Lit Lunch – November 21, 2012

EMBO

ROS-mediated vascular homeostatic control of root-to-shoot soil Na delivery in Arabidopsis
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Sodium (Na) is ubiquitous in soils, and is transported to plant shoots via transpiration through xylem elements in the vascular tissue. However, excess Na is damaging. Accordingly, control of xylem-sap Na concentration is important for maintenance of shoot Na homeostasis, especially under Na stress conditions. Here we report that shoot Na homeostasis of Arabidopsis thaliana plants grown in saline soils is conferred by reactive oxygen species (ROS) regulation of xylem-sap Na concentrations. We show that lack of A. thaliana respiratory burst oxidase protein F (AtrbohF; an NADPH oxidase catalysing ROS production) causes hypersensitivity of shoots to soil salinity. Lack of AtrbohF-dependent salinity-induced vascular ROS accumulation leads to increased Na concentrations in root vasculature cells and in xylem sap, thus causing delivery of damaging amounts of Na to the shoot. We also show that the excess shoot Na delivery caused by lack of AtrbohF is dependent upon transpiration. We conclude that AtrbohF increases ROS levels in wild-type root vasculature in response to raised soil salinity, thereby limiting Na concentrations in xylem sap, and in turn protecting shoot cells from transpiration-dependent delivery of excess Na.

Plant Journal

Enhancing protein stability with retained biological function in transgenic plants
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The final expression level of a transgene-derived protein in transgenic plants depends on transcriptional and post-transcriptional processes. Here, we focus on methods to improve protein stability without comprising biological function. We found that the four isoforms of the Arabidopsis RAD23 protein family are relatively stable. The UBA2 domain derived from RAD23a can be used as a portable stabilizing signal to prolong the half-life of two unstable transcription factors (TFs), HFR1 and PIF3. The increased stability of the TF?UBA2 fusion proteins results in an enhanced phenotype in transgenic plants compared to expression of the TF alone. Similar results were obtained for the RAD23a UBA1 domain. In addition to UBA1/2 of RAD23a, the UBA domain from the Arabidopsis DDI1 protein also increased the half-life of the unstable protein JAZ10.1, which is involved in jasmonate signaling. Taken together, our results suggest that UBA fusions can be used to increase the stability of unstable proteins for basic plant biology research as well as crop improvement.

1. Science. 2012 Oct 5;338(6103):67. doi: 10.1126/science.338.6103.67.
Depression. Defeating the dementors. Introduction.
Stern P.

2. Science. 2012 Oct 5;338(6103):28. doi: 10.1126/science.338.6103.28.
Chemistry. 'Awesome' synthesis could boost protein-based drugs.
Service RF.

3. Science. 2012 Oct 12;338(6104):264-6. doi: 10.1126/science.1227289.
Bacterial quorum sensing and metabolic incentives to cooperate.
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The opportunistic pathogen Pseudomonas aeruginosa uses a cell-cell communication system termed "quorum sensing" to control production of public goods,extracellular products that can be used by any community member. Not all individuals respond to quorum-sensing signals and synthesize public goods. Such social cheaters enjoy the benefits of the products secreted by cooperators. There are some P. aeruginosa cellular enzymes controlled by quorum sensing, and we show that quorum sensing-controlled expression of such private goods can put a metabolic constraint on social cheating and prevent a tragedy of the commons.Metabolic constraint of social cheating provides an explanation for private-goods regulation by a cooperative system and has general implications for population biology, infection control, and stabilization of quorum-sensing circuits in synthetic biology.

4. Science. 2012 Oct 19;338(6105):390-3. doi: 10.1126/science.1225974. Epub 2012 Aug 30.
Processing and subcellular trafficking of ER-tethered EIN2 control response to ethylene gas.
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Ethylene gas is essential for many developmental processes and stress responses in plants. ETHYLENE INSENSITIVE2 (EIN2), an NRAMP-like integral membrane protein,plays an essential role in ethylene signaling, but its function remains enigmatic. Here we report that phosphorylation-regulated proteolytic processing of EIN2 triggers its endoplasmic reticulum (ER)-to-nucleus translocation.ER-tethered EIN2 shows CONSTITUTIVE TRIPLE RESPONSE1 (CTR1) kinase-dependent phosphorylation. Ethylene triggers dephosphorylation at several sites and proteolytic cleavage at one of these sites, resulting in nuclear translocation of a carboxyl-terminal EIN2 fragment (EIN2-C'). Mutations that mimic EIN2 dephosphorylation, or inactivate CTR1, show constitutive cleavage and nuclear localization of EIN2-C' and EIN3 and EIN3-LIKE1-dependent activation of ethylene responses. These findings uncover a mechanism of subcellular communication whereby ethylene stimulates phosphorylation-dependent cleavage and nuclear movement of the EIN2-C' peptide, linking hormone perception and signaling components in the ER with nuclear-localized transcriptional regulators.

5. Science. 2012 Nov 2;338(6107):595. doi: 10.1126/science.338.6107.595.
Scientific meetings. U.S. agencies feel the pinch of travel cutbacks.
Bhattacharjee Y.

6. Science. 2012 Nov 2;338(6107):655-9. doi: 10.1126/science.1225053.
Chloroplast biogenesis is regulated by direct action of the ubiquitin-proteasome system.
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Comment in
    Science. 2012 Nov 2;338(6107):622-3.

Development of chloroplasts and other plastids depends on the import of thousands of nucleus-encoded proteins from the cytosol. Import is initiated by TOC (translocon at the outer envelope of chloroplasts) complexes in the plastid outer membrane that incorporate multiple, client-specific receptors. Modulation of import is thought to control the plastid's proteome, developmental fate, and functions. Using forward genetics, we identified Arabidopsis SP1, which encodes a RING-type ubiquitin E3 ligase of the chloroplast outer membrane. The SP1 protein associated with TOC complexes and mediated ubiquitination of TOC components, promoting their degradation. Mutant sp1 plants performed developmental transitions that involve plastid proteome changes inefficiently, indicating a requirement for reorganization of the TOC machinery. Thus, the ubiquitin-proteasome system acts on plastids to control their development.

7. Science. 2012 Nov 2;338(6107):659-62. doi: 10.1126/science.1226743. Epub 2012 Oct 18.
Tricking the guard: exploiting plant defense for disease susceptibility.
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Typically, pathogens deploy virulence effectors to disable defense. Plants defeat effectors with resistance proteins that guard effector targets. We found that a pathogen exploits a resistance protein by activating it to confer susceptibility in Arabidopsis. The guard mechanism of plant defense is recapitulated by interactions among victorin (an effector produced by the necrotrophic fungus Cochliobolus victoriae), TRX-h5 (a defense-associated thioredoxin), and LOV1 (an Arabidopsis susceptibility protein). In LOV1's absence, victorin inhibits TRX-h5,resulting in compromised defense but not disease by C. victoriae. In LOV1's presence, victorin binding to TRX-h5 activates LOV1 and elicits a resistance-like response that confers disease susceptibility. We propose that victorin is, or mimics, a conventional pathogen virulence effector that was defeated by LOV1 and confers virulence to C. victoriae solely because it incites defense.

8. Science. 2012 Nov 2;338(6107):662-5. doi: 10.1126/science.1226734. Epub 2012 Oct 11.
Tug-of-war in motor protein ensembles revealed with a programmable DNA origami scaffold.
Derr ND, Goodman BS, Jungmann R, Leschziner AE, Shih WM, Reck-Peterson SL.

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Comment in
Science. 2012 Nov 2;338(6107):626-7.

Cytoplasmic dynein and kinesin-1 are microtubule-based motors with opposite polarity that transport a wide variety of cargo in eukaryotic cells. Many cellular cargos demonstrate bidirectional movement due to the presence of ensembles of dynein and kinesin, but are ultimately sorted with spatial and temporal precision. To investigate the mechanisms that coordinate motor ensemble behavior, we built a programmable synthetic cargo using three-dimensional DNA origami to which varying numbers of DNA oligonucleotide-linked motors could be attached, allowing for control of motor type, number, spacing, and orientation in vitro. In ensembles of one to seven identical-polarity motors, motor number had minimal affect on directional velocity, whereas ensembles of opposite-polarity motors engaged in a tug-of-war resolvable by disengaging one motor species.