Nature Reviews Molecular Cell Biology | Published online 9 Nov 2016; doi:10.1038/nrm.2016.150

PLANT CELL BIOLOGY

Blue light gives CRY the blues

> “interference of BIC1 with CRY2 dimerization inhibits … photoresponses”

The cryptochrome (CRY) photoreceptors mediate light or photoperiodic regulation of plant development, but how light regulates CRY activity is not clear. In *Arabidopsis thaliana*, CRY2 is activated by blue light and interacts with signalling partners to inhibit the elongation of hypocotyls (the stems of germinating seedlings). Lin, Oka and colleagues now show that blue light activates CRY2 by promoting its dimerization, and identify a CRY2-interacting protein that suppresses its activation.

The authors screened cDNA-overexpressing *A. thaliana* transgenic lines to identify negative regulators of CRYs. Overexpression of one gene, which they named BLUE-LIGHT INHIBITOR OF CRYPTOCHROMES 1 (*BIC1*), resulted in a phenotype that resembled that of plants with mutations in both *cry1* and *cry2*, which includes blue-light-insensitive hypocotyl growth. *BIC1* has a homologue, *BIC2*, and plants with mutations in both *bic1* and *bic2* exhibited a blue-light hypersensitive phenotype that was similar to that caused by CRY overexpression, whereas mutations in either *bic1* or *bic2* did not, which indicates that BIC1 and BIC2 redundantly inhibit CRYs.

robertharding/Alamy Stock Photo

Transcriptome analyses revealed that changes in gene expression in response to blue light are similar in plants with mutations in both *cry1* and *cry2* and in BIC1-overexpressing plants, which suggests that BICs function early in CRY-mediated signalling. Indeed, BICs were found to inhibit an early photoreaction of CRY2 — the blue-light-induced formation of nuclear bodies (termed photobodies) that contain CRY2 oligomers. CRY2 formed photobodies within a minute of blue-light exposure in the nucleus of wild-type protoplasts, but not in protoplasts overexpressing BIC1 or BIC2.

These data indicated that BICs can inhibit CRYs directly. In plants co-expressing GFP–CRY2 and MYC-tagged CRY2, an antibody specific for GFP was used to confirm that although small amounts of CRY2 dimers (as shown by co-immunoprecipitation of MYC–CRY2) are present in etiolated plants, they become more abundant following exposure to blue light. CRY2 dimerization was recapitulated in human cells (which do not express BICs endogenously) that were exposed to blue light, but not when BIC1 was co-expressed, which shows that BIC1 inhibits CRY2 dimerization. Accordingly, co-immunoprecipitation experiments revealed that blue light also enhanced the BIC1–CRY2 interaction.

Active CRY2 dimers interact with signalling partners, such as the transcription factor CIB1 and the E3 ubiquitin ligase subunit SPA1, to induce growth changes in response to light. Expression of tagged CRY2, CIB1 and SPA1 proteins in human cells that were exposed to blue light recapitulated the CRY2–CIB1 and CRY2–SPA1 interactions, but co-expression of BIC1 suppressed these interactions, which explains how the interference of BIC1 with CRY2 dimerization inhibits CRY2-dependent photoresponses.

Thus, photoactivated CRY2 forms homodimers that interact with signalling partners to regulate plant growth. BIC proteins, which prevent CRY2 homodimerization and activation, fine-tune the CRY-dependent signalling response.

Eytan Zlotorynski

ORIGINAL ARTICLE Wang, Q. *et al.* Photoactivation and inactivation of *Arabidopsis* cryptochrome 2. *Science* **354**, 343–347 (2016)