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Editorial: Biophotonics for cancer diagnostics and treatment

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Editorial on the Research Topic
Biophotonics for cancer diagnostics and treatment

Every year, significant cancer cases increase has raised unique challenges for scientists, clinicians, and patients. This seemingly intractable disease is one of the leading causes of death, claiming millions of lives every year worldwide [1, 2]. The fatality of cancer is primarily due to the late diagnosis at an advanced stage when fewer therapies are available. Recently, enormous Research has been devoted to developing new techniques capable of offering quick, relevant, and reliable information related to tumor growth so that precise treatments can be given at tumor sites for timely intervention by triggering its regression and preventing its reoccurrences [3, 4].

In this context, innovations in biophotonics, which uses photons to interrogate tumor microenvironments and eliminate cancer cells and tissues, have significantly improved diagnostic acumen by improving the existing procedures and reducing the side effects of anti-cancer treatments. As laser light can be focused onto diffraction-limited spots, the induced light scattering and absorption deliver the information on cellular and sub-cellular levels, available for early detection of cancers. Cancer treatment relies on advanced laser technology with precise guidance to the surgical site and tumor mass. Ultra-short laser bursts allow for clear-cutting and drilling in tissues, which reduces time spent on surgery, bleeding, and patient's pain. Besides, new light sources characterized by low cost, miniaturization, and high flexibility have drawn much attention from medical doctors in cancer screening. On the other hand, the revolution in artificial intelligence (AI) and machine learning (ML) further enhances the efficiency and accuracy of image qualification and quantification, enabling differentiation between normal and malignant tissues and staging cancers [5–8].

In this Research Topic of Frontiers in Physics entitled "*Biophotonics for cancer diagnostics and treatment*," we gathered four articles exploring the state-of-the-art biophotonic techniques and machine learning methodologies for cancer diagnosis and treatment. In addition to cancer diagnostics, these articles demonstrated the trajectories of anti-cancer biophotonic methods for the phenotyping of cancer cells or tissues and projected the future direction of therapeutic innovations. The first article by Ellas Spyratou reviewed the role of optical tweezers as an efficient biophotonic tool in cancer theranostics. The article highlights the use of optical tweezers in determining cancer cells' biomechanical, biochemical, and biophysical properties by monitoring the cell-cell and/or protein-protein interactions. Next, Lai et al. described a multi-contrast optical coherence tomography (MCOCT) based technique for studying skin cancer, including OCT angiography and lymphangiography. The group observed the characteristic micro-environmental changes in the skin when cancer progresses from dysplastic nevi to malignant melanoma by obtaining angiographic, lymphatic vascular, and thickness information. Notably, such applications of MCOCT are essential for early skin cancer detection. In another review article, Chu et al. highlighted the automatic and semiautomatic image analysis tools and ML techniques currently used for analyzing morphology and dynamics in mitochondria in healthy or cancerous cells from confocal microscopy images. A comparative analysis of various software packages in terms of their performance, usability, and applications has been thoroughly discussed in the article. In addition, the potential of ML and deep learning in specific image analysis applications, e.g., mitochondria segmentation and classification, motion analysis, and image restoration, have been reviewed in this article. The last Research Topic article by Lin et al. demonstrated the application of a Monte Carlo model for extracting optical properties and intrinsic fluorescence from tissue models with multiple layers by utilizing the parallel computing capability of graphics processing units. The group demonstrated the feasibility of the proposed method in a pilot clinical study where significant differences between stages of cervical intraepithelial neoplasia were observed.

In summary, the range of Research works presented in this Research Topic highlighted the exciting new developments in cancer screening and treatment. Understanding carcinogenesis is undoubtedly one of contemporary science's most significant challenges. Early detection and precise cancer treatment are the keystones for curing the disease or increasing the patient's lifetime. In this context, AI and ML-assisted biophotonic technologies offer unique opportunities for cancer diagnostics and treatment by providing diagnostically relevant information quickly and reliably. We hope that the published representative articles will give a glimpse of the excitement and innovations in this field of biophotonics towards developing effective plans for better health care to the readers of Frontiers in Physics.

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Conflict of interest

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