



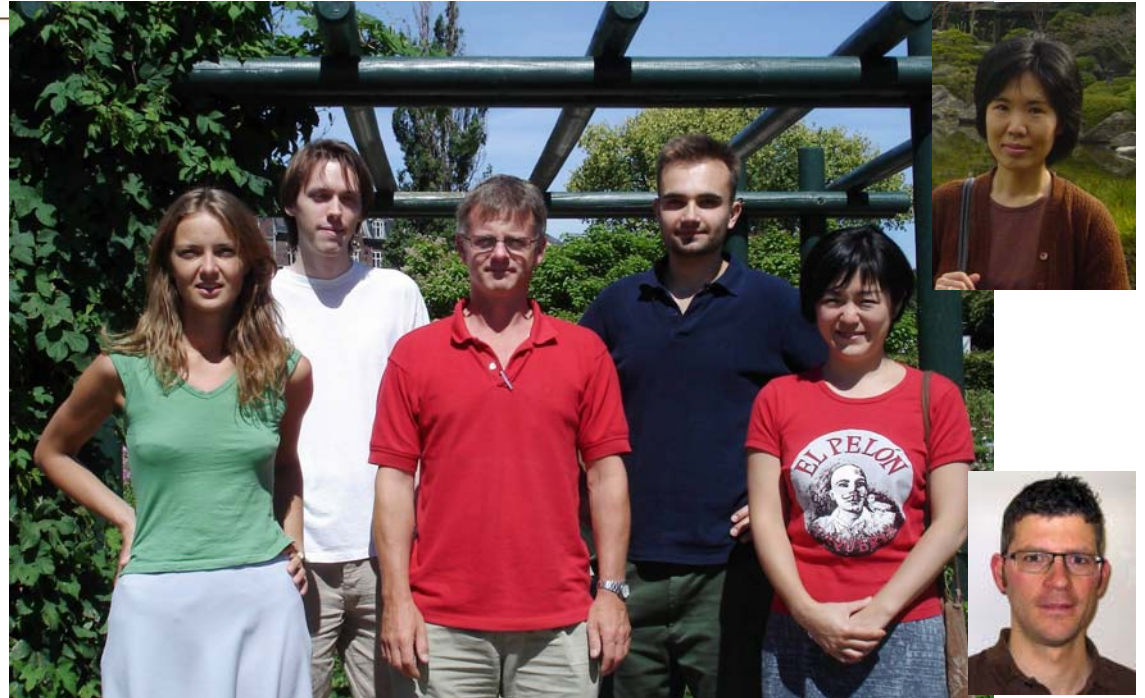
# Biochemistry and genetic background of cell wall digestibility in cereals





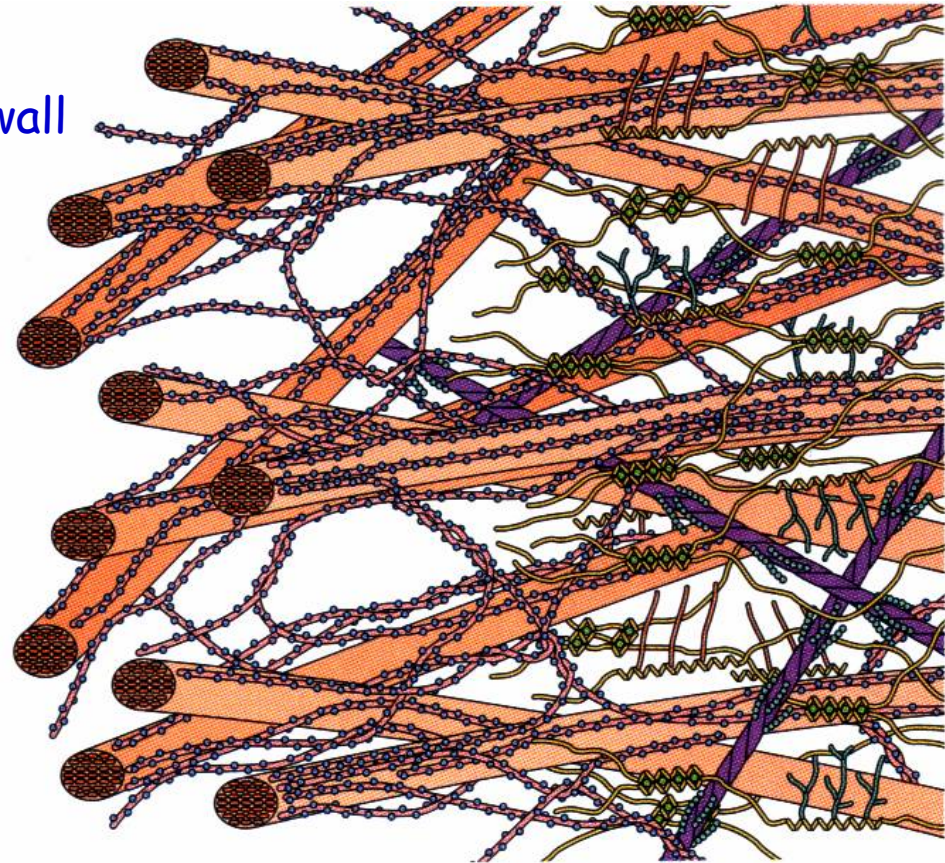
Faculty of Life Sciences

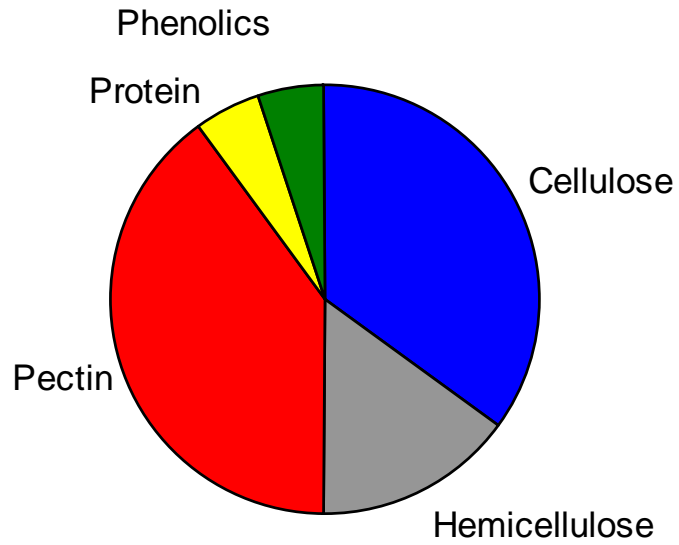
Naomi Geshi,  
Yumiko Sakuragi  
Jacob Krüger Jensen  
Jesper Harholt  
Ulla Christensen  
Casper Søgaard  
Charlotte Sørensen



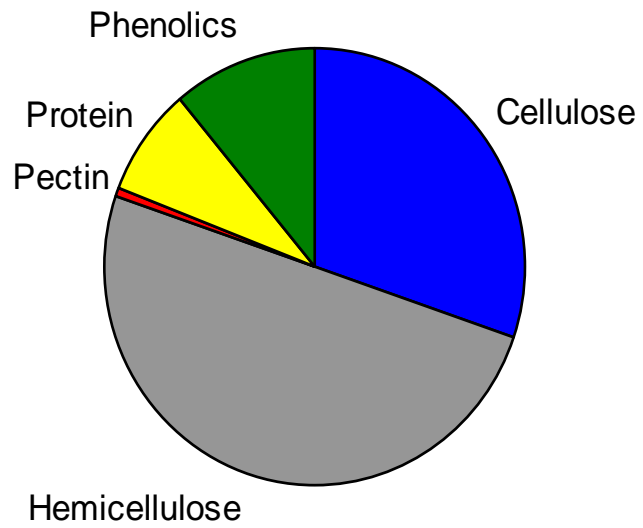


## Schematic model of the plant cell wall





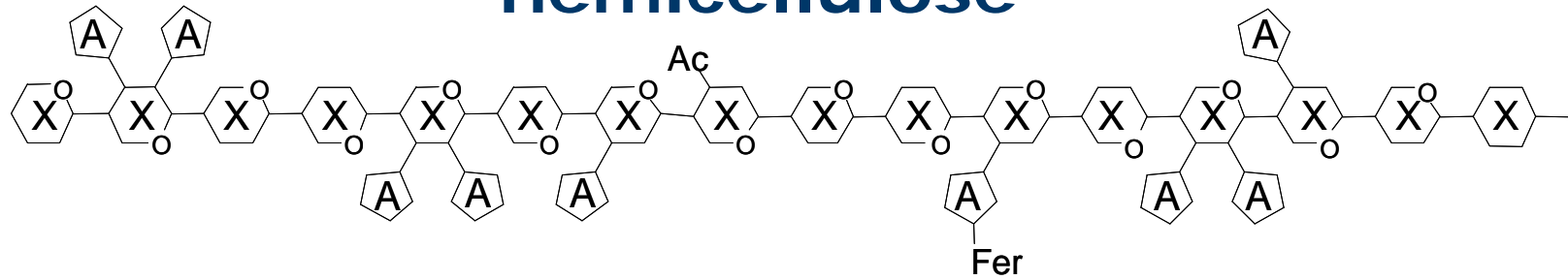
Type I wall  
typical dicot plant



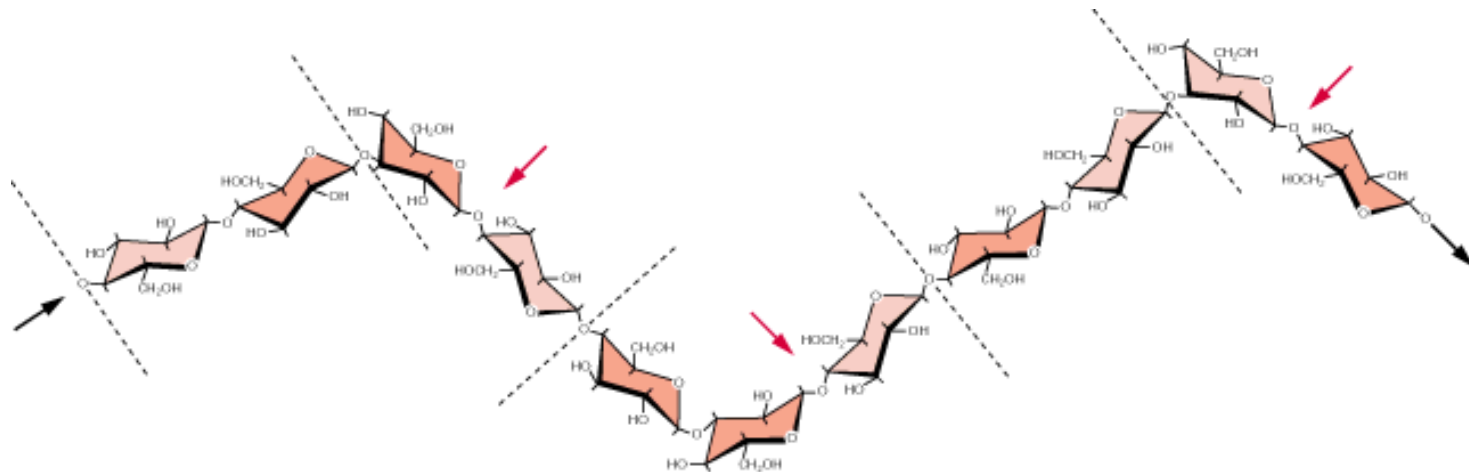
Type II wall  
typical grass



# Grasses contain two major kinds of hemicellulose



Arabinoxylan

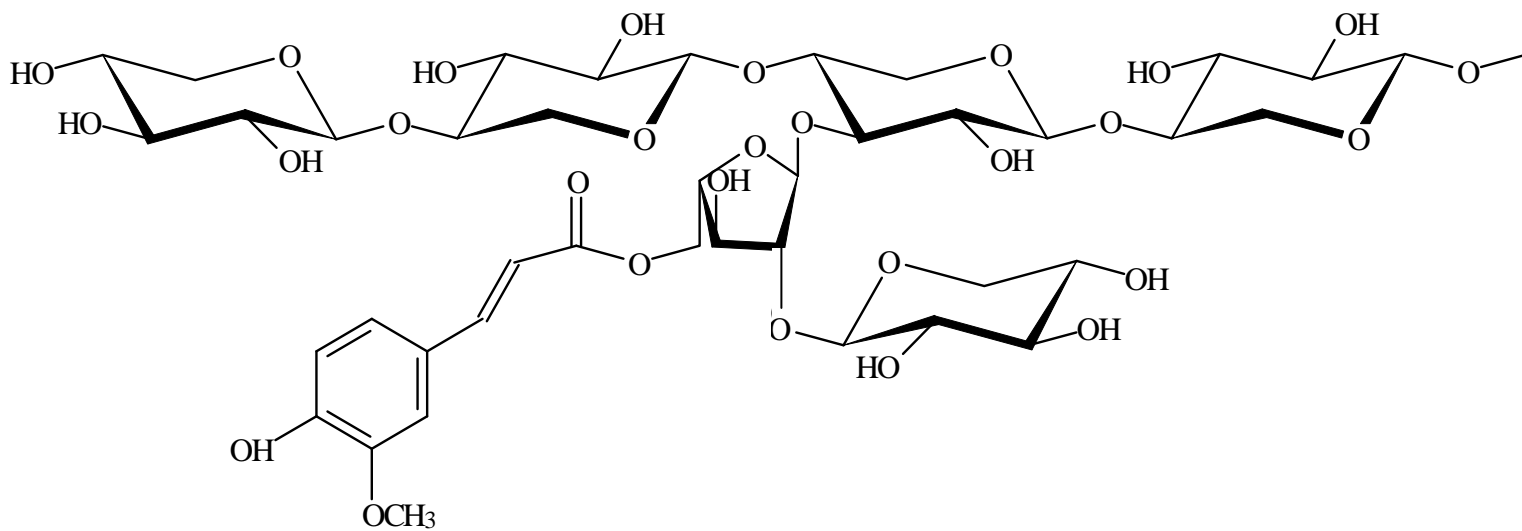
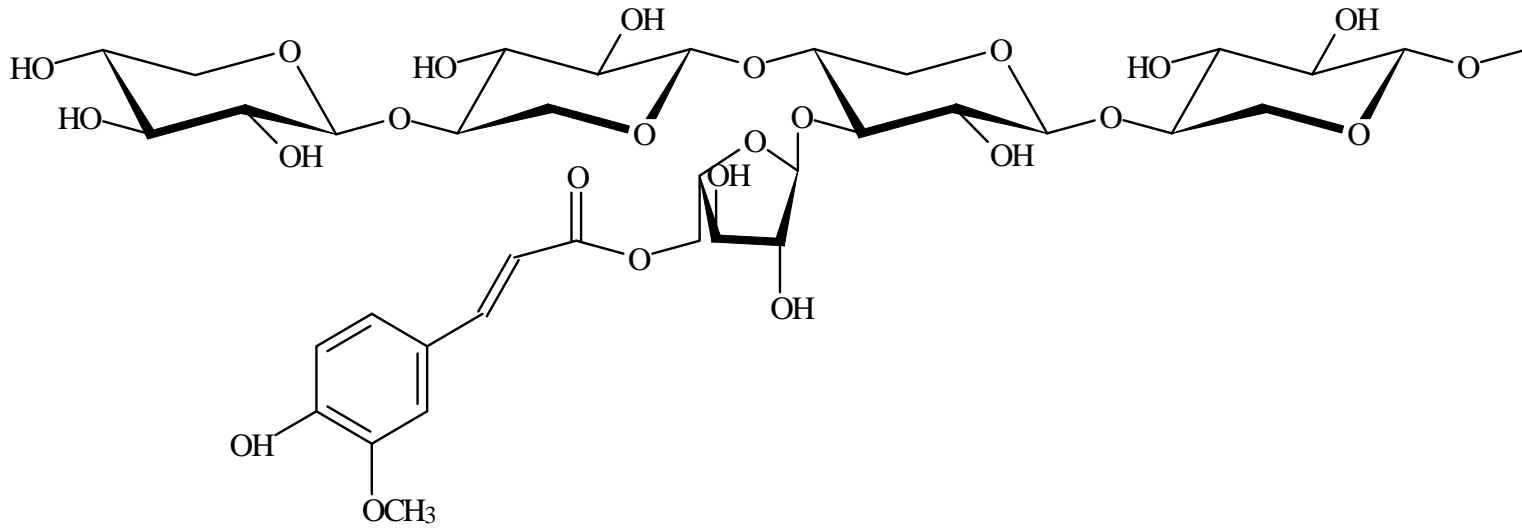


Beta-glucan = 1-3,1-4-beta-glucan

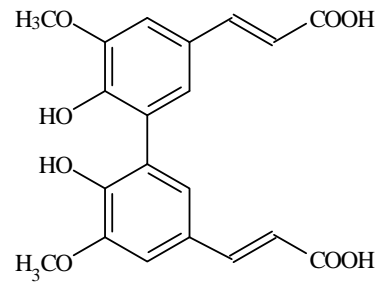




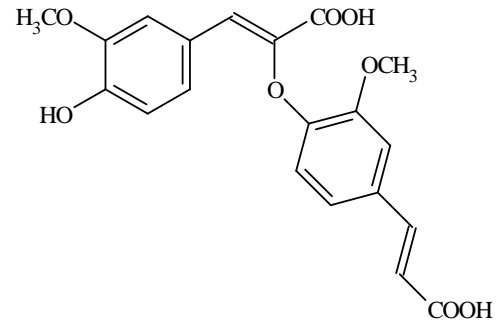
## Coumaric and ferulic acid are characteristic for arabinoxylan in grasses



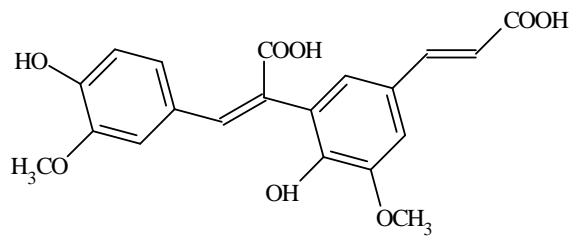
# Common diferulates in grass walls



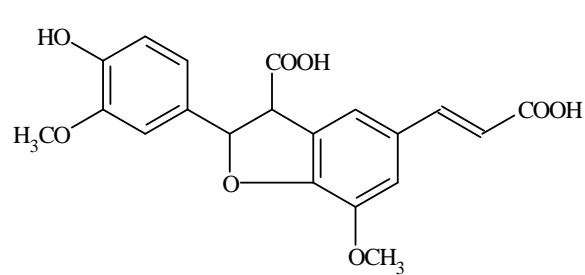
5,5'-diferulic acid



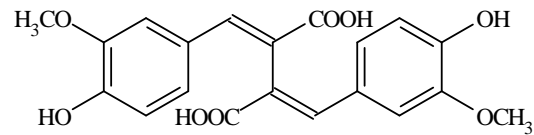
8-O-4'-diferulic acid



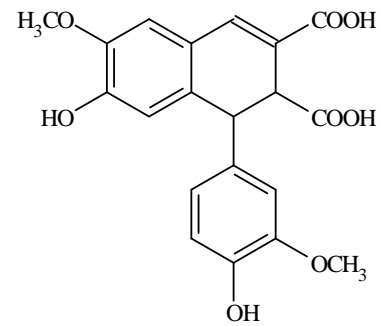
8,5'-Diferulic acid



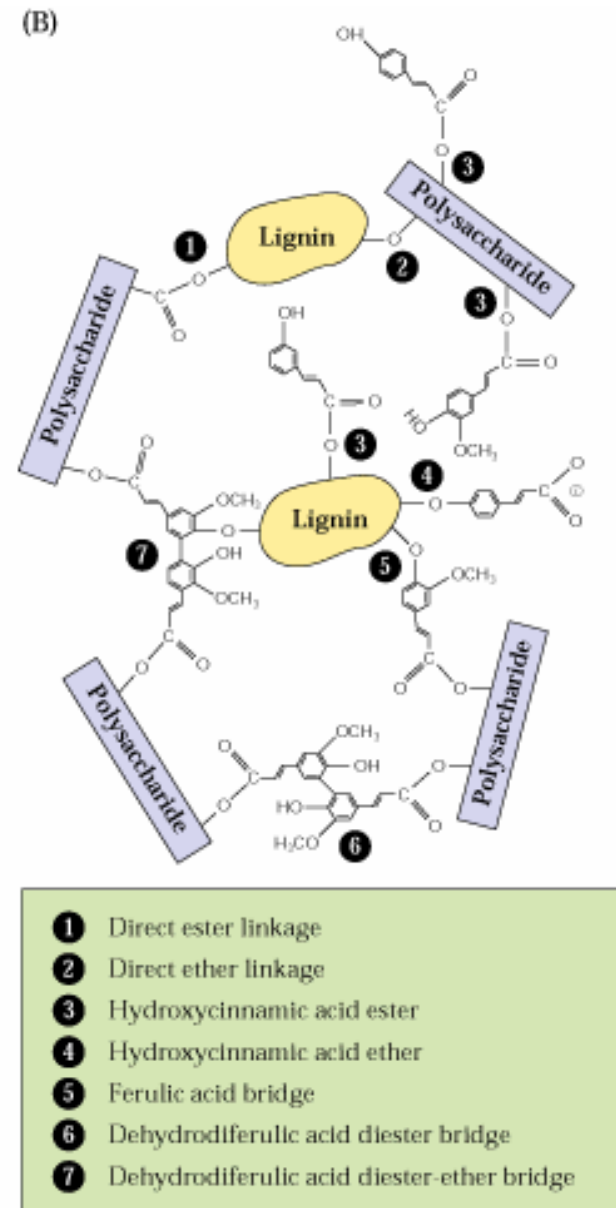
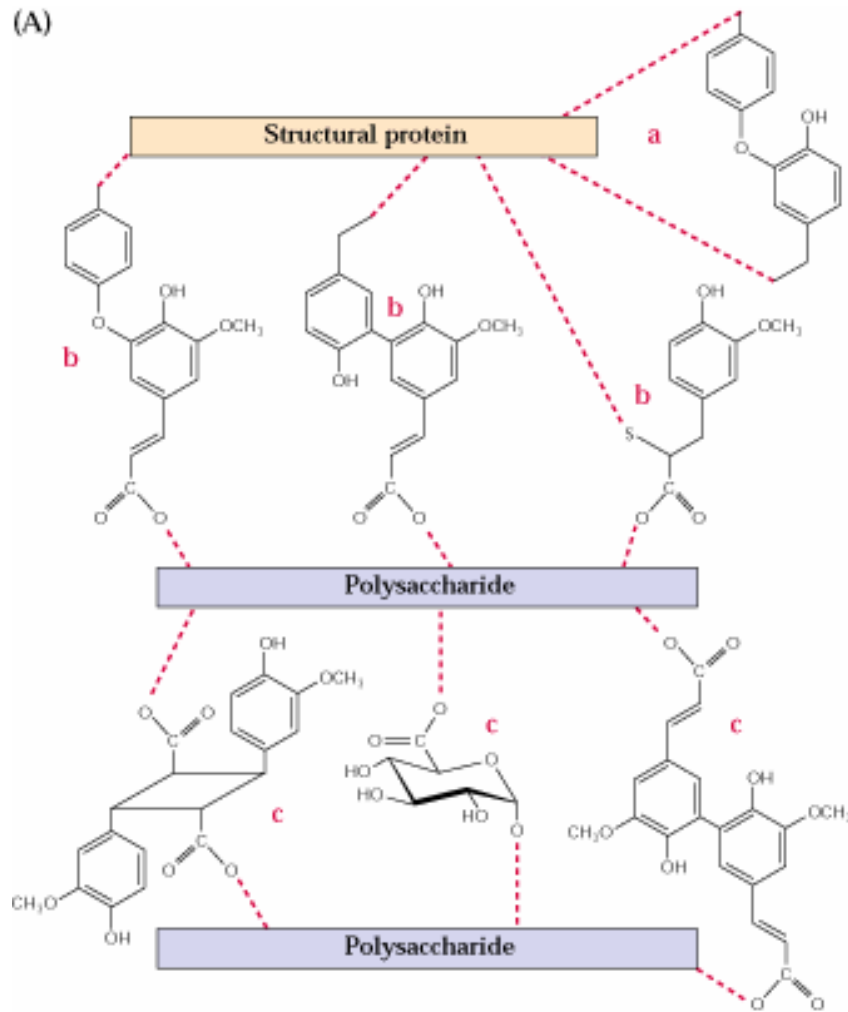
8,5'-Diferulic acid benzofuran form



8,8'-Diferulic acid



8,5'-Diferulic acid aryltetralin form



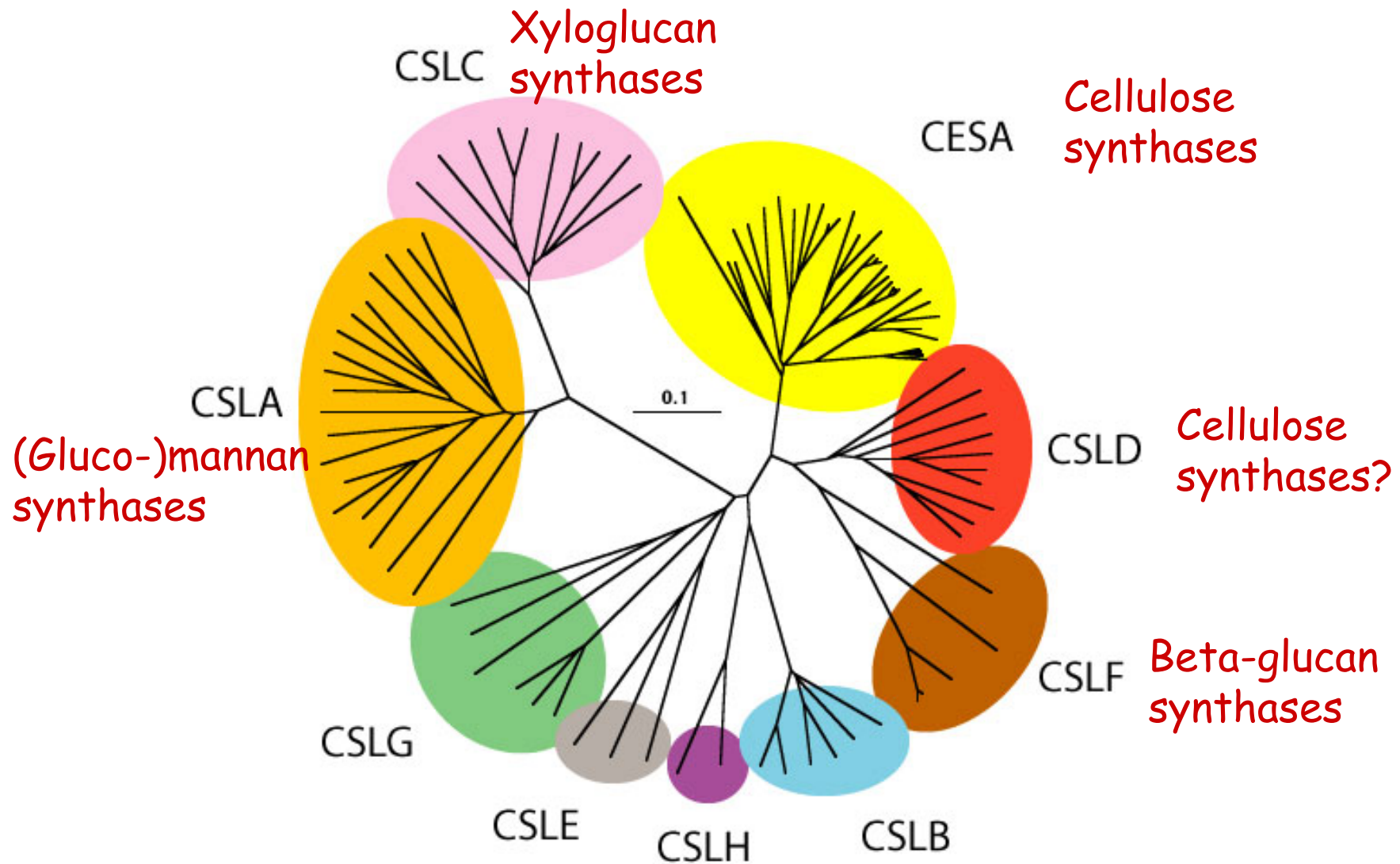
Ferulate and diferulate esters are important determinants of digestibility



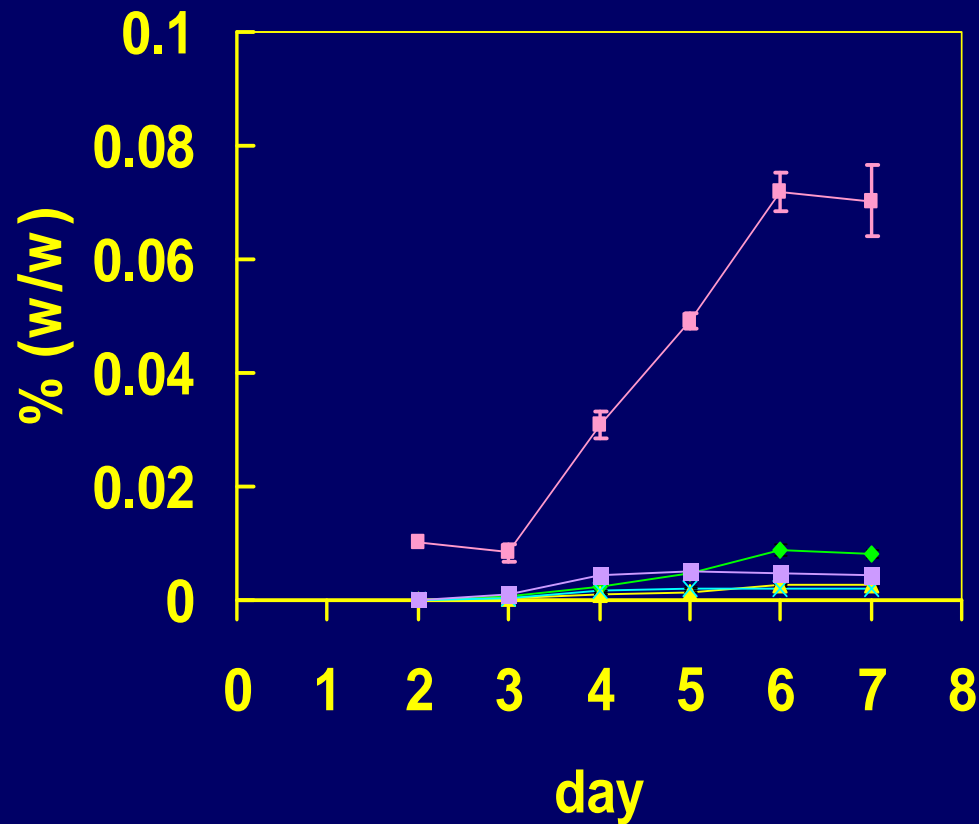
## Research Goals and Challenges:

- Decreased cellulose crystallinity
- Increased beta-glucan / arabinoxylan ratio
- Decreased ferulate ester content
- Increased xylan solubility
- Altered lignin structure or decreased lignin content

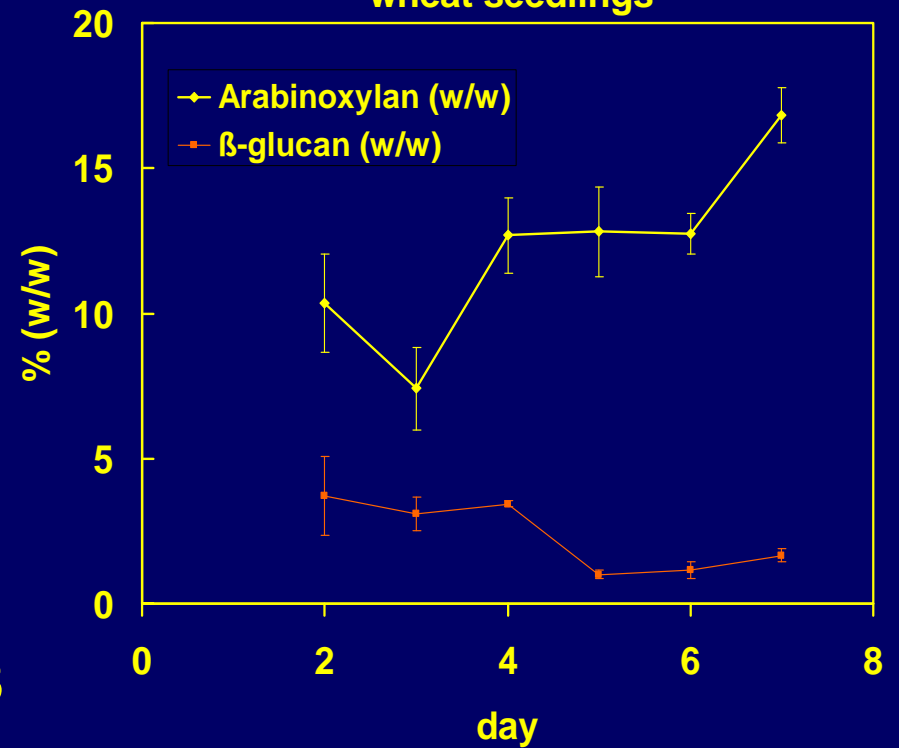
The CESA- CSL superfamily of genes is responsible for synthesis of cellulose and many hemicelluloses



## Hydroxycinnamic acids in developing wheat seedlings

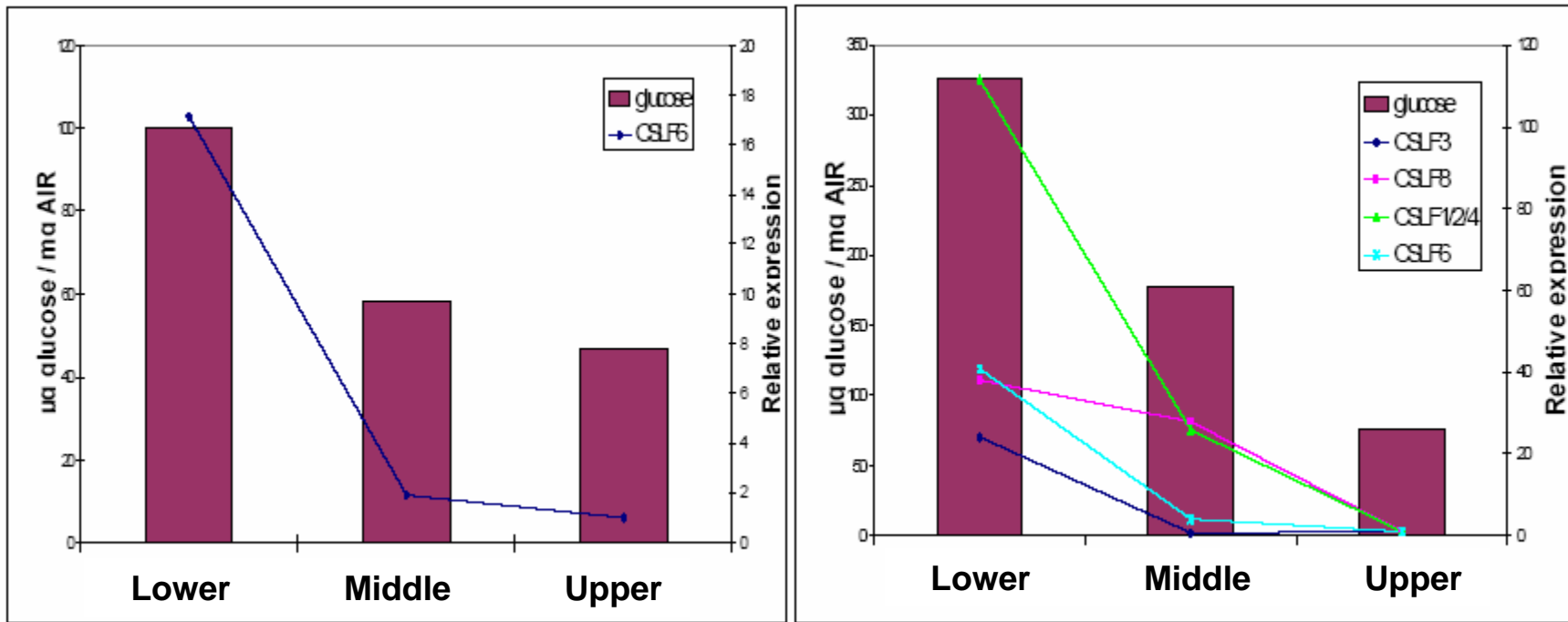


## Arabinoxylan and $\beta$ -glucan in developing wheat seedlings





## Beta-glucan content and CSLF gene expression in 7-day old seedlings



*Brachypodium distachyon*

Wheat

(Andrzej Argalski, Simone Hoogen, Ilona Pisarczyk  
Plant Biotechnology 2007)



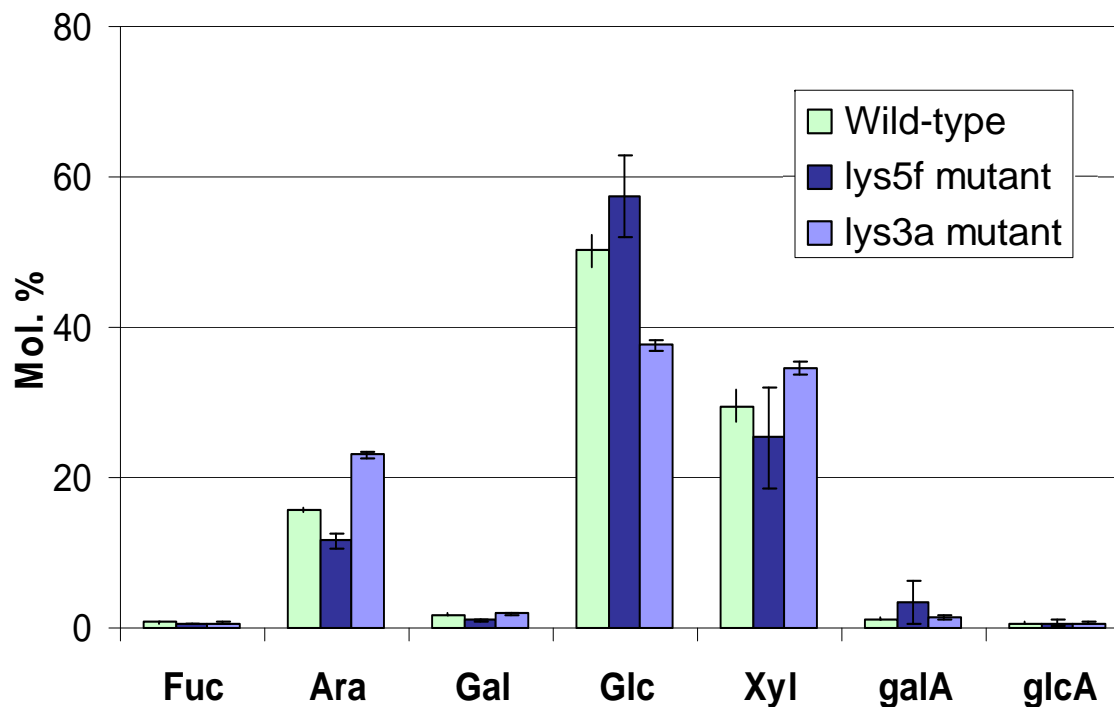


## Barley mutants with high and low content of beta-glucan



Ulla Christensen

Sugar composition in cell walls from barley grain 38 days post anthesis



*lys5f* – high beta-glucan

*lys3a* – low beta-glucan





The genes/proteins needed for beta-glucan synthesis are known

We are beginning to understand their regulation

The genes/proteins needed for arabinoxylan synthesis and feruloylation will be known before the end of 2007

**A Novel Bioinformatics Approach Identifies Candidate Genes for the Synthesis and Feruloylation of Arabinoxylan**

Rowan A.C. Mitchell\*, Paul Dupree, and Peter R. Shewry

*Plant Physiology*, May 2007, Vol. 144, pp. 43–53, 1





Cell wall polysaccharides can be changed considerably without adverse effects to the plant

The knowledge of the biosynthetic machinery enables targeted modifications in *GMO* plants or by molecular breeding

Is the incremental value of feed large enough to pay the cost of this development?



The research goals for bioenergy crops and for cereal feed crops are similar with respect to composition of fibres

Hence, development of feed crops can be driven by the funding for bioenergy science

Development can also be driven by funding for healthy food



US Department of Energy announced yesterday the establishment of 3 Bioenergy Centers at a total of 375 mio \$

"During WW2 we made the Manhattan project

In the 60'ies we went to the moon

Now we will make bioenergy"

"Sustainable, carbon-neutral energy is the most important scientific challenge we face today."

- Steven Chu  
Nobel Laureate and  
Director of Lawrence Berkeley National  
Laboratory

DOE Bioenergy Science Center (BESC), Oak Ridge National Laboratory.

DOE Great Lakes Bioenergy Research Center (GLBRC), University of Wisconsin-Madison.

DOE Joint Bioenergy Institute (JBEI), Lawrence Berkeley National Laboratory.





## *Brachypodium distachyon*- a model temperate grass species



- Small genome (2 X Arabidopsis)
- Rapid generation time (12 weeks)
- Simple genetic transformation
- Genome sequence in 2007
- ESTs and BACs available now
- Point mutants available now



Thank you!

