Gaining new insights into physiological function from biophotonics

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Compared to conventional electronic based instrumentation, photonic methods are exquisitely sensitive. As an example, it is quite easy to measure photon fluxes of a few per second while equivalent electron flows are far below that realised even with sensitive patch-clamp amplifiers. However, the sensitivity of biophotonic methods extends to well below the level of the single cell by providing methods to detect and manipulate even single molecules.

Two decades ago, physiologists struggled to make measurements of intracellular calcium with ion-sensitive electrodes and bio-luminescent probes but the development of new fluorescent molecules for calcium measurement has made calcium measurement quite straightforward – if not always precise and easy. Cell calcium measurements with imaging systems have revealed new levels of complexity in signaling and as a result of the advances in instrumentation and methods it is now clear that the cell does not achieve function like a well stirred bucket of constituents. For example, the discovery of calcium sparks a decade ago clearly reinforced this idea – but we still don't understand how excitation-contraction coupling really works. This problem will be highlighted by some recent results from our laboratory where we have tried to develop and test ways of measuring the minute calcium fluxes underlying calcium sparks.

The microanatomy of the cell must be important for helping turn the cell from a large number of lipid and water soluble chemicals into life. Here new light imaging techniques are playing an important role and combination of computer image processing with high resolution imaging techniques reveals new levels of complexity in cell structure. Furthermore, with biophotonic methods, we can look inside the living working cell (an obvious advantage for those who are interested in how the living cell works). This has always been the classical province of the physiologist.

Promising new directions for physiological research include manipulation of proteins with molecular techniques and again, biophotonics provides powerful methodologies to study the results of such experiments. In this symposium we will look at new data and methods being applied to increased our understanding of physiology. We will see how new biophotonic methods offer ways to probe cell function with unprecedented fidelity and sensitivity. When one considers what may now be achieved with these methods, it would seem that the future of molecular-based physiology is very bright indeed.