

Preface

Proteins are the building blocks of all living cells. Cell fate that includes the type of cell, its function, and the timing of its death are largely determined by which proteins are produced in the cell, and at what quantities and when they are produced. MicroRNAs (miRNAs) regulate the number of protein molecules produced by the messenger RNA molecule in specific cell type at particular developmental stage, thus, emerged as critical regulators of gene expression at posttranscriptional level. The lessons from plant miRNA biology are quite clear. These are the major regulators of gene expression by virtue of their preponderance to target transcription factors. The silencing or fine-tuning of miRNA target genes at appropriate places and times allows the plant to grow and complete its' life cycle normally. On the same lines, miRNA-controlled regulation of gene expression is necessary for plants' adaptation to biotic and abiotic stresses including the lack of nutrients. This book highlights the roles of various miRNAs that control and regulate these diverse plant processes, which are discussed in a detailed manner by expert contributors. Expert authors also emphasize the current challenges and outstanding questions for future research in this field. Thus, this is a comprehensive book on plant miRNA biology covering wide range of topics in the field.

This book begins with a chapter by Zhixin Xie and colleagues, who introduce the plant small RNA world. In this chapter, authors describe the diverse small RNAs and small RNA pathways in plants, including their biogenesis and mode of function. In chapter "Role of microRNA miR319 in plant development", Palatnik and colleagues discuss the role of miR319 and TCP factors in leaf morphogenesis. Plant developmental progression from one phase to the other seems to be controlled by two miRNAs, miR156 and miR172. In chapters "The roles of miR156 and miR172 in phase change regulation" and "Roles of miR156 and miR172 in reproductive development", Rebecca Schwab discusses the role of miR156 and miR172 in phase change transitions from juvenile-to-adult-to-reproductive stages. Plant small RNA pathways include conserved transacting siRNA pathway. In chapter "Trans-acting small interfering RNAs: biogenesis, mode of action and role in plant development", Maizel and Colleagues describe not only the biogenesis of transacting siRNAs but also their functions in controlling leaf polarity and lateral root growth including plant development.

Several developmental and physiological events controlled by gene regulatory networks govern the process of seed development, and miRNAs are also part of such regulatory networks. Nonegaki and colleagues describe the functions of miRNAs in this important process (Chapter “Role of miRNAs in seed development”). High-throughput sequencing of small RNAs to an unprecedented depth from diverse plant species led to the discovery of several novel miRNAs. Assessing their function is one of the major challenges now. Millar and colleagues address various strategies to dissect the functions of these miRNAs in plants (Chapter “Genetic and molecular approaches to assess microRNA function”). Rice is the most important crop in the world and is a model system for monocots, especially for cereals. Helliwell and colleagues summarize the progress that has been made with respect to miRNAs’ discovery, target genes that miRNAs are regulating in rice, as well as functions of some of the rice miRNAs (Chapter “Functions of miRNAs in rice”).

Legumes have established symbiotic relationship with the rhizobia in the specialized structures called nodules that are associated with the roots and the process is called “nodulation.” Nodulation is a highly complex process, which is governed by the spatial and temporal expression of genes and gene products. Senthil Subramanian describes the importance of miRNA-controlled gene regulation during nodulation (Chapter “microRNA regulation of symbiotic nodule development in legumes”). Plant growth and development as well as reproduction depend on availability of adequate macronutrients (N, P, K, S) and micronutrients (Cu, Fe, Zn, Mn, etc.). Plants often are challenged by the inadequate supply of these nutrients, particularly the macronutrients. Recent studies have established a key role for miRNAs in nutrient homeostasis. Julia Kehr summarizes the latest findings on this important topic (Chapter “Roles of miRNAs in nutrient signaling and homeostasis”).

Being sessile organisms, plants are often challenged with abiotic (drought, salinity, cold, heavy metals, and others) and biotic (bacteria, viruses, fungi, insects, and several others) stress factors that negatively impact crop productivity. Therefore, developing crop plants with increased abiotic or biotic stress resistance using molecular breeding or biotechnological approaches are of paramount importance. However, a major challenge has been to identify key genes/proteins or other molecules that play critical roles in stress tolerance. Recent exciting research implicated an important role for miRNAs in plant stress responses. Chapters “Role of microRNAs in plant adaptation to environmental stresses” and “Endogenous small RNAs and antibacterial resistance in plants” discuss the importance of miRNA-dependent gene regulation during abiotic stresses (Sunkar and colleagues) and bacterial pathogens (Katiyar-Agarwal and colleagues), respectively. Finally, Pooggin and colleagues describe the involvement of small RNAs in plant viral resistance (Chapter “Role of virus-derived small RNAs in plant antiviral defense: insights from DNA viruses”).

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