Introduction: Bridging the imaging gap with information

Stephen Paddock

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Often a new technique is discovered from an image in a research article or even from the cover of a journal. Upon closer examination of the paper, some vital details of how the images were produced are omitted. Reference may be made to the technique itself, but paradoxically, upon closer inspection, such technical reports may not include vital steps required to faithfully reproduce the images in the original article. One of the more frustrating and time-consuming aspects of biomedical imaging is the time spent in attempting to reproduce the work from a published report. Most images do not come with a certificate of the many hours of labor required for their final production!

The *BioTechniques* Imaging Supplement is an attempt to bridge the information gap, either real or virtual, between instrument development and research practice by featuring novel technologies, experimental approaches, and software that are constantly coming online. The aim is to sample a range of experimental approaches and illustrate them in short, yet comprehensive reviews, at a level that falls between the technical and the biological.

For over 300 years, the light microscope has been the traditional instrument for imaging cells and tissues. Improvements continue to be made to all parts of the instrument and to those technologies associated with it. The electron microscope continues to be the instrument of choice for imaging at subcellular resolution, although the method is confined to dead cells (1,2). Several light microscopes are becoming available that challenge the diffraction limit of light and produce amazing images of living cells at the nanoscale (3). Moreover, measurements on protein-protein interactions in living cells can be made at extremely high resolution (3–6 nm) in the light microscope using fluorescence resonance energy transfer (4).

There is a limitless variety of specimens for imaging and types of information to be collected using the light microscope. Specimens may range in size from nanometers to meters, in time resolution from milliseconds to days, and in depth from the very surface to deep tissue imaging. Applications range from the routine to the mystical. It is clear that no single instrument exists that can cover the vast range of scale, dimension, depth, and expertise that is demanded by contemporary biomedical research. Progress is being made to standardize image data formats to allow sharing of data between imaging systems (5).

Many of the developments in light microscopy are currently driven by the requirement to study the distribution of macromolecules within living cells at increasingly high spatial and temporal resolution. This has been facilitated by the rapid development of fluorescence microscopy, including improved microscope technologies, fluorescent proteins and dyes (6), sensitive photodetectors, relatively cheap yet extremely powerful computers, and improved software for the acquisition, analysis, and final display of the images.

These developments are illustrated by the emergence of optical sectioning technologies over the past 30 years or so (7). Many images produced using conventional epifluorescence microscopy are not very clear. This is because the image is made up of the optical plane together with contributions from fluorescence above and below the focal plane of interest. This “out-of-focus fluorescence” can now be removed using confocal, multiple photon, or computer deconvolution to produce optical sections with improved contrast and resolution over images produced using conventional epifluorescence (8).

The amount of data collected from modern microscopes has increased dramatically as the instruments have developed in sophistication. The fashion is to refer to such data sets as multidimensional (Figure 1). More dimensions continue to be added as new techniques are developed. Such dimensions now include wavelength from multispectral images, harmonic imaging, and fluorescent lifetimes. The data sets collected with multidimensional imaging can very rapidly become very large, and they present unique problems in coping with the collection, storage, and presentation of the resulting images (9).

What is the role of imaging in the current climate of the continuously
expanding canon of genome biology? The answer is a very positive one for imaging technologies, because it is absolutely necessary to understand the function of macromolecules at the tissue, cell, and subcellular levels, and for this a record of their changing distribution during development and conservation across genomes is vital. Moreover, methods of the early detection of pathological states, often first revealed by the inspection of genome sequences at the tissue, cell, and subcellular levels are equally important. Many of these approaches depend on optical imaging (10, 11).

REFERENCES


Address correspondence to Stephen Paddock, Howard Hughes Medical Institute, Dept. Molecular Biology, Univ. Wisconsin, 1525 Linden Drive, Madison, WI 53706, USA. e-mail: paddock@wisc.edu; www.molbio.wisc.edu/carroll

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