Peptide-driven biomineralization for controlled intracellular drug delivery

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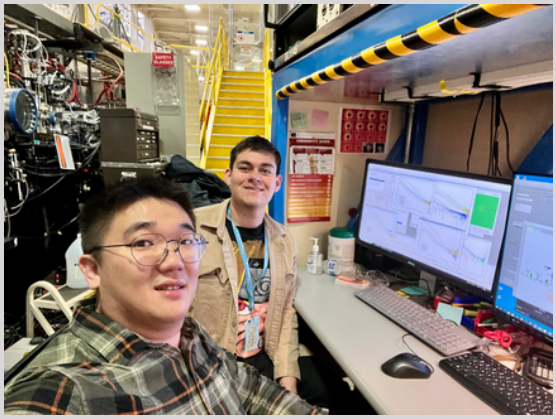

Chen with Gianneschi lab member Nathan Rosenmann

Living organisms adapt to the environment ingeniously and assemble various organic composites with exquisite hierarchical structures through biomineralization to fulfill physiological functions. Replicating this hierarchical design principle in synthetic materials has long-attracted scientists, from both the perspective of the fundamental science and that of potential biomedical applications. Peptides, as natural ingredients of biological systems, are intriguing candidates for this purpose. The dynamic nature of noncovalent interactions amongst the peptide building blocks dictates that their supramolecular assemblies can be precisely regulated through various kinetic parameters. Despite their ubiquitous nature, we have a surprising lack of knowledge regarding precisely how peptide molecules self-assemble in solution, or undergo even the most basic changes in morphology, size and structure. Until recently, the lack of viable characterization techniques hindered direct observation of peptide nano-assemblies in solution, particularly those exhibiting stimuli-responsive behaviors in real time.

In this NU-TAU nanoscience and nanotechnology exchange program, we propose to provide fundamental insights into the underlying molecular mechanism of peptide hierarchical self-assembly and lay the basis for a biocompatible drug delivery platform with stimulus-response. A primary goal of this collaborative research program is to develop a fundamental understanding, based on direct observation and characterization, of the dynamic behaviors of peptide nano-assemblies in solution. During my time at Northwestern University, I had the opportunity to acquire expertise in liquid cell Transmission Electron Microscopy and cryogenic Transmission Electron Microscopy. These cutting-edge imaging methods facilitated our investigation of nanoscale solvated peptide structures and enabled real-time observation of dynamic changes in solution in response to stimuli. In addition to that, I was able to learn X-ray absorption spectroscopy characterization technique at Advanced Photon Source during the exchange, which allowed us to combine in-situ imaging techniques with X-ray absorption spectroscopy to elucidate dynamic morphological transitions and the local geometry of peptide assemblies.

Overall, this fruitful and informative exchange program between NU-TAU Nanoscience and Nanotechnology strengthened research collaborations between the Gazit group at Tel Aviv University and the Gianneschi group at Northwestern University. Personally, these experiences have enabled me to gain a deeper understanding of in-situ transmission electron microscopy and synchrotron X-ray techniques. I firmly believe that these invaluable experiences will have a profound impact on my future research endeavors.

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