Chemical Probes for Lighting up Life Processes

Ankona Datta

Department of Chemical Sciences, Tata Institute of Fundamental Research, 1 Homi Bhabha Road, Mumbai, India

Email: ankona@tifr.res.in

Dynamic changes in molecular levels and distribution are associated with all life processes and importantly regulate key decision-making events in biology. Thus, spatiotemporal dynamics of small molecules and ions are central to biological function ranging all the way from the essential, encompassing cell-signaling, transport, immunity and recycling, to most pathophysiological conditions including cancers, inflammation, and neurodegeneration. In this backdrop, the ability to catch molecules of life in action using optical imaging modalities is extremely powerful, enabling visualization of the spatial organization and temporal dynamics of molecules within living systems. Central to scientific endeavors in visualizing molecules in action toward deciphering life processes are chemical probes that can non-invasively enter living systems and report on molecular localization in an optical imaging set-up. My research group works on the development of rapid-responsive optical probes and sensors for temporal-tracking, quantification, and imaging of bio-molecules within living systems.[1-4] Our USP lies in strategically combining fundamental insights from coordination chemistry and molecular recognition along with computations to design novel small-molecule and peptide-based sensors. In this talk, I will highlight our recent endeavors in chemical sensor development for lighting up signal-mediating lipids, phosphoinositides, in living cells (Figure). [1,3] Finally, I will touch upon our recent efforts toward live multiplexed imaging of bio-analytes.[2,5]

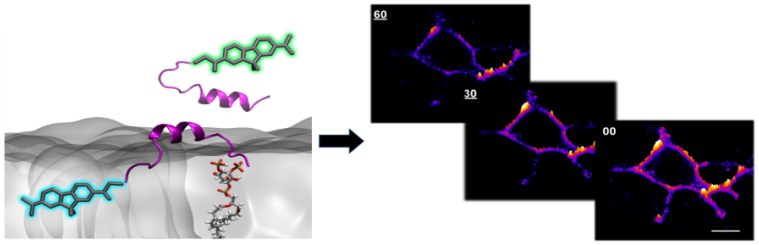

Figure. Left: Schematic representing our strategy for phospholipid sensing, leveraging initial directional electrostatic interactions with a phospholipid headgroup followed by dipping of a peptide into the cell-membrane. Right: Visualizing lipid dynamics in living neurons (0-60 s), scale bar 10 µm.

References

1. Kundu, R.; Mondal, S.; Kapadia, A.; Banerjee, A. A.; Kucherak, O. A.; Klymchenko, A. S.; Koushika, S. P.; Venkatramani, R.; Vaidya, V. A.; Datta, A., *Chemical Science* **2025**, *16,* 10970-10982.
2. Kahali, S.; Baisya, R.; Das, S.; Datta, A., *JACS Au* **2025,** *5* (1), 343-352.
3. Kundu, R.; Kumar, S.; Chandra, A.; Datta, A., *JACS Au* **2024,** *4* (3), 1004-1017.
4. Kahali, S.; Das, S. K.; Kumar, R.; Gupta, K.; Kundu, R.; Bhattacharya, B.; Nath, A.; Venkatramani, R.; Datta, A., *Chemical Science* **2024,** *15* (28), 10753-10769.
5. Das, S. K.; Xi, H.; Yamamoto, I.; Fujita, K.; Datta, A., *ChemRxiv* **2025**.