

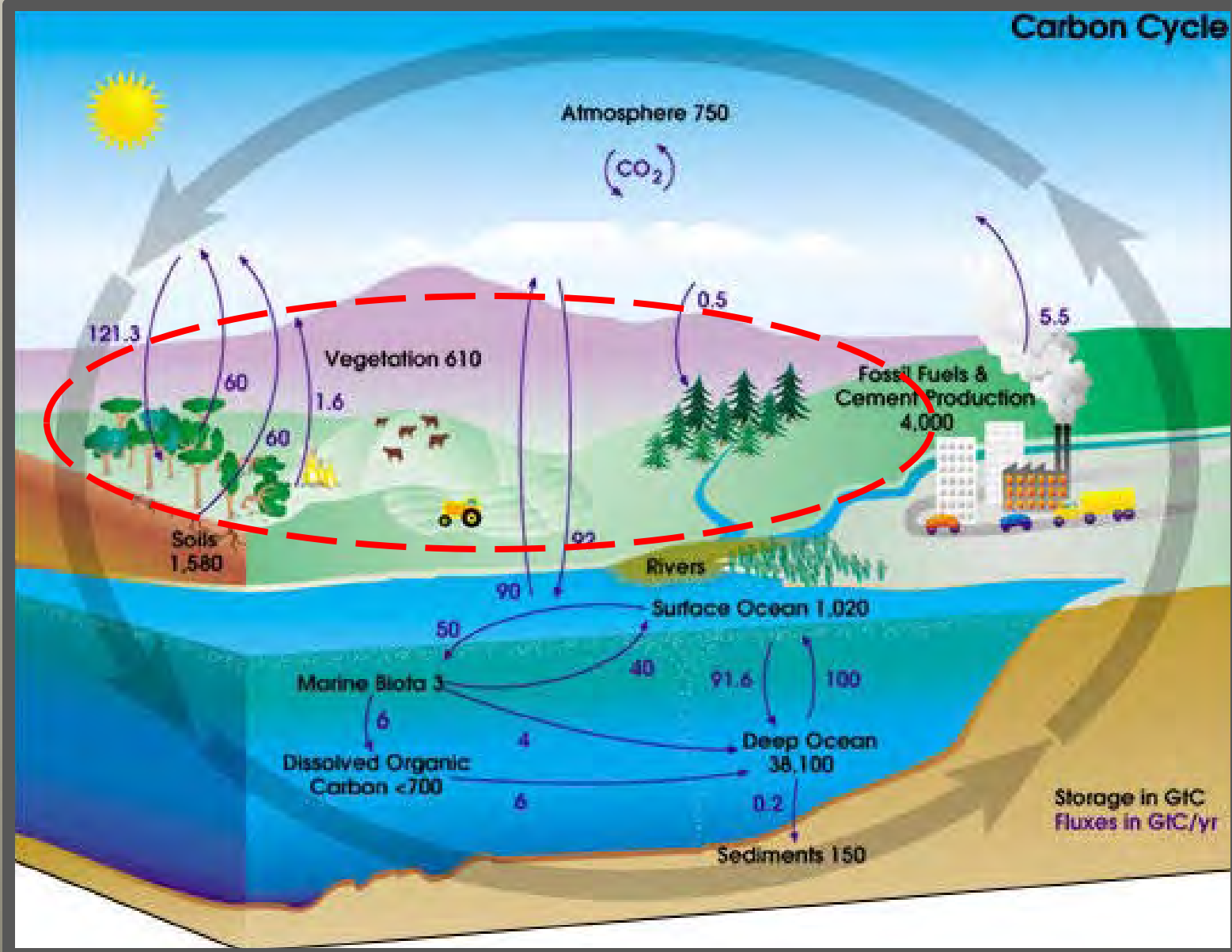
Seeking The Perfect Fibre

A Moving Target in a Changing World

Brian Ellis

Michael Smith Laboratories - UBC

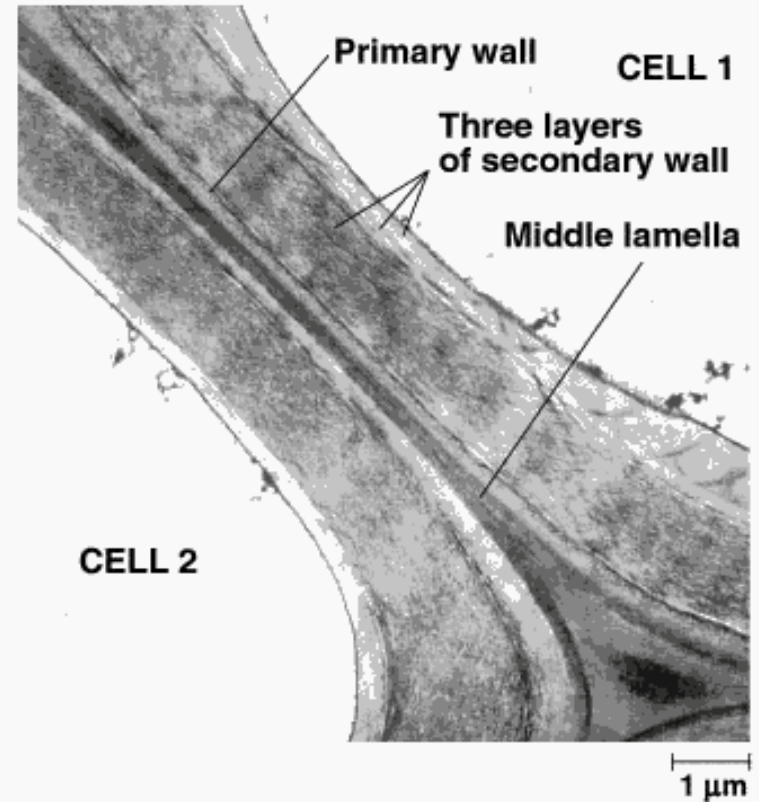
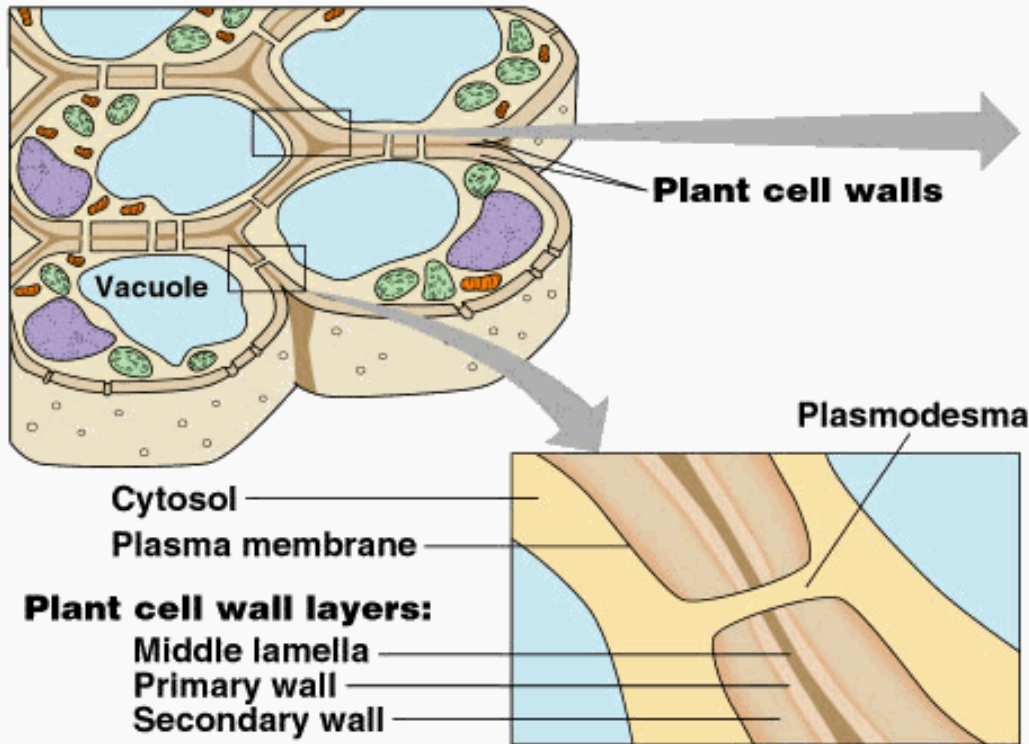
Carbon Cycle



Terrestrial biomass consists predominantly of plant cell walls

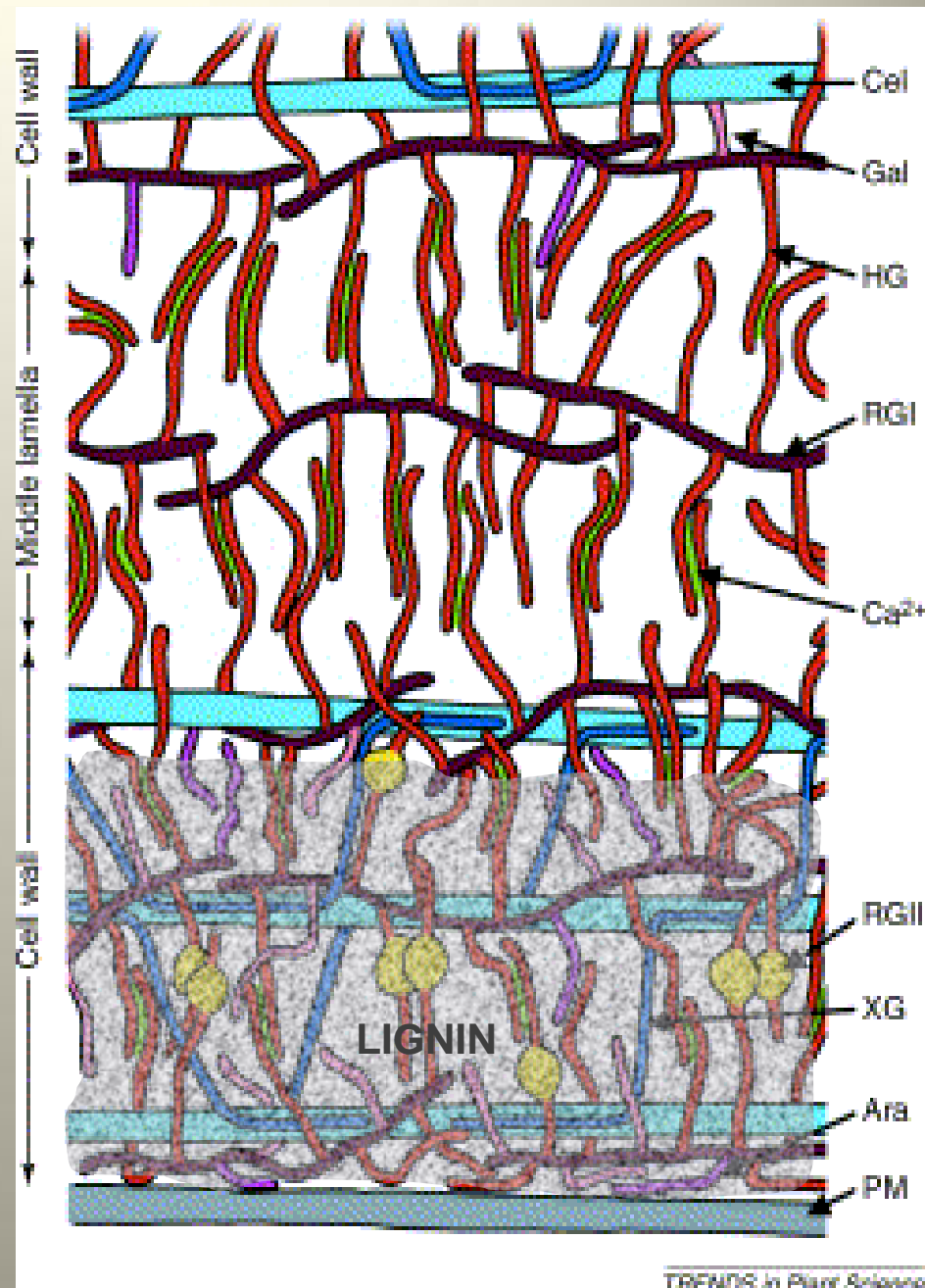


Plant cell walls are complex structures



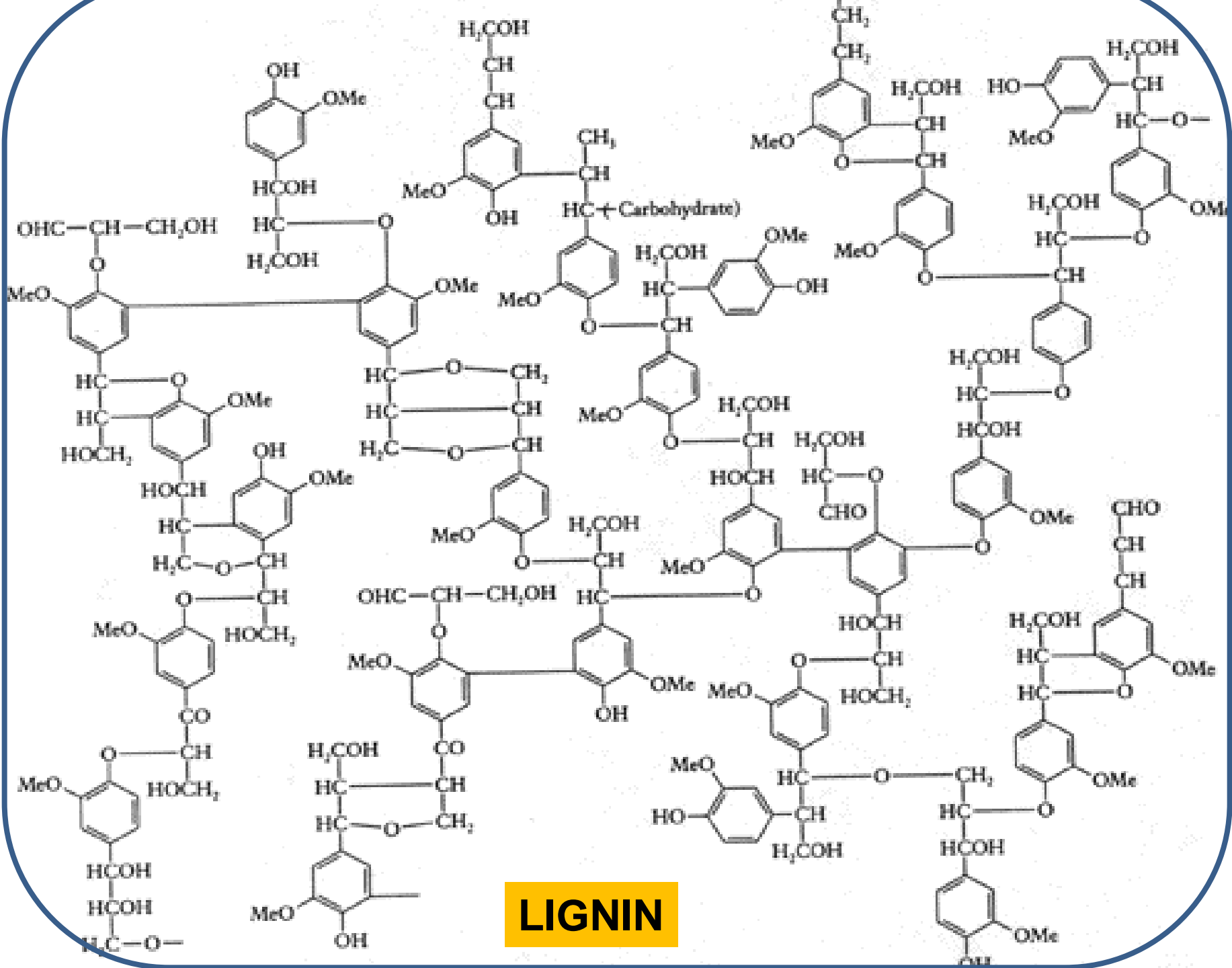
We know a lot about cell wall structure and chemistry

We don't really understand how it is generated

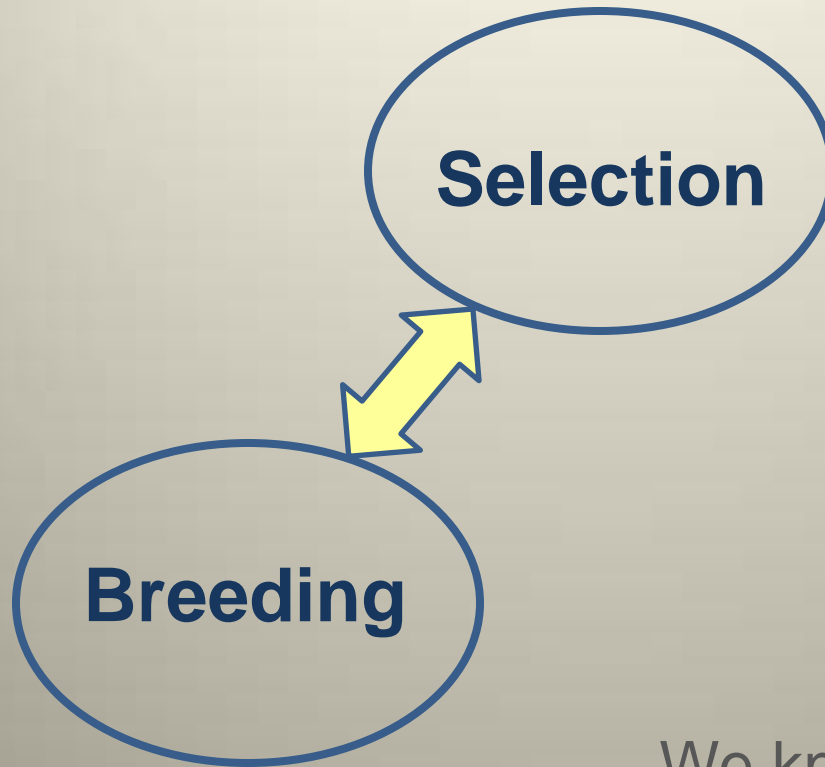


The role of plant cell wall polysaccharide composition in disease resistance

Vorwerk et al (2004) Trends in Plant Science



The Road to Better Fibres



We know a lot about cell wall structure and chemistry

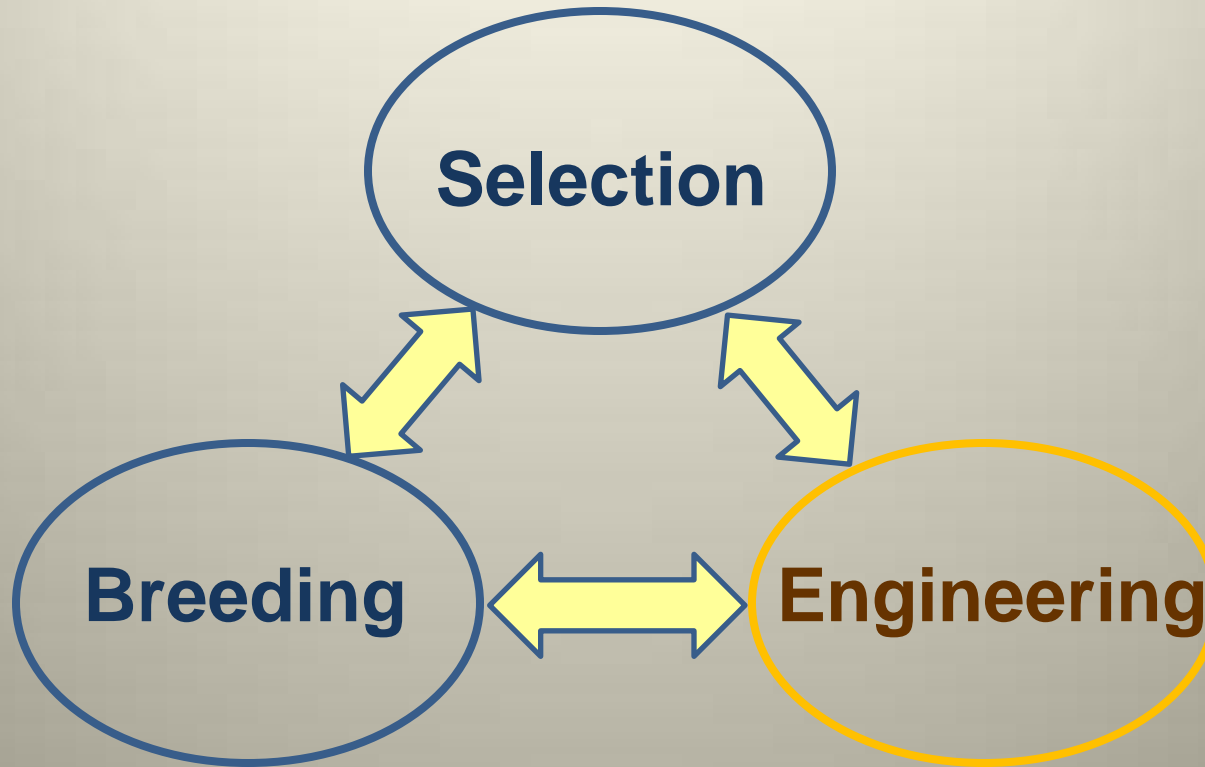
We don't really understand how it is generated

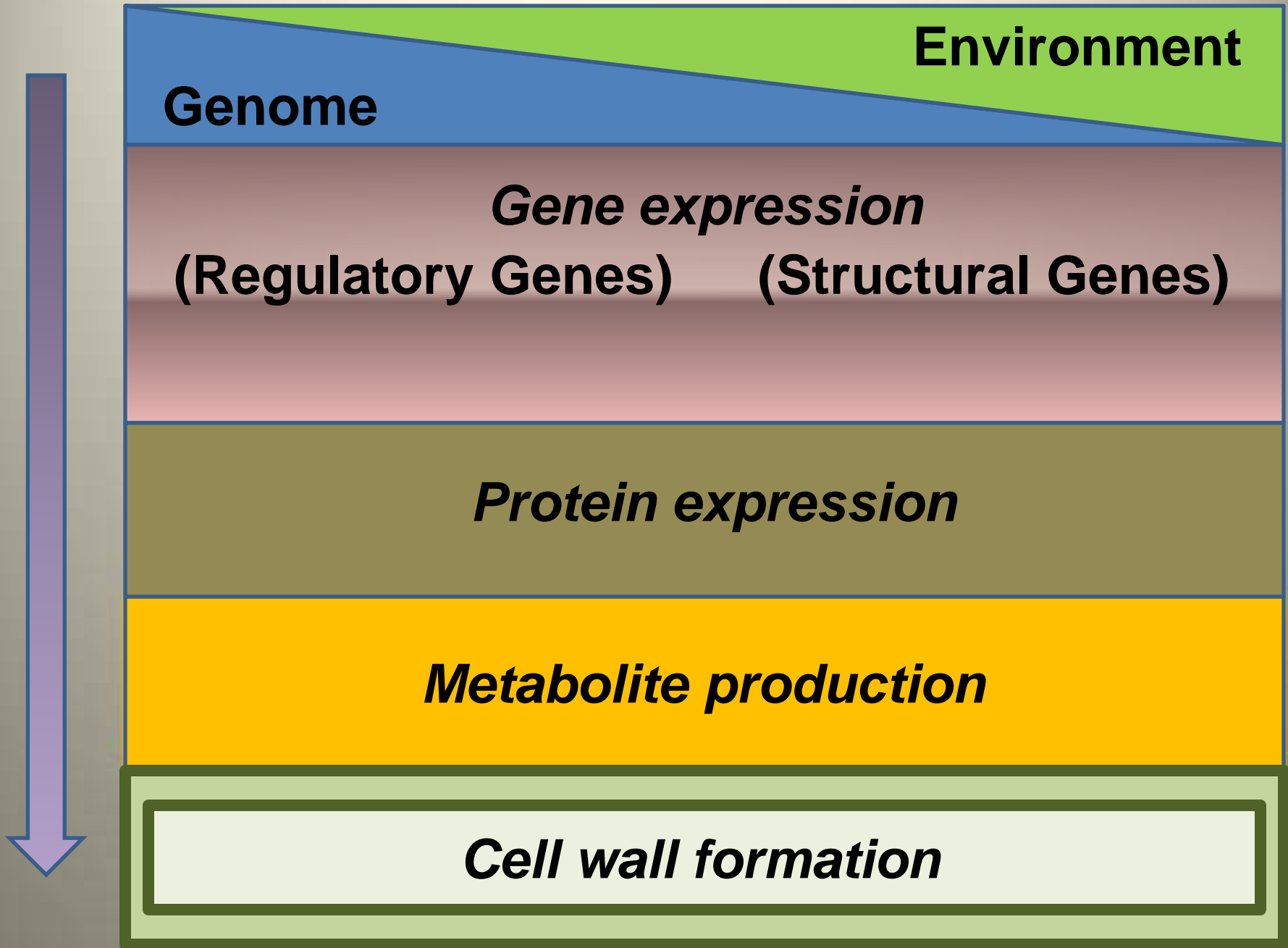
The Genomics Era

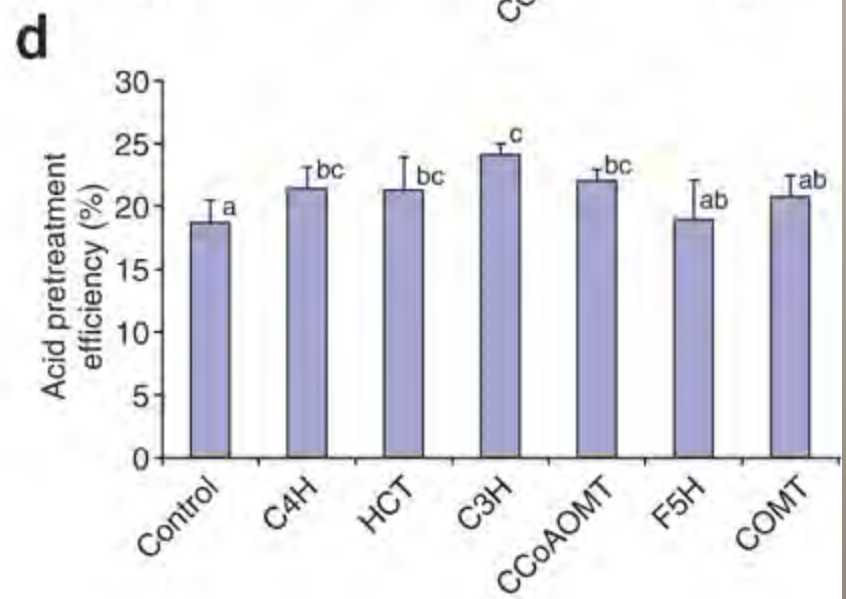
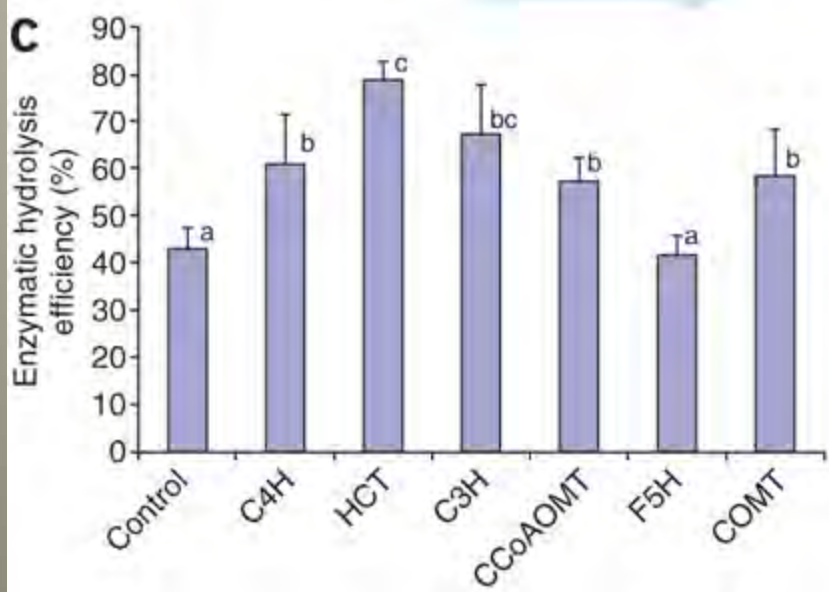
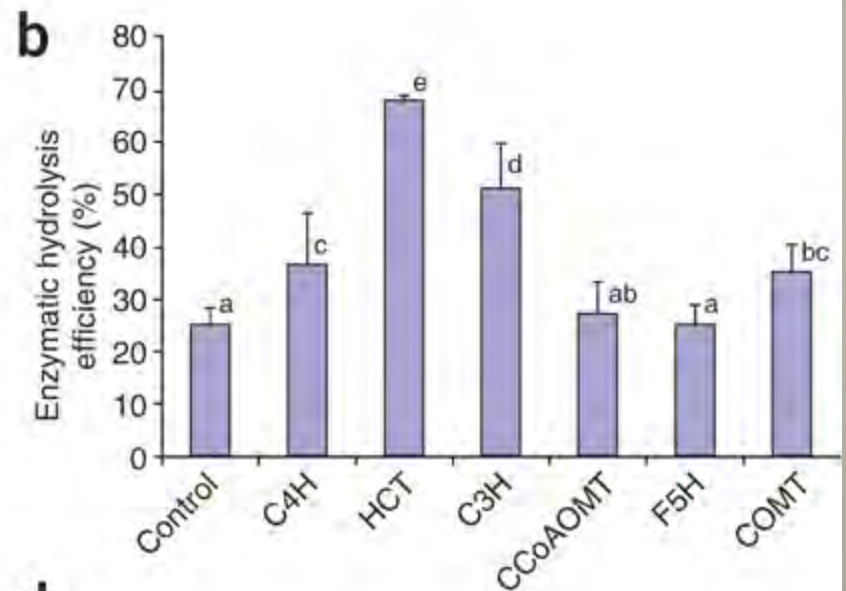
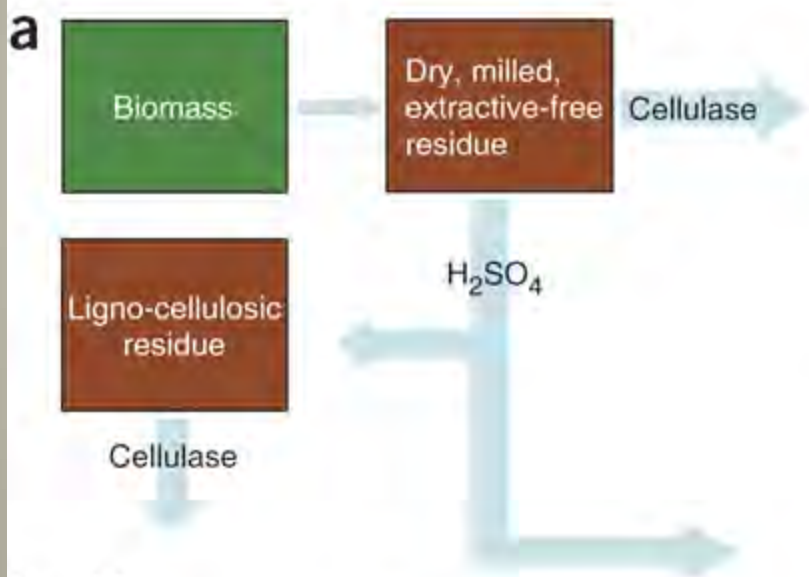
Both the form and the chemistry of
plant cell walls
are under genetic control

modified by
environmental factors

Adding Another Dimension







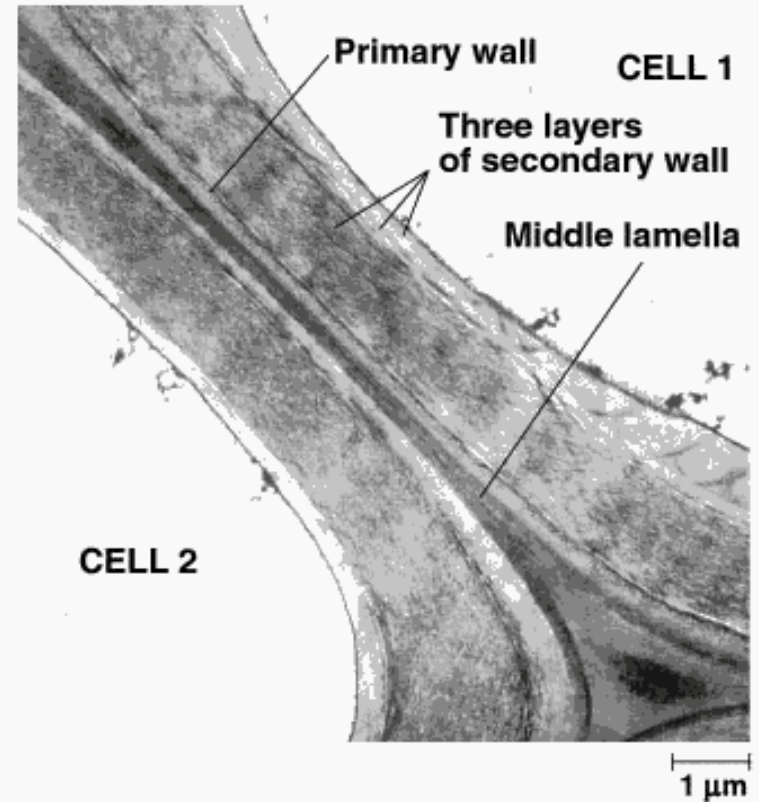
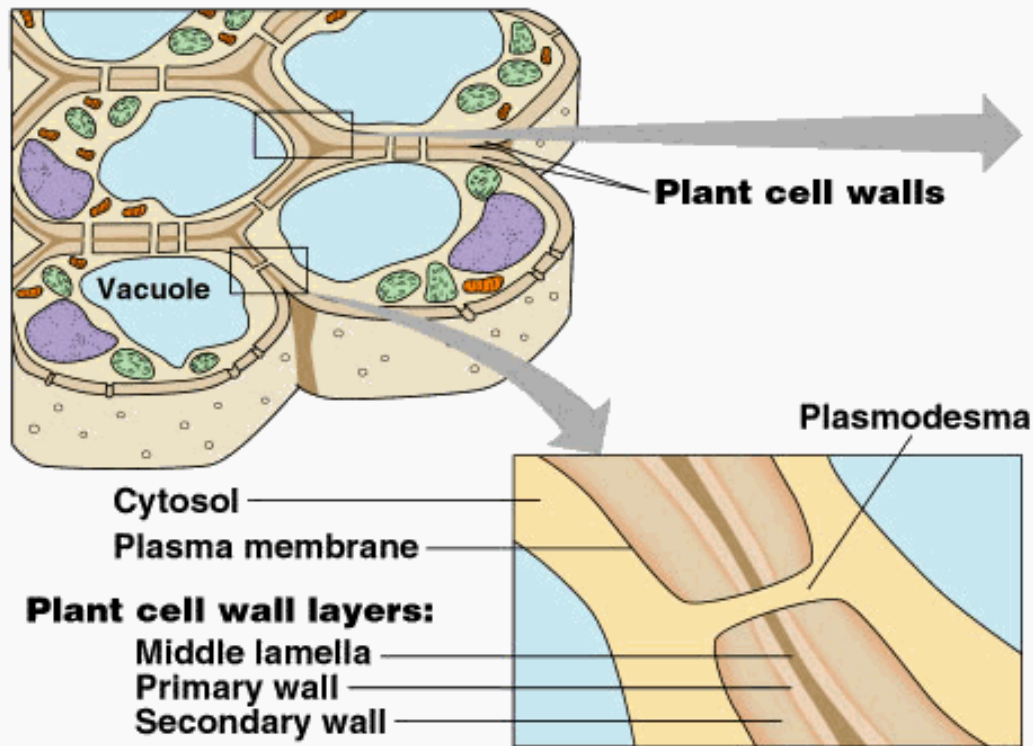
Lignin modification improves fermentable sugar yields for biofuel production
 F Chen¹ & RA Dixon
 Nature Biotechnology 2007

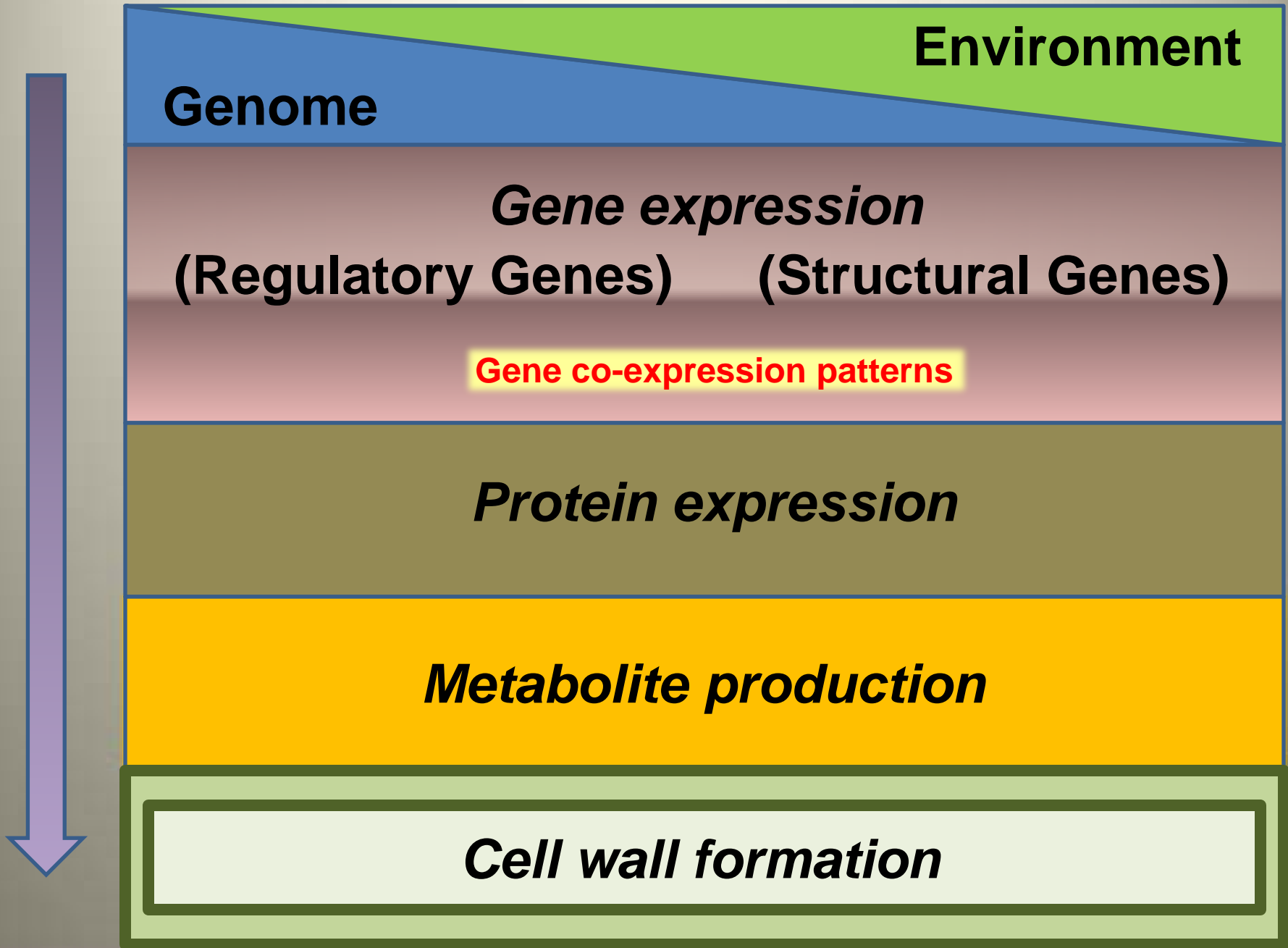
Table 1. Syringyl and Guaiacyl Monomer Contents of Wild-Type and C4H-F5H-Transformed Poplar As Determined by Thioacidolysis and Derivatization Followed by Reductive Cleavage (DFRC)

tree line	total G units ($\mu\text{mol/g}$)	total S units ($\mu\text{mol/g}$)	S:G	% mol syringyl lignin	
				thioacidolysis	DFRC
WT	254.4	484.2	1.90	65.6	64.7
Line H	58.9	836.5	14.17	93.4	92.6

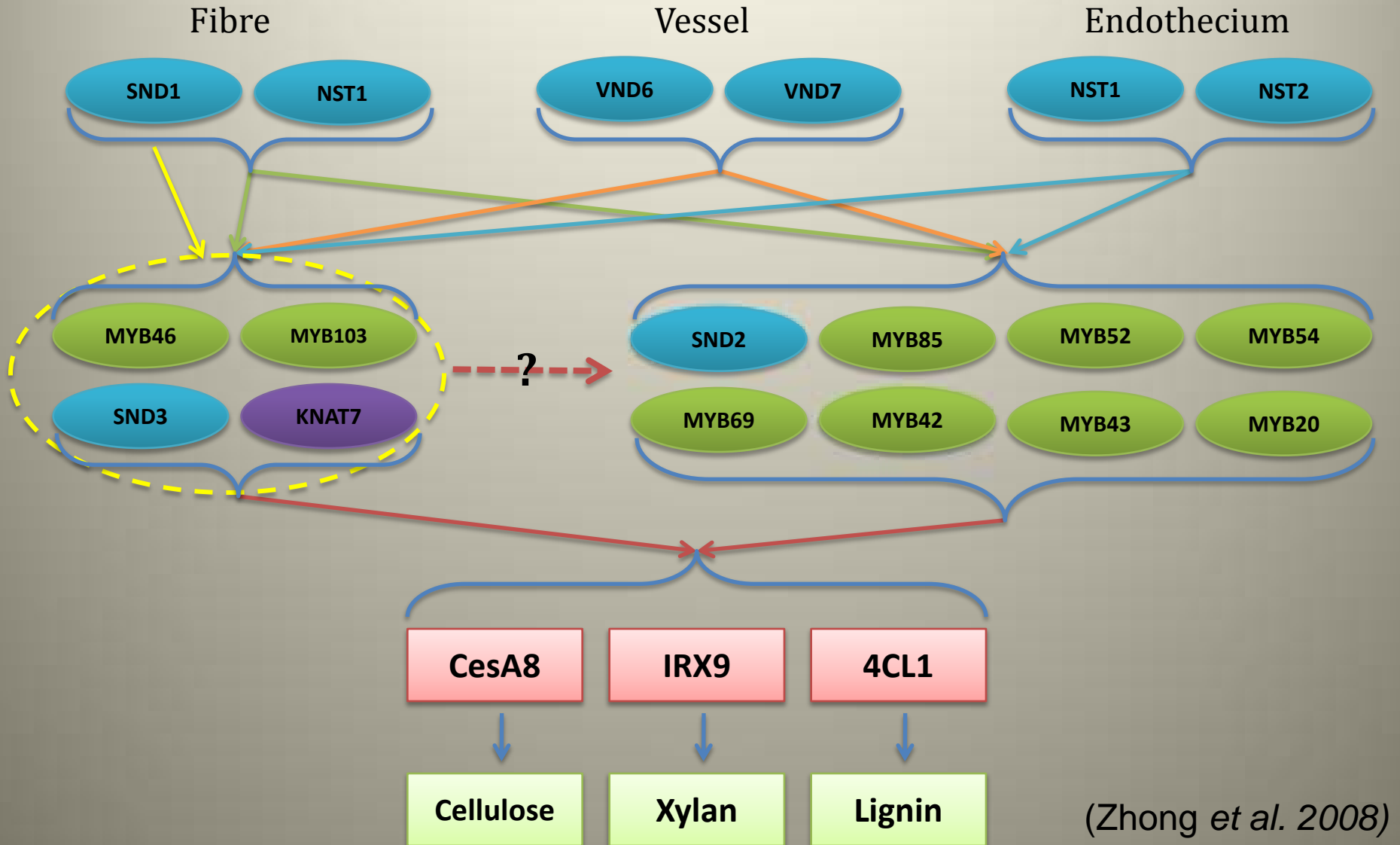
Significant Increases in Pulping Efficiency in C4H-F5H-Transformed Poplars: Improved Chemical Savings and Reduced Environmental Toxins

Plant cell walls are complex structures



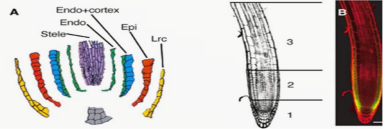
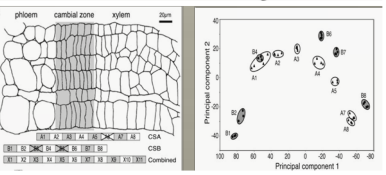
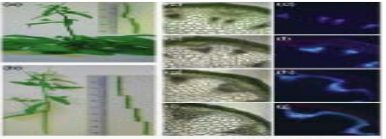


Part of the transcriptional network regulating secondary cell wall biosynthesis



Which transcriptional changes are truly specific to fibre development?

How can we isolate development stage-specific tissues for microarray analysis?

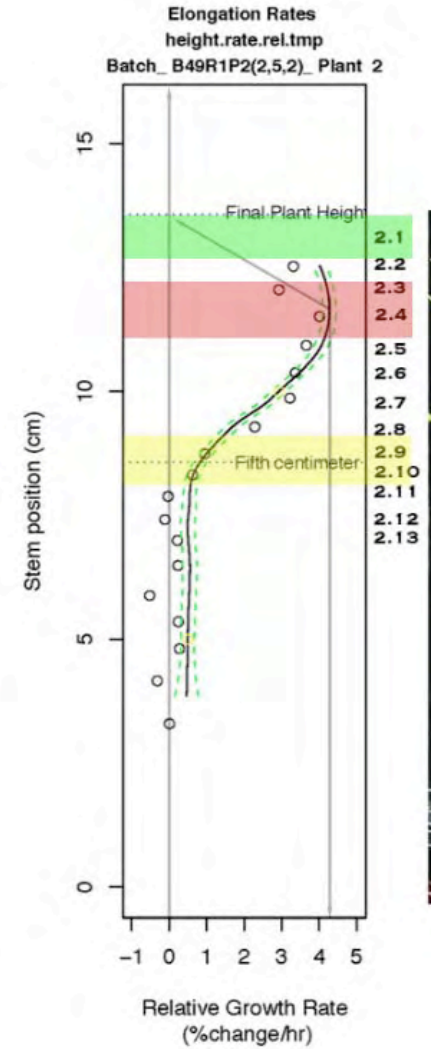
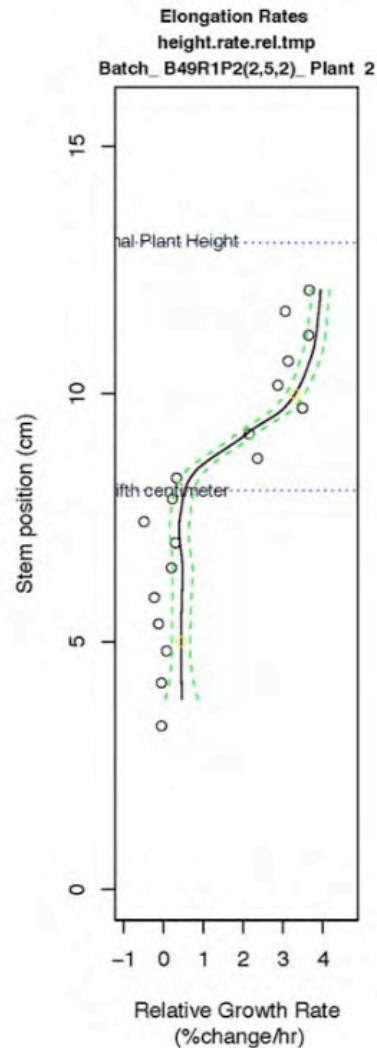
Sampling approaches for stage-specific transcriptomics	Development stage specific?	Fibre-specific?	Practical for Arabidopsis stems?	Phenotyping
<p>FACs-sorting GFP lines</p> 	<p>Yes</p>	<p>Potentially</p>	<p>No</p>	<p>No</p>
<p>PCA of expression data</p> 	<p>Yes</p>	<p>Potentially</p>	<p>No</p>	<p>Potentially</p>
<p>Plant portioning</p> 	<p>On Assumption</p>	<p>Potentially</p>	<p>Yes</p>	<p>No</p>

Growth Kinetic Profiles (GKPs) Can Be Used To Define Stem Developmental Context

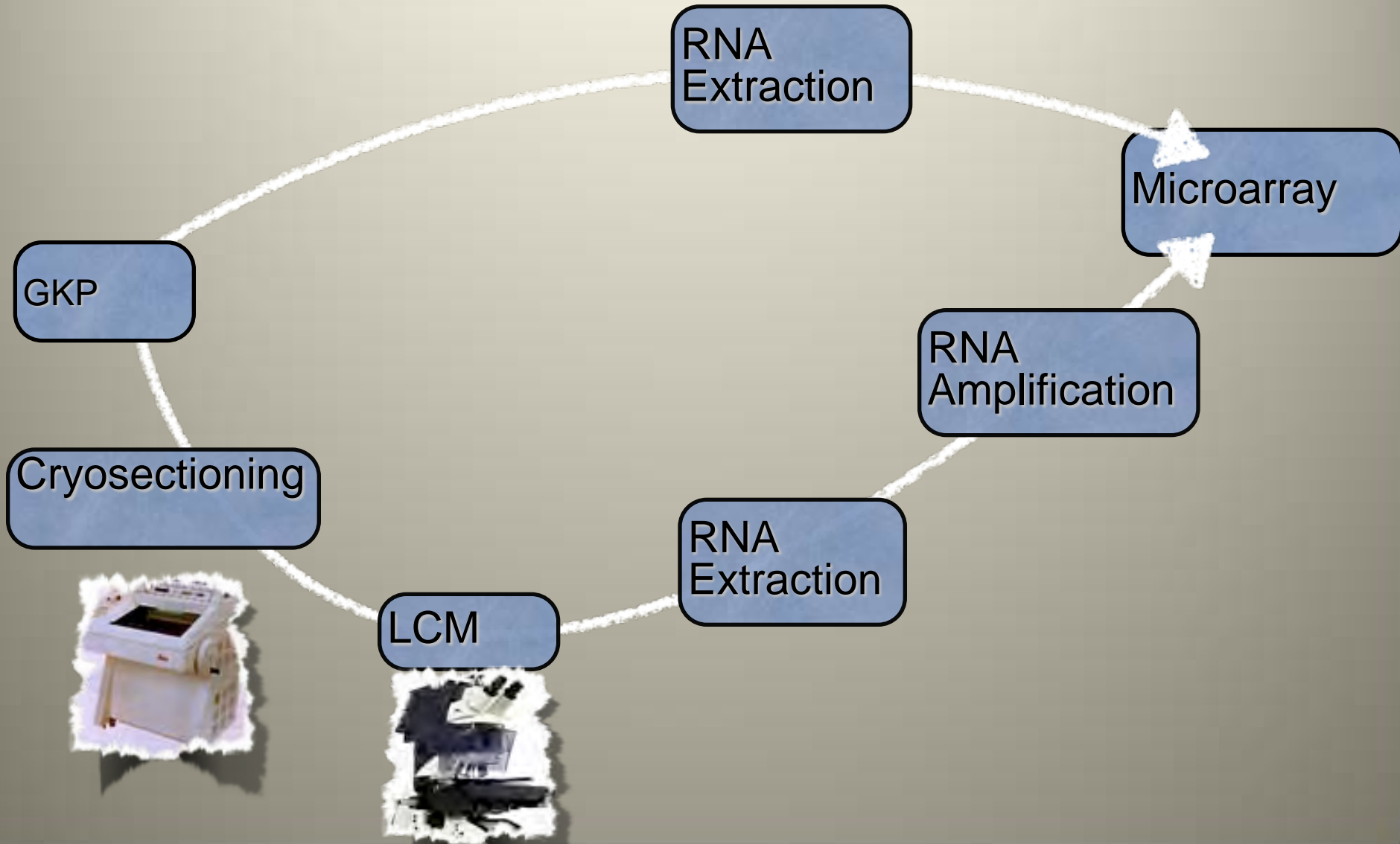
- Fibres and other cell types expand within the larger context of inflorescence stem development
- Whole-stem elongation can be observed and profiled to yield a **GKP**
- **GKPs** will have distinguishable features relating to developmental status
- **GKPs** provide a guide to sampling developmentally-equivalent tissues for global gene expression profiling



Identification of Development Stage-Specific Tissues from Individual Plants



Cell Type-specific Transcriptional Profiling (Microgenomics)



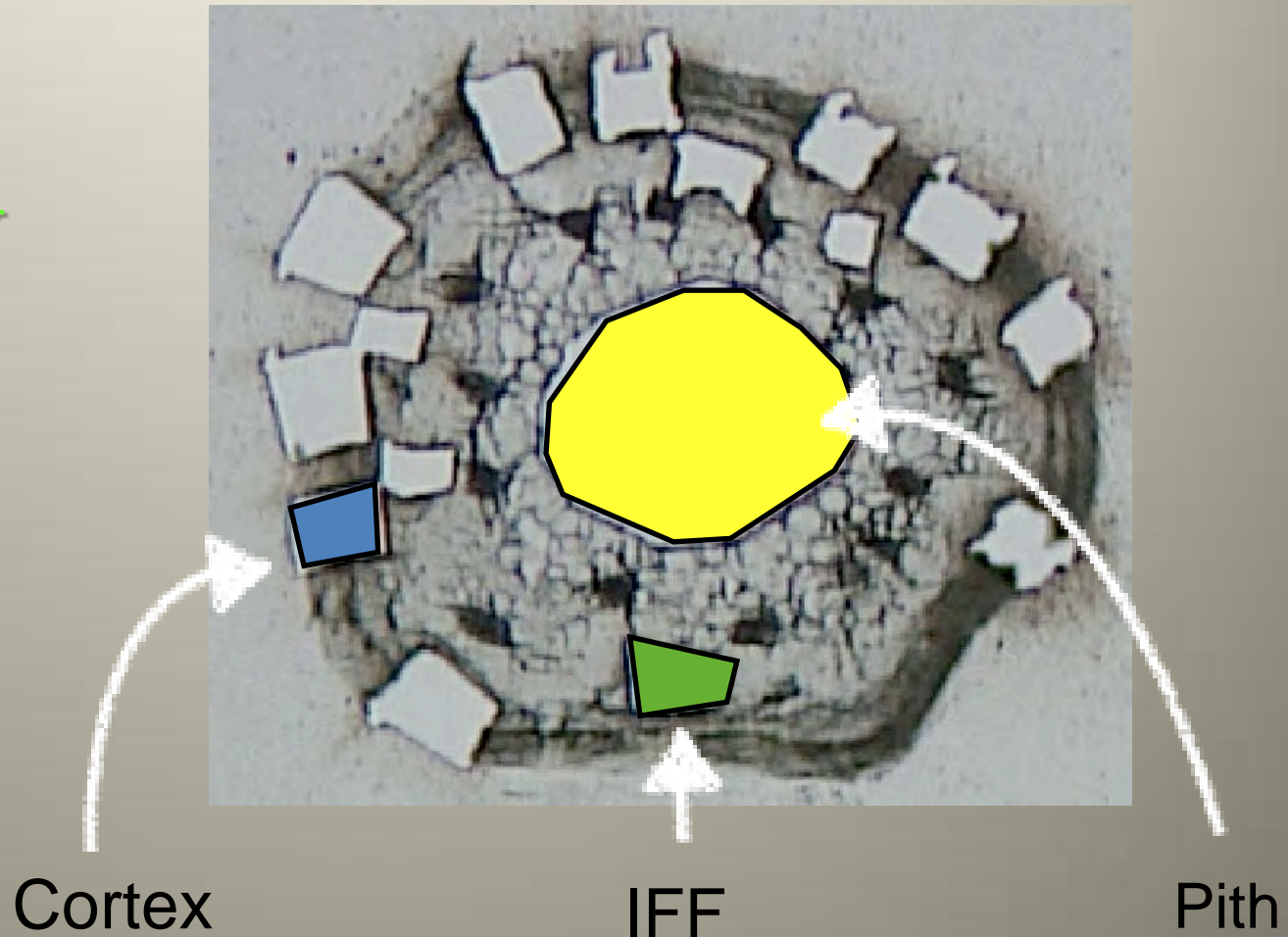
Laser Capture Micro-dissection of Distinct Cell Types

3 contrasting cell types

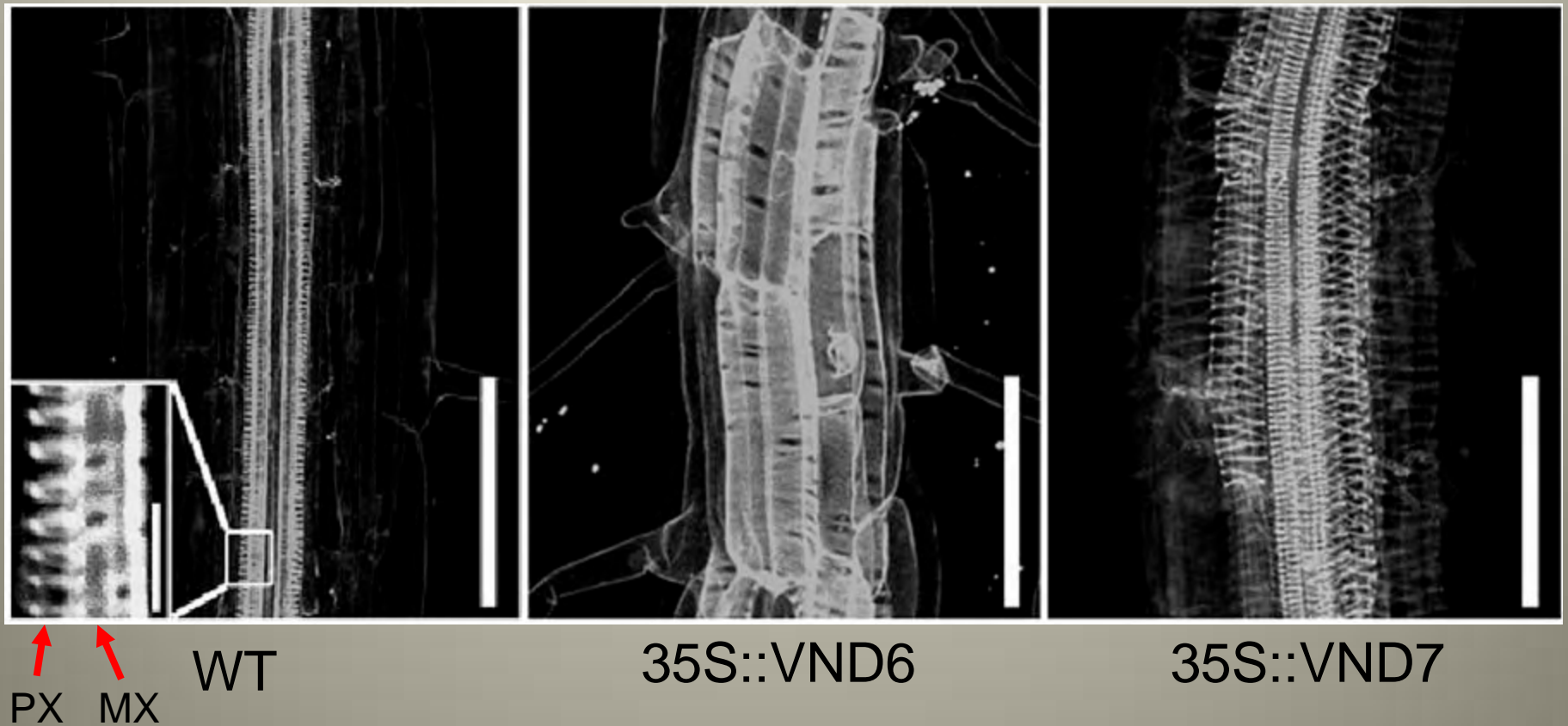
Cortex

Pith

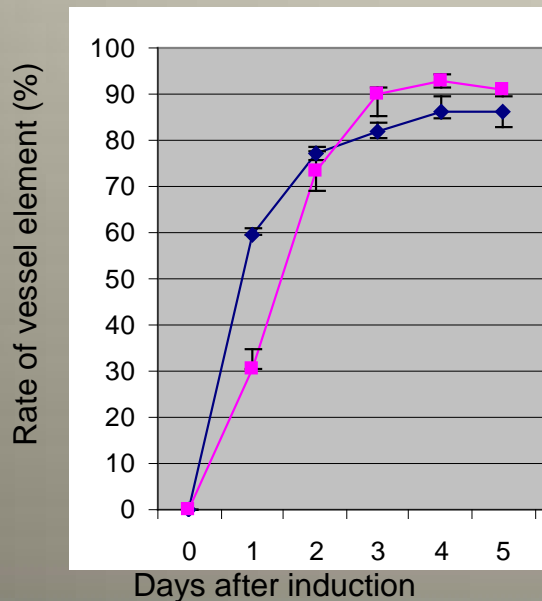
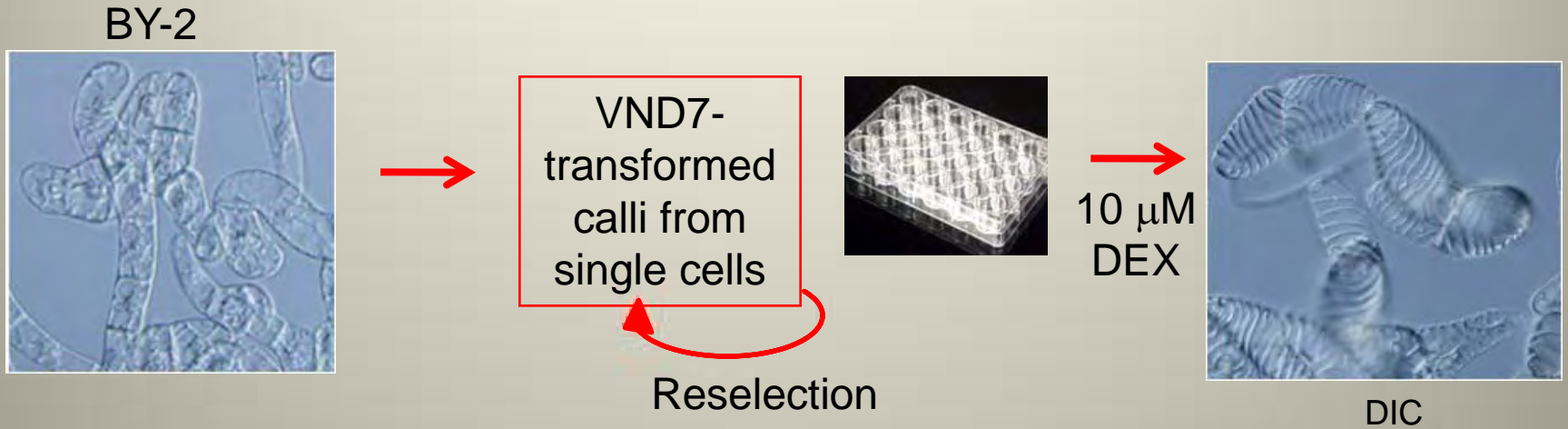
Interfascicular fibres (IFF)



Over-expression of transcription factors VND6 and VND7 induces trans-differentiation into metaxylem- and protoxylem-like vessel elements in *Arabidopsis* roots, respectively



Inducible expression of VND7 can synchronously re-program cells to deposit specific patterns of secondary wall thickenings in tobacco BY-2 cells in culture



Sub-line 12-15
Sub-line 12-19



Alexa488-WGA, CLS

Looking ahead

The pace of gene discovery relevant to fibre and other biomass characteristics will continue to accelerate

The pleiotropic nature of regulatory gene action will require sophisticated approaches to their manipulation

Genetically modified trees and other biomass crops with novel cell wall traits are already in field trials

Acknowledgements



Shawn Mansfield – UBC
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Ankit Walia
QingNing Zeng

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Plant Fibre Network
Green Crop Network
CREATE project : *Working on Walls*

Genome Canada

Treenomix I