

# What Life Scientists Should Know About Molecular Imaging

## Optical Imaging, Ultrasound, Photoacoustics

### **Multiscale molecular and functional photoacoustic imaging: fundamentals, applications, and prospects**

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Learning Objectives:

- Basic principles of multi-scale photoacoustic imaging
- Photoacoustic imaging using molecular probes, with example applications
- Photoacoustic imaging of vascular functions, with example applications
- The state-of-the-art development in biomedical photoacoustics

While super-resolution imaging has broken through the optical diffraction limit to enable our visualization of the sub-cellular world in live cells, photoacoustic imaging has broken through the optical diffusion limit to allow us seeing intact biological tissue in vivo at an unprecedented depth (up to several cm) with rich optical contrasts. As a result, photoacoustic imaging can provide anatomic, functional, and molecular information on biological tissue at multiple scales from organelles to organs. In conjunction with optically absorbing molecular probes, acoustic-resolution photoacoustics can image deep to provide a macroscopic view of the disease status. On the other hand, their optical-resolution counterpart can offer optical-diffraction limited spatial resolution to visualize microscopic vascular functional changes using endogenous contrasts. In this educational lecture, first, we will recap the fundamentals of photoacoustic imaging, including the basic principles of acoustic- and optical-resolution photoacoustics and their various implementation forms; then, we will introduce example applications of these technologies for both molecular and functional biomedical imaging; finally, we will summarize and give some updates on the state-of-the-art development in the field.