Tata Institute of Fundamental Research
Survey No. 36/P, Gopanpally Village, Serilingampally, Ranga Reddy Dist., Hyderabad – 500 046

Seminar

Sensing across scales: Probing the mitochondria and exploring unusual light sensing modules in nature

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I will present our multi-disciplinary approach combining for devising new measurements, sensing dynamics across scales and exploring new natural photo sensory systems for basic biology and health.

Mitochondria are critical regulators of bioenergetics, signalling, calcium homeostasis and redox processes. Despite the recognition of mitochondria as a central cellular hub and regulatory centre, knowledge of the ways in which the mitochondrial network communicates with other cellular processes is still rudimentary. To address this we have developed a palette of cell-permeable, easy to use fluorescent probes to map mitochondrial activity/state and cellular heterogeneity with high spatial and temporal resolution. These new bright, highly stable chemical probes sense changes in the local microenvironment like membrane order (viscosity/tension) as well as chemical changes (pH, ROS). This approach is applicable even in sensitive cells like neurons, primary cells and stem cells (*Gulyani et al US patent granted 2020, Raja et al 2017,* 2021). We are particularly interested in how the mitochondrial network responds to different kinds of stimuli, and what may be the various unexplored sensory and response mechanisms associated with the mitochondria.

For instance, the fluidity of the inner mitochondrial membrane (IMM) has been a subject of long standing debate, especially since it is not yet known if respiration (And the flux of the electron transport chain) is diffusion-controlled or rate controlled. This has profound implications for the overall efficiency of respiration, metabolic adaptation and redox processes. Using multi-modal fluorescence lifetime imaging microscopy, we have made a startling discovery that as cells can rapidly (as fast as in minutes) modulate the overall fluidity of the inner mitochondrial membrane in response to metabolic stimuli and respiratory demand. This highlights a new sensory and response paradigm regulating the IMM at the nanoscale.

Our search for new sensing systems is inspired by nature. I will also share our discoveries on new ways in which organisms can sense and process light itself. We have established new light sensory systems in planarian flatworms that inhabit low light conditions; (*Shettigar et al Science Advances 2017, Shettigar PNAS 2021*). In this endeavour, we have uncovered new protein switches (potential optogenetics) and sensory architecture (body-wide sensory arrays). Our findings shed light on how relatively 'simple' neural networks can produce a breath-taking array responses and reveal design principles for engineering novel photosystems/devices.

Thursday, Apr 13th 2023

04:00 PM (Tea / Coffee 03.45 PM)

Auditorium, TIFR-H