PREFACE

Plant growth is regulated by physiologically active substances called plant hormones and is further influenced by various environmental stimuli, including light. Studies of such active substances can be traced back to observations and writings of Charles Darwin and his son Francis more than 100 years ago. They observed that light induces bending of the plant hypocotyl and stimulates the stomatal opening, and hypothesized the involvement of effective substances in these phenomena. Research on the molecular mechanisms behind such phenomena had to wait until molecular genetic studies with model plants such as *Arabidopsis thaliana* were developed.

Although plants endogenously produce plant hormones, exogenously supplied plant hormones can also trigger responsive reactions similar to those of endogenously induced ones. Based on these characteristics, mutants of model plants that exhibit abnormalities in response to specific plant hormones and environmental stimuli have been isolated, and causative genes and corresponding proteins have been identified. Furthermore, molecular studies using protein–protein interactions, plant–pathogen interactions, and actions of growth inhibitors have also contributed to the identification of key molecules, such as receptors and downstream controllers that transmit signals generated by these stimuli. These molecular studies have accelerated biochemical understanding of the intracellular signaling pathways responsible for plant responses to stimuli.

This book includes reviews on current understanding of signaling pathways that control physiologically critical processes in plants. Most of the key molecules in these pathways were discovered within the past decade. In 2005, Matsuoka's group reported on the F-box-containing receptor of gibellin (GA), which was selected as a "Breakthrough of the Year 2005" by *Science*. In the history of abscisic acid (ABA) research, although several receptor candidates had been considered, one molecule was eventually proposed in 2009 to control activities of a specific protein phosphatase and kinase downstream of the receptor. Strigolactone (SL), identified in 2008 as the 8th plant hormone, is the new functional substance that induces germination of a parasitic plant and controls the branching pattern. Although at least two factors and a receptor candidate, including the F-box, have been identified within the SL signaling pathway, some points still remain to be elucidated.

Discoveries of peptides that act as signaling molecules in plants and their corresponding receptors contributed important knowledge to the field of developmental biology. Genome analyses have predicted that thousands of functional peptides exist in plants. Although florigen, which induces flowering, had long been hypothesized, its molecular features were eventually revealed around 2000 in Arabidopsis and rice. Cytokinesis in plants is distinctive from that occurring in other eukaryotes. Molecular studies with plant cells demonstrated that the unidentified transcriptional signal specifically generated at the G2-M transition of the cell cycle activates the mitotic kinesin-mediated MAP kinase cascade that is essential for the execution of complex and integrated cytokinetic events.

Concerning the typical environmental stimulus light, research on a blue light photoreceptor and its downstream signaling pathway has recently shown remarkable progress. The plant cryptochrome (CRY) involved in controlling photomorphogenesis and the circadian clock was first identified in plants in 1993 as a blue light receptor that controls COP1-mediated protein degradation. Around 2000, two new blue light receptors, phototropin controlling the stomatal opening and ZTL (ZEITLUPE) responsible for the circadian clock, were also discovered in plants and together commonly encode the LOV domain. In addition, the former also codes the protein kinase domain, whereas the latter codes the F-box domain, which suggests that they may function in light signaling pathways. Recent advancements in these investigations are introduced in this book.

Interestingly, four out of nine signaling pathways (for GA, SL, CRY, and ZTL) described in this book include protein degradation systems involving an F-box protein family. Additionally, signaling pathways stimulated by auxin and jasmonic acid, although not touched on here, also include the F-box proteins. Thus, the ubiquitin–proteasome system of protein degradation is widely conserved as a central mechanism for the perception of various signals in plants. Although protein kinase and phosphatase are responsible for many plant signaling pathways, by connecting with characteristic interacting factors, they are integrated uniquely into plant systems. This book introduces typical pathways mediated by such stimuli as ABA, peptide ligands, cell cycle signaling, and phototropin.

Many factors remain unknown in the signaling pathways introduced here. Identification of these as-yet unknown molecules should be critical for our understanding of the overall frameworks of the pathways. Further research advancements in this field will likely contribute to opening up new research areas in basic plant biology as well as molecular breeding to generate useful plants. We hope that readers in many research areas will find topics of interest in this book.

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