UNIVERSITEIT GENT

Plant Systems Biology

VIB

Improving wood quality for biofuels

September 13, 2010
Gent, Belgium

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René Custers (regulatory affairs)

Plants as raw material for renewable energy

- Oil-> climate change
- Non renewable
- Geopolitical tension

- Plants are renewable source of liquid energy

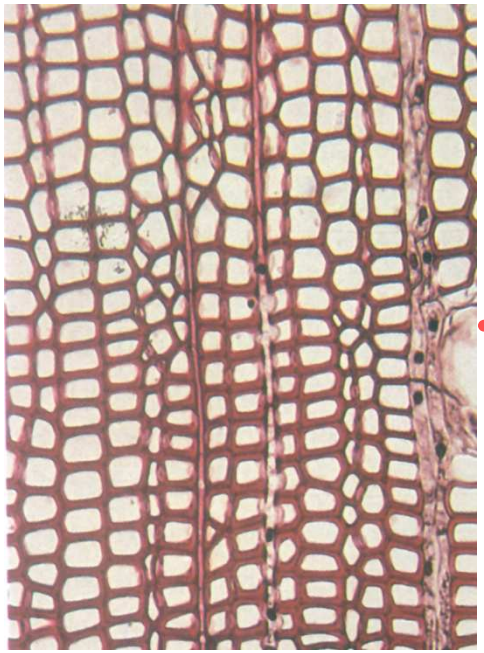
Biofuels today

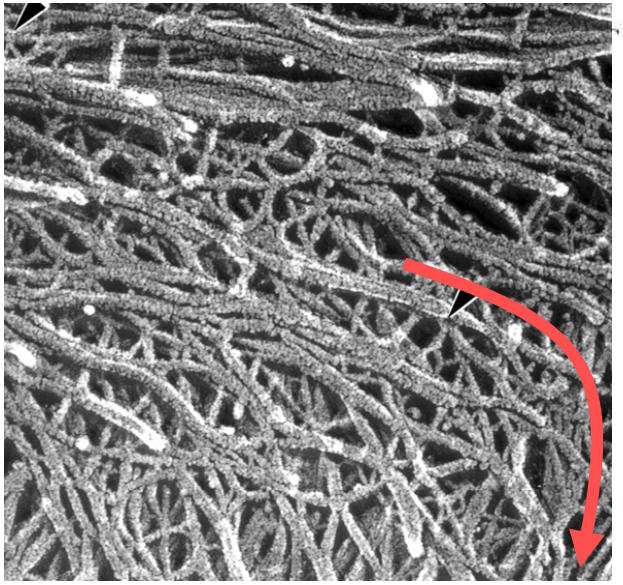
- **First generation biofuels**
  - Bio-ethanol from starch
  - High energy input
  - Relatively few CO_2 reduction
  - Competition with food chain

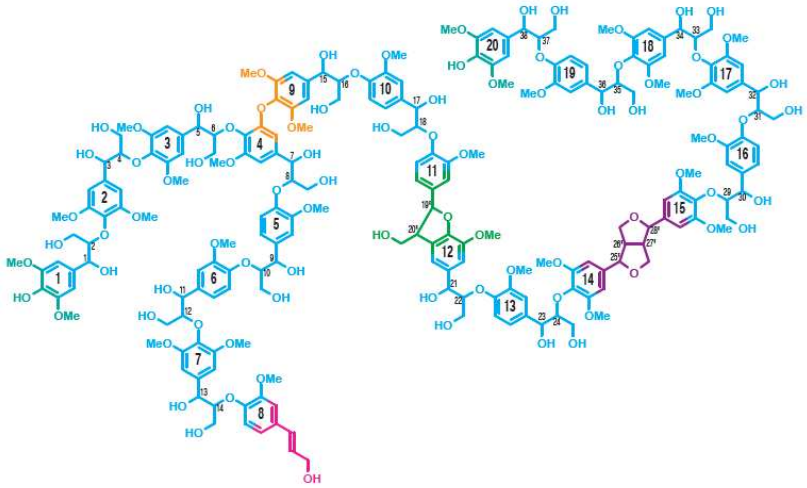
Biofuels tomorrow

- **Second generation biofuels**
  - Dry biomass from the plant = 75% sugar
  - Fast growth
  - Perennial
  - Low energy-input
  - High CO_2 reduction
  - Marginal soils
  - No competition with food chain

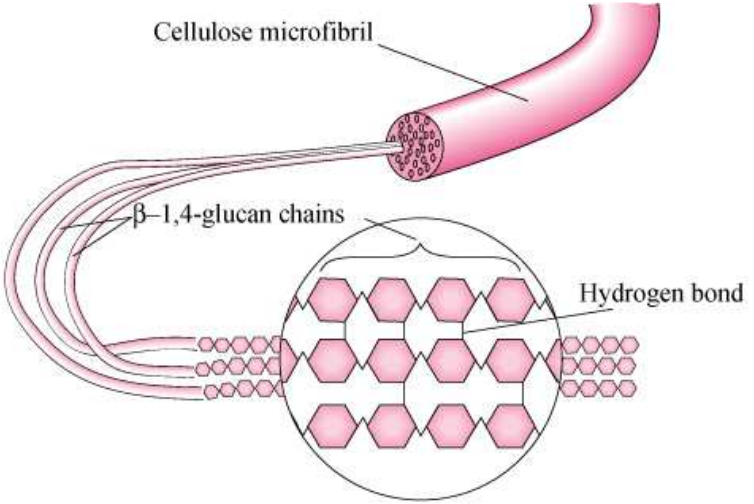
Lignocellulose to ethanol





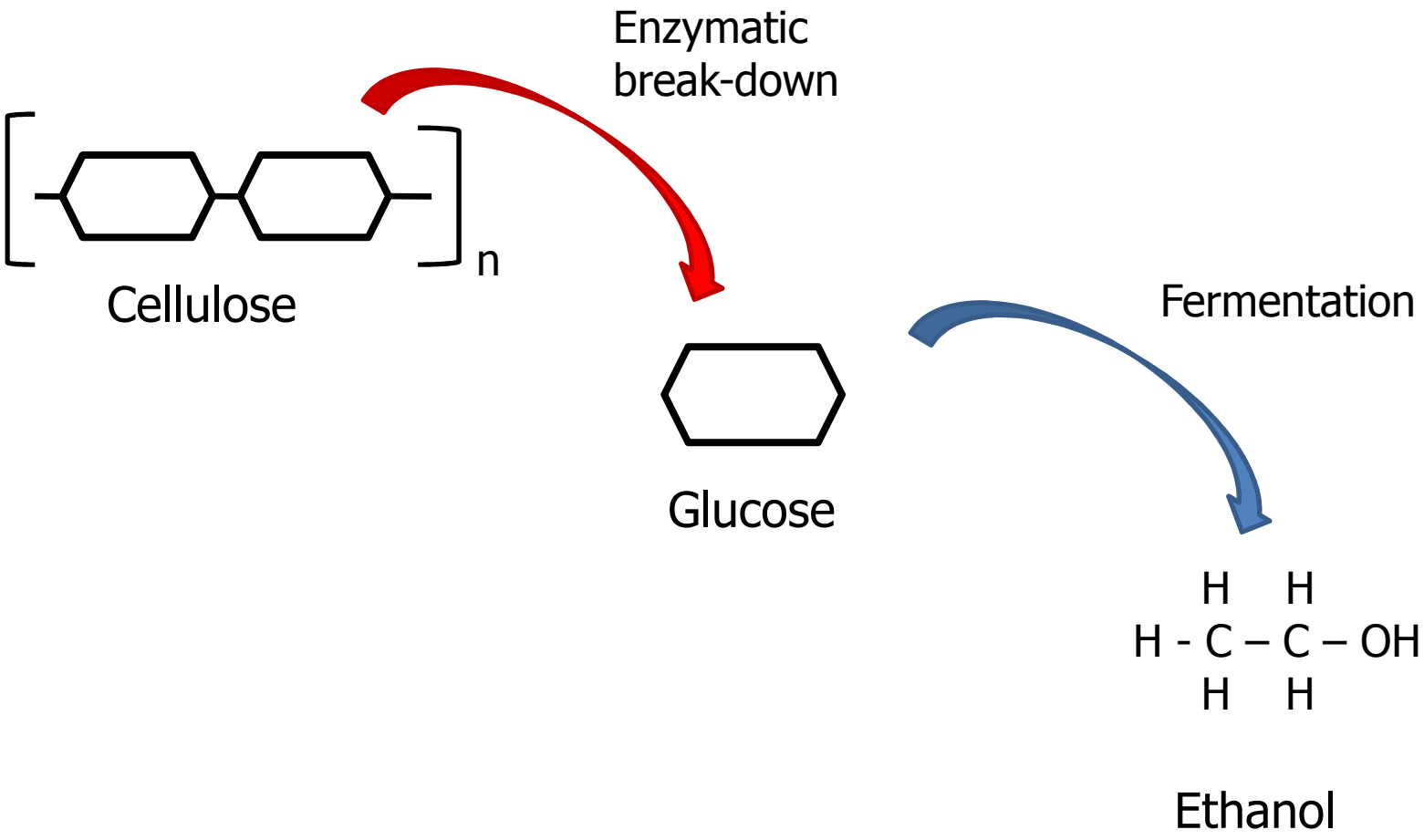


Lignin polymer

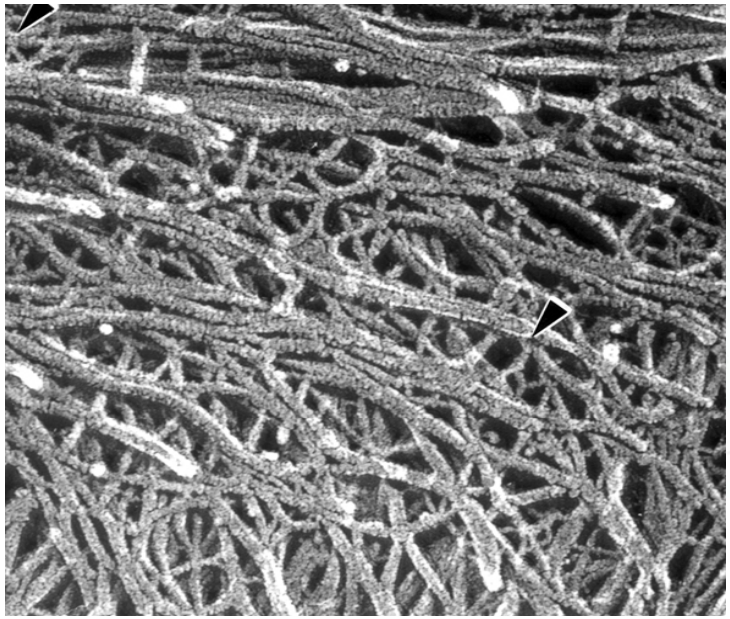


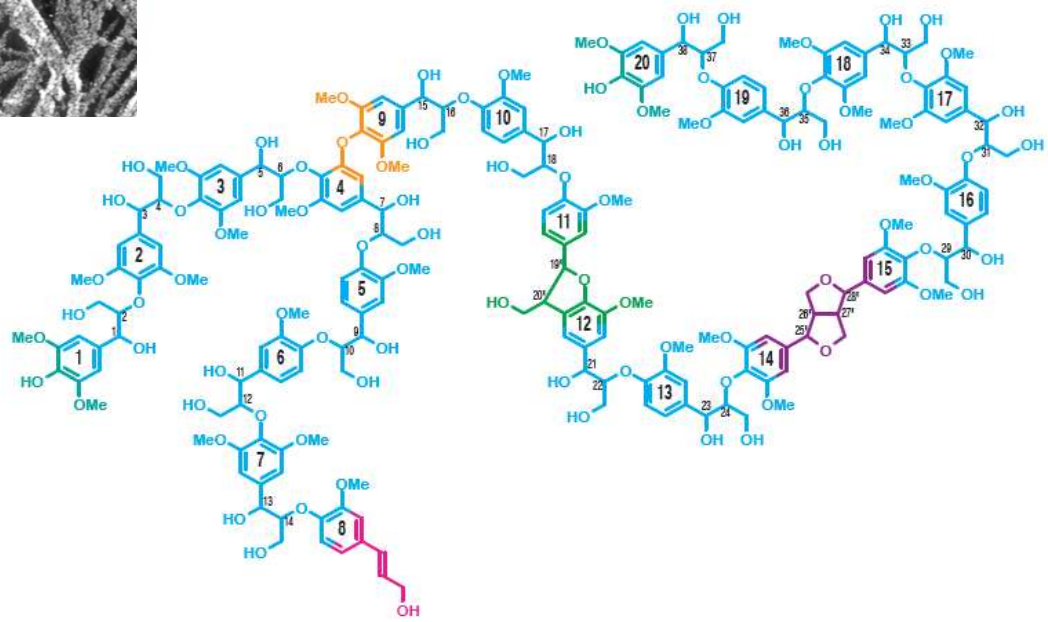
Polymerised glucose

From wood to bio-ethanol

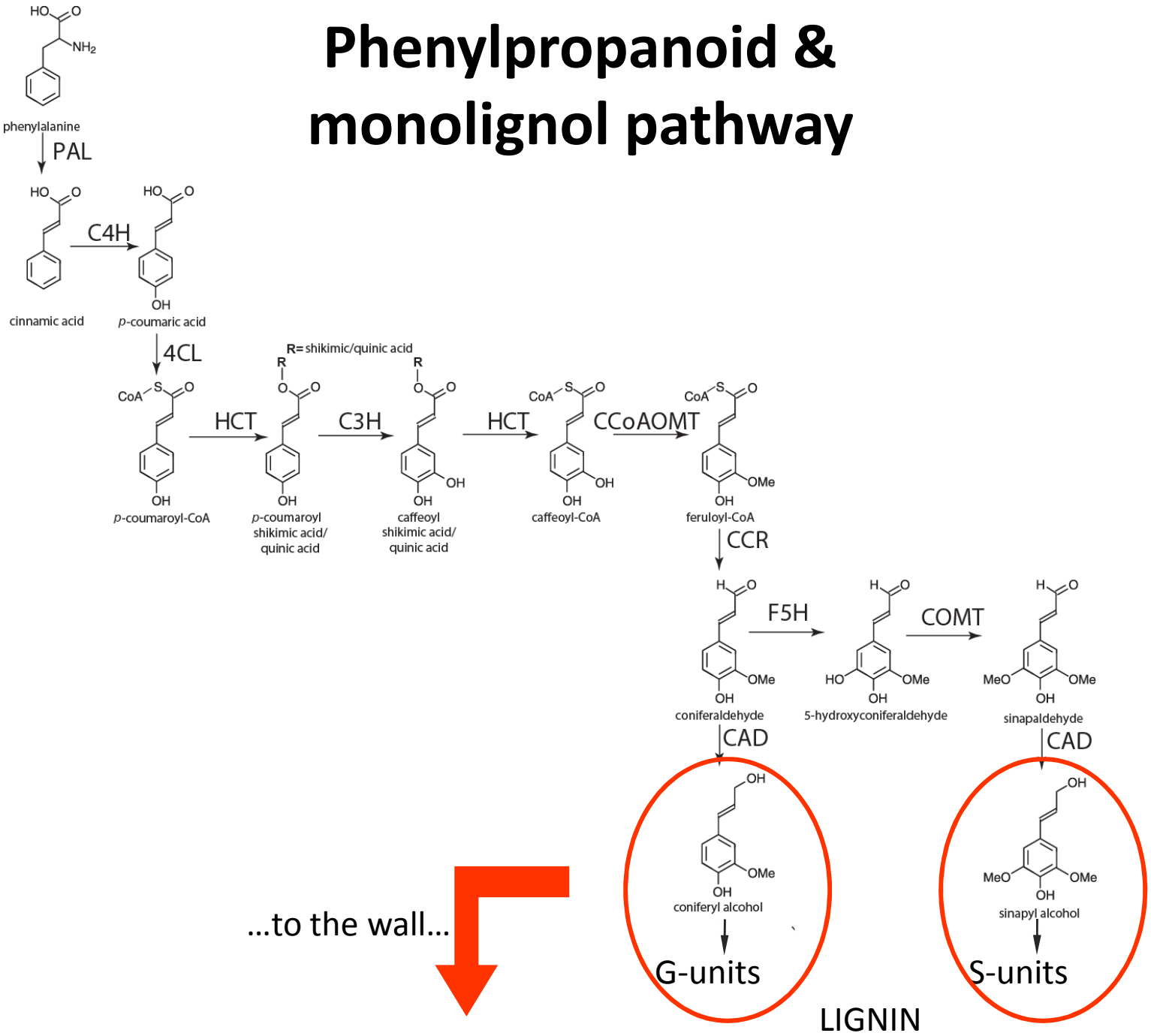


Lignin polymer fills the cell wall

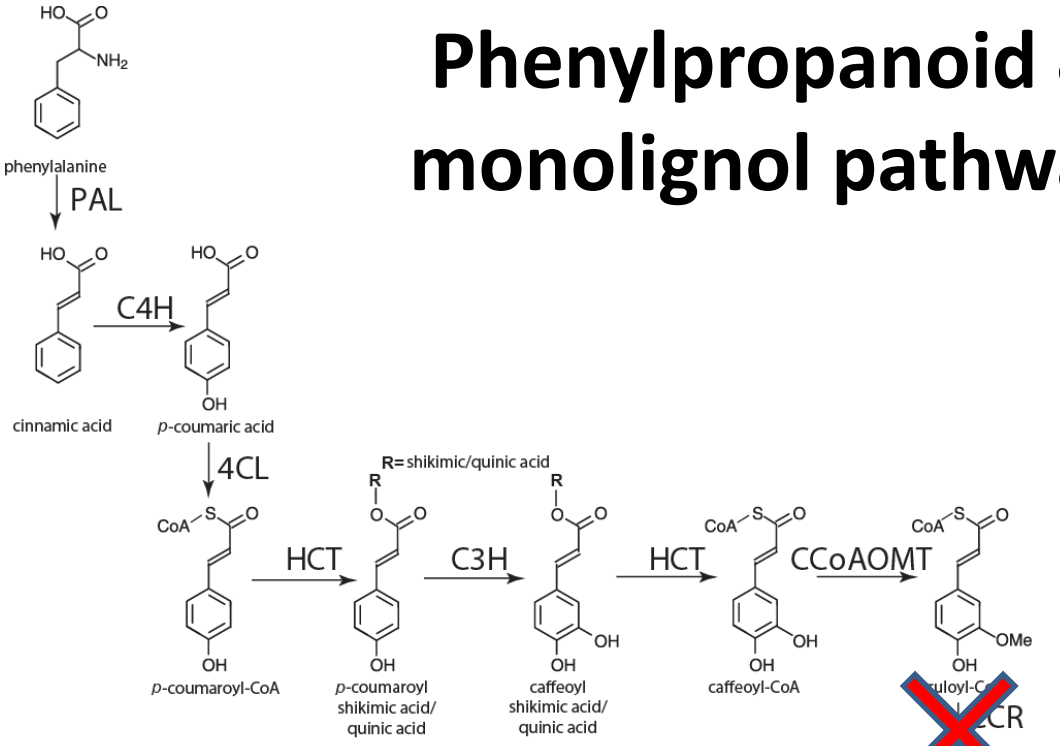


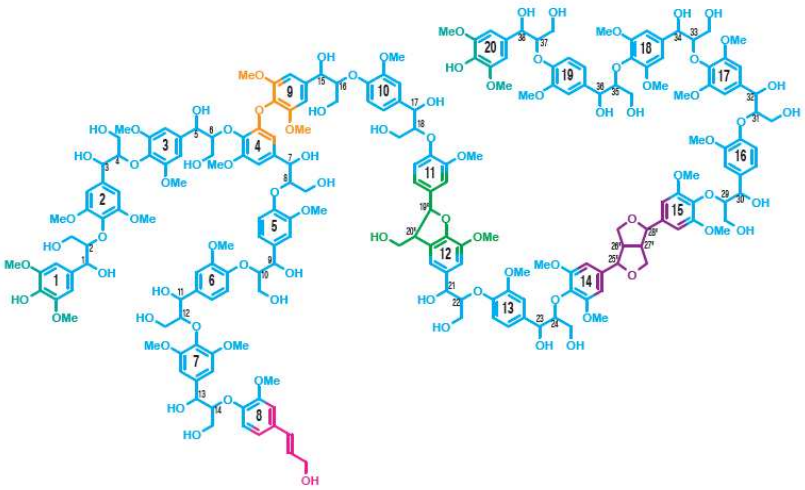


Phenylpropanoid & monolignol pathway



Phenylpropanoid & monolignol pathway





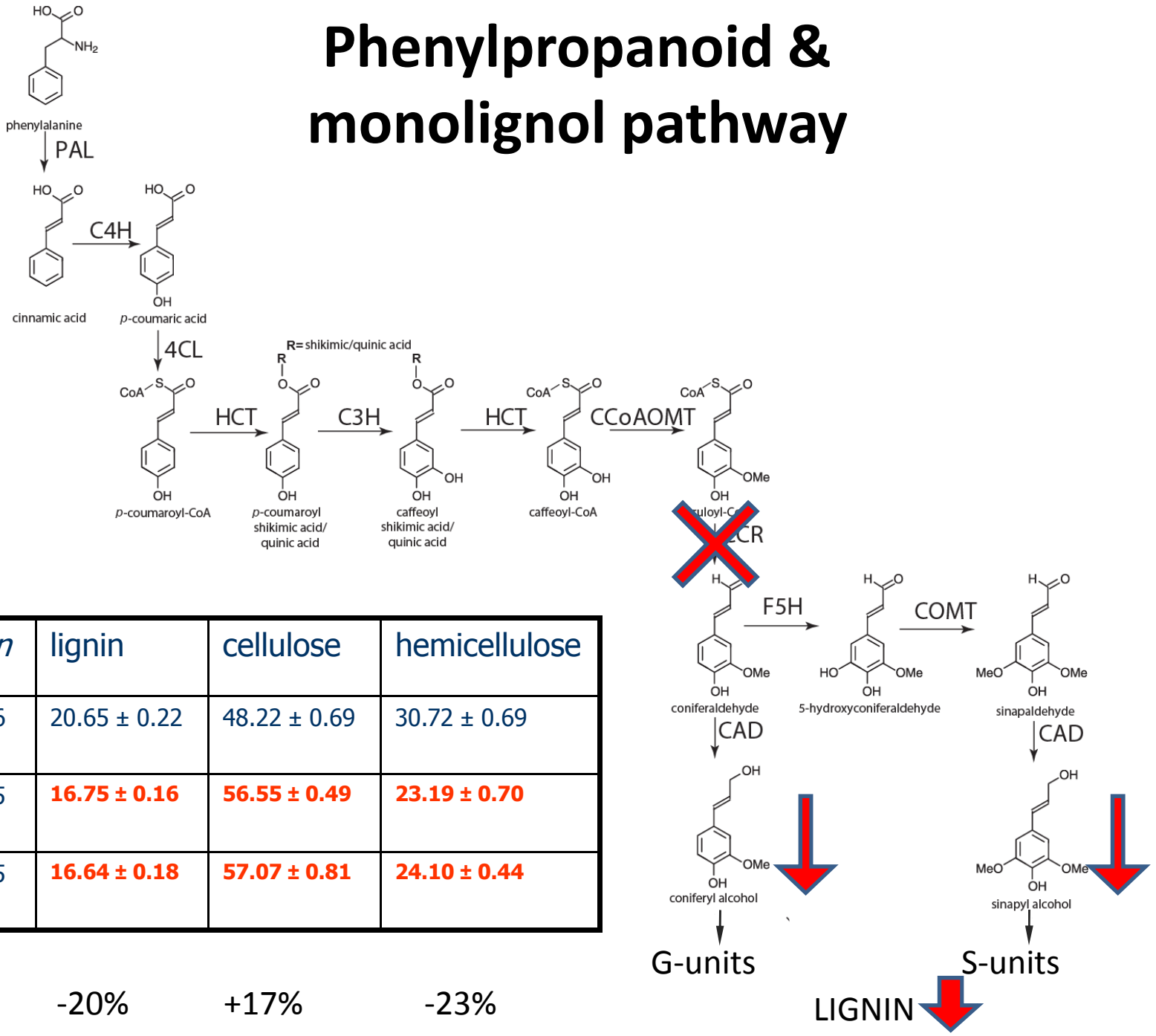
CCR down-regulated poplar

Phenotype

Twigs from CCR-deficient trees

WT, 2 months; CCR, 7 months

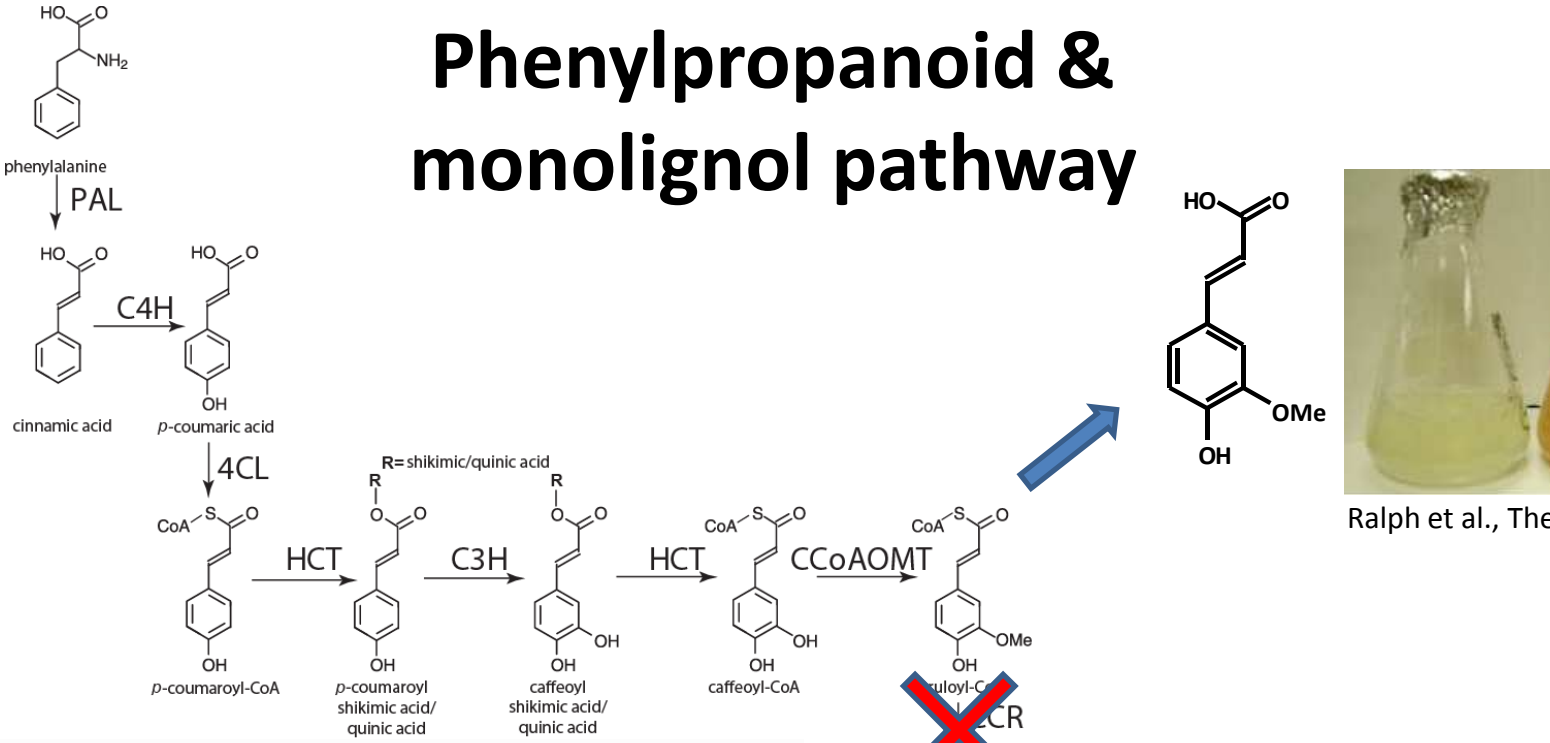
Phenylpropanoid & monolignol pathway



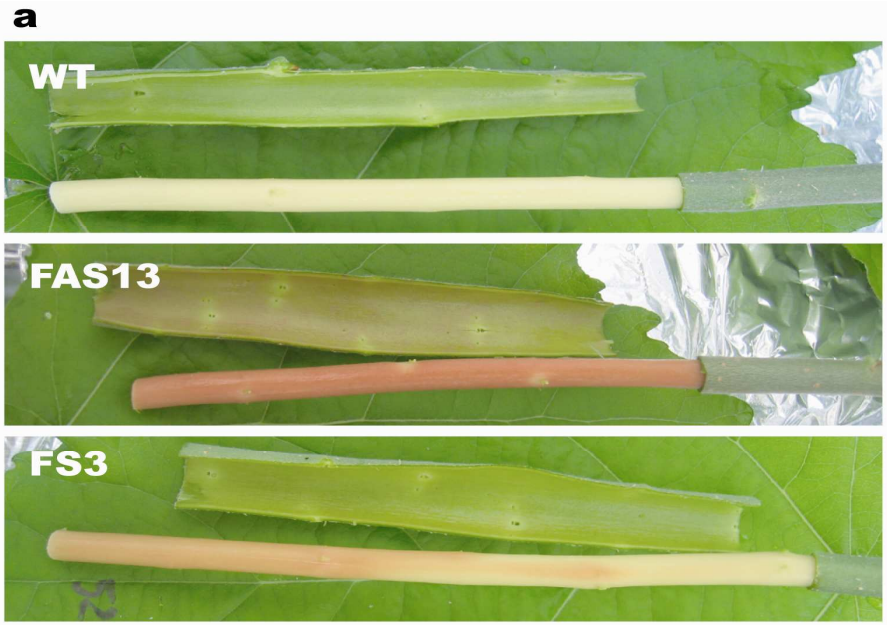
Line	*n*	lignin	cellulose	hemicellulose
WT	6	20.65 ± 0.22	48.22 ± 0.69	30.72 ± 0.69
FS3	5	**16.75 ± 0.16**	**56.55 ± 0.49**	**23.19 ± 0.70**
FS40	5	**16.64 ± 0.18**	**57.07 ± 0.81**	**24.10 ± 0.44**

-20% +17% -23%

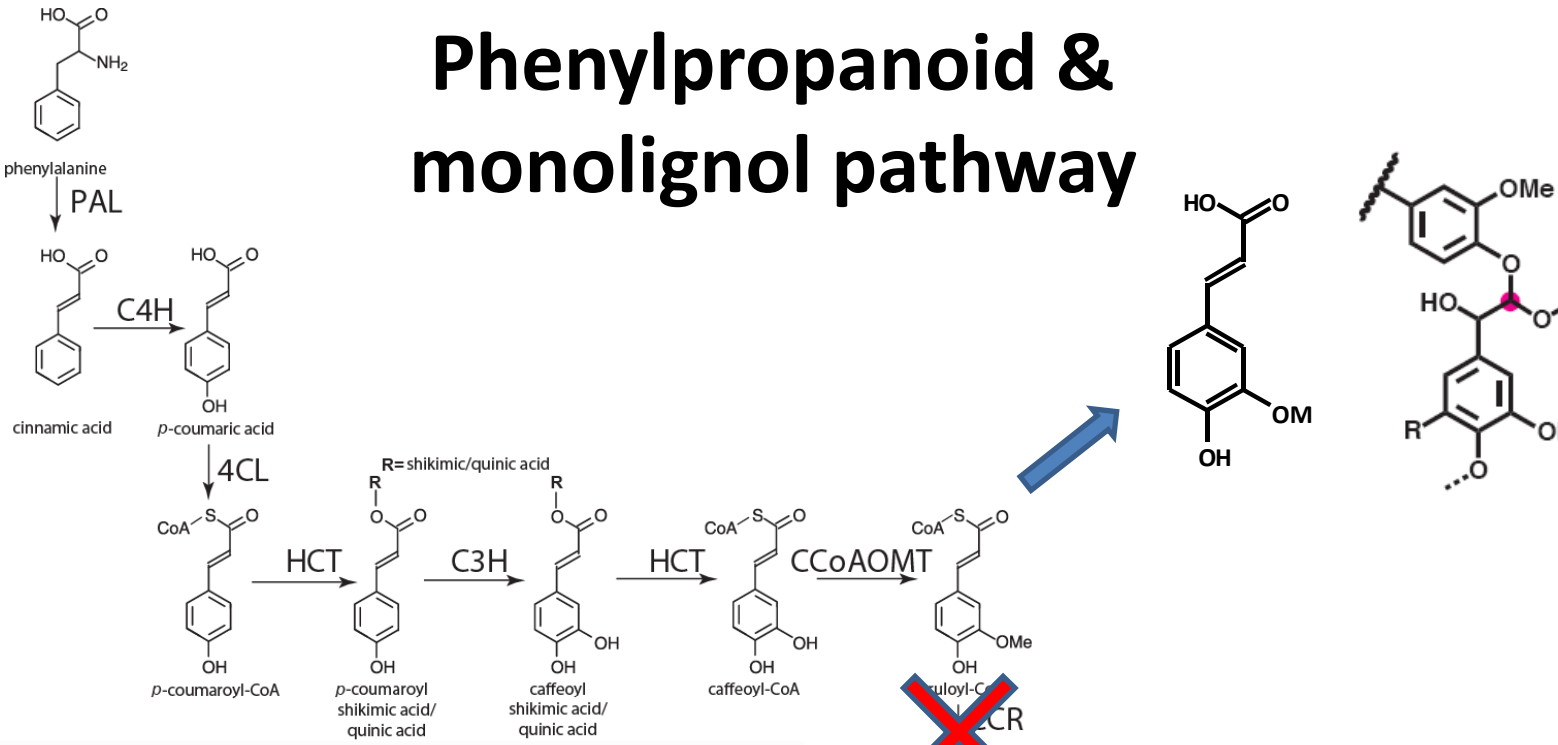
Phenylpropanoid & monolignol pathway



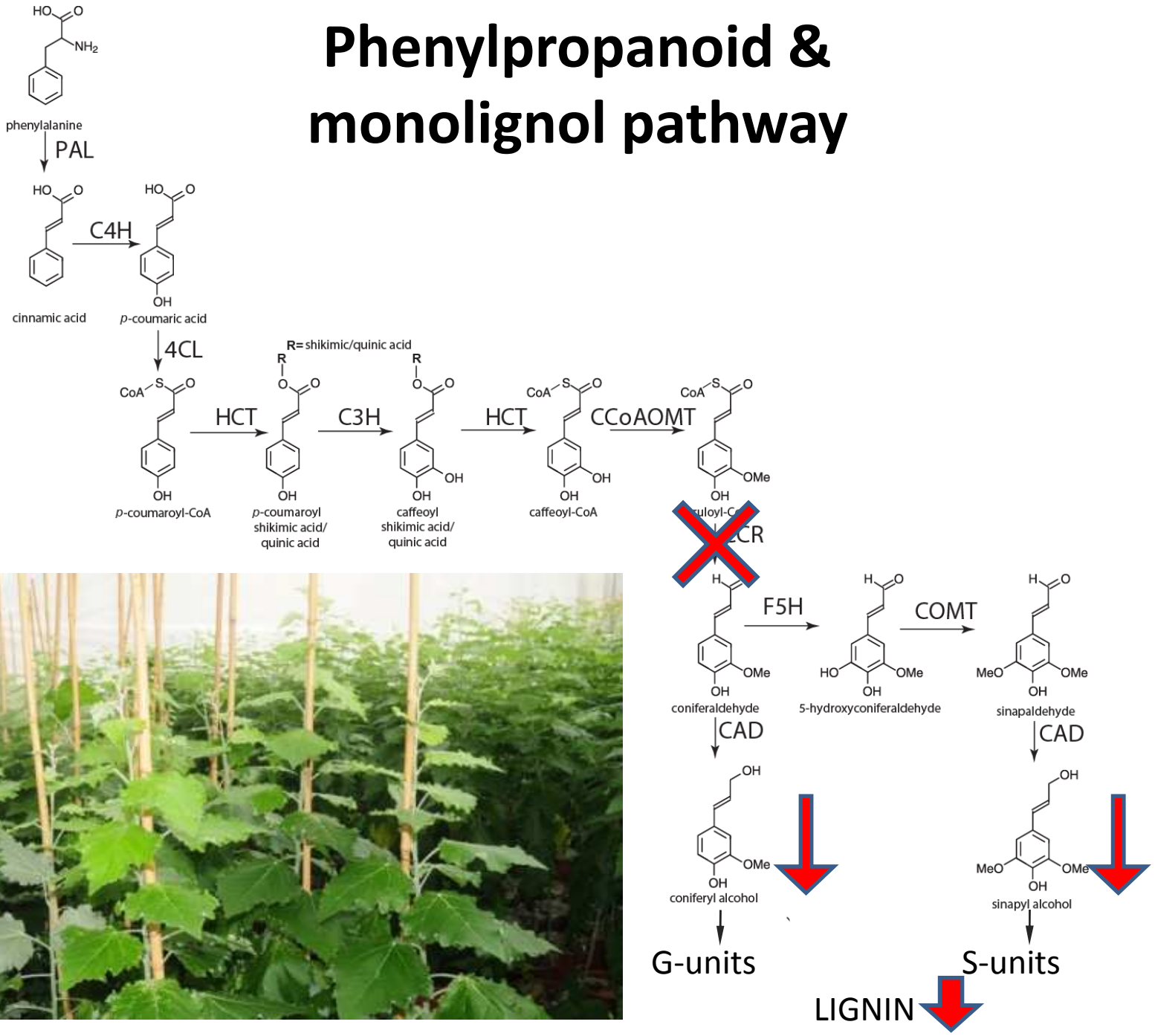
Ralph et al., The Plant Journal



Phenylpropanoid & monolignol pathway

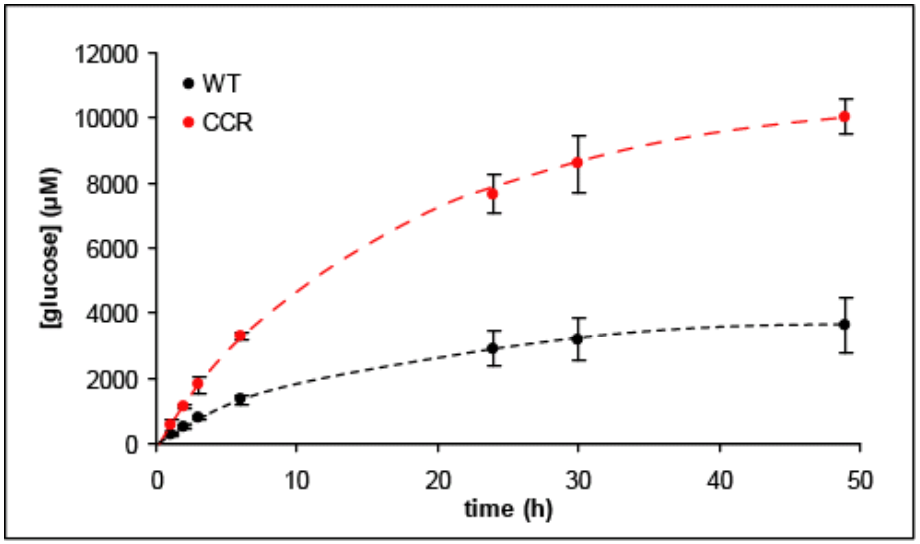


Phenylpropanoid & monolignol pathway



Improving saccharification potential

poplar



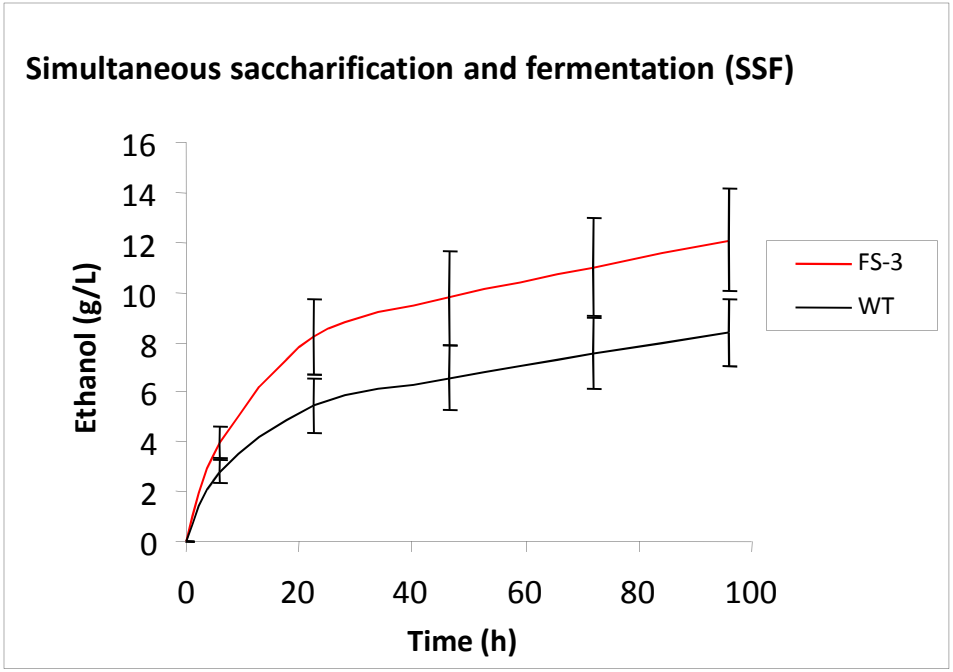
Transgenic (>200%)

Wild type

CCR defective -> 50% to 2-fold more glucose released from stems

SSF of CCR-deficient poplar

(with acidic pre-treatment)

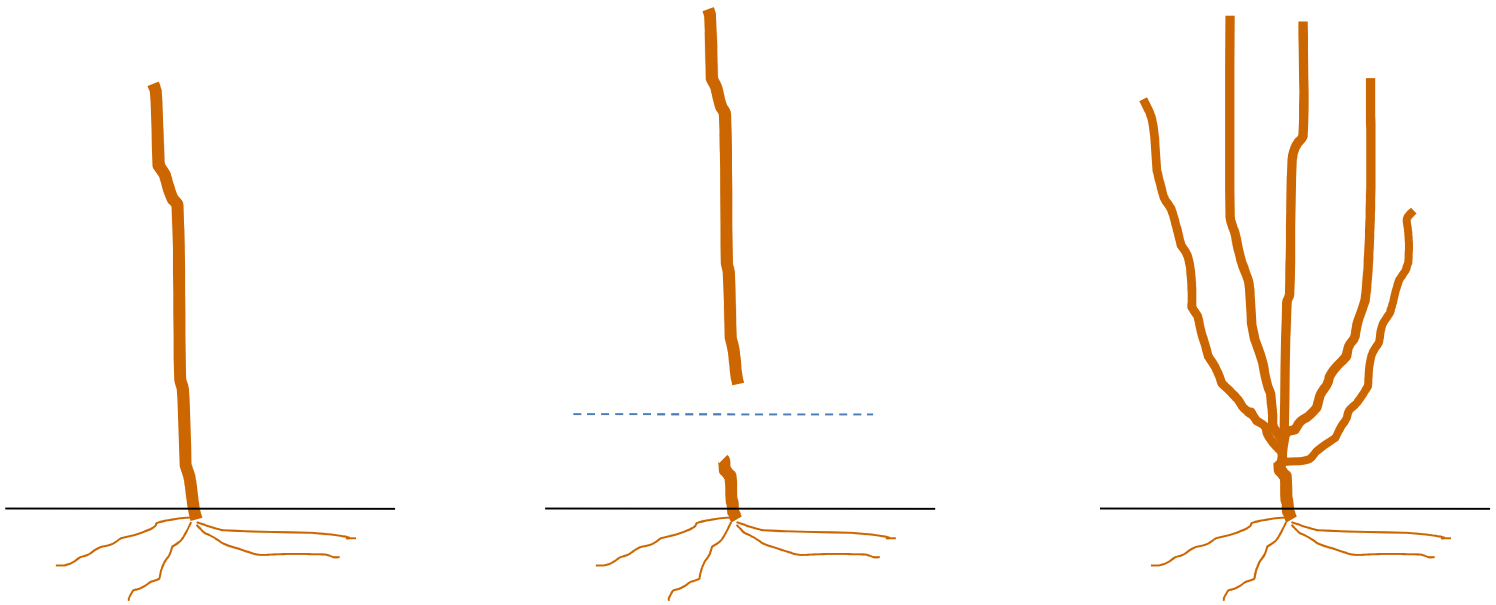


-> 50 % more ethanol released by CCR-down-regulated poplar

Aim of field trial

- Greenhouse ≠ outdoor
  - Seasons
  - Deep soil
  - Wind, rain and pests
  - Insufficient biomass for fermentation tests
  - Short rotation coppice (SRC) culture

Short rotation coppice biomass production



Year 1

End of year 1

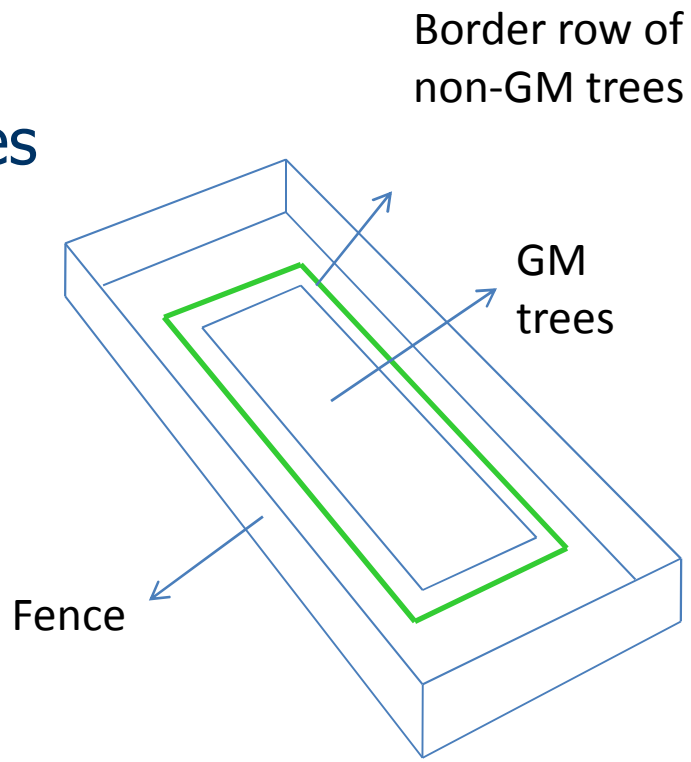
Year 2 - 4

Short rotation coppice biomass production

- 15,000 cuttings/ha
- 3-year rotation for 15-20 years
- ~12 ODT/ha/y

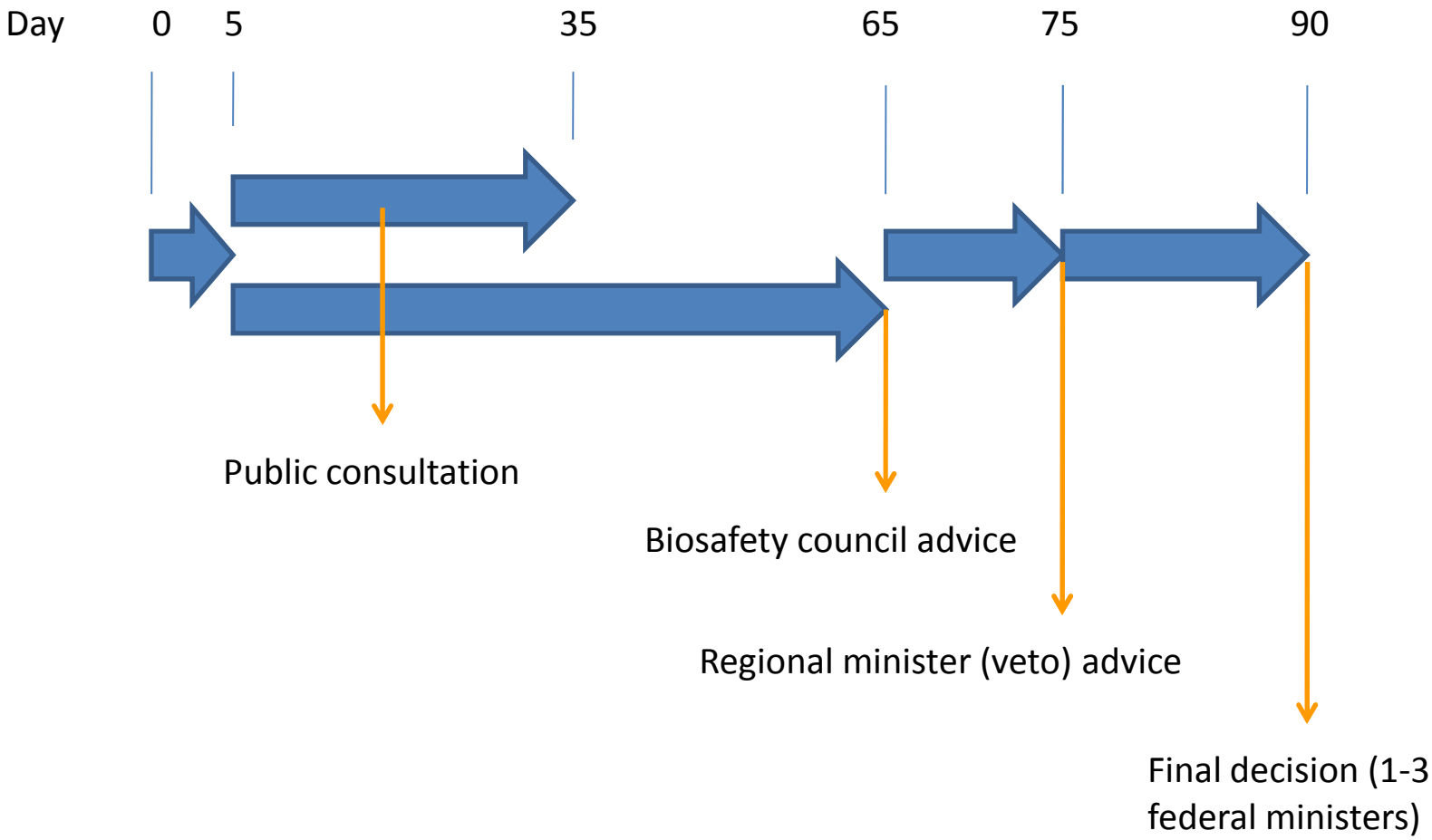
VIB's field trial proposal

- WT and 2 CCR down-regulated lines
- 120 trees/line
- Harvest after three years
- 8-years trial



- No flowering
- No food
- Cellulosic ethanol

The field trial authorization request



The field trial permit sequel

- April 2008: positive advice Biosafety Council
- May 2008: permit refused because of three non-legal reasons
- July 2008: VIB case at the Council of State
- Dec 2008: Council of State rules in favor of VIB
- Feb 2009: additional Biosafety Council advice
- Feb 2009: federal authorities sign permit
- May 2009: start of field trial

VIB's field trial – planted May 6th, 2009

First tree planted by minister Patricia Ceyssens

First bottle of ethanol from transgenic trees

Acknowledgements

PSB-VIB
Rebecca Van Acker
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Dirk Inzé

Leplé *et al.*, *The Plant Cell* 2007
Ralph *et al.*, *The Plant Journal* 2008
Strauss *et al.*, *Nature Biotechnology* 2009
Walter *et al.*, *Nature Biotechnology* 2010


Thank you