

# Plant root diffusional barriers: Genesis and implications for nutrient efficiency and stress tolerance

David E Salt, University of Aberdeen



ERA-CAPS

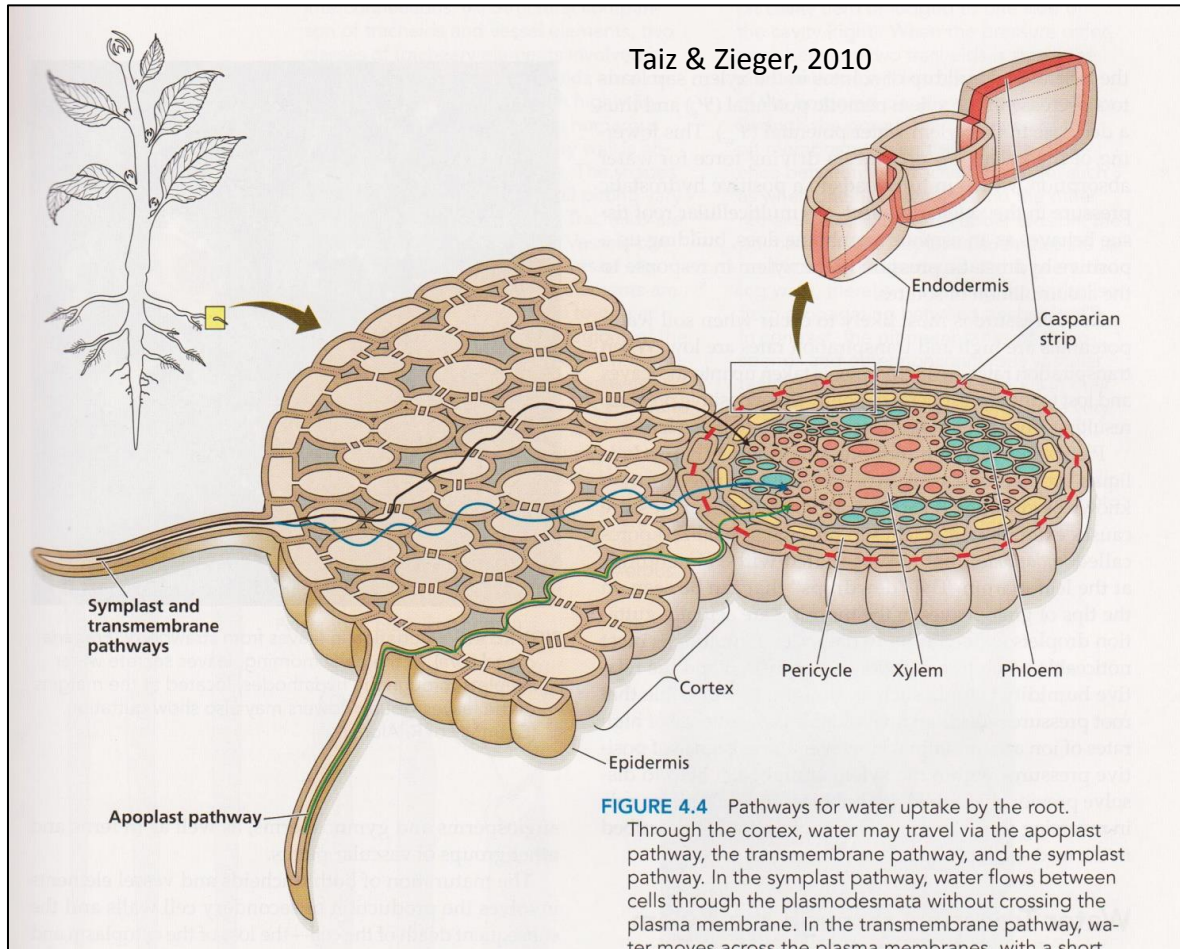
ERA-NET for Coordinating  
Action in Plant Sciences





Organisation	Name of team member	Expertise
University of Aberdeen	Salt, David E., Prof. (project leader)	Molecular plant physiology including Casparian strip development
University of Bonn	Franke, Rochus B., Dr (PI)	Functional genomics of Lignin and Suberin biosynthesis.
	Grundler, Florian, Prof. (CoPI)	Plant-nematode interactions
	Siddique, Shahid, Dr (CoPI)	Plant-nematode interactions
IPK, Gatersleben	von Wirén, Nico, Prof. (PI)	Plant mineral nutrition
INRA, BPMP, Montpellier	Boursiac, Yann, Dr (PI)	Whole root and single cell hydraulics
	Maurel, Christoph, Dr (CoPI)	Whole root and single cell hydraulics & modelling
INRA, LEPSE, Montpellier	Muller, Bertrand, Dr (PI)	Analyses and modelling of plant responses to water deficit
	Simonneau, Thierry, Dr (CoPI)	Analyses and modelling of plant responses to water deficit
Wageningen University	Aarts, Mark G.M., Dr (PI)	Mineral nutrient and trace element stress (deficiency & excess)
University of Copenhagen	Schjoerring, Jan K, Prof. (PI)	Distribution and chemical speciation of mineral nutrients and trace elements
	Husted, Søren, Prof. (CoPI)	

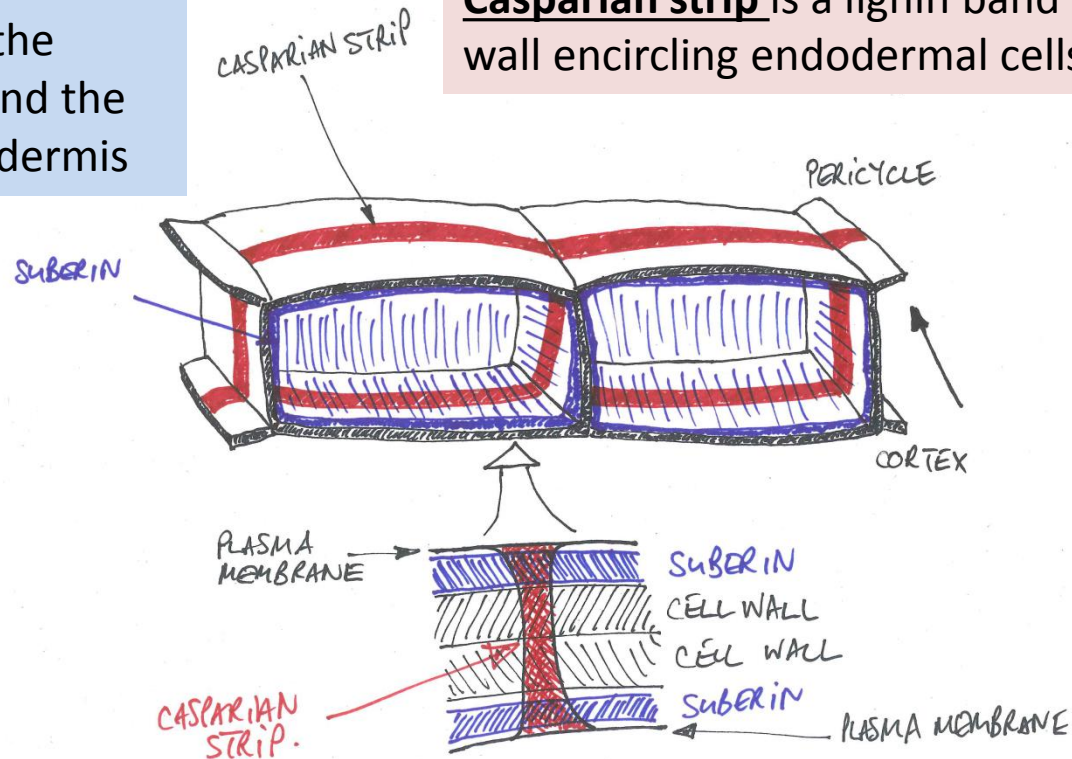
*What and where are the Barriers in the root?*



## *Casparian strip and suberin barriers*

**Suberin** is a waxy material deposited between the plasma membrane and the cell wall of the endodermis

**Casparian strip** is a lignin band within the cell wall encircling endodermal cells

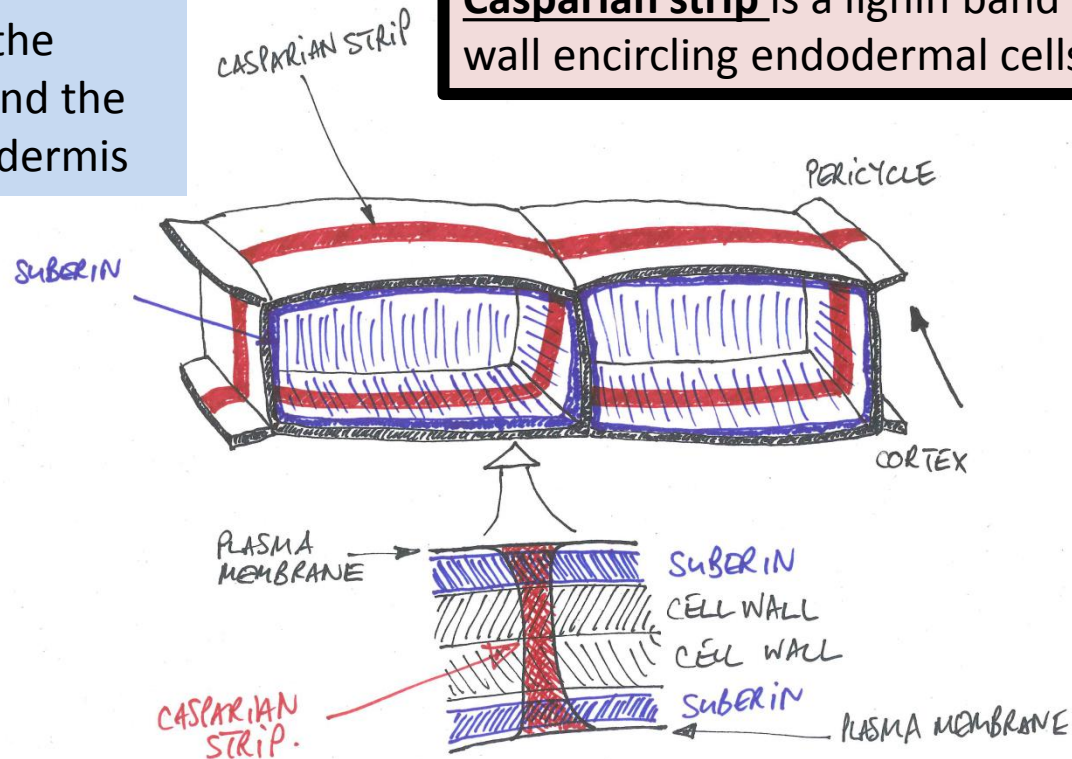


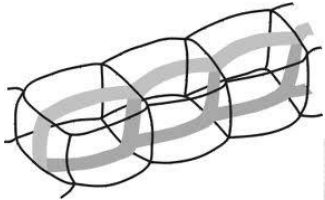


## *Casparian strip and suberin barriers*

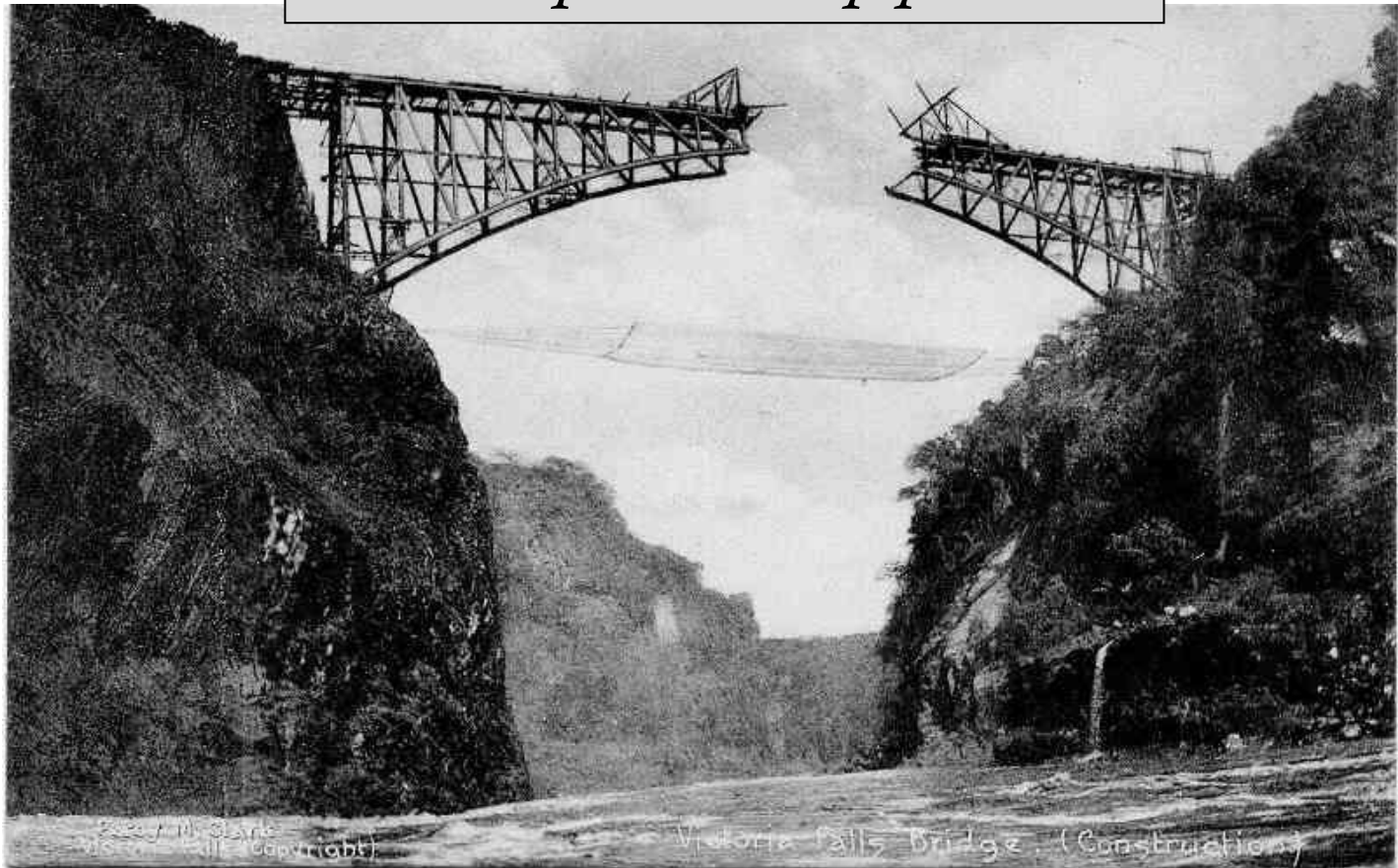
**Suberin** is a waxy material deposited between the plasma membrane and the cell wall of the endodermis

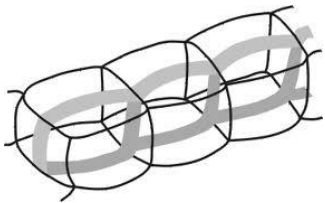
**Casparian strip** is a lignin band within the cell wall encircling endodermal cells



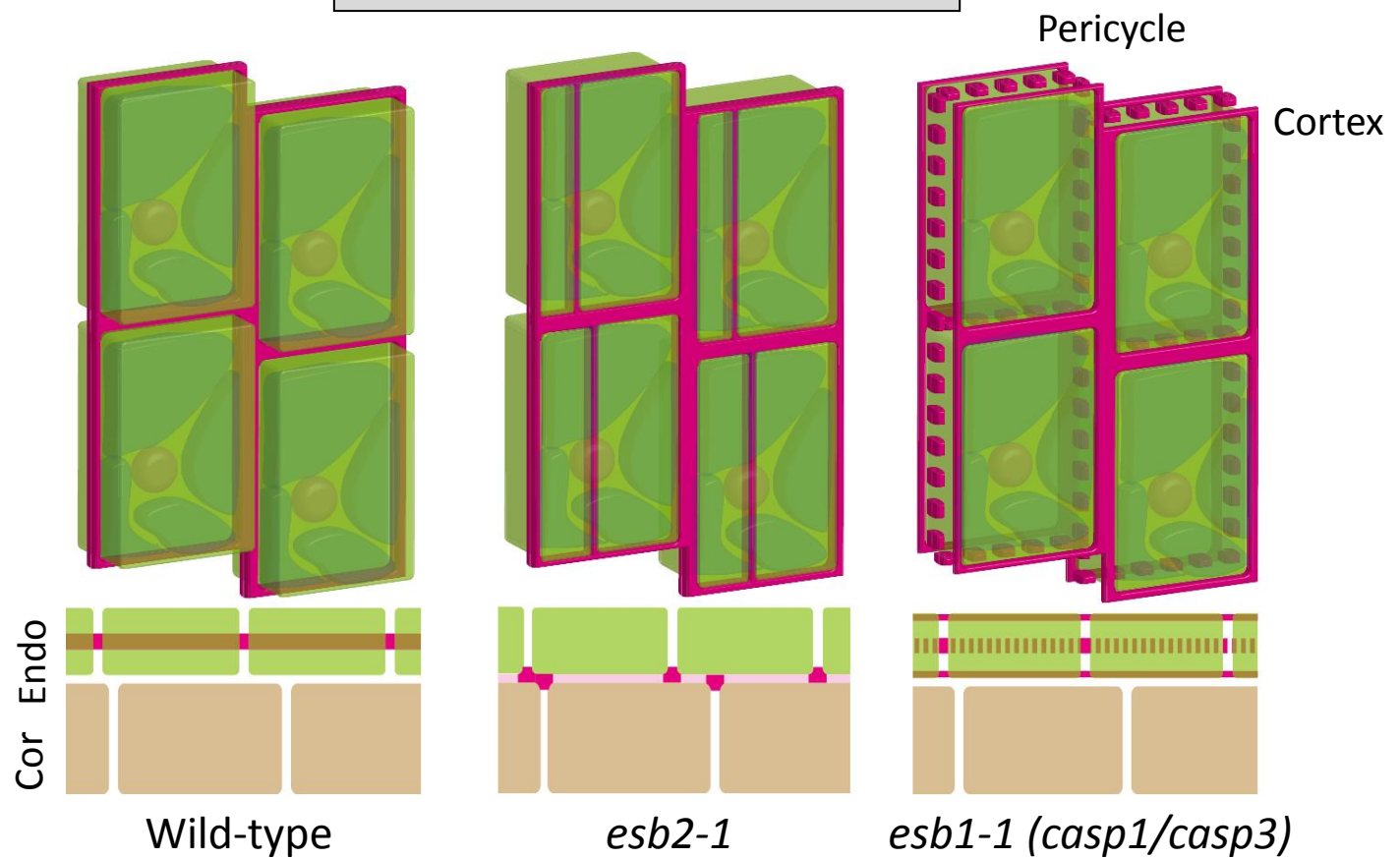


## *The Casparian strip problem*

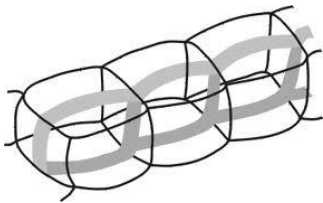




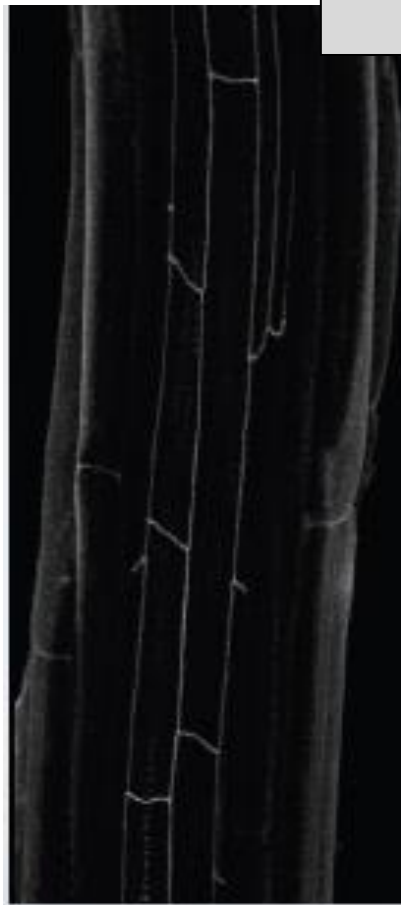
## *The approach*



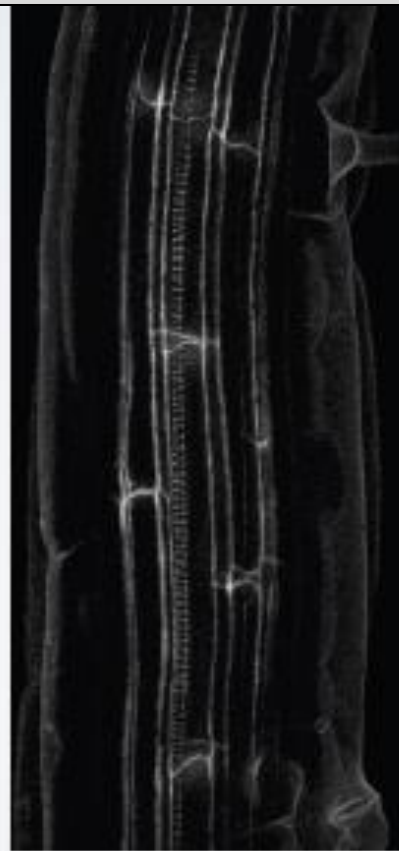




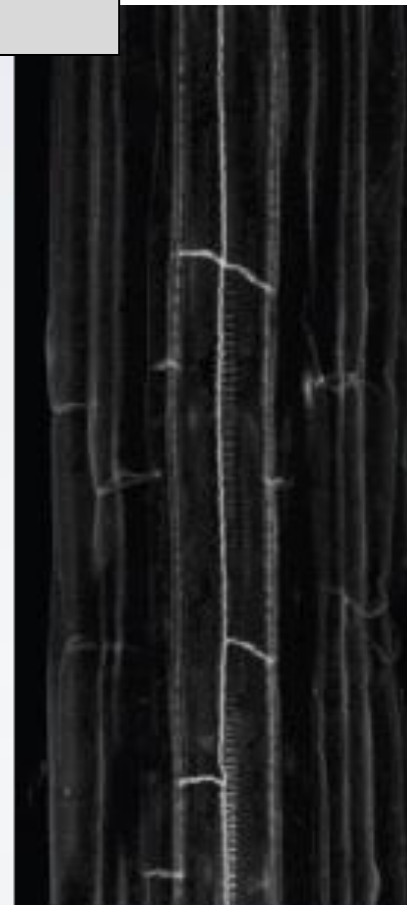
## *The approach*



Wild-type



*esb2-1*

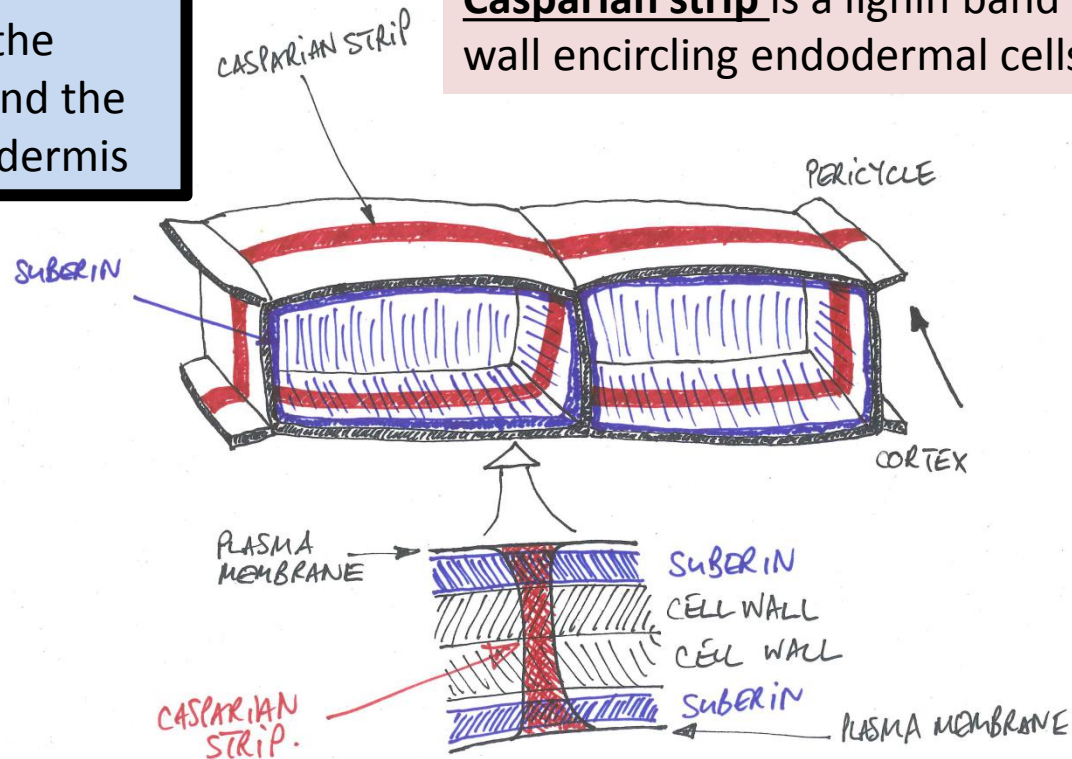


*esb1-1 (casp1/casp3)*

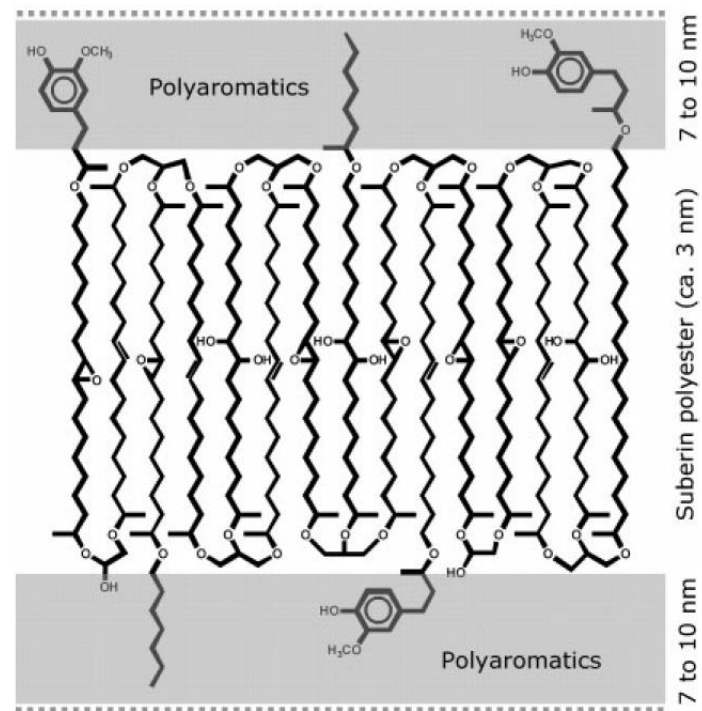
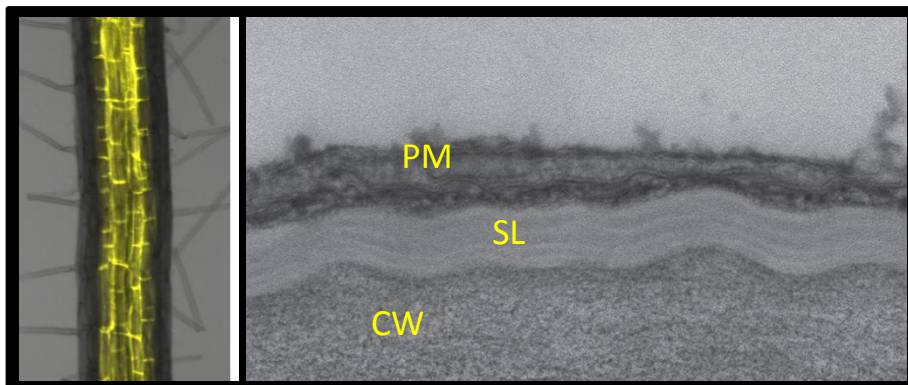
## *Casparian strip and suberin barriers*

**Suberin** is a waxy material deposited between the plasma membrane and the cell wall of the endodermis

**Casparian strip** is a lignin band within the cell wall encircling endodermal cells



## *The suberin problem*



## *The approach*

*Journal of Experimental Botany*, Vol. 59, No. 9, pp. 2347–2360, 2008

doi:10.1093/jxb/ern101

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Experimental  
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### RESEARCH PAPER

## **The *Arabidopsis* cytochrome P450 *CYP86A1* encodes a fatty acid $\omega$ -hydroxylase involved in suberin monomer biosynthesis**

Rene Höfer<sup>1</sup>, Isabel Briesen<sup>1</sup>, Martina Beck<sup>1</sup>, Franck Pinot<sup>2</sup>, Lukas Schreiber<sup>1</sup> and Rochus Franke<sup>1,\*</sup>

## *the plant journal*

*The Plant Journal* (2009) 57, 80–95

doi: 10.1111/j.1365-3113X.2008.03674.x

## **The *DAISY* gene from *Arabidopsis* encodes a fatty acid elongase condensing enzyme involved in the biosynthesis of aliphatic suberin in roots and the chalaza-micropyle region of seeds**

Rochus Franke<sup>1,\*</sup>, Rene Höfer<sup>1</sup>, Isabel Briesen<sup>1</sup>, Mitja Emsermann<sup>1</sup>, Nadia Efremova<sup>2</sup>, Alexander Yephremov<sup>2</sup> and Lukas Schreiber<sup>1</sup>

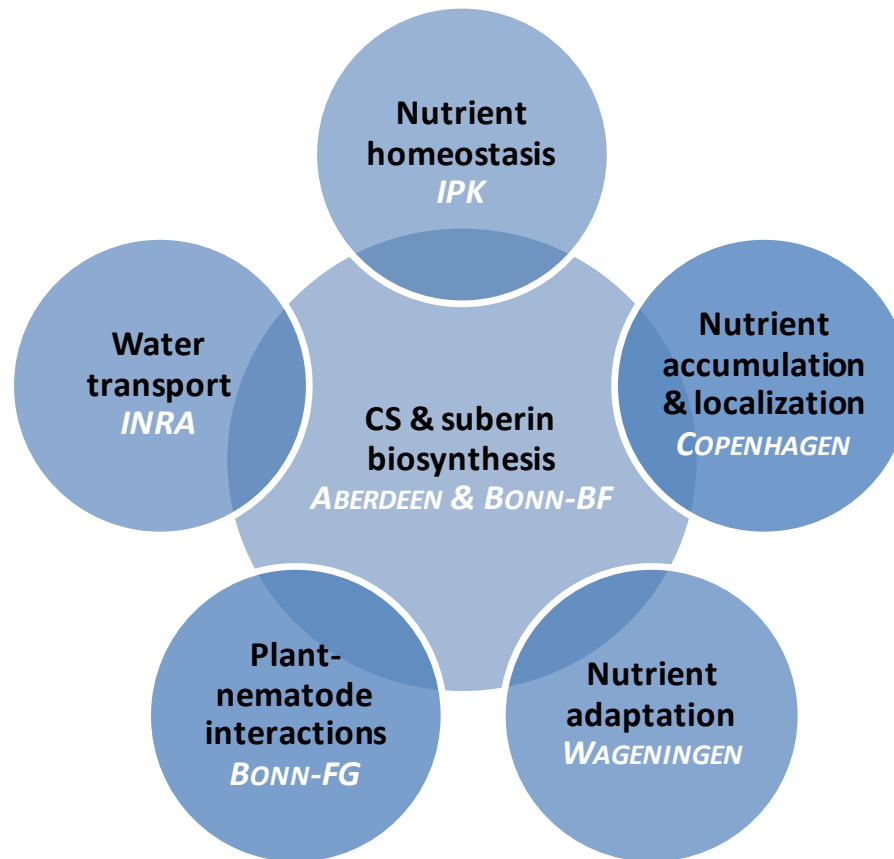
## **CYP86B1 Is Required for Very Long Chain $\omega$ -Hydroxyacid and $\alpha,\omega$ -Dicarboxylic Acid Synthesis in Root and Seed Suberin Polyester<sup>1[W][OA]</sup>**

Vincent Compagnon<sup>2</sup>, Patrik Diehl<sup>2</sup>, Irène Benveniste, Denise Meyer, Hubert Schaller, Lukas Schreiber, Rochus Franke, and Franck Pinot\*

*Plant Physiology*<sup>®</sup>, August 2009, Vol. 150, pp. 1831–1843,



*What physiological role do these barriers play?*

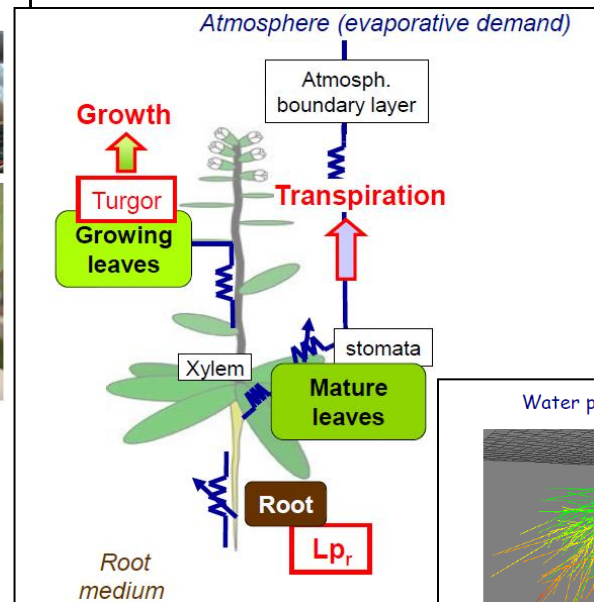
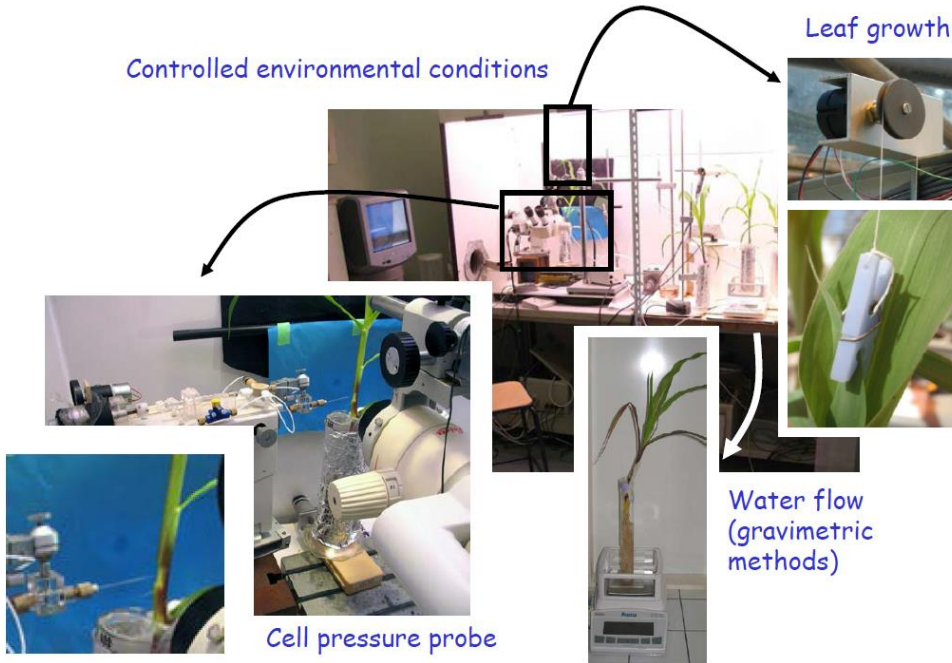


# Water Transport

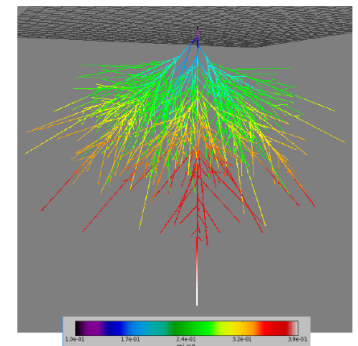
## Leaf growth, cell turgor and water flow measurements

Controlled environmental conditions

Leaf growth

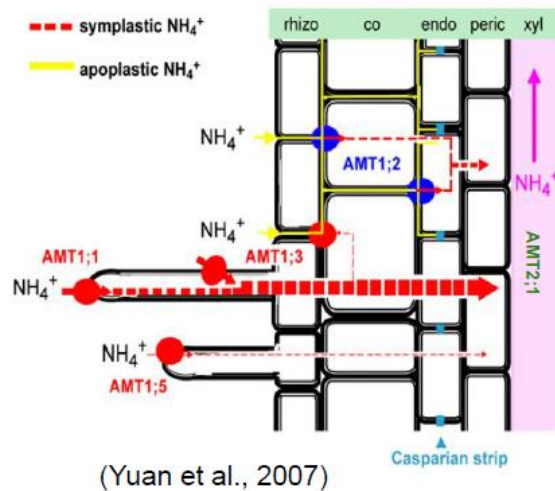


Water potential representation

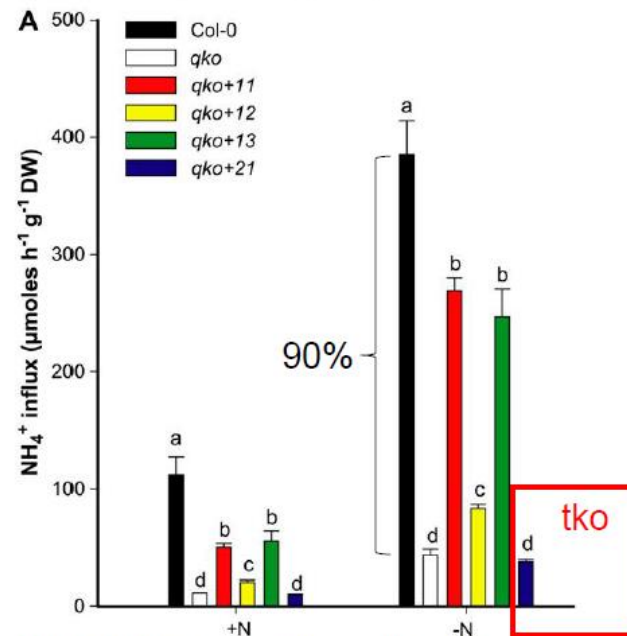


# Mineral nutrient transport

## High affinity ammonium transport system in Arabidopsis roots



## Ammonium uptake capacity in *amt* mutants



High-affinity ammonium uptake rate decreases by 90% in *amt1;1amt1;2amt1;3amt2;1* quadruple mutant

# Plant-nematode interaction

the plant journal

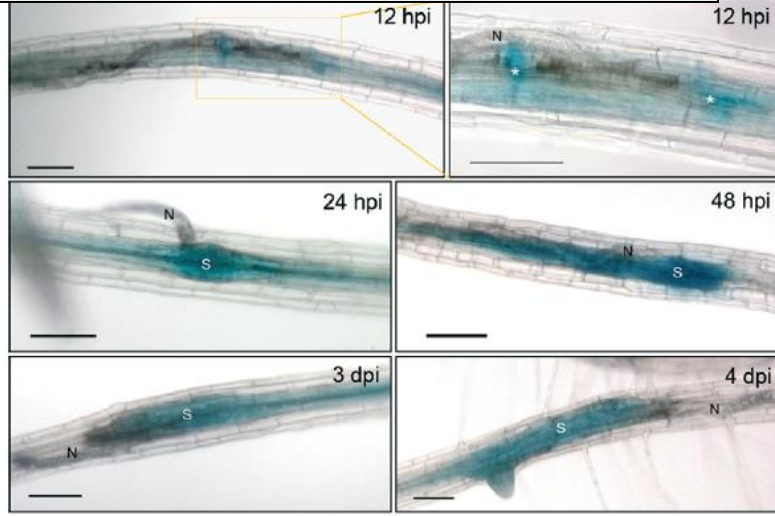


The Plant Journal (2013) 74, 852–866

doi: 10.1111/tpj.12170

## An Arabidopsis ATPase gene involved in nematode-induced syncytium development and abiotic stress responses

Muhammad Amjad Ali<sup>1,2</sup>, Stephan Plattner<sup>1,2</sup>, Zoran Radakovic<sup>2</sup>, Krzysztof Wiczeorek<sup>1</sup>, Abdelnaser Elashry<sup>1,2</sup>, Florian M.W. Grundler<sup>2</sup>, Moritz Ammelburg<sup>3</sup>, Shahid Siddique<sup>1,2</sup> and Holger Bohlmann<sup>1,\*</sup>



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the plant journal

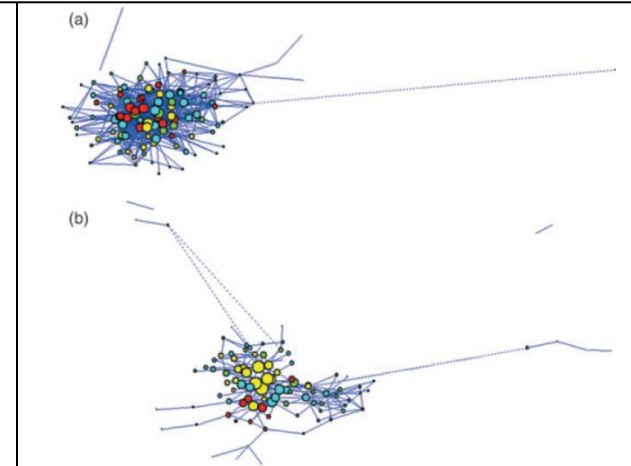


The Plant Journal (2010) 62, 1058–1071

doi: 10.1111/j.1365-3113X.2010.04217.x

## Metabolic profiling reveals local and systemic responses of host plants to nematode parasitism

Julia Hofmann<sup>1,\*</sup>, Abd El Naser El Ashry<sup>1</sup>, Shahbaz Anwar<sup>1</sup>, Alexander Erban<sup>2</sup>, Joachim Kopka<sup>2</sup> and Florian Grundler<sup>1</sup>





## *Nutrient adaptation*

Determine the effect of the barriers on mineral nutrient efficiency and toxicity using high throughput phenotyping

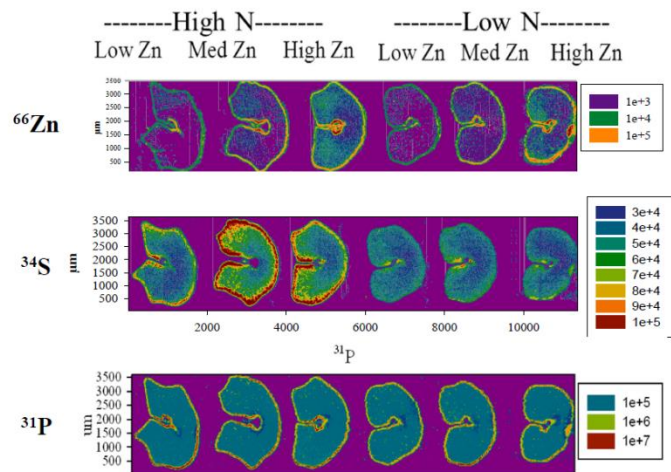
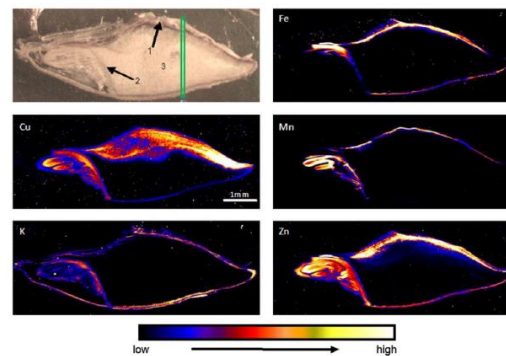


# *Analytical approaches*

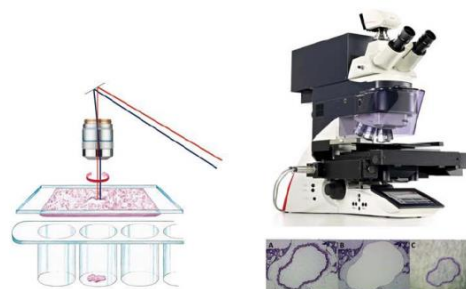
NWR Eximer Laser System



Synchrotron XRF, nano-SIMS



Laser (capture) micro dissection (LMD)





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