Preface

Since the discovery of fluorescein more than a century ago, fluorescent dyes and stains have become workhorse reagents in experimental biology. Although much of this work has been accomplished with small-molecule dyes, there have been a number of notable exceptions (e.g., phycobiliproteins, expressible fluorescent proteins, and so on). However, although the number of small-molecule fluorescent probes has progressively increased, there have been few "inherently new" types of probes for use by the laboratory biologist.

Quantum dots are an inherently new class of fluorescent probes. Taking advantage of the unique attributes of nanometer-scale semiconductor particles, quantum dots (QDs) provide bright, stable, and sharp fluorescence for use in many biological labeling applications. Although small-molecule dyes, and even proteins, can be made as pure, homogeneous entities, quantum dots are engineered materials—consequently QDs from different sources may be different in composition and performance. This "materials" characteristic is important to consider, because the particular source for QDs may be vital to their functioning in a particular assay.

Since commercial debut of QDs only a few years ago, numerous publications have demonstrated their enabling utility in biological detection. *Quantum Dots: Applications in Biology* attempts to capture many of these diverse biological applications so the reader can not only observe what others have accomplished, but also anticipate new uses for these novel reagents.

This book is organized into five parts. The first two parts cover the use of QDs in imaging fixed and living cells (and tissues), respectively. Protocols are included for using QDs in routine (protein and structural cellular labeling), as well as in enabling applications (single-receptor trafficking, clinical pathology, correlative microscopy). Clearly, QDs will have a large impact in imaging applications owing to their outstanding photostability.

The third part shows early efforts aimed at using QDs in live animals. Although much work still needs to be done here, one again sees the promise of the technology to make a positive impact on human health.

The final two parts demonstrate the versatility of QD technology in existing assay technology. First, in flow cytometry, QDs show the promise of delivering more information—ultimately via a less expensive instrument platform. Additionally, one sees the application in immunosorbent (microplate) assays, reverse-phase protein arrays, and in a novel, multiplexed genotyping assay.

In early attempts to use QDs researchers were forced to develop their own protocols (which often differ dramatically from the analogous organic-dye protocols) to get even routine applications working. The original published procedures (usually available in the supplemental information along with primary publications) were not consistently or widely available, limiting substantially the number of people willing to try QDs in their applications. At this time, the published literature is growing very quickly. There have been over 250 peer-reviewed publications in this area since the original papers in 1998, and roughly half of these are now relying on commercially available reagents. Standard reagents and emerging standard protocols make quantum dots a well-established method for biological labeling in a wide variety of applications. The authors hope *Quantum Dots: Applications in Biology* provides a good starting reference for protocols that can be used to get reliable performance from QD-enabled applications.

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