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Biophotonics: An Interdisciplinary Convergence

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In recent decades, our globe has witnessed many great achievements and revolutions in various scientific fields. The most spectacular of these advancements has emerged from the intermarriage between diverse scientific disciplines, such as electronics and biology. The more diverse the disciplines are, the more significant achievements will be gained. Therefore in the new century, major scientific and technological breakthroughs are expected to occur at the boundaries between disciplines, due to the perspectives and insight that cross-disciplinary scientists gain from their different backgrounds.

To step in this direction, it seems necessary that universities, institutions and academic journals should provide an interdisciplinary platform, for a better and efficient integration between different and even diverse areas of science. It is so important that this issue should be considered in the mission of scientific organizations.

These platforms can act as a medium of exchanging the advances being made in different disciplines. The fruit of this task would be new revolutionary ideas and concepts, along with easy and efficient applications of findings of one discipline in the fields of others.

What dominates the scientific research nowadays is reductionism or the adoption of reductionist approaches. As useful as such approaches might be in their own rights, being obsessed with them could hinder one from due consideration of the interdisciplinary convergence. Thus, it is vital that alongside the reductionist approaches, one should also provide for the necessary arrangements to enhance interdisciplinary convergence and cooperation. It is important to note that working several disciplines in parallel, often with independent goals, is not enough, what we need is the collaboration of a variety of disciplines from different fields of study through joint planning, decision-making, and goal-setting, i.e. moving from multidisciplinary education and practice, to an interdisciplinary one. We need an academic environment that provides such interdisciplinary policies and programs to enhance the practice of each discipline. This in turn, calls for a new generation of academic professionals who can bridge and fuse together different scientific disciplines with each other. To demonstrate the practical example of the fruit of marriage between two disciplines, the fields of electronics and biology could be introduced as a case in point.

Recent advances in molecular biology and electronics, in particular photonics and application of innovative electronical technologies in medicine and biology have led to a fruitful convergence between electronics and biosciences. Presently, most biological science disciplines have been influenced by photonics, and this rapidly growing science and technology area has contributed dramatically to the biological revolution that is currently being witnessed [1]. The advancement in this area is so fast and exciting that, some go so far as to consider it as the prime technological advance of the new millennium.

Biophotonics is one of the best examples of integration between different disciplines, creating quite a few opportunities for interdisciplinary cooperation of a wide range of expertise. According to Philipp and Berlien, "In future, it will be necessary to bring together the wide spectrum of possibilities offered by biophotonics, in conjunction with all of the other medical techniques" [2]. Biophotonics involves a fusion of photonics and biology and deals with the study of the interaction of light with biological matter. It employs this interaction effectively for many applications, such as medical diagnostics and imaging, biosensing, laser tissue engineering, drug delivery at the single cell level, and light activated therapy. Such innovative applications have led to fascinating discoveries, which have provided profound insights into the nature of a vast range of biological processes.

Biophotonics-based technologies of imaging and sensing are going to have a substantial impact on different aspects of medical sciences, such as biomarker analysis, medical diagnosis, and understanding physiological and pathological processes at different scales, ranging from micro to nano-levels. This critical information can be used in understanding, treating and preventing a disease, and will be of great value in early detection of diseases.

Nanobiophotonics is a branch of biophotonics that intends to enhance the capability of photonic techniques used in biology and overcome some of its limitations such as resolution, contrast and chemical specificity. It also attempts to go beyond mere imaging, and includes sensing and manipulation at the nanoscale. The use of nanostructures to probe biomaterials with higher sensitivity or higher specificity makes nano biophotonics, a promising research field to develop biosensing methods and devices with excellent sensing capabilities to overcome some challenging issues in medicine, such as early detection of diseases. It would be also possible to achieve nondestructive assessment of engineered biomaterials *in vitro* and *in vivo*, using nano biophotonic-based techniques.

A synergistic combination of nanotechnology and biophotonics is conspicuous in quantum dots. They provide unprecedented opportunities for addressing many of the current challenges in disease diagnosis and therapy. At the present, quantum dots have been extensively employed for various biomedical and medical applications, such as sensing, biomedical imaging, drug delivery, gene technology, cell tracking, single-particle tracking in the live cell, light-activated therapies and image-guided surgery.

It is not all the story, and interdisciplinary research is striving to bring the benefits of quantum dots to more and more innovative and applied emerging technologies, such as photonic implants, wireless smart drug delivery systems, smart medical home monitoring devices, wireless imaging systems, and smart mobile biosensors.

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