

Preface

The plant hormone auxin plays essential roles in diverse plant developmental processes including morphogenesis, organogenesis, vascular tissue differentiation, and growth responses to biotic and abiotic signals. The involvement of auxin in the broad spectrum of biological processes is mainly mediated by its regulation of cell division, expansion, and differentiation. Experimental evidence indicates that local auxin gradients generated by three families of auxin transporter proteins are essential for auxin actions. The molecular cloning of auxin transporter proteins in the past two decades marks a milestone in auxin research. Importantly, the biological activity of auxin transport proteins is associated with their characteristic plasma membrane localization. The PIN-FORMED (PIN) family of auxin efflux proteins has been shown to exhibit asymmetric plasma membrane localization and determine the direction of auxin flow. The maintenance of PIN protein plasma membrane localization involves clathrin-coated vesicle endocytosis, a process that is evolutionarily conserved in plant, yeast, and animal cells, and intracellular trafficking targeting proteins to distinct plasma membrane domains or lytic vacuoles for turnover. Auxin reinforces its own transport by regulating transcription and endocytosis and recycling of its transport proteins. Recently, a group of new auxin transport proteins, the so-called “short” PINs, has been demonstrated to localize to the endoplasmic reticulum membrane and play a role in intracellular transport and homeostasis of auxin.

Experimental evidence supports that membrane microdomains regulated by the composition of membrane lipids and sterols play a role in endocytosis of auxin transport proteins. Intriguingly, differences exist in the clathrin-mediated endocytosis of auxin influx and efflux proteins. Within plant cells, sequence-specific phosphorylation by plant AGC kinases counterbalanced by protein phosphatase-mediated dephosphorylation is necessary to channel PIN proteins to distinct intracellular trafficking pathways destined to specific membrane domains. Auxin transport proteins are also targeted to lytic vacuoles for protein turnover. Interestingly, gravity and light, two prevalent environmental signals, have been shown to modulate intracellular trafficking and targeting of auxin transport proteins during plant tropic responses.

Amongst numeric milestones in the field of auxin research are the identification and characterization of auxin signaling pathways and the TIR1/AFB family of auxin receptors. Development of different auxin sensors and quantification methods with increased sensitivities has greatly facilitated auxin research in the model species *Arabidopsis thaliana*. The advanced molecular and genetic tools have gradually become available in other plant species with interesting biological processes, providing new insights into our understanding of the role of polar auxin transport in developmental processes such as plant–microbe interactions.

As sessile organisms, higher plants evolved various mechanisms to cope with changing environmental conditions. Biotic and abiotic stresses have profound effects on plant development and reproduction in part through manipulation of the level, response, and distribution of plant hormones. As summarized in this book series, polar auxin transport is a prime target/mediator of abiotic and biotic stress responses of plants, as well as a practical target for agronomic trait improvements in crop plants. While tremendous progresses have been made in auxin research, new insights of the role of auxin transport in diverse developmental processes await to be gained.

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