Preface

Bioluminescence is a spectacular natural phenomenon where light is emitted from a living organism due to an internal biochemical reaction. Perhaps, the most well-known case of bioluminescence involves the "flashes of light" that we observe on summer nights emitted by the different species of terrestrial fireflies. While this may be the most common avenue of initial exposure to bioluminescence for millions of people, bioluminescence is even more prevalent in a variety of organisms that inhabit our seas and oceans. In the early 1960s, the discovery of two proteins, namely, aequorin and green fluorescent protein (GFP) from the jellyfish *Aequorea victoria*, by Shimomura and co-workers opened a new era in the study of bioluminescence. Specifically, this discovery spurred the interest of scientists to focus on the marine world, where bioluminescence is truly abundant; sunlight cannot penetrate efficiently in the deep oceans, and therefore, bioluminescence becomes a major source of illumination. This emission of light aids marine organisms in mating, fetching food, and scaring predators, among other functions. The quest for the identification of new marine bioluminescent organisms and for the understanding of the nature of their bioluminescence continues and is beautifully described and illustrated in our book in Chapter 2. There is no question that with the discovery of aequorin, and, later on, of the green fluorescent protein, GFP, Dr. Osamu Shimomura re-invigorated the field of bioluminescence. Dr. Shimomura reviews the history and properties of aequorin in Chapter 1.

Although bioluminescence is common in nature, only a few photoproteins have been isolated and characterized. Certain properties of photoproteins such as superior detection sensitivity, hazard-free handling, lack of cellular toxicity, and low background noise have positioned them as an excellent alternative analytical reagents to radiolabels. The cloning and recombinant production of these proteins has provided a major thrust for their applications in a variety of fields. These applications encompass the fields of biochemical, analytical, medical, and environmental science, as well as drug discovery and diagnostics. Among the proteins isolated from bioluminescent organisms, GFP and luciferases have become important tools in molecular and cell biology, whereas aequorin has proven to be an excellent label for analytical assays and intracellular calcium measurements. It is difficult to compile the enormous amount of work performed with these three proteins and others like obelin in a single book. Hence, we have narrowed the focus of our book to mainly the applications of photoproteins in bioanalysis.

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The choice of contributed material in this book covers a variety of topics related to photoproteins. The book begins with a chapter narrating the discovery of photoproteins and their properties. The subsequent chapters discuss the phylogenetic tree of bioluminescent organisms, novel luciferases, and their applications in biotechnology. The sections following these chapters cover applications of photoproteins in bioanalysis including protein-protein interactions, nucleic acid analysis, bioluminescence resonance energy transfer assays, *in vivo* imaging, biomedical assays, whole cell sensing, and binding assays. The book also discusses the applications of photoproteins in advances in instrumentation, as well as their incorporation into micro-total analysis systems (μ-TAS). Commercial sources and description of photoproteins and their substrates compiled in a tabular format should serve as a quick, easy-to-use guide for readers interested in working with these proteins.

The aim of this book is to provide the readers with an overview of the current state-of-the-art in photoprotein-based bioanalysis, as well as to encourage a growing number of investigators interested in photoproteins to explore new avenues of research. In that regard, it was our goal to make the content of this book stimulating to a broader scientific community.

With advances in biotechnology, the creation of designer proteins with unprecedented properties is easier than ever before. Photoproteins will continue to provide an excellent scaffold for "tailor-made" proteins with applications in a variety of research fields. As bio-nanotechnology and nanoscale analysis become more prevalent, the demand will increase to develop techniques with high sensitivity that can detect biomolecules in biological and environmental samples. High throughput and multi-analyte detection will play an increasingly important role, as well. Photoproteins have a great potential to be a solution to this new challenge given their low detection limits and virtual lack of background interferences, along with their ability to supply a "palette of colors" that can be employed in parallel analysis. Moreover, as we voyage to uncharted regions of our oceans and rainforests, the relevance of photoproteins will be enhanced by the discovery of new proteins with unique and unknown properties.

Finally, we should mention that photoprotein research has been a focal point of work in our laboratories since 1994, and that this topic of study has always been rewarding and stimulating. Therefore, we are delighted to have the opportunity to assemble the work of outstanding scientists in the fields of photoproteins and bioanalysis for our book. In that regard, it is important to emphasize that completion of this book would not have been possible without the contribution from all of the authors and the support from our publisher, Wiley-VCH. We would like to extend our most sincere gratitude and appreciation to all of them, as well as to the granting agencies that support our work, namely the National Science Foundation, the National Institutes of Health, the National Institute of Environmental Health Sciences, and the National Aeronautics and Space Administration.

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