Understanding how whole organisms, tissues, and cells perceive and process signals has given rise to the biological discipline of “Signal Transduction.” Signal transduction research in turn is rapidly evolving not least due to novel and improved analytical methods that have led to an increase in our understanding of the molecular mechanisms underlying cellular signaling. Progress has been made both at the level of single-component analysis and in vivo imaging that can reveal rapid changes at the cellular level as well as at the systems level where transcriptomics and phosphoproteomics, in particular, afford a window into complex biological responses including long-term adaptive responses.

The last two decades have seen a growing interest in cyclic nucleotide research in plants with an emphasis on the elucidation of the roles of cGMP and, perhaps to a lesser extent, cAMP. Here we detail both established and novel techniques and approaches to better understand the biological role of this important signaling system. Chapter 1 summarizes major trends in plant signal transduction and cyclic nucleotide research with an emphasis on molecular methods. The subsequent chapters cover two major themes. The first is centered around the detection and quantification of cyclic nucleotides and the discovery and characterization of novel nucleotide cyclases as well as experimental procedures to elucidate cyclic nucleotide-dependent cellular processes (Chapters 2–12). The second main theme covers bioinformatic methods to identify candidate nucleotide cyclases and cyclic nucleotide-gated channels. In addition, we also detail a computational method to infer biological functions of candidate nucleotide cyclases (Chapters 13–15).

Further to the above-mentioned themes, one chapter is dedicated to methods for identifying and characterizing cyclic nucleotide phosphodiesterases that obviously play an important part in cyclic nucleotide signaling and cyclic nucleotide homeostasis (Chapter 16). Additionally, two chapters on the measurement of reactive oxygen species and nitric oxide in plant tissues have been included since these compounds are critical components of biotic and abiotic plant stress responses and are associated with cyclic nucleotide transients as well as downstream responses (Chapters 17, 18). The final chapter (Chapter 19) details a method that allows the quantification of photosynthetic responses to cyclic nucleotides.

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