What Life Scientists Should Know About Molecular Imaging

Optical Imaging, Ultrasound, Photoacoustics

Optical Tomography of Deep Tissues

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Learning Objectives: The attendees will understand and be able to explain the basic concepts in five areas:

- Tissue Optics
- DOT Instrument Basics
- DOT Image Reconstruction Basics
- Mouse FMT Imaging Systems
- Human Optical Neuroimaging Systems

Who will benefit from this information? This talk is designed for people who have an interest in recent advancements in deep tissue optical imaging and Optical Tomography. Optical Tomography (or Diffuse Optical Tomography – DOT) provides molecular- and functional- in vivo imaging in deep tissues (>1mm) well beyond the depths of advance optical microscopy methods. The intense scattering of light by tissues means that DOT uses measurements of diffuse light or multiply scattered light. In mouse, fluorescent molecular tomography (FMT) provides the power of fluorophore-based contrast (targeted, genetic and active) with volumetric imaging. FMT can be combined with CT or MRI imaging to provide a combined molecular/anatomical data. In humans, endogenous tissue spectroscopy is more common, and DOT is used for functional neuroimaging and tissue spectroscopy in breast cancer.

How was a problem determined? These optical techniques are being developed to complement optical microscopy, positron emission tomography (PET) and fMRI techniques by addressing scenarios that are difficult to address with the alternate methods. For example, in mouse, FMT provides a molecular imaging with a great array of activations strategies (e.g. genetically engineered mice), and greatly simplified contrast agent logistics (e.g. long shelf life ~months). In humans, NIRS, and the more recent advancements in Diffuse Optical Tomography (DOT), provide a portable bedside technique for mapping both functional tasks and resting state functional connectivity. While historically NIRS has been limited to resolutions of >3.5 cm, new DOT imaging has demonstrated resolution of <1.5 cm with improved brain specificity and methods for co-registering function to reference anatomy. Examples of how these issues have been addressed in mice, initial in vivo systems used fluorescence planar reflectance imaging. Newer FMT systems provide better depth sensitivity profiles, improved resolution and a platform for integration with anatomical datasets from CT or MRI. In humans, traditional NIRS measurements have been used in a great variety of cognitive science studies. Using the improved performance of DOT, validation studies have shown voxel-to-voxel correlations between DOT and fMRI in visual, motor and language tasks. Most recently these techniques been extended to clinical situations with initial feasibility demonstrated in functional connectivity studies of preterm infants.

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