Preface

Plants have evolved sophisticated mechanisms to respond to a variety of environmental (abiotic and biotic) stimuli to survive. One can imagine that this ability is more prominent in plants than in animals because plants, as sessile organisms, must continue to adjust their physiology to an ever-changing environment throughout their life cycle after they are rooted in place. It could be several months for some plants, or several hundreds of years for some tree species. In any case, this is an astonishing ability of all plant species.

The question of how plants can defend themselves against various environmental stresses has been one of the prominent topics for plant researchers, including agronomists, because this factor is particularly important for agricultural production. Both abiotic stresses, such as drought, salt, cold, and heat, and biotic stresses from pathogen or insect attack cause a significant negative impact on agricultural production. Therefore, understanding the molecular mechanisms of stress tolerance not only provides scientific knowledge but also contributes various future applications to agriculture.

Over the past two decades, significant effort has been made to understand signal transduction after stress perception, and our knowledge in this area has remarkably increased. For example, the role of the phytohormone abscisic acid (ABA) in drought, temperature, and salt stresses and its signal transduction to induce tolerance to these stresses are increasingly clear. A variety of *Arabidopsis* mutants that show alteration in stress responses was isolated, and some components of the signal transduction cascades, such as transcription factors and kinases, were identified. Furthermore, the phytohormones salicylic acid (SA) and jasmonic acid (JA) are well-known factors that coordinate proper pathogen resistance responses. SA- and JA-dependent signaling pathways are also being studied intensively, and some important factors in these pathways were revealed.

To date, however, these signal transduction pathways have been investigated relatively independently, mainly because it was difficult to consider various stimuli simultaneously. Consequently, we tend to create a model of a linear pathway or, at most, one with several branches from the main pathway. However, considering that plants undergo continuous exposure to multiple stresses under natural conditions, these signal transduction pathways must interconnect to allow plants to coordinate and prioritize their reactions for survival using limited resources. Indeed, recent studies about the crosstalk between these signal cascades are becoming a central theme in various research fields, and we believe that it is time to summarize our current knowledge to understand the complexity of the signaling crosstalk.

Recent groundbreaking findings about the manipulation of phytohormonal crosstalk by pathogenic microorganisms to suppress pathogen resistance responses have been reported (see Chapter 5). Furthermore, a variety of environmentally sensitive *Arabidopsis* mutants that shows alterations in pathogen resistance responses has been reported, providing solid evidence for the crosstalk between abiotic and biotic stress responses (see Chapter 6). These recent discoveries led to the promotion of signal crosstalk research, and we now expect a new era in the field of signal transduction in plants.

In this book, we focus on the forefront of signal crosstalk research in plants. The book comprises eight chapters to cover current important topics, such as phytohormones (Chapter 1), mitogen-activated protein kinase cascades (Chapter 2), transcription factors (Chapter 3), Ca^{2+} cascades (Chapter 4), and reactive oxygen species (Chapter 7). Each chapter was written by a leader in the field and summarizes significant discoveries in recent reports. Because of space limitations, we could not cover other important topics, such as involvement of cytochrome p450 or phosphatases. These factors are currently receiving tremendous attention as players in signal crosstalk. We hope to have another opportunity to cover these topics in the near future. Additionally, we regret being unable to have comprehensive coverage of signal crosstalk between environmental stresses and developmental regulation. However, to cover one of the recent interesting topics in this area, we included a chapter on the TOR (target of rapamycin) signaling pathway, which is well conserved among many living organisms, including plants, as a key element in cell growth control and biotic/abiotic stress responses (Chapter 8).

The complex integration of multiple environmental stimuli is one of the most important abilities for plant survival, and it is now clear that the study of signal crosstalk in environmental stress responses will be a key topic for the next decade. A future challenge is to uncover the key elements that act as nodes of crosstalk and how these work on the molecular level. We are convinced that this book will provide an advanced summary of the key elements involved in signal crosstalk and a stepping stone for further understanding of signal crosstalk in plant stress responses.

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