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Commentary

Auxin: A Pivotal Hormone in Plant Growth and Development

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DESCRIPTION

Auxin, one of the most studied phytohormones, plays a fundamental role in regulating plant growth and development. Discovered over a century ago auxins are central to plant physiology, influencing processes such as cell elongation, organ differentiation and response to environmental stimuli. This article explores the biochemical pathways, physiological roles and molecular mechanisms of auxin action, highlighting its importance in plant biochemistry and physiology.

Biochemical basis of auxin

The most common naturally occurring auxin is Indole-3-Acetic Acid (IAA). It is primarily synthesized from the amino acid tryptophan *via* a series of enzymatic reactions. Auxin biosynthesis occurs in the apical meristems, young leaves and developing seeds. Tryptophan-dependent pathways involve key enzymes like tryptophan aminotransferase and Yucca flavin monooxygenases, which catalyze the conversion of tryptophan into IAA. Other tryptophan-independent pathways also contribute to auxin synthesis, though they are less well understood. Auxin is transported throughout the plant *via* polar auxin transport mechanisms. This directional movement is facilitated by Pin-Formed (PIN) proteins and Auxin1/Like-Aux1 (AUX/LAX) transporters, ensuring precise distribution essential for developmental regulation.

Role in plant growth and development

Auxin governs cell division, elongation and differentiation, making it indispensable for plant growth. At the cellular level, auxin promotes cell wall loosening by activating proton pumps, acidifying the cell wall and enabling expansion. This is achieved through the activation of specific transcription factors, including Auxin Response Factors (ARFs) which regulate the expression of auxin-responsive genes.

Cell Elongation and Expansion: Auxin regulates cell elongation by modulating the expression of genes involved in cell wall loosening. Through its interaction with proteins such as expansins, auxin reduces cell wall rigidity facilitating turgor-driven cell expansion. This process is important in stem elongation and primary growth.

Apical dominance: Auxin synthesized in the shoot apex suppresses lateral bud outgrowth maintaining apical dominance. By inhibiting cytokinin signaling in axillary buds, auxin ensures resource allocation to the main stem.

Root formation and development: Auxin directs root architecture by promoting lateral root initiation and gravitropic responses. Auxin gradients established by PIN transporters guide root tip growth and adaptation to environmental conditions.

Vascular tissue differentiation: Auxin signaling stimulates vascular tissue development particularly xylem and phloem differentiation. This ensures efficient water and nutrient transport.

Stress and environmental responses: Auxin integrates external stimuli, such as light and gravity, facilitating plant adaptation and survival under diverse environmental conditions.

Molecular mechanisms of auxin action

Auxin, a vital plant hormone, orchestrates a diverse of physiological and developmental processes, including cell elongation, apical dominance and root formation. Its molecular action hinges on dynamic gradients and precise signaling pathways. Auxin binds to Transport Inhibitor Response 1/Auxin Signaling F-Box (TIR1/AFB) receptors, promoting ubiquitin-mediated degradation of Auxin/Indole-3-Acetic Acid (AUX/IAA) repressors. This enables ARF transcription factors to activate auxin-responsive genes, driving cellular changes. Auxin transporters like PIN and Aux1 establish directional flows, influencing morphogenesis. Crosstalk with other hormones integrates environmental and endogenous signals, ensuring coordinated growth. Unraveling auxin's molecular mechanisms offers provides significant understanding of plant adaptability, growth regulation and potential applications in agriculture and biotechnology

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Crosstalk with other hormones

Auxin does not act in isolation but engages in complex crosstalk with other hormones. For instance, gibberellins and auxin coordinate elongation, while cytokinin modulates auxin's effects on organogenesis. Auxin also interacts with ethylene during stress responses and with abscisic acid during seed dormancy and germination. Such interactions highlight the integrative role of auxin in maintaining plant homeostasis.

CONCLUSION

Auxin is a phytohormone regulating plant growth, development and environmental adaptation. Through its biosynthesis, transport and signaling pathways, auxin influences processes like cell elongation, apical dominance and root development. Its interactions with other hormones ensure coordinated growth and stress responses, highlighting auxin’s central role in plant physiology and its potential in agricultural advancements.