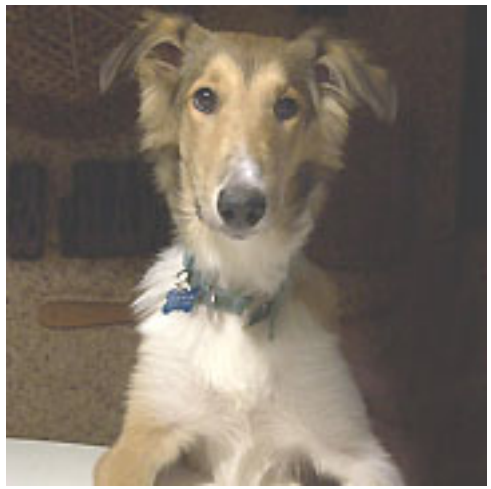
USDA Agricultural Outlook forum 2007

- BREAKING THE CELL WALL BARRIER

- Sarah Hake
- Plant Gene Expression Center
- USDA-ARS

- Thursday March 1, 2007

Human selection in the evolution of dogs



AGRO FOOD INDUSTRY hi-tech

INTERNATIONAL JOURNAL FOR FOOD, CHEMICALS, PHARMACEUTICALS, COSMETICS AS LINKED TO AGRICULTURE THROUGH ADVANCED TECHNOLOGIES

6

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The ancestor of maize is teosinte, a wild grass that grows in Mexico

maize

teosinte

Humans selected for traits that enhanced the use of teosinte as a crop

Teosinte

Seeds easily disperse

Hard glumes (seed coast) thus seeds survive in gut of animals

Maize

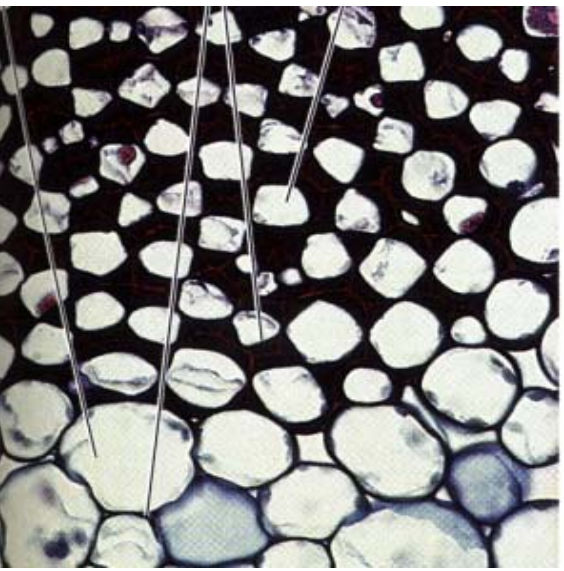
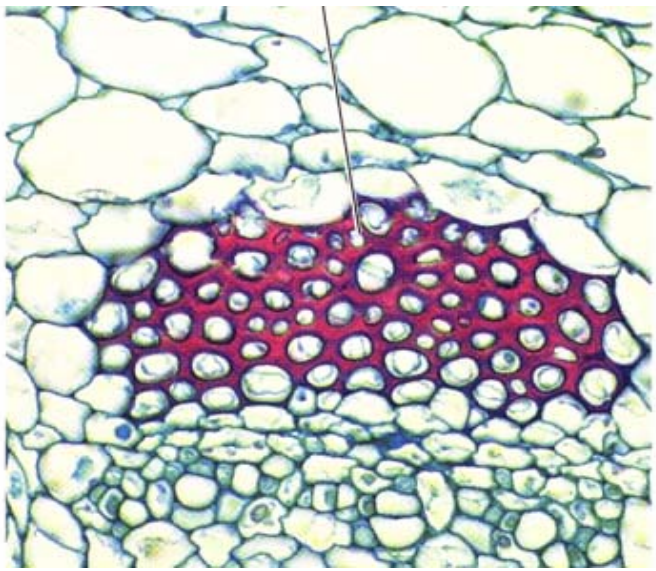
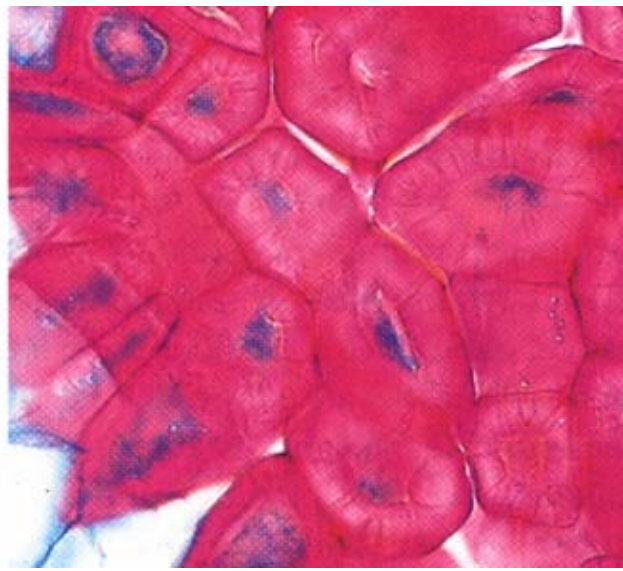
Non-shattering (no seed dispersal)

More kernels

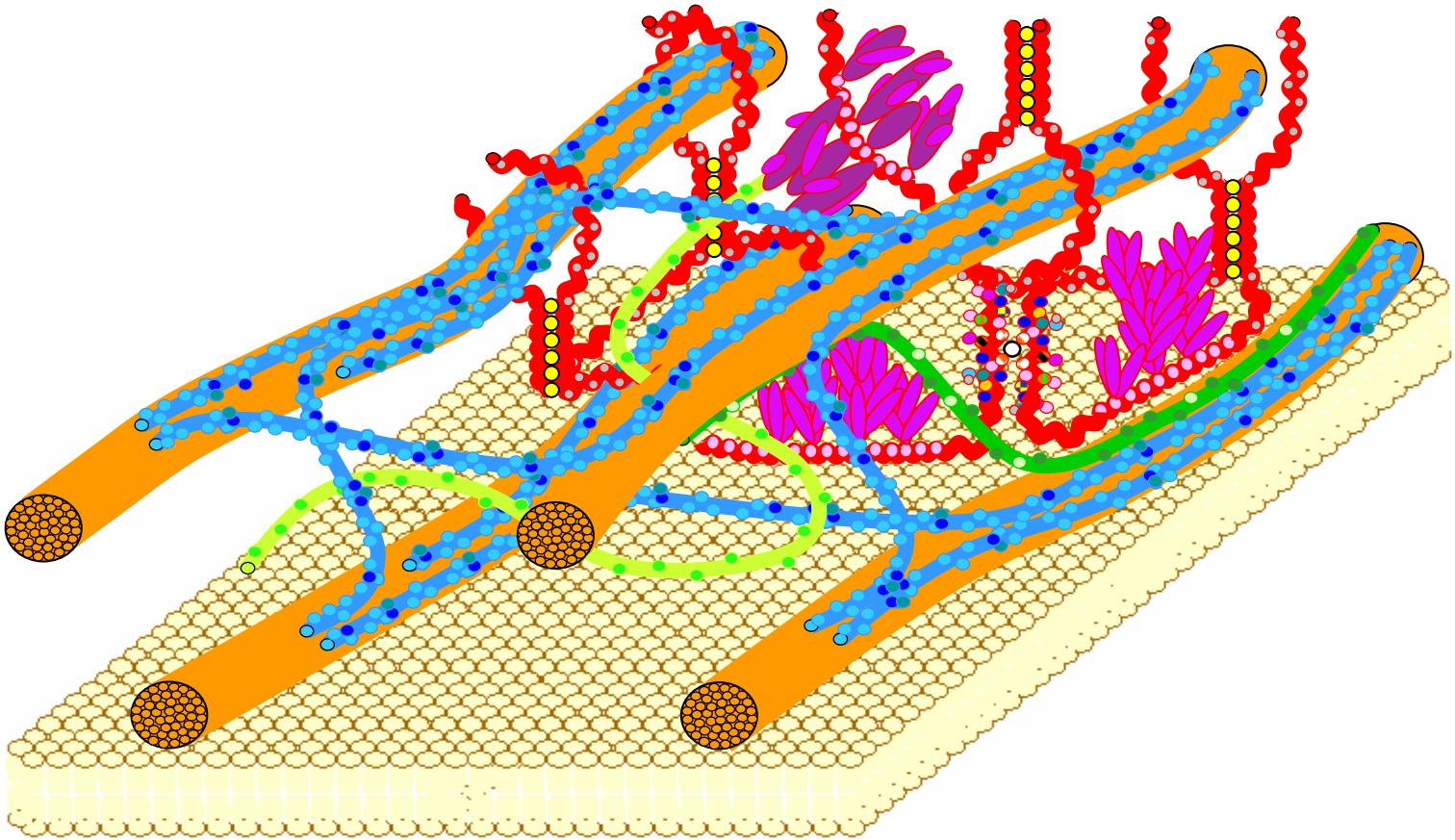
Soft glumes (seed coat)

We need to begin selecting for the next generation of bio-fuel crops

- Optimal use of plant material for fuel will take advantage of the carbon locked up in the cell wall.

Cell walls are constructed of complex polysaccharides



Cellulose

Hemicellulose

- xyloglucan
- galactomannan
- arabinoxylan

Pectin

Homogalacturonan

- Ca^{2+}-crosslinked
- non-methylesterified
- methylesterified

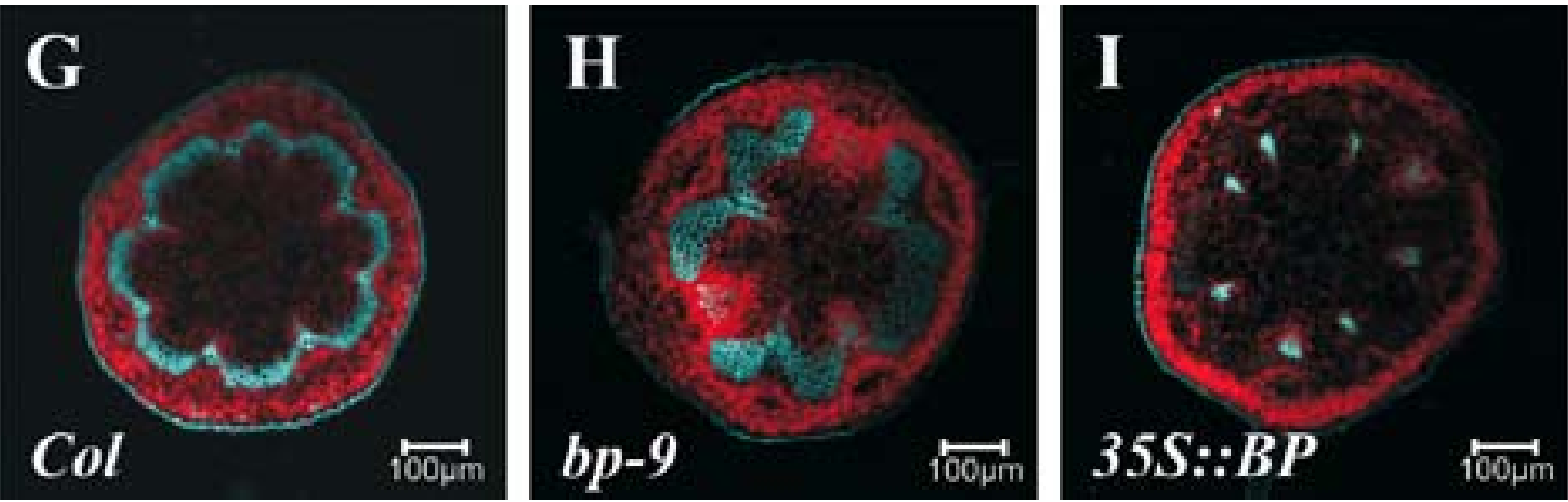
Rhamnogalacturonan

RG I (galactan) (arabinan)

RG II (boron-diester)

Cross-linked with the polysaccharides is a polymer that is essentially a super-glue, **lignin**.

Providing rigidity and water proofing, but keeping the cellulose from easy fractionation



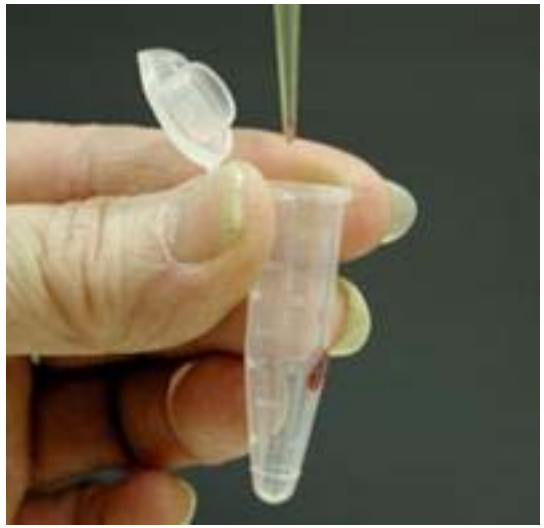
In order to breed for the next generation of biofuels, we need to take a genetic approach to determine how cell walls are put together and how to optimize biomass

1) determine the genes that make and take apart cell walls

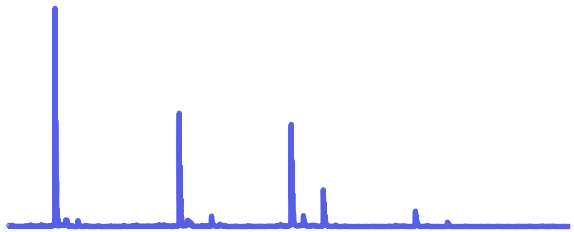
2) determine the “master regulators” that orchestrate the process

Mutagenize the genome and sort through mutants to find new cell wall components

samples collected



ground to fine powder
add hydrolytic enzymes



MALDI-TOF Mass spectrometry

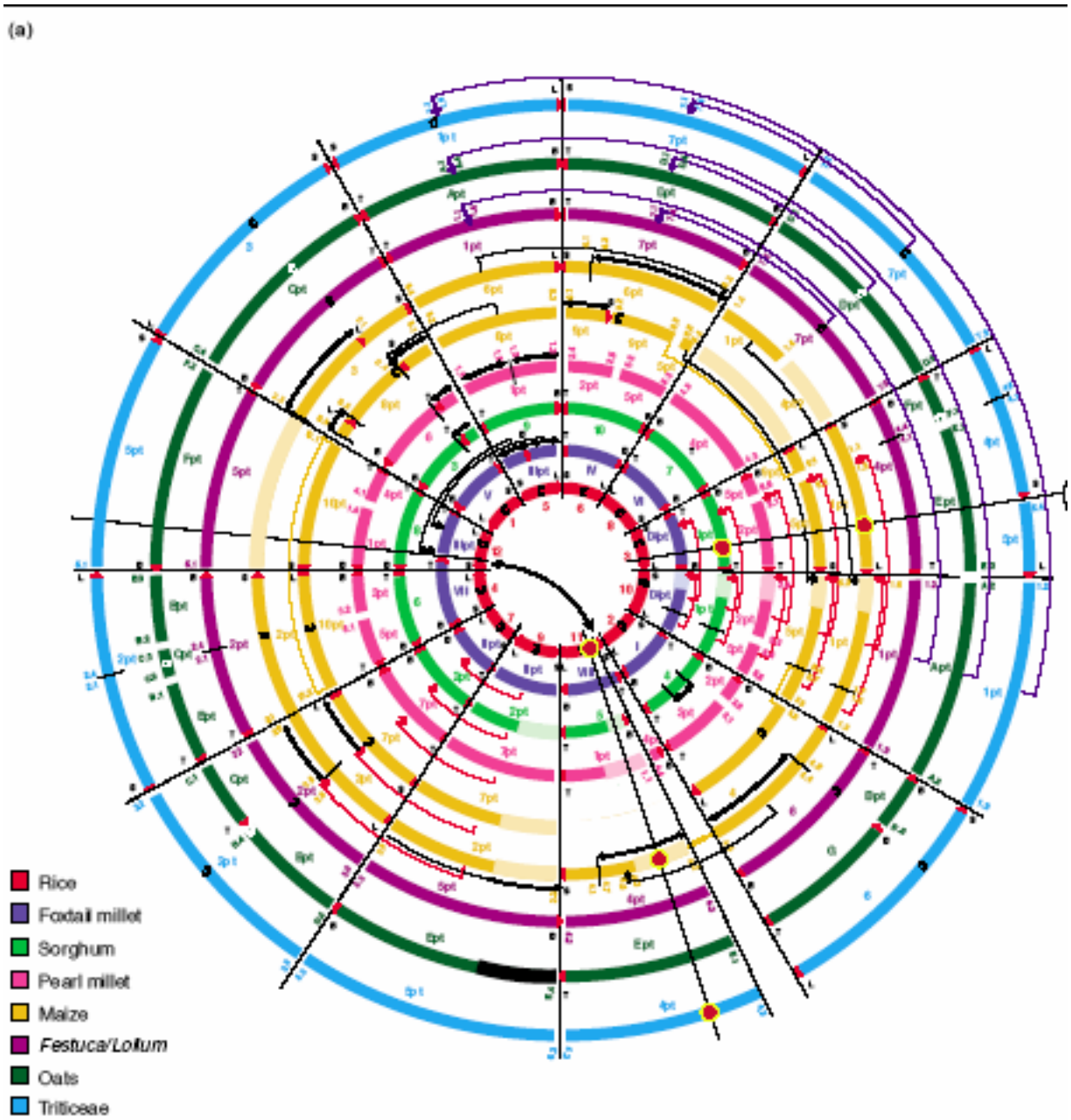
Identify genetic variants

Collaboration with Markus Pauli, Golm US-EC task force
- ability to carry out high-through put analysis

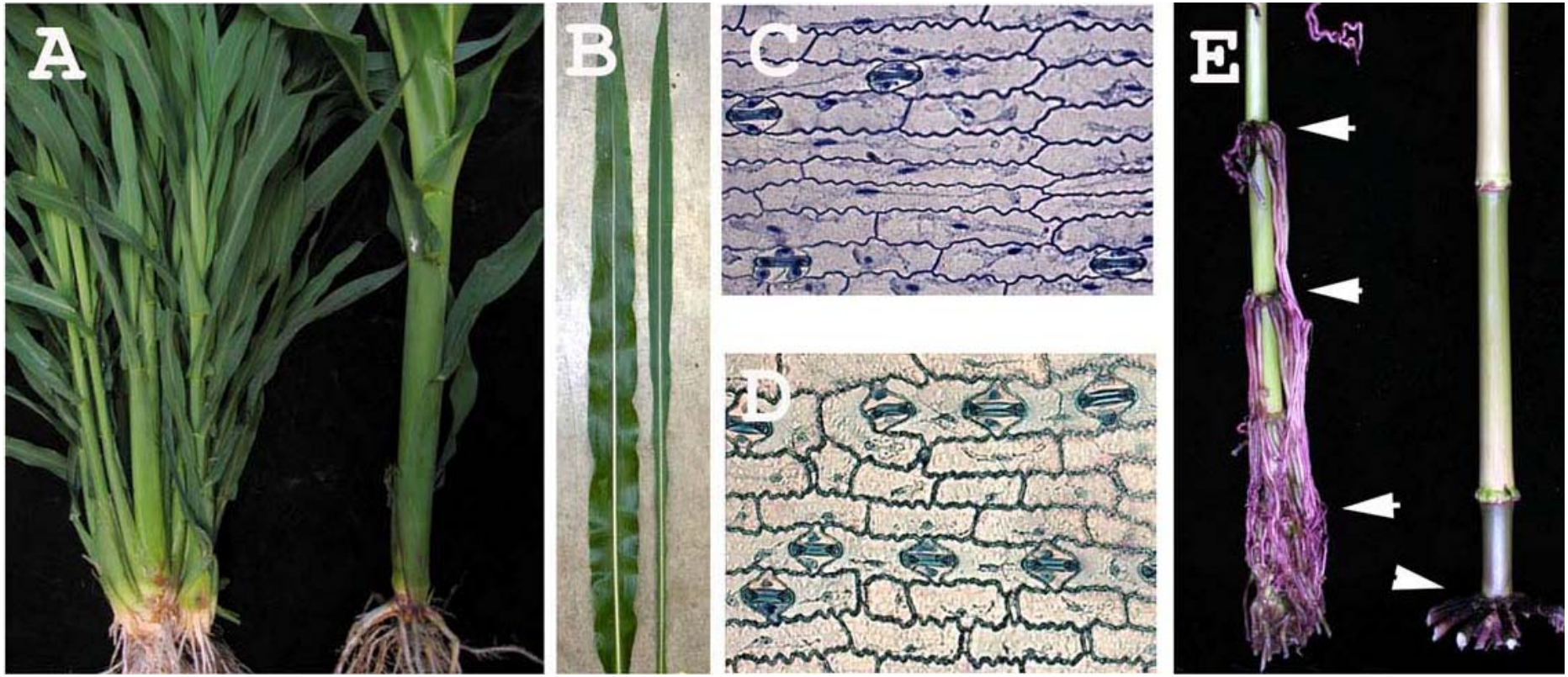
Many biofuel crops are in the grass family, discoveries in one species can easily be transferred to another

Anomochlooideae (3)
Pharoideae (11)
Puelioideae (11)
Bambusoideae (970)
Streptogyna (2)
Oryzoideae (105) - rice
Stipeae (400)
Brachypodium (16)
Aveneae (1050) - oats
Poeae (1210) - ryegrass, fescue
Triticeae (480) - barley, wheat, rye
Diarrhena (4)
Meliceae (130)
Nardus + *Lygeum* (2)
Brachyelytrum (1)
Pooideae
Aristidoideae (300)
Danthonieae (270)
Arundinoideae (20)
Chloridoideae (1350) - finger millet
Eriachne (42)
Centothecoideae (30)
Gynerium (1)
Paniceae (2240) - common millet, foxtail millet, pearl millet
Andropogoneae (1000) - maize, sorghum, sugar cane
Micraira (13)
Panicoideae
60-70 mya
20-30 mya

The grasses share a common ancient genome, allowing the transfer of gene discovery



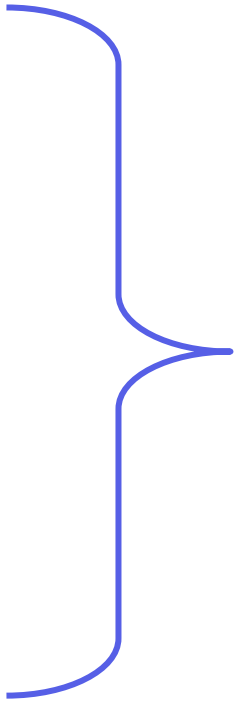
Mutants have been identified that affect lignin



Corngrass mutants make many more leaves that have reduced lignin

In addition to accessible cell walls, the optimal biofuel plant will have increased yields

- Reduced lignin
-
- Yield
- Flowering time
- Height
- leaf number
- stem diameter
- Branching, seed #
- upright growth



We have mutants for all these traits

EPOBIO: Realizing the Economic Potential of Sustainable Resources - Bioproducts from Non-food Crops

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Flagship project: Plant cell walls in relation to biorefining - Markus Pauly and Ralf Moller, Max Planck Institute, Golm

Other collaborations

John Vogel and Christian Tobias, WRRC
George Chuck, PGEC, NRI
Torbert Rocheford, University of Illinois, NSF