In optical imaging, each pixel carries color information that can be represented by intensities of primary colors. Mass spectrometry imaging (MSI) is an emerging technology for the mapping of molecular distributions in tissues. Similar to hyperspectral imaging, pixels in MSI carry entire spectra with multitudes of features that represent greatly enhanced information. In most existing studies, the chemical information encoded in each pixel is conveyed by the mass-to-charge ratios and intensities of the ions. This approach often ignores the presence of isobaric ions (e.g., structural isomers) in a complex sample. In addition, conventional MSI is performed by sampling on a predefined rectangular grid that does not reflect the natural cellular pattern of the tissue. Therefore, molecular information from multiple cells may be captured together and the cellular differences can be obscured. Laser ablation electrospray ionization (LAESI) mass spectrometry (MS) is an ambient ionization technique that enables rapid local analysis of water containing biological samples. In MSI applications, LAESI allows for the two- and three-dimensional mapping of metabolite, lipid, and protein spatial distributions in untreated biological tissues. In this talk, developments in LAESI-MSI are presented that enhance the information content of a pixel in three different ways. In a novel combination of LAESI-MSI with ion mobility separation (IMS), ionized molecules produced at each interrogated location on the tissue were separated by a traveling wave IMS, and then analyzed by a quadrupole time-of-flight mass spectrometer. Molecular images of the tissue sections were constructed for ions selected by \( m/z \), and isobaric species were distinguished by their drift times corresponding to distinct molecular structures. We demonstrated that IMS enhanced the metabolite coverage of LAESI in biological tissues, and enabled the differentiated MSI of isobaric species. Further, because each laser pulse removes a well-defined amount of material, corresponding to a voxel, from the focal spot, three-dimensional images can be constructed. Three-dimensional LAES-MSI was performed on microbial colonies in the context of Kirby-Bauer (KB) antimicrobial susceptibility testing. The results provided a deeper insight into microbe-antibiotic interactions, and enabled the simultaneous KB testing of two bacterial species. Finally, automated cell-by-cell imaging was developed based on individual cells serving as the natural pixels. This approach automated the recognition of cells and their addressing for systematic ablation. Cell types with particular morphologies can also be selected for analysis. It increases the image acquisition efficiency and stability, and allows molecular imaging with single cell resolution.

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Friday, October 2, 2015
SEH B1220
2:00-3:00 p.m.
Refreshments will be served at 1:45 p.m.