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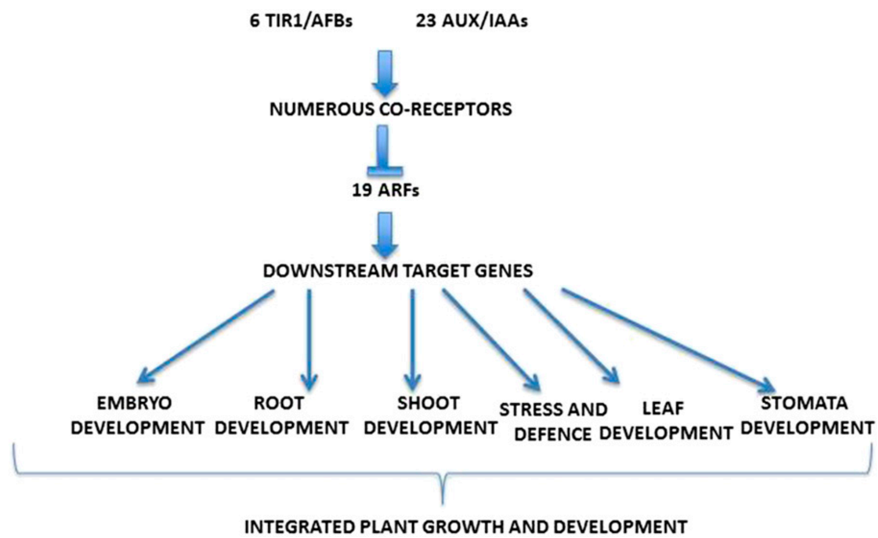
IN BRIEF

The Plant Cell Reviews Dynamic Aspects of Plant Hormone Signaling and Crosstalk

Plant hormones can exert strong, seemingly independent actions on plant growth and development. Auxin generally promotes growth; cytokinins delay leaf senescence and influence cell division; abscisic acid causes bud dormancy and promotes stomatal closure; gibberellins function in seed germination, and so on. Of course, in reality, these hormones exert many of their effects through a complex series of interactions with other hormones and signaling molecules. Much research on hormone biology today involves investigating precisely how plant hormones interact with each other and other factors to orchestrate plant growth and response to environmental inputs. This issue of *The Plant Cell* includes five review articles focusing on dynamic aspects of plant hormone signaling and crosstalk.

Auxin activity is greatly dependent upon its directional cell-to-cell transport, facilitated by the PIN family of auxin efflux facilitators. **Adamowski and Friml (2015)** review the evolution and developmental roles of the PIN proteins, which have become highly specialized with respect to expression pattern, subcellular localization, and developmental role. PIN gene expression and protein localization are regulated by auxin itself, and PIN protein activity is influenced by a number of other phytohormones. Adamowski and Friml review current models of these interactions, showing how the PIN proteins constitute a central hub that integrates information from endogenous and exogenous signals to control the distribution of auxin and, thus, many aspects of plant growth and development.

Auxin regulates the expression of genes that bind transcription factors called auxin response factors (ARFs). Auxin accumulation in specific cells—facilitated by the PIN proteins—leads to ARF-mediated regulation of target gene expression through the interaction of auxin with a coreceptor complex consisting of a TIR1/AFB protein and an Aux/IAA protein. TIR1/AFB is the F-box subunit of the E3 ubiquitin ligase complex $SCF^{TIR1/AFB}$, whereas Aux/IAA proteins function as transcriptional repressors of ARFs. Auxin binding to TIR1/AFB leads to SCF-mediated degradation of the associated Aux/IAA protein, thus relieving repression of ARF-mediated regulation of target genes. **Salehin et al. (2015)** review recent results focusing on the ways in which TIR1/AFBs, Aux/IAAs, and ARFs interact to control myriad aspects of plant development (see figure), while **Guilfoyle (2015)** focuses on the PB1 domain of ARFs and Aux/IAAs, which is a key protein-protein interaction domain critical for protein function.



Auxin regulation of different developmental processes. In *Arabidopsis*, six TIR1/AFB can interact with 23 different Aux/IAAs to form numerous coreceptor complexes. In addition, each Aux/IAA protein may interact with up to 19 ARFs to regulate distinct sets of target genes that control different physiological processes. (*Reproduced from Salehin et al. [2015], Figure 2.*)

Auxin acts in concert with cytokinins to control many aspects of plant growth. The two hormones generally have opposing but nevertheless complementary effects. **Schaller et al. (2015)** focus on this "yin-yang" interaction of auxin and cytokinin in several developmental contexts, including regulation of apical meristems, root patterning, the development of the gynoecium and female gametophyte, and organogenesis and phyllotaxy in the shoot.

Localized environmental stimuli, such as from pathogen attack, wounding, or other abiotic stresses frequently elicit a systemic response in plants that activates resistance or acclimation pathways in remote, unstressed tissues. A systemic response to abiotic stresses is termed systemic acquired acclimation (SAA) and is analogous to systemic acquired resistance to biotic pathogens. The hormone abscisic acid (ABA) plays important roles in plant response to environmental stimuli, in particular abiotic stresses that affect stomatal function. **Mittler and Blumwald (2015)** summarize our knowledge of SAA in response to abiotic stresses and propose a model that integrates generation of a systemic ROS-calcium hydraulic wave with ABA leading to the induction of SAA and stomatal regulation.

These reviews highlight exciting new results on auxin perception and signaling, auxin interactions with cytokinin, and the dynamics of ABA signaling in response

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to abiotic stresses. They also highlight remaining challenges and unanswered questions.

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