

# 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<sup>FOOD</sup>INDUSTRY


*hi-tech*

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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 coat) thus seeds survive in gut of animals



## Maize

Non-shattering (no seed dispersal)

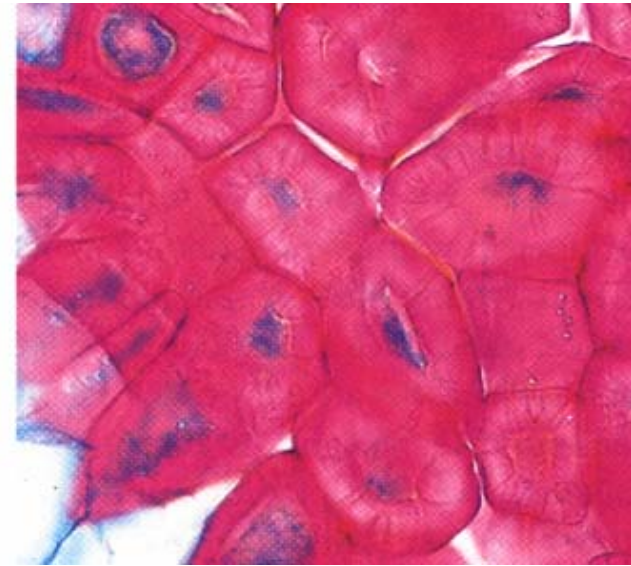
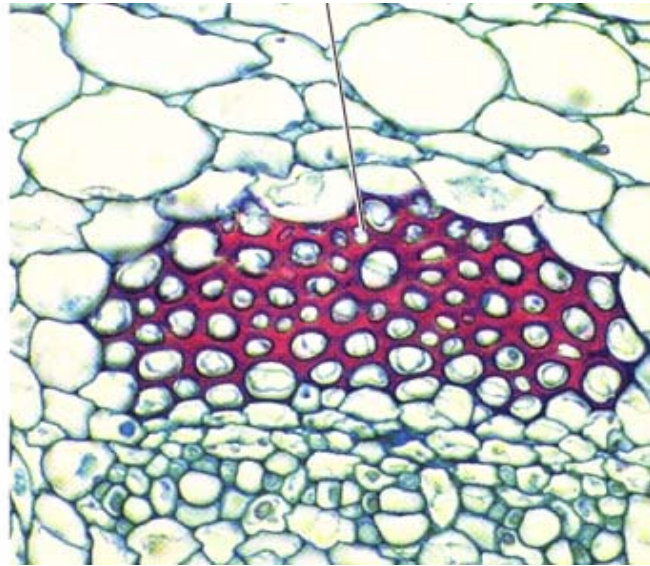
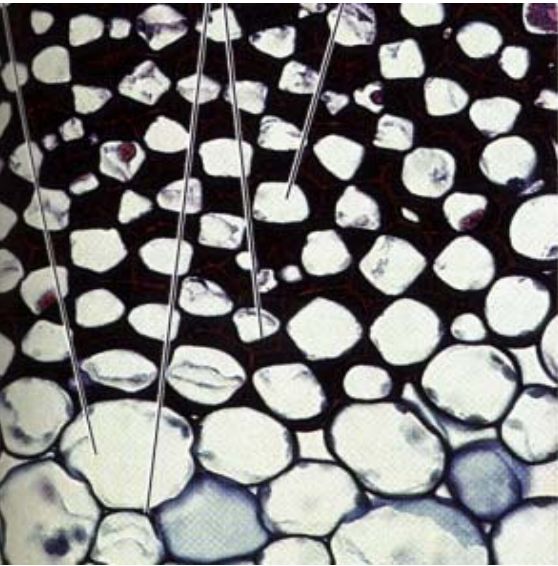
More kernels

Soft glumes (seed coat)



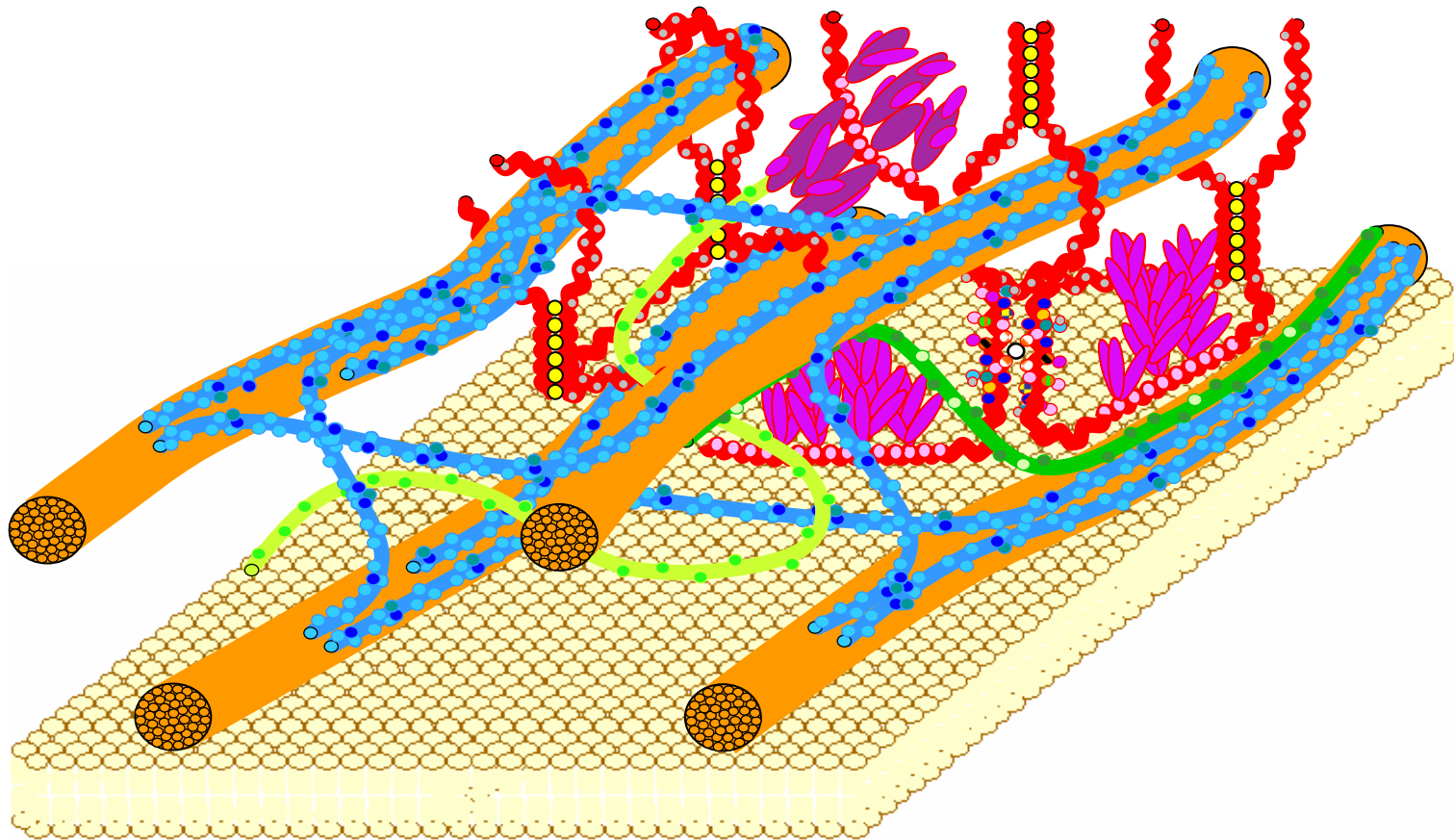
# We need to begin selecting for the next generation of bio-fuel crops

- 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





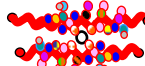
## Hemicellulose

-  xyloglucan
-  galactomannan
-  arabinoxylan

## Homogalacturonan

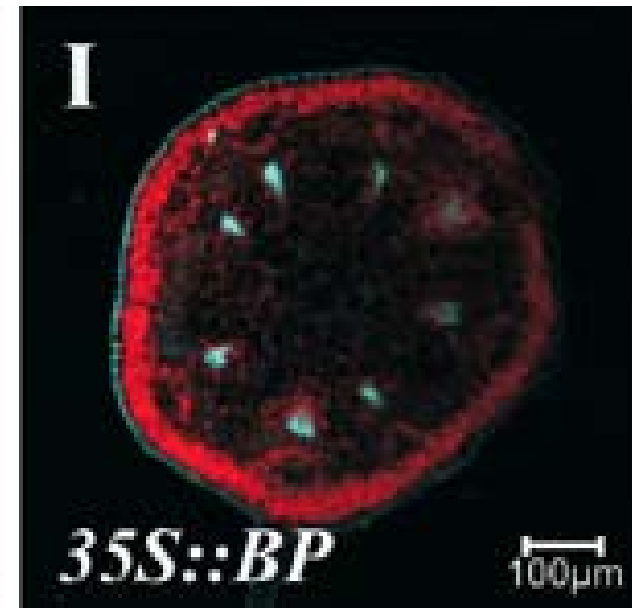
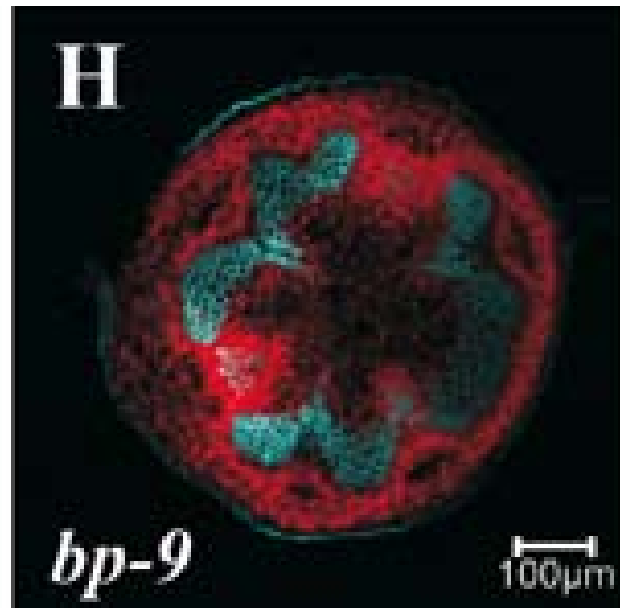
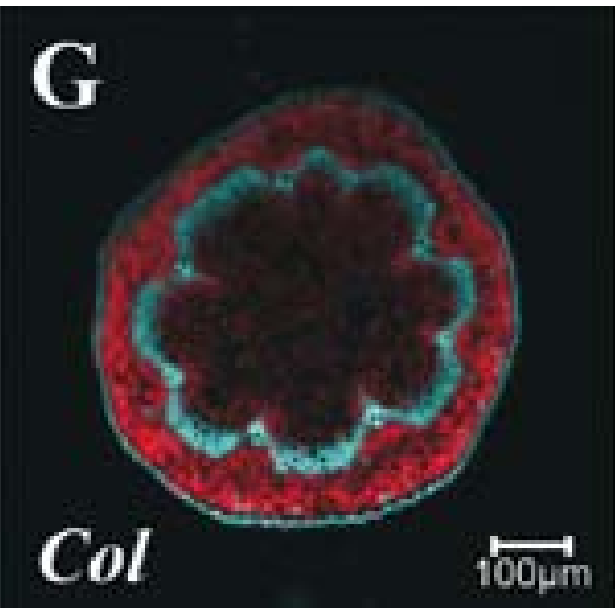
-  Ca<sup>2+</sup>-crosslinked
-  non-methylesterified
-  methylesterified

## Pectin

-  Rhamnogalacturonan I (galactan)
-  Rhamnogalacturonan II (arabinan)
-  Rhamnogalacturonan 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

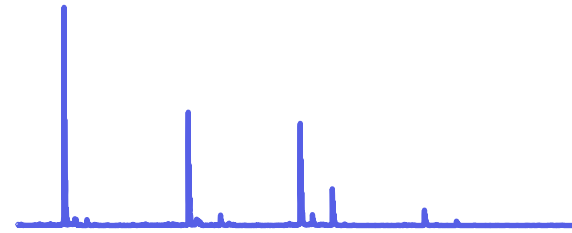




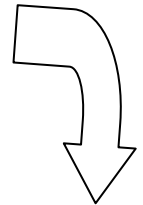
samples collected



ground to fine powder  
add hydrolytic enzymes



MALDI-TOF Mass spectrometry

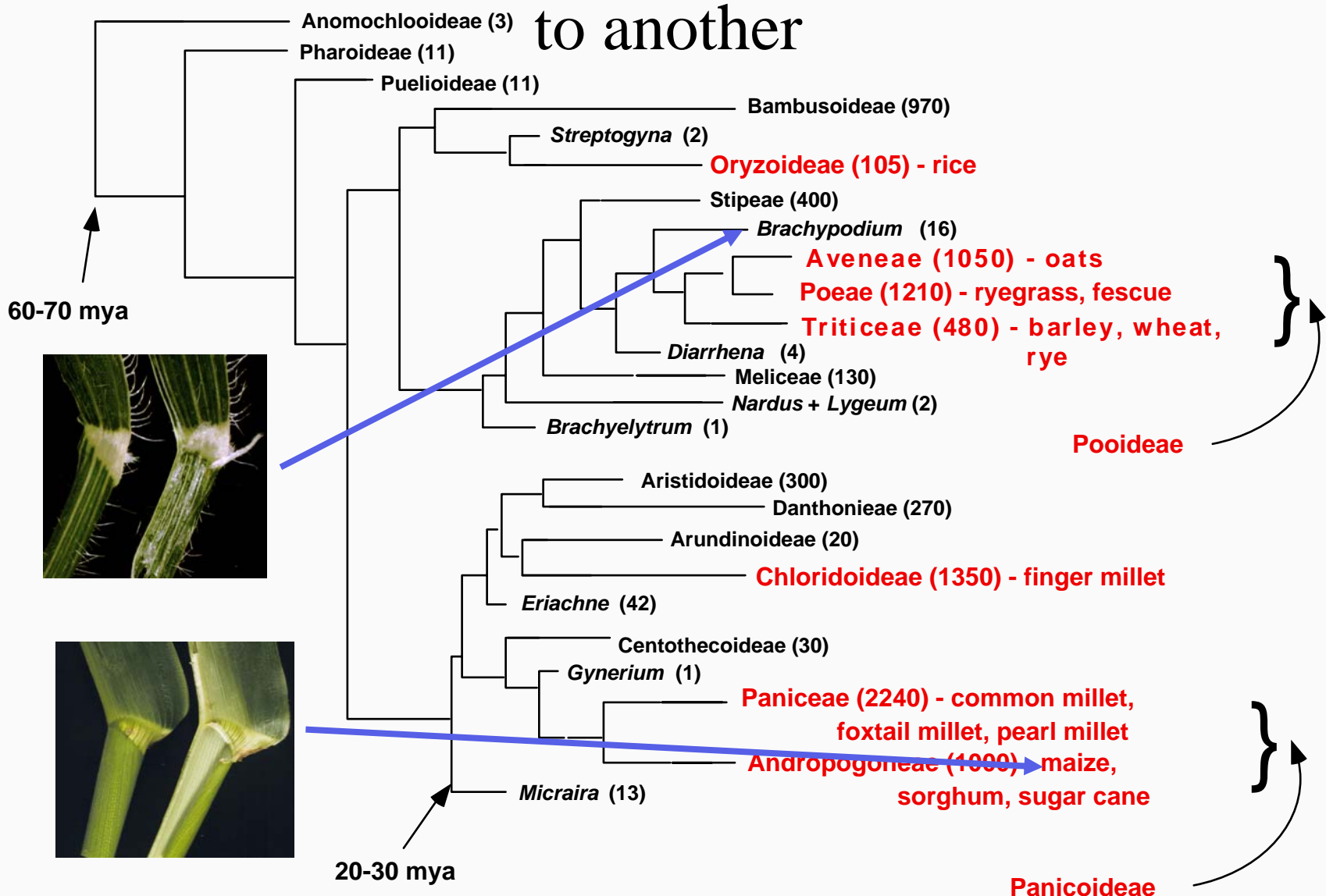


Identify genetic variants

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

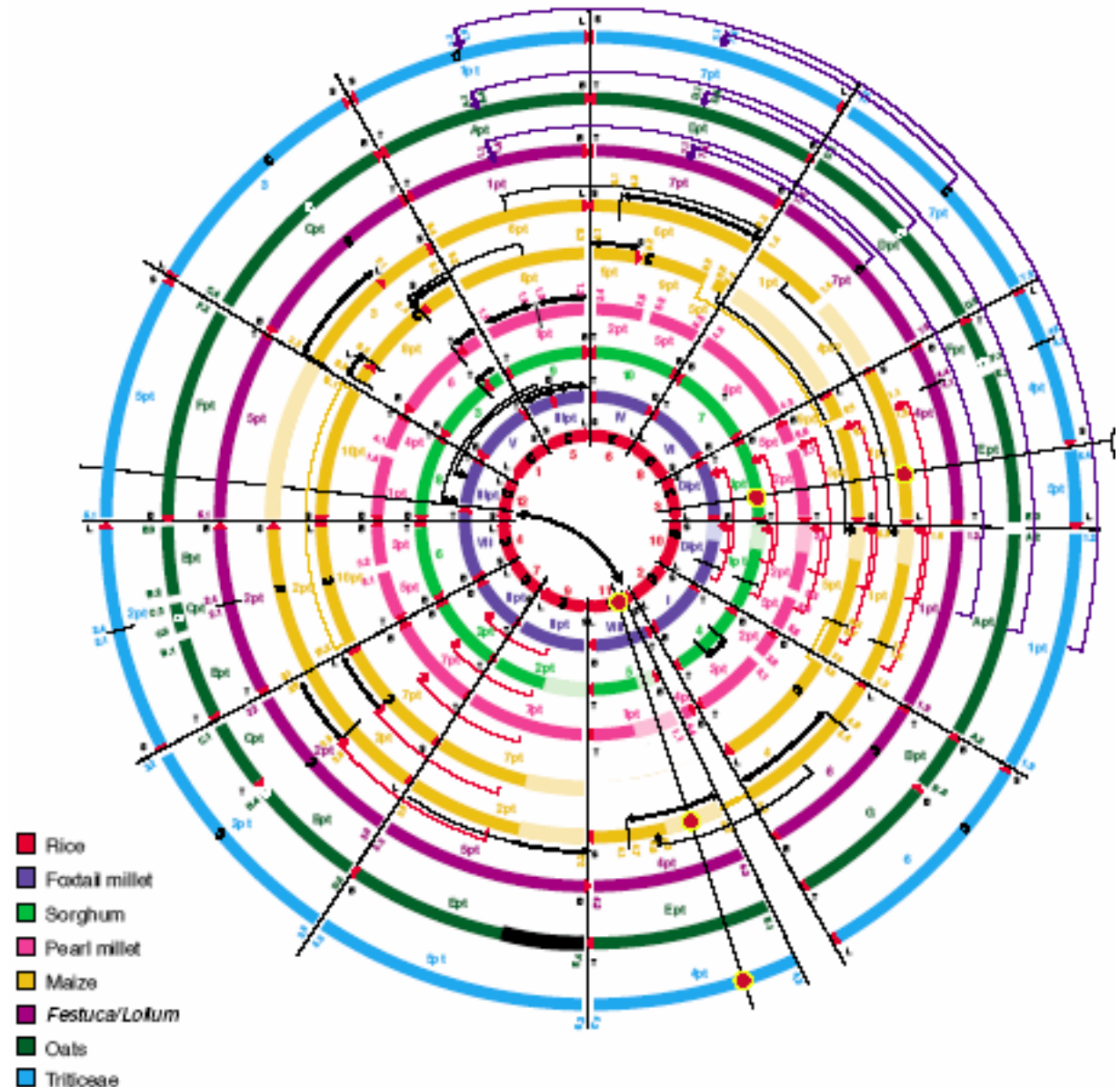


Many biofuel crops are in the grass family, discoveries in one species can easily be transferred to another



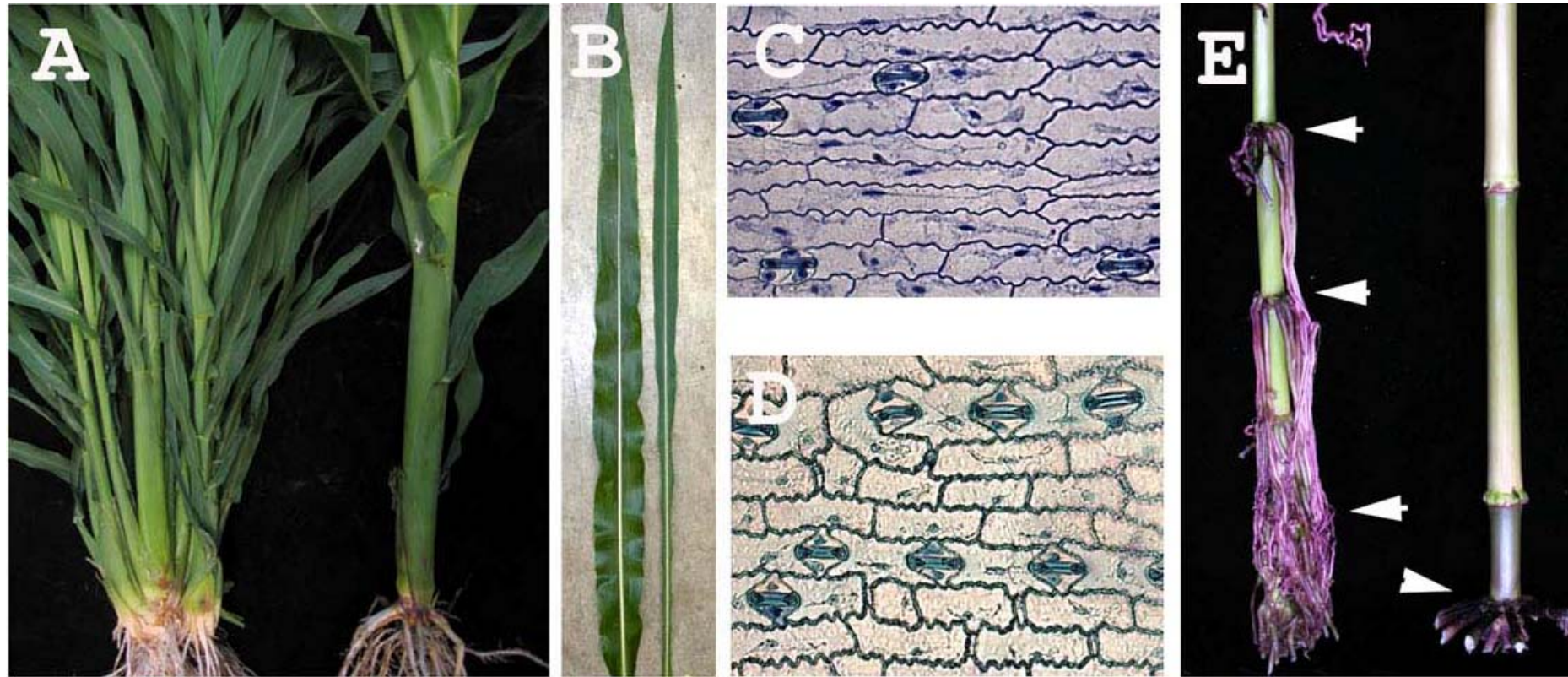
The grasses share a common ancient genome, allowing the transfer of gene discovery

(a)



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