Chemical Imaging of Subcellular Organization and Dynamics

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Abstract Content:

Understanding how chemical composition is organized and dynamically regulated within cells is central to modern cell biology and neuroscience. Chemical imaging approaches now enable direct visualization and quantification of metabolites, lipids, and signaling molecules at subcellular resolution. One of these is mass spectrometry imaging with SIMS. Mass spectrometry imaging (MSI) has emerged as a powerful platform for mapping the chemical organization and dynamics of cells with high molecular specificity and spatial resolution. In this talk, I will highlight recent advances in development and application of techniques such as imaging mass spectrometry, nanoscale secondary ion mass spectrometry (NanoSIMS), super-resolution fluorescence microscopy, and correlative electron microscopy to subcellular imaging. Together, these methods provide complementary insights into the spatial distribution and temporal evolution of organelles, vesicles, and protein assemblies. Emphasis will be placed on integrating structural and chemical information to resolve heterogeneity within subcellular compartments, including vesicle dense core and halo regions, stress granules, and mitochondria/vesicle interfaces. Emerging strategies combining live-cell electrochemical measurements with high-resolution imaging further enable functional interrogation of processes such as exocytosis and metabolic regulation with comparison to MSI data. These developments are transforming our ability to link molecular composition with cellular function, offering new opportunities to elucidate mechanisms underlying neurotransmission, disease pathology, and cellular adaptation.

Reference:

Key words: Mass spectrometry imaging, complementary imaging methods, cells, organelles, protein condensates