Preface

Making light work: illuminating the future of biomedical optics

Over the last three decades the field of biomedical optics has produced technologies designed to extract valuable structural and functional information from biological tissues. Many of these techniques, such as near infrared spectroscopy (NIRS), exploit the optical absorption characteristics of the body’s intrinsic chromophores, haemoglobins and cytochromes, allowing the measurement of tissue oxygenation, blood flow and oxygen metabolism. The non-invasive, portable and low cost benefits of optical techniques have led to them being employed across the range of clinical and life sciences. In 1996, a Royal Society Discussion Meeting was held to examine the recent progress in the field of NIRS and imaging (Philosophical Transactions of the Royal Society B, 1997, 352).

Since then there has been an explosion of interest in the development of new optical systems and their use in the monitoring of intact biological systems, particularly the brain, breast and muscle. The field has witnessed a widespread transfer of NIRS monitoring techniques from the laboratory to the bedside, and the evolution of benchtop systems into clinical prototypes. For example, there is now widespread use of NIRS in human brain mapping, in vivo gene expression studies in biology and medicine, the clinical assessment of a range of neurological conditions and the monitoring of muscle physiology and pathophysiology. Underpinning this work has been the development of complex theoretical models of light transport in tissue, which have guided instrument design and allowed reconstruction of three-dimensional optical images. In addition, mathematical models of the biochemistry and physiology of oxygen transport mechanisms in the specific organs under investigation have been developed to aid the interpretation of the measured optical data.

Specifically, the use of two-photon spectroscopy is able to provide an unprecedented view of in vivo brain activity on a cellular and microvascular level; optical molecular imaging is revolutionizing the speed of drug testing in animal models; photoacoustic techniques now provide high-resolution images of the structure and function of vascular systems in healthy and diseased tissue; near infrared imaging technologies are making a major impact in the field of neurodevelopmental psychology, where optically measured localized changes in cortical oxygenation are allowing the investigation of increasingly subtle cognitive processes never before examined in the young infant brain; and the advent of lightweight wearable systems (with associated wireless transmission capabilities)

One contribution of 20 to a Theo Murphy Meeting Issue ‘Illuminating the future of biomedical optics’.
is leading the way for ambulatory optical monitors of physiology in a wide range of applications.

The aim of the 2010 Theo Murphy Discussion Meeting was to bring together a highly interdisciplinary group of international experts to focus on how new advances in optical technologies will shape the future vision for this rapidly evolving field of biomedical research.

Expertise from a range of disciplines was represented including physics, engineering, neonatology, clinical neurology, sport science, photochemistry, neuroanaesthesiology, biochemistry, neuro-developmental psychology and molecular biology. This span of expertise provided the basis for broad discussion topics including the latest innovations in optical source and detector technologies which will inform the development of the next generation of optical imaging systems; the impact of optical technologies and methodologies in a wide range of clinical and

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life science applications; advances in optical probe development and techniques for targeted imaging at cellular and microvascular levels.

In order to assess current thinking of the leaders in the field represented at this meeting, all attendees were asked to consider and respond to the following three questions: (a) What has been the most important innovation in the last 20 years? (b) What is the most exciting prospect for the next 20 years? (c) What is the major challenge to achieving this? The answers (summarized in figure 1) were used to inform the overview of the proceedings given in the introductory article of this issue [1].

These responses, the invited talks, discussions and articles contained within this Theo Murphy Meeting Issue demonstrate that although real challenges remain, the future is bright for optical technologies as they continue to illuminate our understanding of the human body in health and disease.

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