Department of
Mechanical Engineering
The University of Hong Kong

SEMINAR

Title: **Understanding Fundamental Molecular Mechanisms of Lipid Membranes and Developing Design Principles for Biomimetic Membranes**

Speaker: **Dr. Di Jin**

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Venue: **Room 734-735, Haking Wong Building, HKU**

Date: **March 24, 2025 (Monday)**

Time: **9:30am**

Abstract:

Direct angstrom-level, nano-Newton force measurements with the surface force balance (SFB) have revealed that phospholipids, in the form of single-component lipid bilayers, are remarkably effective biolubricants, with friction coefficients comparable to those of synovial joints such as hips and knees. However, synovial joints contain over a hundred lipid species.

This proliferation of lipids raises a central question: is it natural redundancy, or does it contribute synergistically to optimize lubrication at cartilage surfaces?

Existing SFB experiments on a limited number of mixed-lipid membranes have demonstrated that certain combinations can exhibit superior lubrication properties, yet the underlying physical principles remain unclear. To address this, we investigate the roles in the mixed-lipid membranes of the most common synovial lipids, and relate their presence to the synergistic behavior observed at the holistic level, particularly in dynamic membrane processes such as hydration lubrication and hemifusion. This research integrates molecular dynamics simulations, artificial intelligence, and AI-guided AFM experiments, enabling high-throughput exploration of the vast parameter space of mixed-lipid membranes. We also use the SFB—with its unique sensitivity and resolution in measuring membrane interactions —to validate and refine our conclusions.

As our understanding of these biophysical processes deepens, we can better interpret the design principles shaped by evolution and assess the extent of possible redundancy. Ultimately, these bio-inspired insights will guide the development of artificial, biocompatible lipid membranes with a spectrum of properties depending on their composition. These range from better lubrication treatments at one end, as for widespread joint-related diseases such as osteoarthritis, to better drug-delivery by lipid-based nanocarrier vesicles (liposomes or lipid nanoparticles) at the other, through more facile vesicle-membrane/cell fusion processes.

Biography:

Dr. Di Jin is currently a research associate in the Department of Molecular Chemistry and Materials Science at the Weizmann Institute of Science in Israel. She received her Bachelor's degree in Environmental Engineering from the Massachusetts Institute of Technology in 2013. Following her Master's degree in Environmental Fluid Mechanics and Hydrology from the University of California, Berkeley, she studied microbial motility at the Cavendish Laboratory, Department of Physics, at the University of Cambridge and received her Ph.D. in 2019. Since 2018, she has been a postdoctoral researcher and later a research associate in Prof. Jacob Klein's group at the Weizmann Institute of Science. Her current research focuses on using state-of-the-art surface interaction measurements, molecular dynamics simulations, and artificial intelligence to study biological membranes and confined liquids.

ALL INTERESTED ARE WELCOME