of Dendrimer-Conjugated Vancomycin with a Model Bacterial Surface

I worked with Professor Sinniah on a study that examines the use of dendrimer-conjugated Vancomycin in targeted drug delivery. Vancomycin is a powerful antibiotic that is used to treat illnesses caused by Gram-positive bacteria. However, when a bacterial strain mutates and becomes resistant, Vancomycin is unable to bind effectively to the cellular surface, making it unable to enter the cell and halt the infection. In response to this challenge, Dr. Seok Ki Choi of the University of Michigan has developed a dendrimer (a synthetic, globular molecule with Vancomycin attached) as a means to deliver Vancomycin into bacterial cells. Dr. Choi's study has shown that the average binding capabilities of the dendrimer-conjugated Vancomycin to model bacterial cell surfaces are far better than the binding of Vancomycin alone. The goal of our study was to quantify the force interactions of a single dendrimer molecule with a model bacterial surface to determine if the dendrimer-conjugated Vancomycin maintains a superior binding capability on the singular scale.

We used Atomic Force Microscopy to study the force interactions of the dendrimer with the model surface. Atomic Force Microscopy utilizes a cantilever and a laser to quantify force measurements: the dendrimer is attached to the tip of the cantilever, which is then lowered to the model cell surface. As the cantilever pulls away from the surface, any interaction between the dendrimer and the surface causes the lever to bend, and this bending movement in turn affects the movement of a laser that reflects off the back of the cantilever. The laser movement is recorded using a detector, and the data is transcribed and translated into digital data on the computer.

This summer we focused on developing a reliable experimental methodology. Our results so far show that the dendrimer-conjugated Vancomycin binds to the surface within the expected force range of 30 to 100 pN. We will continue with more experimental trials to enable greater precision and accuracy, and we also plan to use mathematical models to determine the kinetic binding constants of the Vancomycin-surface interaction.

Personally, I have gained a lot of insight and experience into the technique and skill required to work with force spectroscopy. I have been able to practice the physical skills required to handle the delicate instruments and dendrimer materials as well as the analytical

skills that are required to interpret the large amounts of data produced in each experiment. I look forward to continuing to do research at Calvin in the future.