Journal of
Biomedical Optics

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Special Section on Selected Topics in Biophotonics: Optogenetics and Label-Free Optical Spectroscopy

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Stefan Andersson-Engels, Peter E. Andersen, "Special Section on Selected Topics in Biophotonics: Optogenetics and Label-Free Optical Spectroscopy," *J. Biomed. Opt.* **23**(7), 071201 (2018), doi: 10.1117/1.JBO.23.7.071201.

Special Section on Selected Topics in Biophotonics: Optogenetics and Label-Free Optical Spectroscopy

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The present special section entitled "Optogenetics and Label-Free Optical Spectroscopy" comprises one invited review paper and several contributed papers from the summer school Biophotonics '17 as well as contributed papers within the general scope of the school.

1 Motivation and Purpose of Biophotonics Graduate Schools

Over the past decade, lasers, optical methods, and instruments based on light interaction with tissues have emerged as powerful techniques for medical diagnostics, monitoring wide spectra of tissue function, and pathology. In biophysics and biology, optical sensing and manipulation of cells have strengthened understanding of basic cell function. Together with improved laser therapeutic techniques, optical sensing and cell manipulation form the basis for the increased interest in biophotonics. Throughout Europe, the U.S., and the rest of the world, major research centers are highly active in this field that in a broad sense may be labeled biophotonics. Therefore, education within this area is increasingly important.

The main purpose with the biennial graduate summer school is to provide education within biophotonics for students and young scientists at the highest international level. Our aim is to attract internationally renowned researchers as lecturers who would attract the most talented young researchers worldwide in the field of biophotonics.

2 Format of the Biophotonics Graduate Summer School

The school mainly targets graduate students and postdoctoral fellows from around the world. The format of the school is a combination of lectures and student poster presentations, with time between lectures for discussions and exchange of scientific ideas. The lecturers cover one topic in a full session composed of four lectures, which thoroughly covers the basics and state of the art of each topic. On one hand, this choice limits the number of topics taught at each school. On the other hand, the topics selected for the schools are covered in detail. Therefore, the range of topics taught will change from school to school.

An important feature of the school format is that students and lecturers spend the entire week together, which provides excellent opportunities for the exchange of scientific ideas, networking, and socializing.

The 8th International Graduate Summer School Biophotonics '17[1] covered the basics of lasers as well as supercontinuum sources and their application in medicine, tissue optics, photodynamic therapy, optical tweezers and their applications in biophotonics, opto-genetics, diffuse optical and molecular imaging, optical coherence tomography, photo-acoustic tomography, Raman spectroscopy and sensing (covered in the invited tutorial) and coherent Raman scattering microscopy. In addition, at the kick-off of the school, current trends in pathology were covered in one keynote lecture, and the topics of entrepreneurship and translating ideas into applications eventually becoming products were covered in a second keynote lecture. A third keynote on spectroscopy in life science was delivered by Prof. Sune Svanberg at the end of the school.

3 Special Section in the Journal of Biomedical Optics

We are pleased to introduce the contributions to this special section on "Optogenetics and Label-Free Optical Spectroscopy" comprising one invited tutorial paper and eight contributed papers, mainly from the participants of the school but also from other researchers in the field. Not all of the contributions are strictly covered by the title of the special section, but all contributions reflect the core topics of the school and span the fields of biomedical optics and biophotonics. The invited tutorial paper is:

- E. C. Bautista, I. Latka, C. Matthaeus, I. Schie and J. Popp, "In vivo Raman spectroscopy: From Basics to Applications."

This paper from a lecturer at the school is tutorial in character and provides an excellent background to the field of *in-vivo* Raman spectroscopy while also pointing to applications and future challenges. This invited tutorial provides a natural continuation to previous tutorial papers on the foundation of diffuse optics,[2] imaging thick tissues with diffuse optics,[3] molecular imaging,[4] optical micromanipulation,[5] photodynamic therapy,[6] optical coherence tomography,[7] biological imaging with coherent Raman scattering microscopy,[8] photoacoustic tomography,[9] and fiber-based sources for biophotonics[10] published in similar special sections from previous schools. These papers all belong to a planned series of tutorial review papers from each biennial school that provide high-level, open-access educational material for the benefit of the scientific community and, in addition, fulfill our own motivation for creating the school in the first place. With this special section, there are in total ten excellent tutorials that provide profound introduction into the basics of our field.

In addition to the invited tutorial paper, we have eight contributed papers. Marois et al. discusses optimum wavelength selection for diffuse spectroscopy, based on simulated light-tissue interactions, i.e., linking to the core topic of tissue optics.[2,3] Optical coherence tomography[7] is continuing to expand into new applications: here polarization-sensitive OCT is covered by Golde et al. for potential in dental applications, i.e., caries. Awasthi et al. addresses image processing of ill-posed data sets, particularly for photoacoustic tomography.[9] Continuing on image analysis, Lenz et al. describe a method based on feature extraction from OCT images of ex vivo brain tissue, which may provide a future useful tool during surgical procedure. Abbasi et al. reports laser-induced breakdown spectroscopy as a potential tool for autocarbonization detection in laserosteotomy. Endoscopic OCT is applied for *in vivo* imaging of the oral cavity for studying soft/hard tissues, described by Walther et al. Using Monte Carlo modeling Durkee et al. optimize illumination of mouse lung in order to detect low level fluorescence pulmonary pathogens, demonstrating vast performance improvement as a result, and linking to light-tissue interactions.[2,3] Finally, Gunther et al. demonstrate theoretically improved deep tissue imaging by combining photoacoustic tomography and slow light spectral filtering, e.g., more than 10 cm imaging depth in transmission mode.

Acknowledgments

The editors would first like to thank all the lecturers and participants of the summer school Biophotonics '17 for making the school a very fruitful and positive experience, the authors of all papers in this special section for their excellent contributions, and the many reviewers around the world who provided high-quality reviews of the manuscripts. Your dedicated efforts have made this high-quality special section possible. The editors would also like to thank the JBO publication staff, Rita Davis and Karolyn Labes in particular, for their invaluable support and prompt assistance in helping meet the JBO standards. Finally, the editors would like to thank Prof. Lihong Wang, editor-in-chief, for his never-ending support and stimulating encouragements during the entire process of making this special section.

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