Long-distance transport and seed loading of nutrients and toxic metals.

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Now what?
Today’s plan…

- Allocation of nutrients within plant tissues.
- Cell-specific translatome analyses to map seed loading processes.
  (Trends & current tools)
- Dynamic view of nutrient mobilization within the plant.
  (Bottlenecks and needs)
  Modeling / sensing / data integration

Transition metals are extremely reactive

**Essential**  
(Fe, Zn, Mn, Cu)  
catalysis, redox centers, structure.

**Non essential**  
(Cd, Hg, Ag)  
properties similar to *essential* metals
Our goal is to understand how plants mobilize micronutrients and toxic metals.

Fe and Zn deficiencies are among the most prevalent nutrient deficiencies in the world.

100+ million people worldwide are exposed to As and Cd due to irrigation with contaminated water.

Biofortification:

Moving toward a precise nutrition: preferential loading of seeds with essential nutrients over non-essential toxic elements.
Which transporters mobilize metals (and other nutrients) into seeds?

Transporters expressed in companion cell are key to move molecules into seeds.

Companion cell Ribo-seq (Polysome-IP)

= 250 ng total RNA
HQ RNA-seq library
Without pre-amplification
Ribo-seq of phloem-loading cells was used to identify phloem-specific transporters

Organized in 96-well plates for high throughput screening

Mather A. Khan, Andrew Riga and Mendoza-Cozatl, unpublished
Ionome dynamics through plant development

Integration of transcriptomics, development and phenomics

WT (Col)  mutants
So…

top-down approach       (reductionist)

bottom-up approach      (systems)

?
**Metabolic control analysis**  
(a quantitative approach to understand metabolism)

**Steady state**  
(an unvarying condition in a physical process)

Constant rate of synthesis (continuous flow) without changes in intermediary metabolites.

\[
\text{Flux} \neq \text{Concentration}
\]

\[
C_j^1 + C_j^2 + \ldots + C_j^n = 1
\]

Flux control coefficient

Enzyme with low \(C_j\)

Enzyme with high \(C_j\)

Modeling allows predictions  
(new hypothesis)

**How do you know you have a good model?**
Summary

• We have the technology to track the expression of plant genes at tissue-specific resolution (link to metabolites missing!).
  Expression during development? Stress? Drought?

• Metabolic engineering requires a good understanding of both, the individual components and system properties as a whole.
  Combination of top-down and bottom-up approaches

• Dynamic view of nutrient mobilization throughout the plant
  Sensors, modeling, data integration (cross-disciplinary training) funding opportunities

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