Quantitative Information Processing in Plants

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Plants, despite lacking sensory organs and centralized information processing, thrive in dynamic and challenging environments. To quantify hormonal signals being redistributed by environmental cues to reprogram growth, we have developed high-resolution, genetically-encoded FRET biosensors for several plant hormones. Building on our understanding of seedling morphogenesis derived from cellular gibberellin measurements (Griffiths, 2024) and an auxin-mechanics morphodynamic model (Walia, 2024), we now characterise auxin dynamics themselves using IAA GENETICALLY-ENCODED OPTICAL-BIOSENSORs (IAAGOs) FRET biosensors. During early development, the embryonic stem transitions through apical hook formation, maintenance, and opening to protect the shoot meristem during soil emergence. We demonstrate that light-induced hook opening emerges from the longitudinal expansion of subepidermal cells acting in parallel with epidermal cell walls that differentially resist expansion. This developmental transition is gated by wall alkalinity and auxin, both of which are depleted upon illumination. Furthermore, we identified a mechanochemical feedback loop where physical constraints on seedlings alter gibberellin levels, auxin signalling and cellular growth. We use GPS2 and IAAGO3 biosensors to directly capture gibberellin and auxin dynamism as seedlings respond to physical and light stimuli. A tentative model will be presented resolving the ebbs and flows of gibberellin and auxin accumulation during hook formation and opening.

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