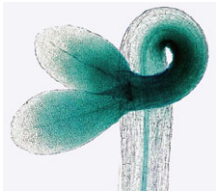
Auxin gradients hook up seedling growth

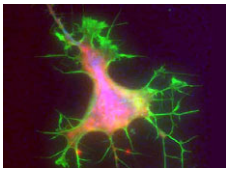
In plants with two embryonic leaves (cotyledons), the apical hook protects the shoot meristem as the seedling pushes through the soil towards the surface. This hook, which forms at the top of the hypocotyl (the part of the seedling below the cotyledons) soon after germination, opens when the seedling is exposed to light, allowing the cotyledons to expand. In this issue, two papers by Eva Benková, Dominique Van Der Straeten and colleagues use real-time analysis to investigate the roles of the plant hormones auxins and ethylene during apical hook development in *Arabidopsis thaliana* seedlings.

On p. 597, Van Der Straeten and colleagues describe how the auxin influx carriers AUX1 and LIKE AUX1 3 (LAX3) are involved in auxin-ethylene interactions during apical hook development. By localising auxin biosynthesis enzymes and influx carriers and measuring auxin levels and auxin reporter expression, they show that auxin biosynthesis and translocation from the cotyledon and meristem into the hypocotyl is necessary for hook development. Ethylene treatment, they report, increases auxin accumulation in the meristem, cotyledons and hypocotyl, and a strong ethylene signal enhances auxin biosynthesis at the inner side of the hook. Finally, mutant analysis shows that LAX3 is essential for proper hook formation, whereas AUX1 is involved in an ethylene-induced hook exaggeration phenotype.

On p. 607, Benková and co-workers report that PIN proteins, a family of auxin efflux carriers, also play a role in apical hook development. The authors show that several PIN proteins have specific, partly overlapping spatial and temporal expression patterns in the hook. Elimination of these PIN proteins by mutation, they report, interferes with particular phases of hook development. Furthermore, ethylene-induced enhancement of apical hook formation and subsequent hook curvature exaggeration is accompanied by changes in auxin distribution and in the expression of several PIN genes.

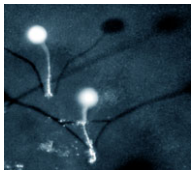


Based on these combined results, Benková, Van Der Straeten and colleagues propose a model in which the coordinated activities of LAX3 and of the potentially ethylene-regulated AUX1 and PIN proteins regulate the transport of auxins made in the cotyledons, meristem and hypocotyl tip of the seedling basipetally towards the root and laterally towards the outer hypocotyl tissue layers, thereby establishing an auxin gradient that controls apical hook development.



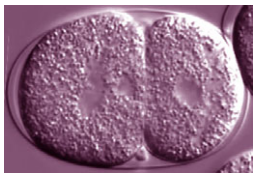
Vitamin A could keep Hirschsprung's at bay

Hirschsprung disease (HSCR) is a life-threatening developmental defect of the enteric nervous system (the ENS, which controls intestinal function) that is generally believed to be caused by genetic mutations. But now, Ming Fu, Robert Heuckeroth and co-workers reveal that vitamin A deficiency might also be a causative factor (see p. 631). Vitamin A is a precursor of retinoic acid (RA), and the authors show that mice in which RA is depleted when dietary vitamin A is removed develop HSCR-like defects, which are characterised by ENS precursors failing to migrate into the distal bowel. In mice carrying a *Ret* gene mutation, the most common identified cause of HSCR in humans, even mild vitamin A deficiency increased the risk of HSCR-like disease. The authors provide a cellular mechanism for these findings by demonstrating that RA is required for ENS precursor polarisation and migration. These data suggest that some cases of HSCR could be prevented by ensuring adequate levels of vitamin A in maternal diets.



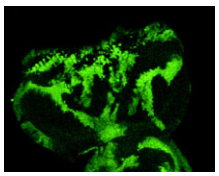
To transcribe or not to transcribe...

Throughout development, cells encounter extracellular signals that induce gene transcription, but is the cells' transcriptional response directly graded with signal concentration or a binary on-off switch? Now, Jonathan Chubb and colleagues report that the immediate-early transcriptional response in the social amoeba *Dictyostelium discoideum* is mainly binary (see p. 579). During development, *Dictyostelium* cells choose between stalk and spore fates. Using an innovative fluorescent RNA construct that allows the live monitoring of nascent RNA, the researchers quantified the transcriptional response of *Dictyostelium* cells to different levels of the stalk fate-promoting extracellular signals DIF and cAMP. They found that the response is highly variable between cells, but that the strength of the individual transcriptional response, measured as fluorescence pulse duration, frequency and intensity, is largely unaffected by signal concentration. However, higher signal concentrations trigger transcription in more cells, indicating that individual cells have different signal concentration thresholds. From their results, the authors suggest that the *Dictyostelium* transcriptional response is mainly binary and speculate that this is conserved in other developmental contexts.



PAR-4/LKB1 breaks with STRADition

The human tumour suppressor kinase LKB1 regulates cell proliferation and polarity, and mutations in its encoding gene cause the cancer-predisposing Peutz-Jeghers syndrome. Its activity appears to depend on the adapter protein STRAD, but mutations in *STRAD*, unlike those in *LKB1*, do not predispose individuals to tumours. Richard Roy and co-workers now determine in *C. elegans* that this discrepancy is caused by differential requirements for the STRAD orthologue STRD-1 in cell proliferation and polarity (see p. 661). *C. elegans strd-1* mutants were isolated in a screen for defective germline stem cell (GSC) quiescence. The analysis of these mutants showed that the LKB1 orthologue PAR-4 requires STRD-1 to suppress GSC proliferation through AMPK phosphorylation, whereas the PAR-4-mediated establishment of apicobasal polarity through the phosphorylation of proteins like PAR-1 and MEX-5 is unaffected. The authors therefore suggest that because human *STRAD* mutations are not cancer-predisposing mutations, LKB1 might also have as-yet-unidentified STRAD-independent functions that underpin its tumour-suppressor activity.



Dropping Crumbs increases size and Notch activation

The transmembrane protein Crumbs is essential for establishing epithelial apicobasal polarity but, puzzlingly, this function appears to be largely dispensable in developing *Drosophila* imaginal discs – epithelia that make adult organs during metamorphosis. On p. 641, Emily Richardson and Franck Pichaud now identify a surprising new role for Crumbs in regulating *Drosophila* organ size. Using mutant and RNA interference analysis, the researchers found that *crumbs* function is dispensable for head formation, but regulates head, eye and wing size, and that loss-of-function mutant tissues overgrow because of increased cell proliferation. The researchers further report that eye overgrowth depends on Notch signalling, with a loss of *crumbs* function leading to an increase in the endocytosis of Notch and its ligand Delta, an event required for Notch downstream activity. Based on these and other data, the researchers conclude that Crumbs can limit ligand-dependent Notch activation and that Crumbs and endocytic mechanisms are jointly involved in organ size control, a finding that should stimulate future research in the field.