Molecules at the Membrane: Structural Mechanisms of Aggregation and Disruption

Speaker: Dr. Venus Singh Mithu

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ABOUT THE SPEAKER:

Dr. Venus Singh Mithu is a nuclear magnetic resonance (NMR) spectroscopist with over 12 years of post-PhD experience in exploring the structural and dynamic aspects of chemical and biomolecular systems. His research has significantly contributed to understanding amyloid aggregates implicated in Alzheimer's disease and Type II diabetes, supporting structure-based drug design. From 2014 to 2023, he led an independent research group developing design principles for bioactive ionic liquids. He has secured national and international research funding, collaborated across disciplines, and managed research infrastructure. Currently, he is a Research Associate at the Max Planck Institute for Multidisciplinary Sciences, Göttingen, following previous roles as a Humboldt Fellow and Manfred Eigen Fellow. He served as Assistant Professor at Guru Nanak Dev University, Amritsar, from 2014 to 2023.

Dr. Mithu earned his Ph.D. and Master's degrees from the Tata Institute of Fundamental Research, Mumbai, and his Bachelor's in Chemistry from Panjab University, Chandigarh. His accolades include fellowships from the Alexander von Humboldt Foundation, Max Planck Society, and DAAD. He has supervised four Ph.D. and eleven Master's students, several of whom now hold postdoctoral positions in the United States.

ABSTRACT:

This talk presents two independent studies that investigate membrane-associated molecular processes through solid-state NMR and complementary biophysical techniques.

Amyloid Aggregation in Type 2 Diabetes: Aggregation of human islet amyloid polypeptide (hIAPP) into fibrils is a hallmark of β-cell dysfunction in type 2 diabetes. We used solid-state NMR to characterize hIAPP fibrils formed on phospholipid membranes at physiological pH. At pH 7.4, fibrils are homogeneous; at pH 5.3, they show polymorphism and C-terminal variation. The N-terminus undergoes a helix-to-strand transition, likely driving membrane interaction and fibril stabilization. Our findings provide the first structural insights into membrane-mediated hIAPP fibrils.

Ionic Liquids Meet Biomembranes: Ionic liquids (ILs) are promising green solvents, but their amphiphilic cations can disrupt membranes and induce cytotoxicity. Using dye leakage assays and solid-state NMR, we identify critical structural and compositional factors that govern IL-induced membrane perturbation and toxicity. We validate this structure–property model by designing new ILs with tailored membrane interactions and controlled bioactivity. This framework guides the development of safer, more targeted biomedical ILs.

HOSTED BY:

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