

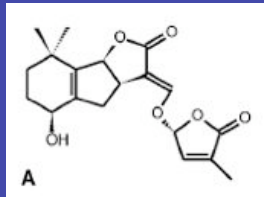
# Signal integration and the bud activation switch



# Plant developmental plasticity



# Strigolactone is required for branching plasticity

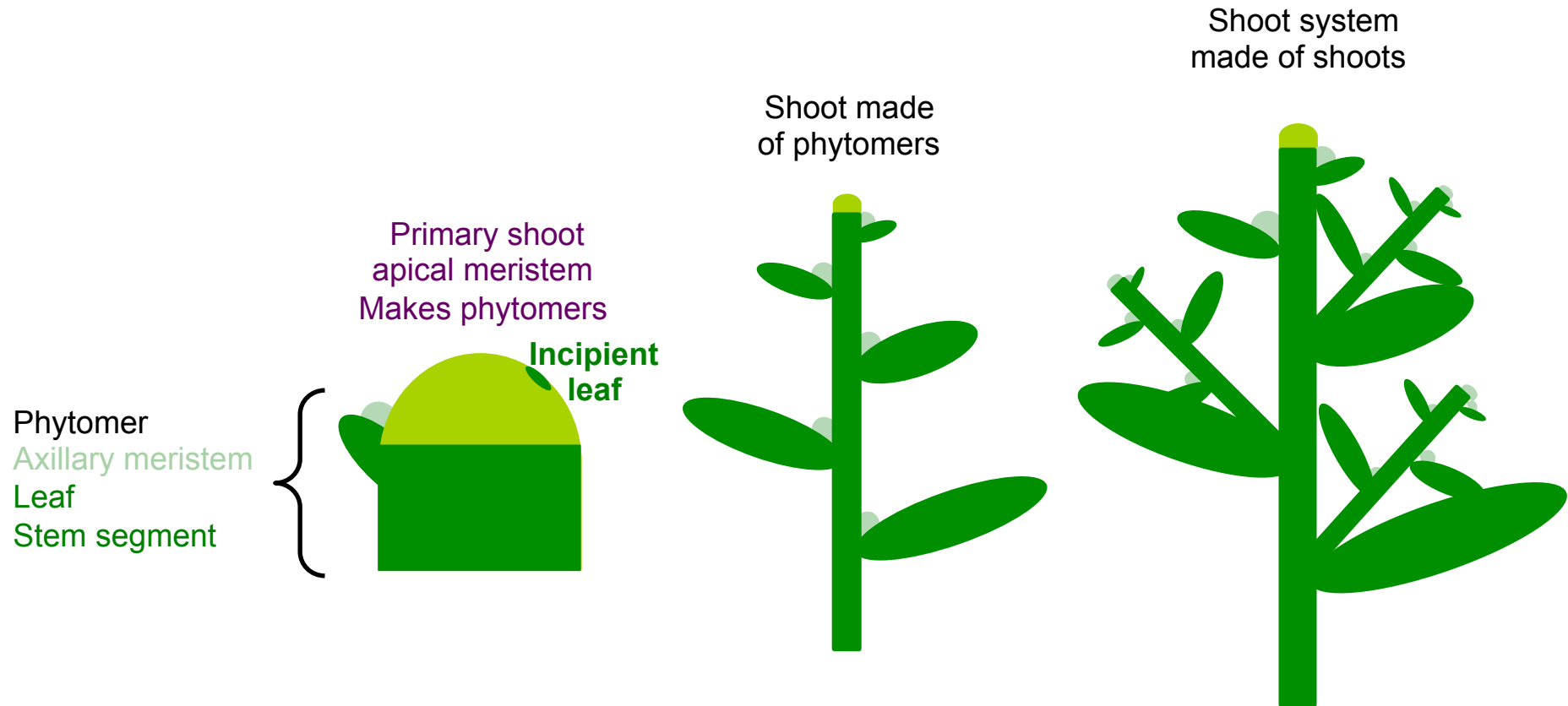


WT



*max1*

# Shoot systems are fractal



# Bud activation decisions



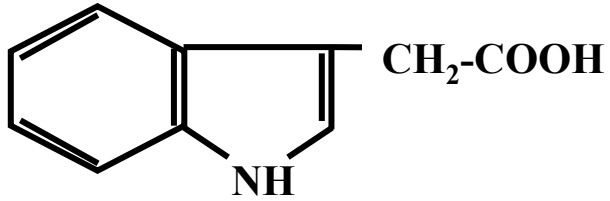
Genotype

Environment

Physiology

Development

# Auxin flow in the shoot system



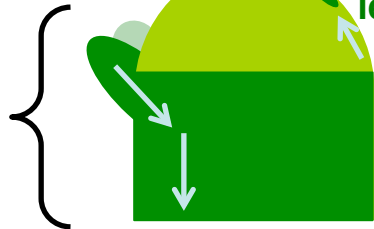
Auxin flow



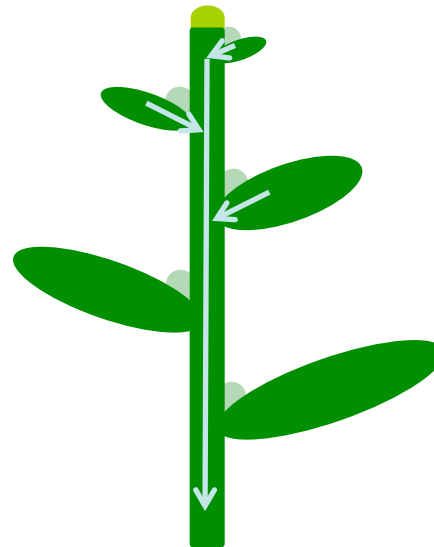
Primary shoot apical meristem  
Makes phytomers

Incipient leaf

Phytomer  
Axillary meristem  
Leaf  
Stem segment



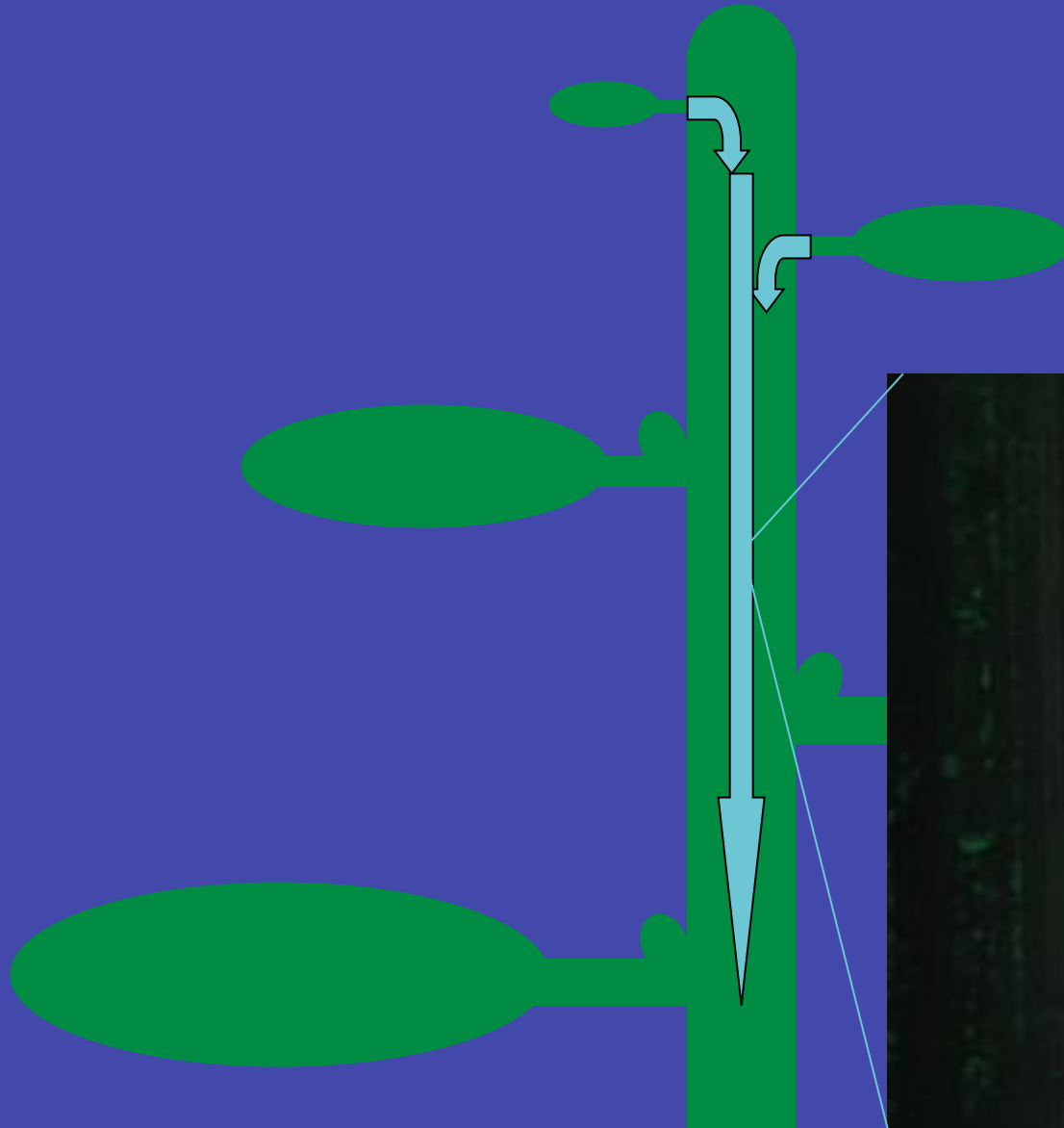
Shoot made of phytomers

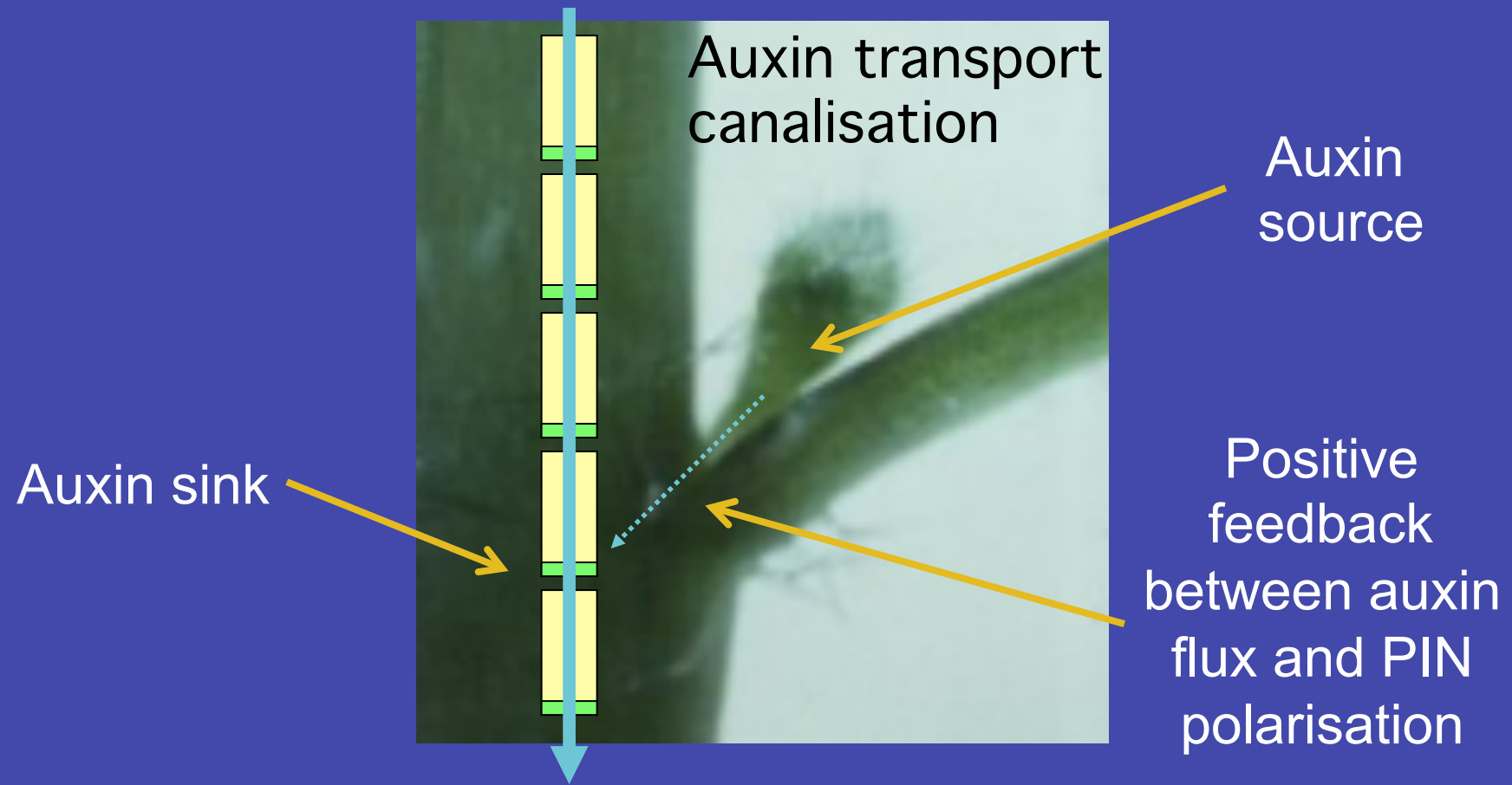


Shoot system made of shoots



# Auxin

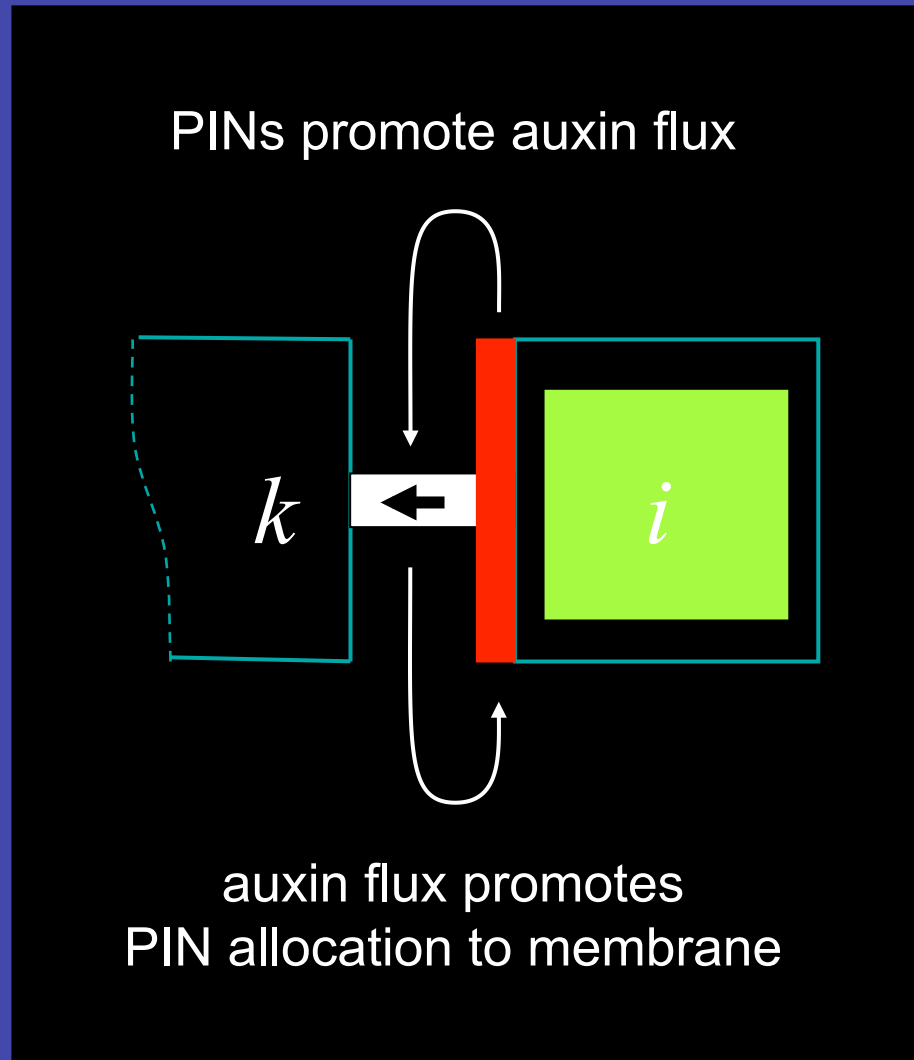




Hypothesis: For sustained activation, buds must establish canalised auxin transport from the bud apex into the stem



# Canalisation theory – feedback loop



$$\frac{d[PIN]}{dt} = \rho \frac{\Phi^n}{K^n + \Phi^n} + \rho_0 - \mu[PIN]$$

$\Phi$ - is the flux from  $i$  to  $k$

$\rho$ - PIN insertion constant

$\mu$ - PIN removal constant

Przemek  
Prusinkiewicz



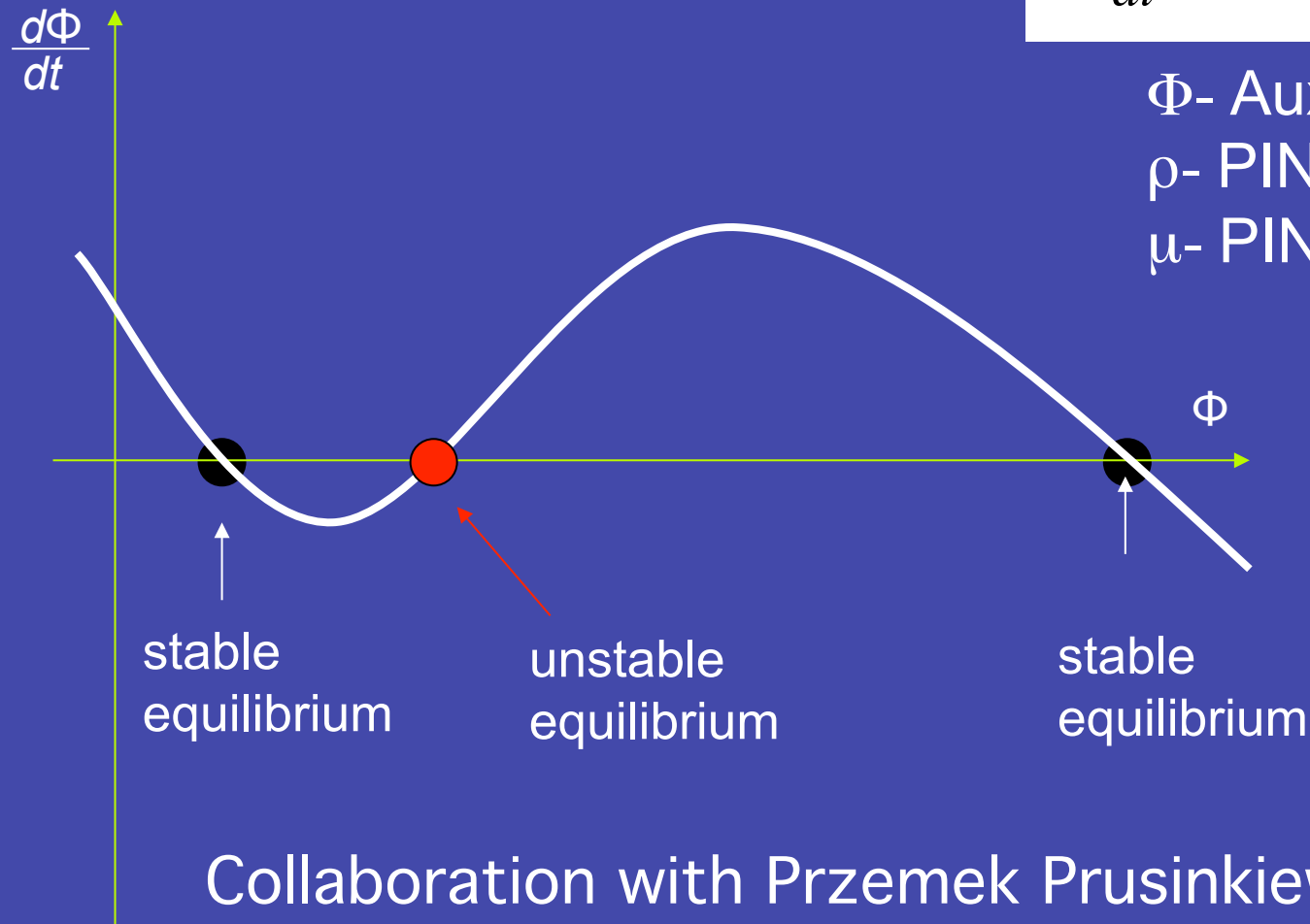
# Bistability of a basic auxin transport canalisation model

$$\frac{d[PIN]}{dt} = \rho \frac{\Phi^n}{K^n + \Phi^n} + \rho_0 - \mu[PIN]$$

$\Phi$ - Auxin flux

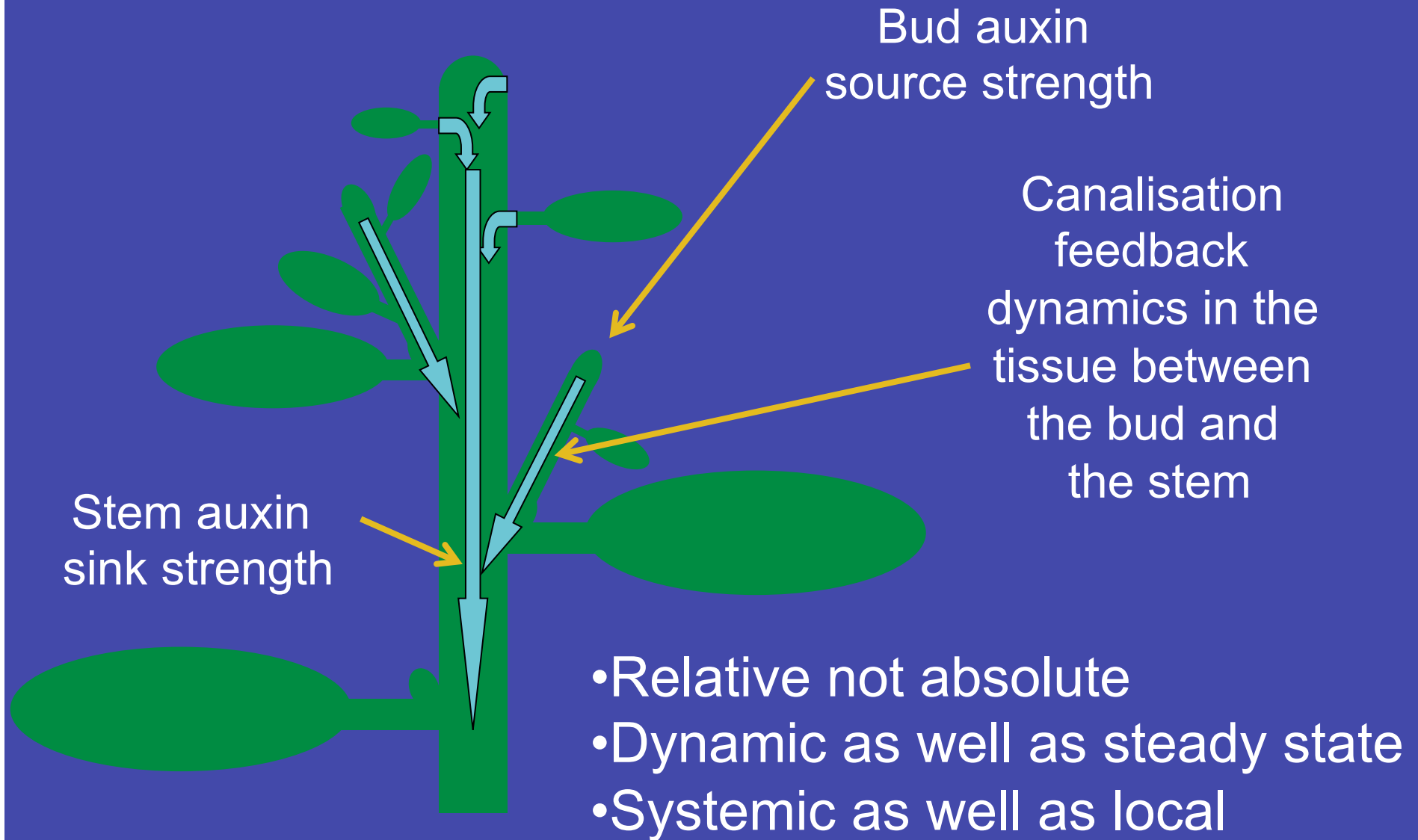
$\rho$ - PIN insertion constant

$\mu$ - PIN removal constant



Collaboration with Przemek Prusinkiewicz

# Competitive canalisation as regulatory system



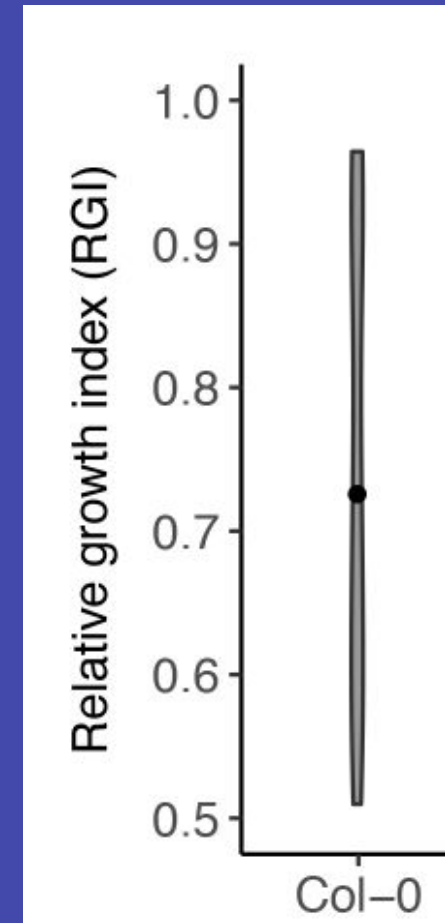
# Bud activation is competitive



Equal  
growth

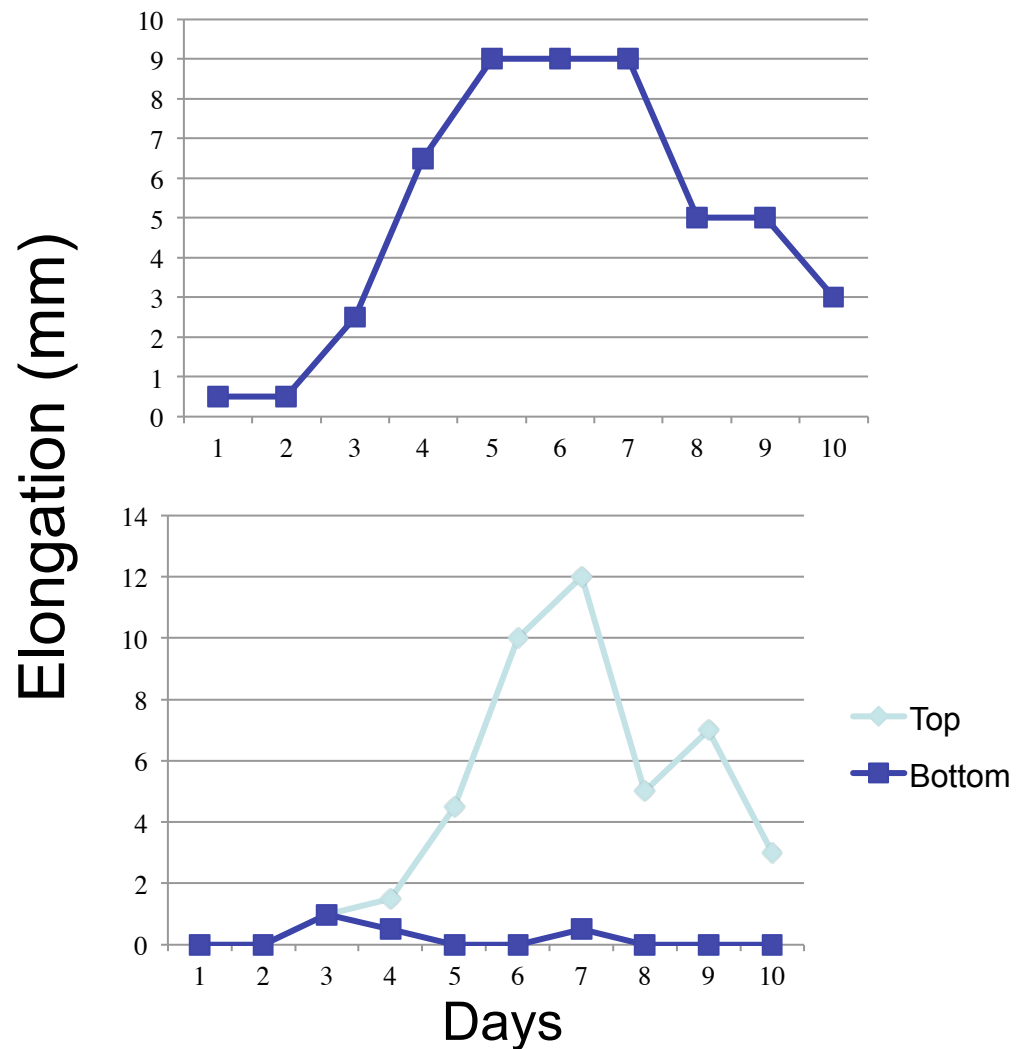
Apical bud  
grows

Basal bud  
grows

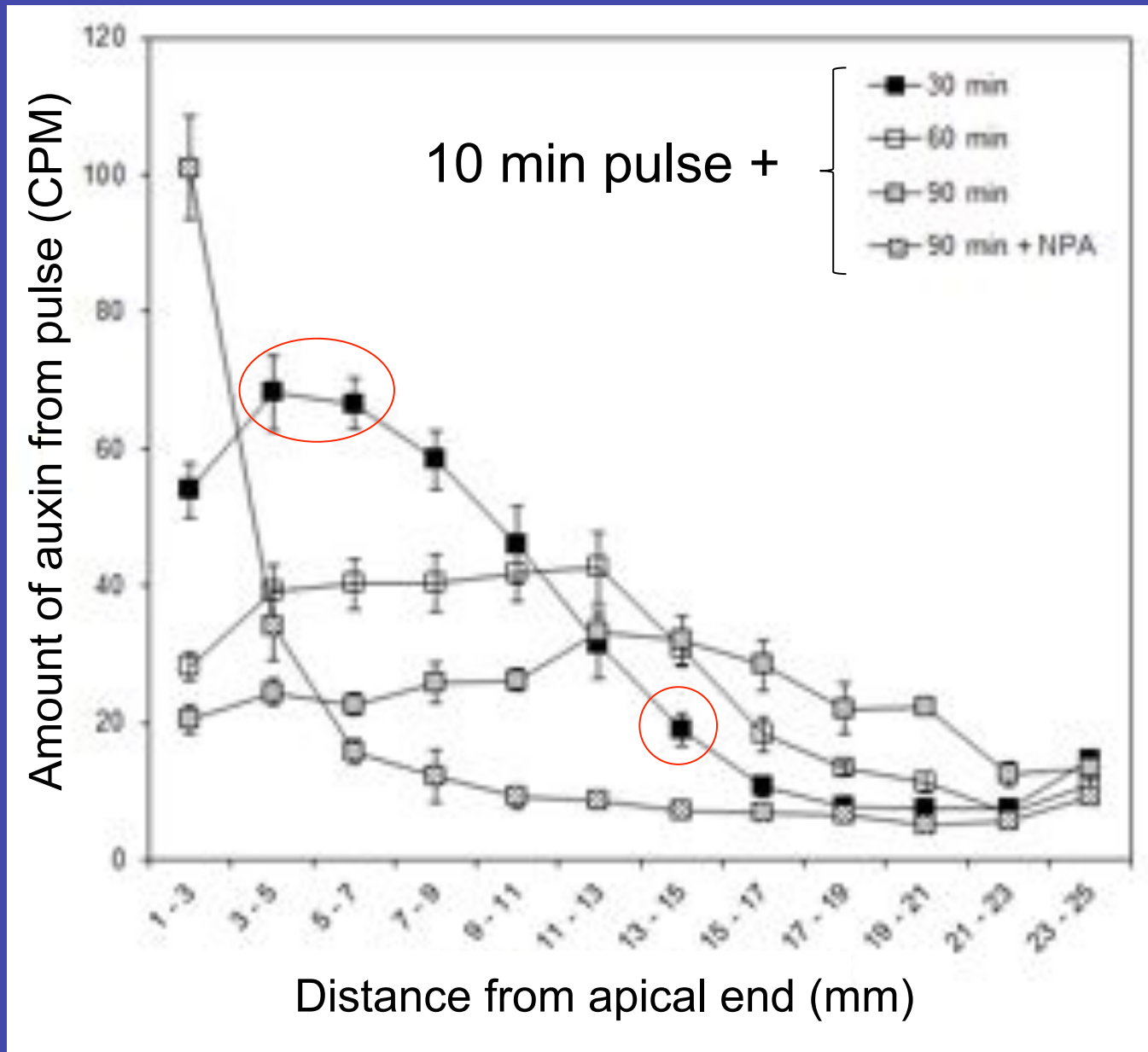


Length of longest/  
Length of both

# The winning bud on two-bud explants activates more slowly than a solitary bud



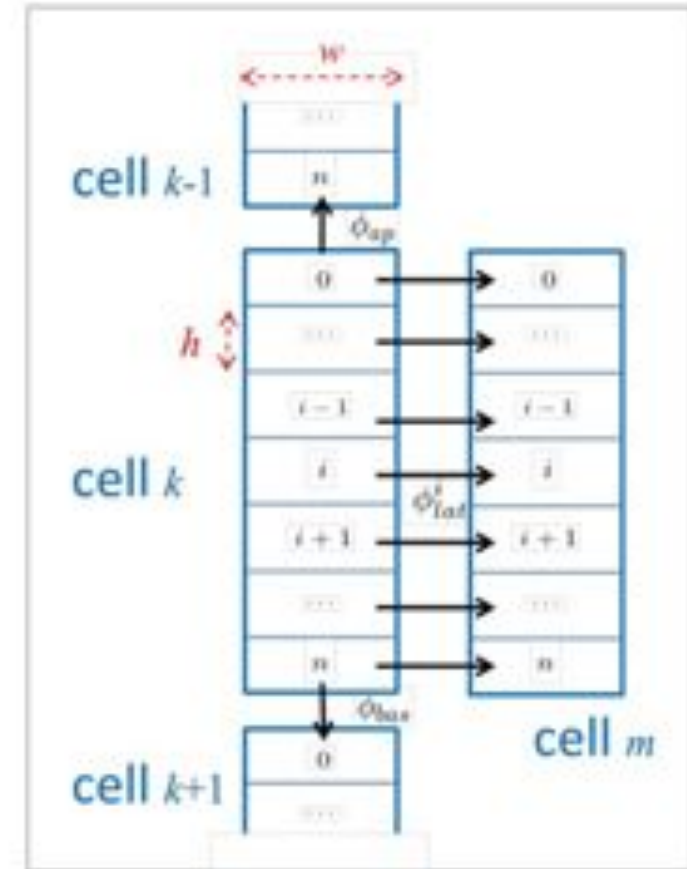
# Stem auxin transport dynamics are complex



# Modelling auxin transport in the stem

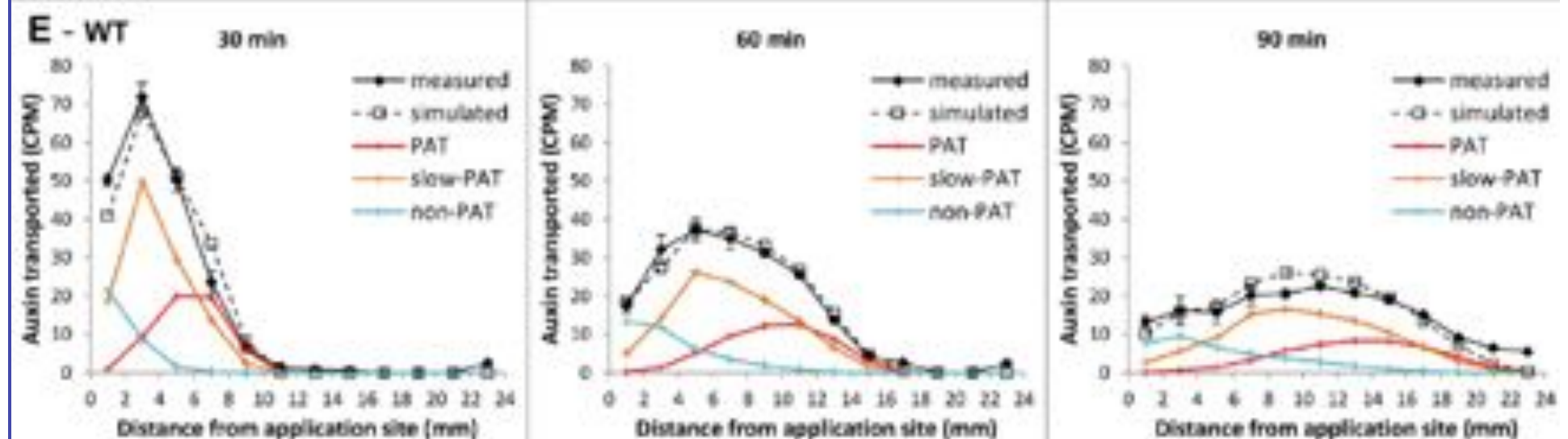
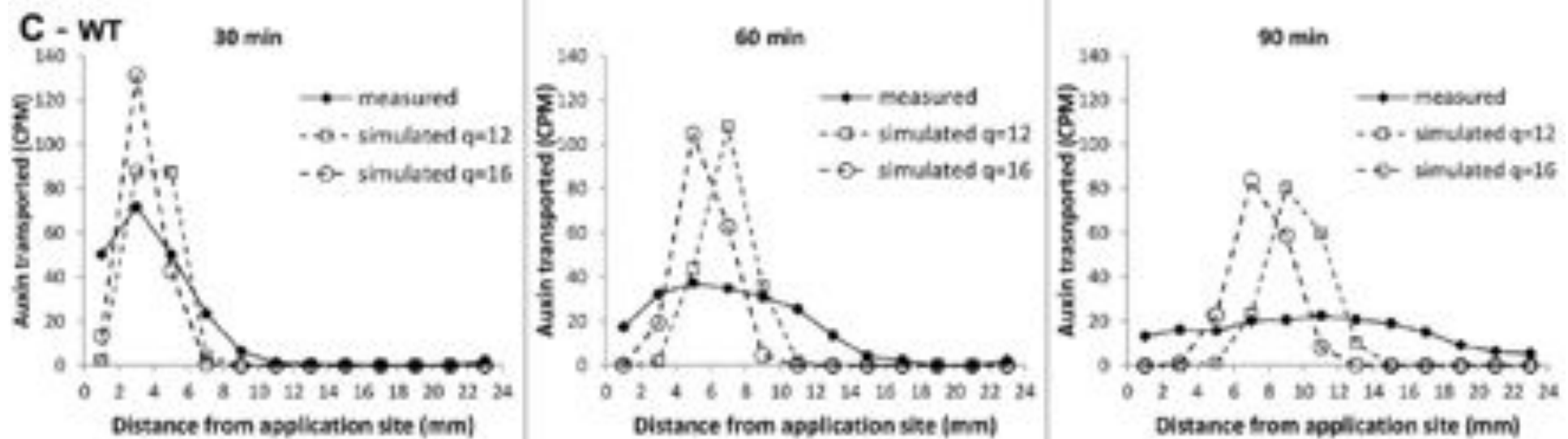
Auxin movement is modelled by:

- (1) Diffusion inside cells, lengthwise only, using  $n+1$  cell sub-divisions
- (2) Direct transport from one cell into the next



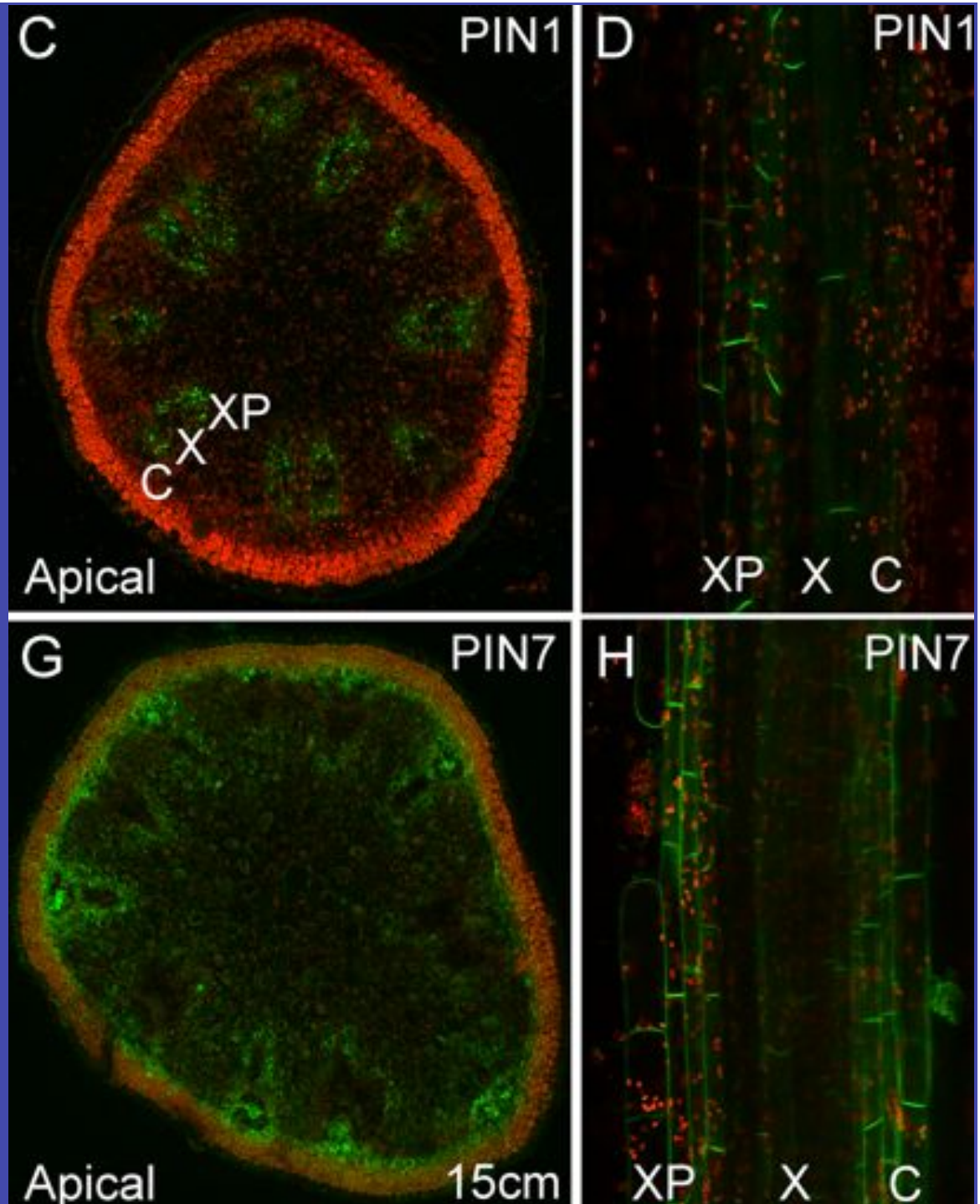


# Auxin transport in the stem is multimodal

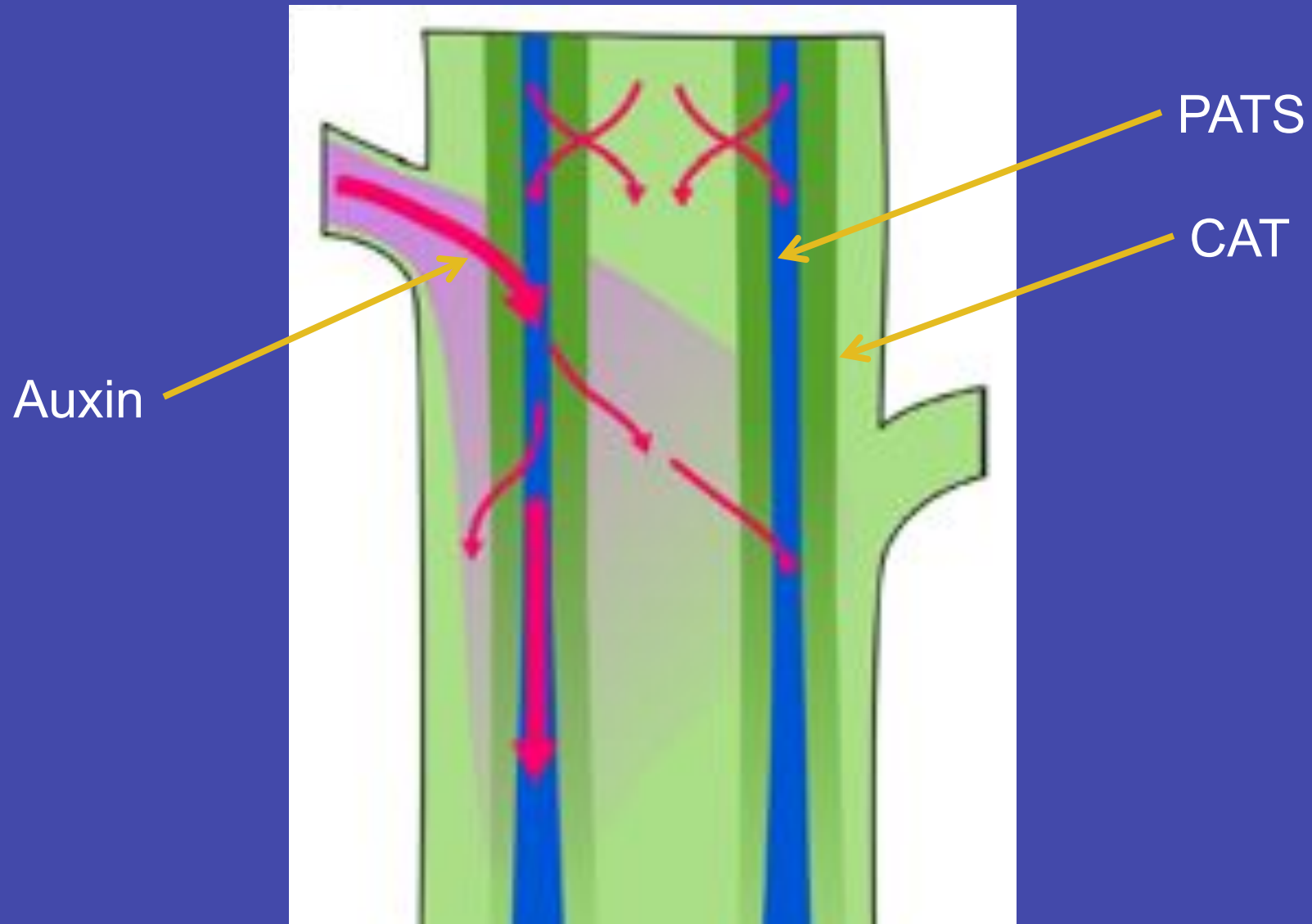


PIN1 accumulates in the polar auxin transport stream

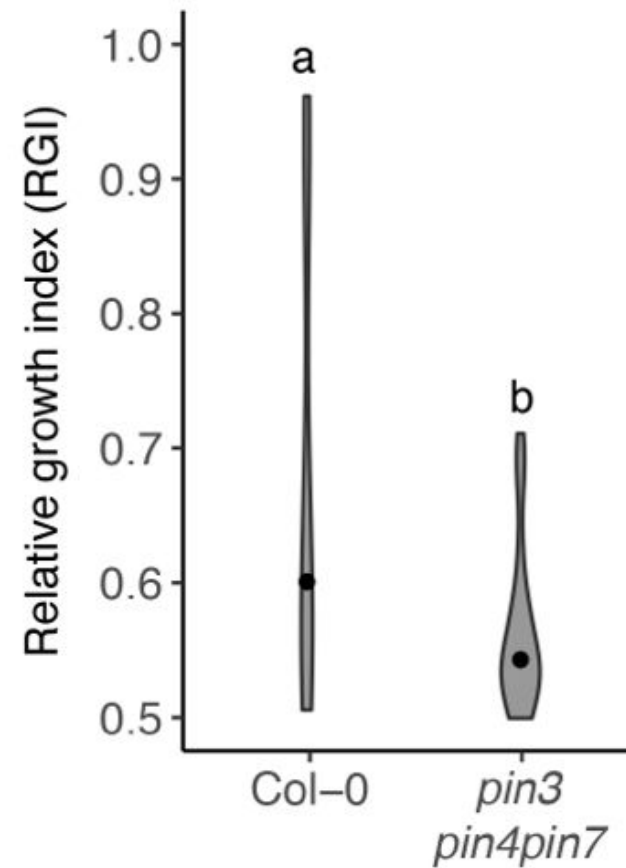
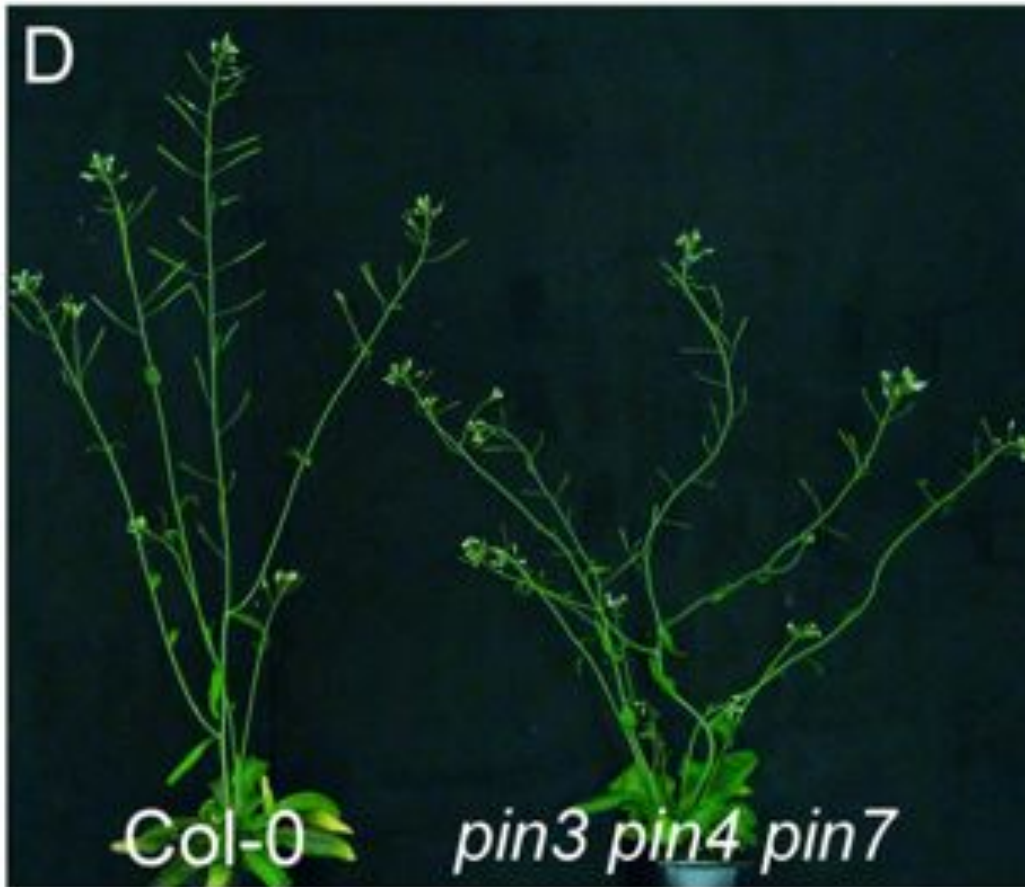
PIN3 4 & 7 accumulate more widely expressed



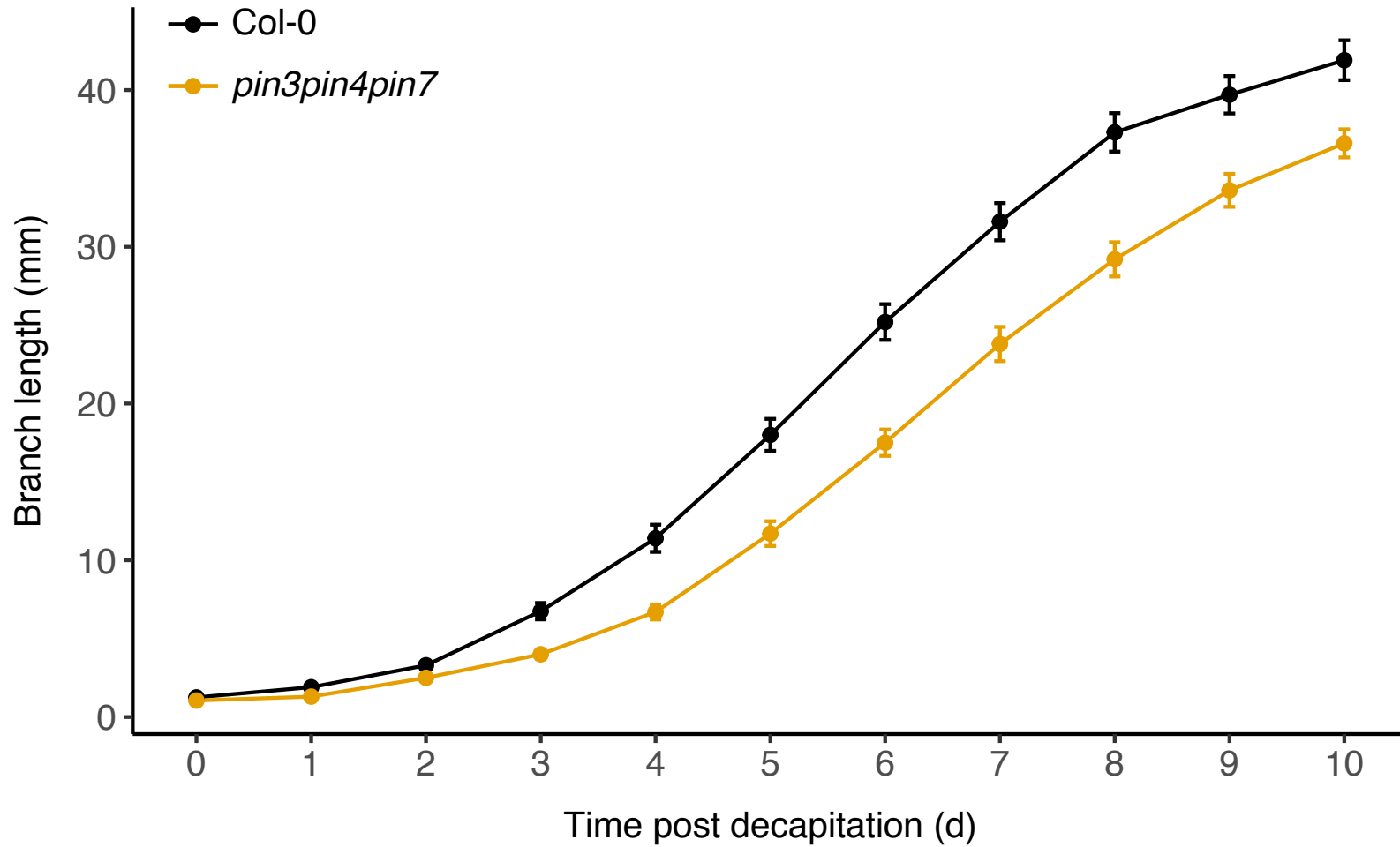
# Multimodal auxin transport mediates communication between apices



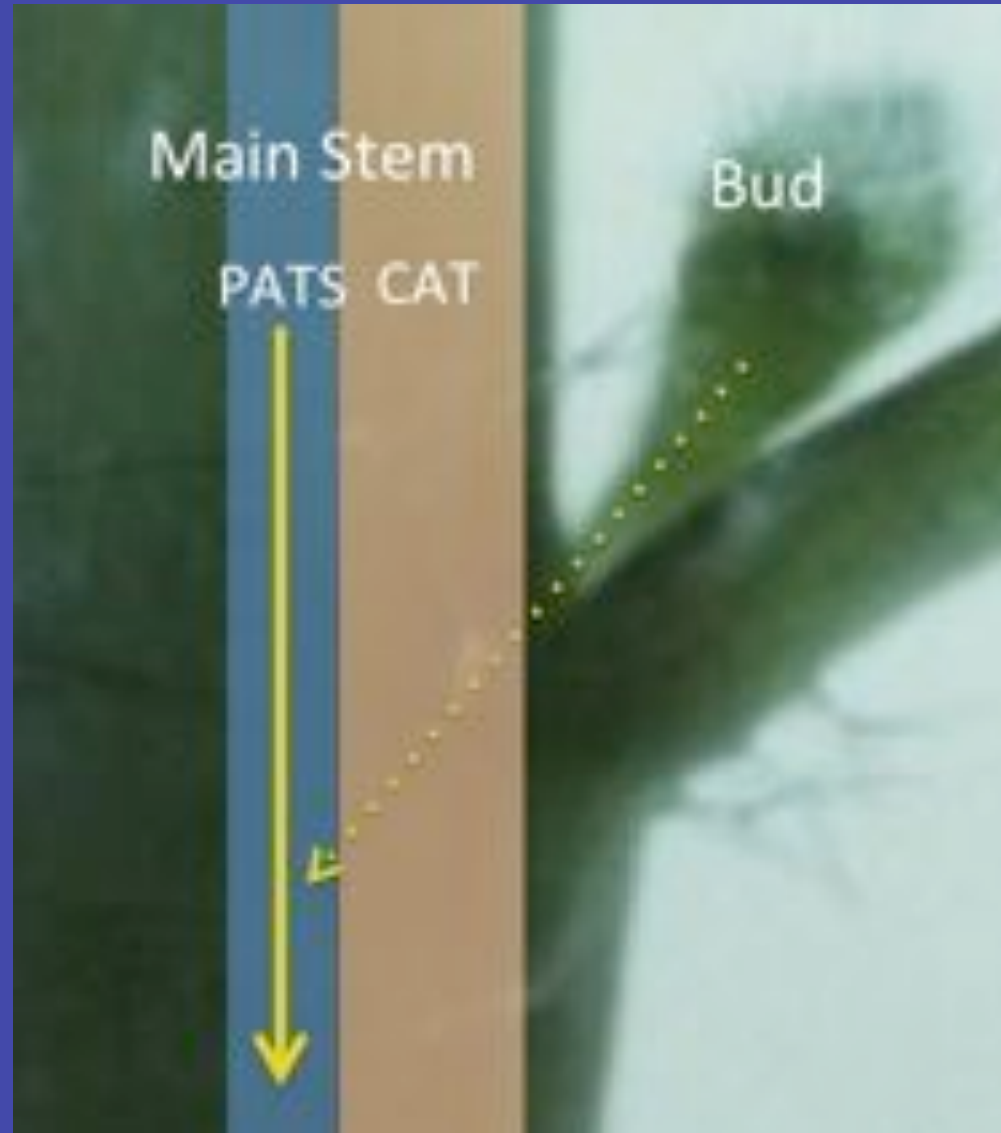
# PIN3 4 & 7 are required for bud-bud communication



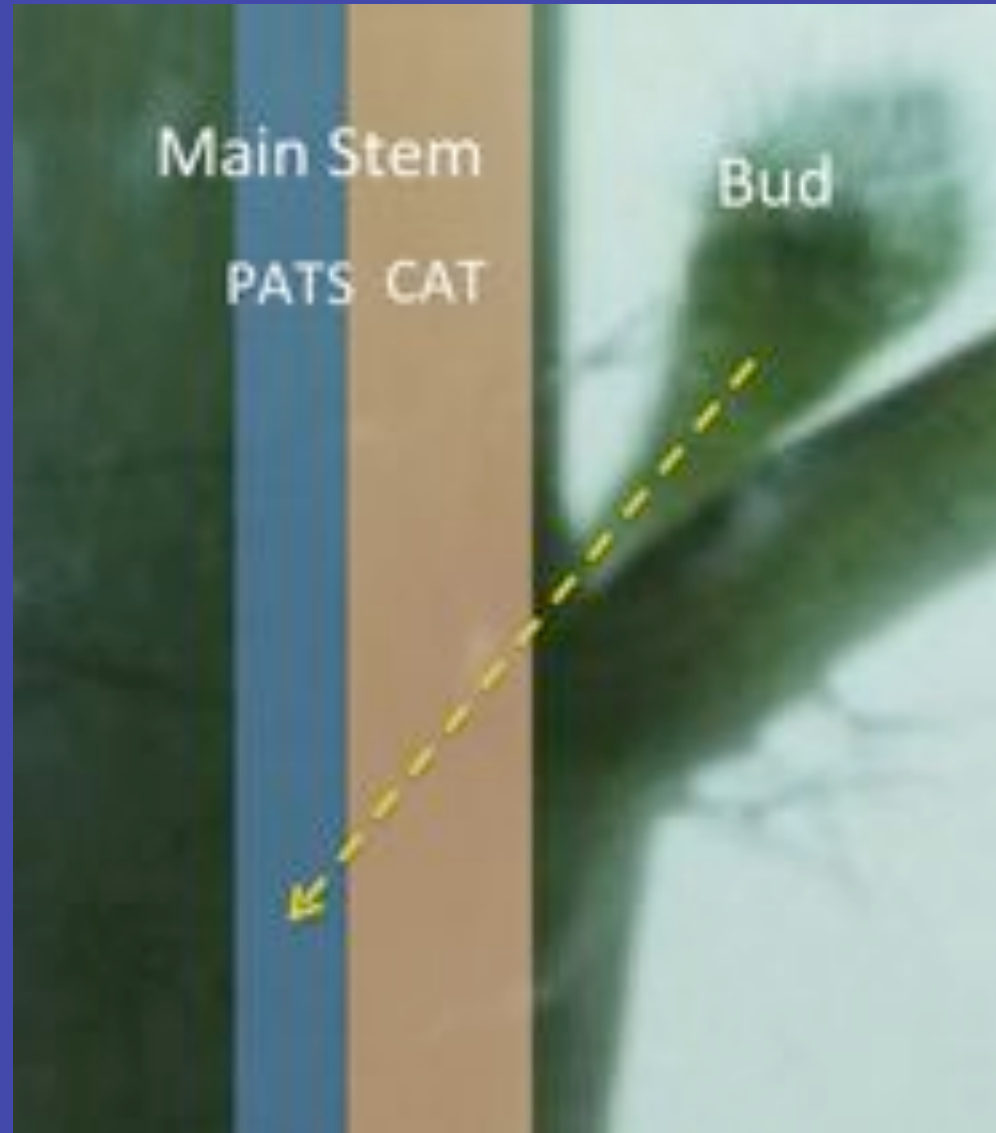
# *pin3 pin4 pin7* mutation delays bud activation



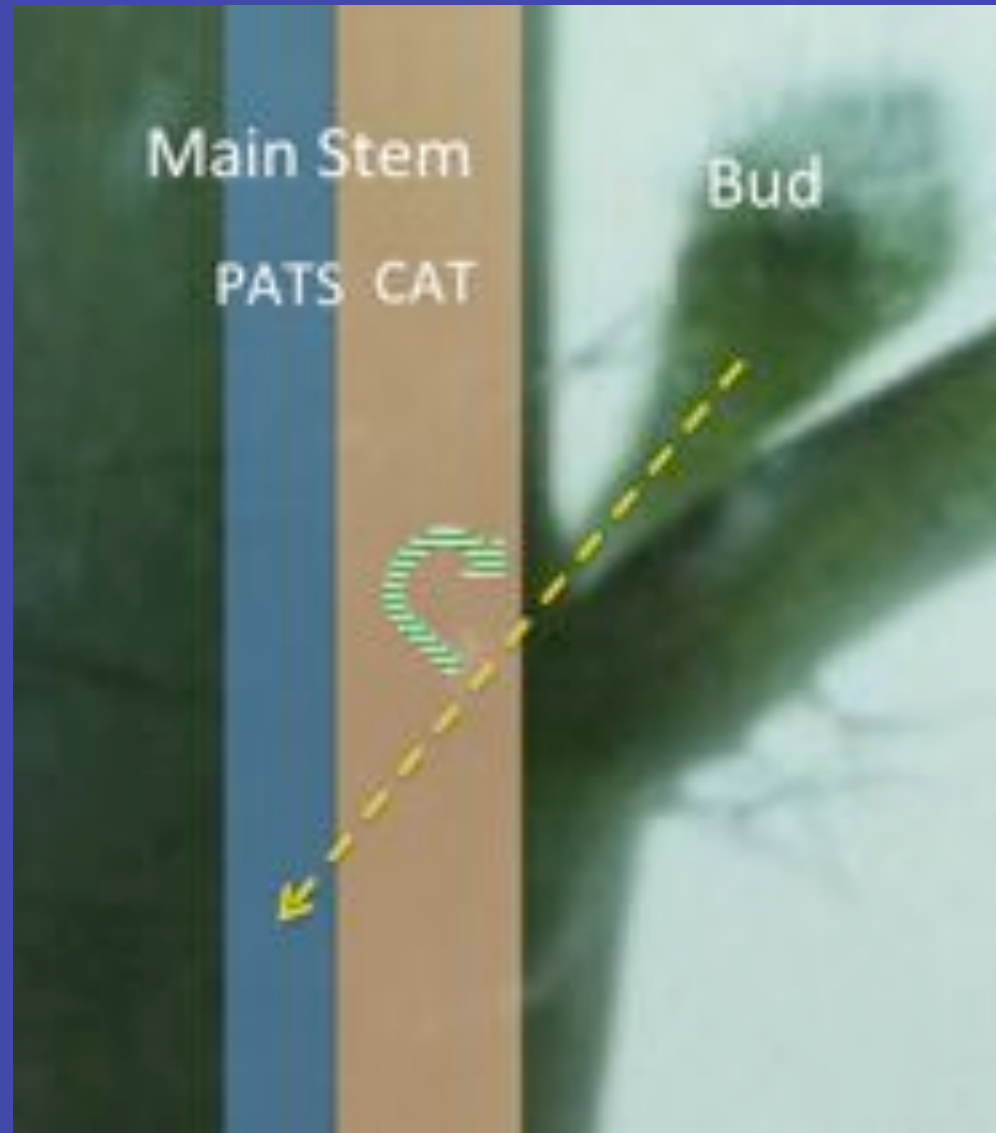
# Two-step canalisation?



# 1. Increased stem auxin sink strength

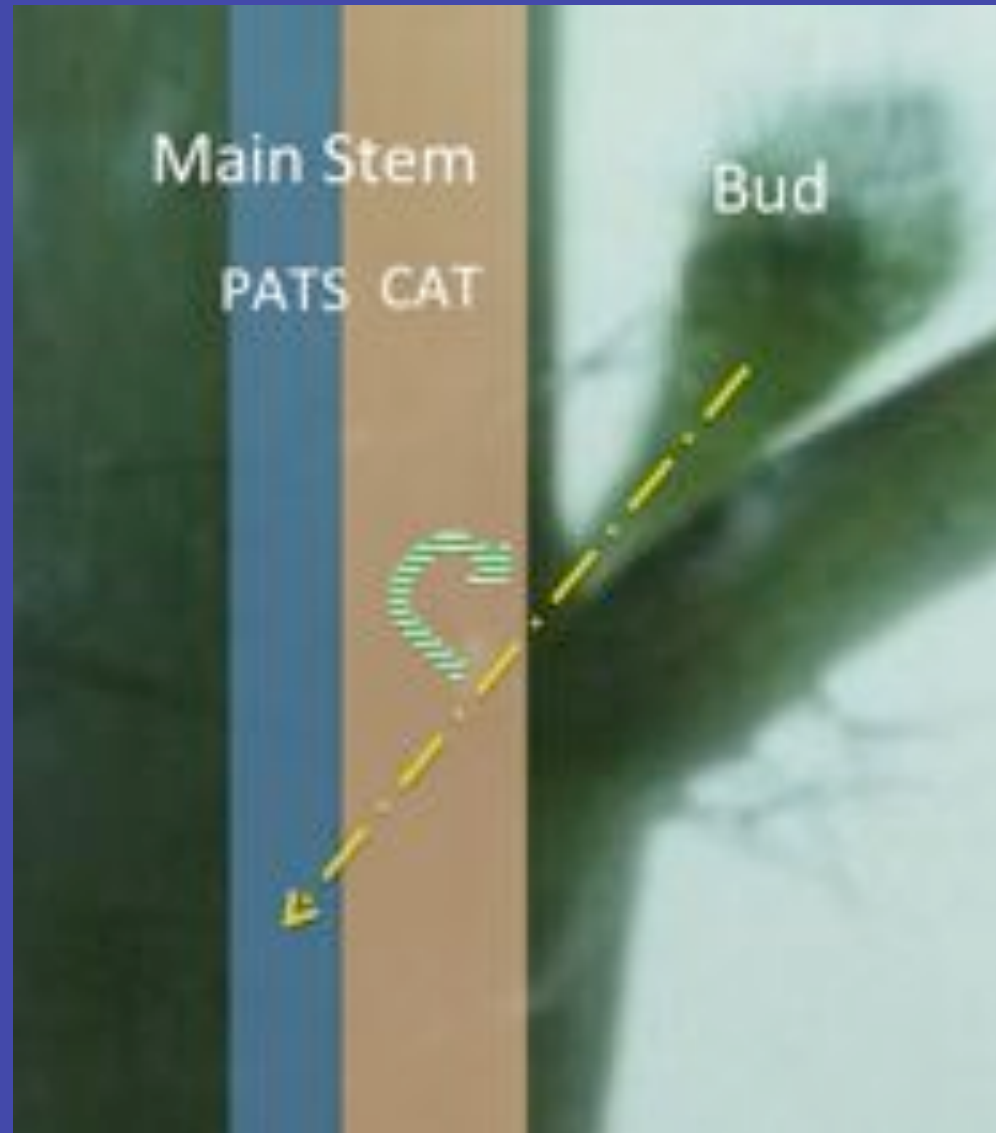


## 2. Weak PIN3/4/7-mediated canalisation

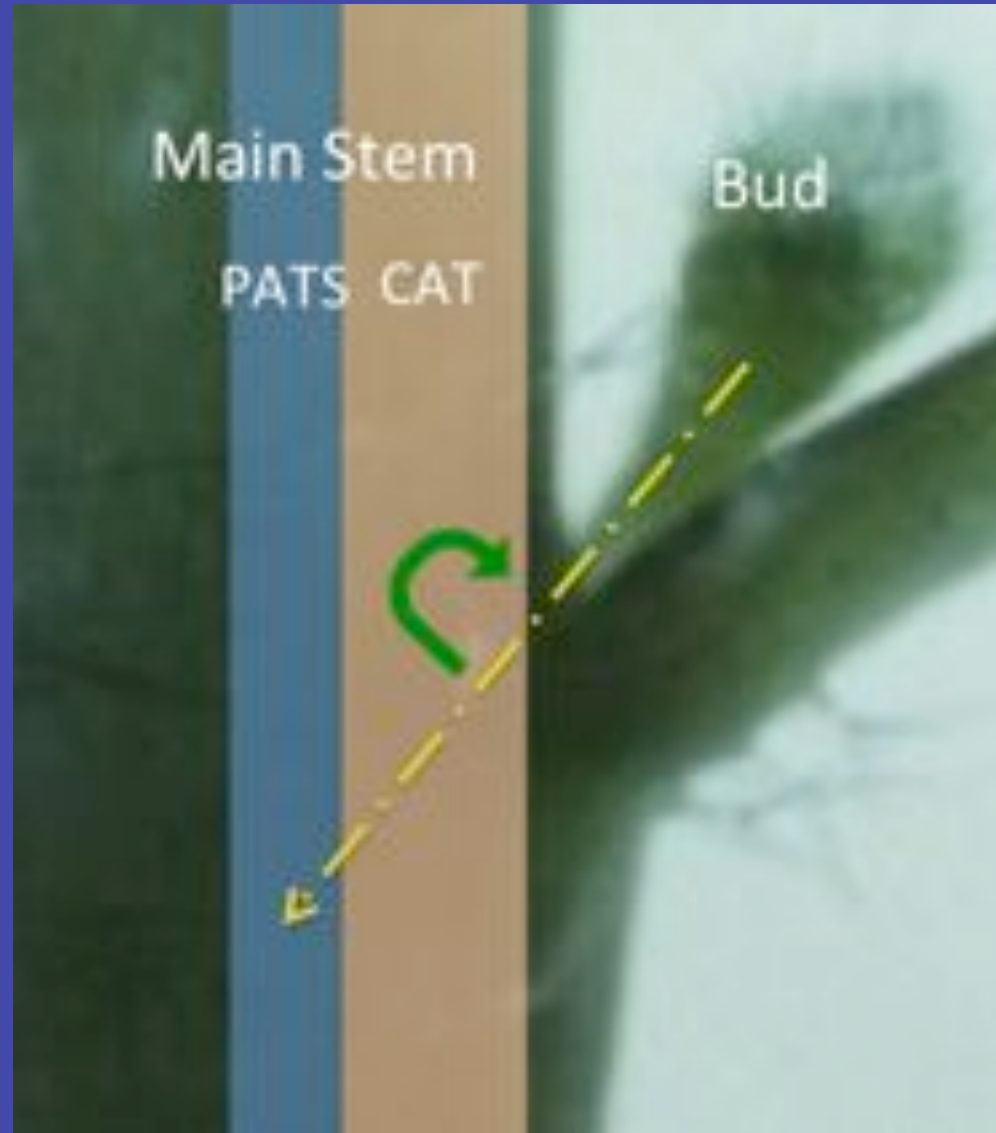




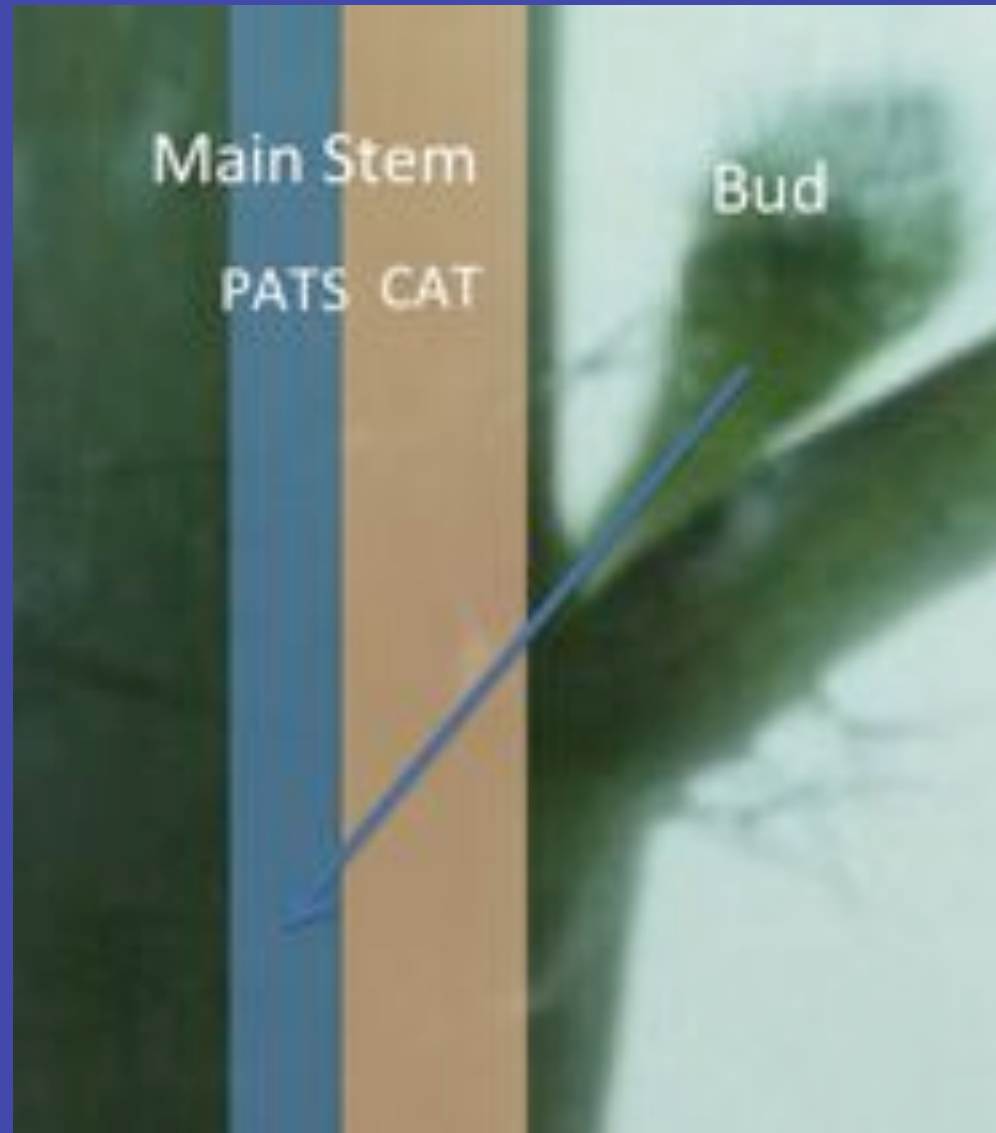
### 3. Increased auxin and auxin flux from bud



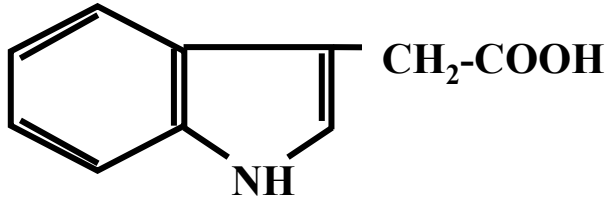
## 4. Strong PIN1-mediated canalisation



## 5. PATS established from bud



# Auxin flow in the shoot system



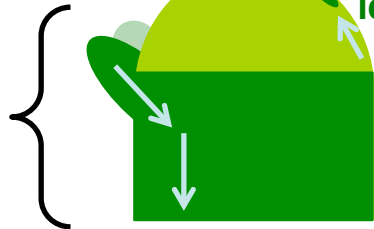
Auxin flow



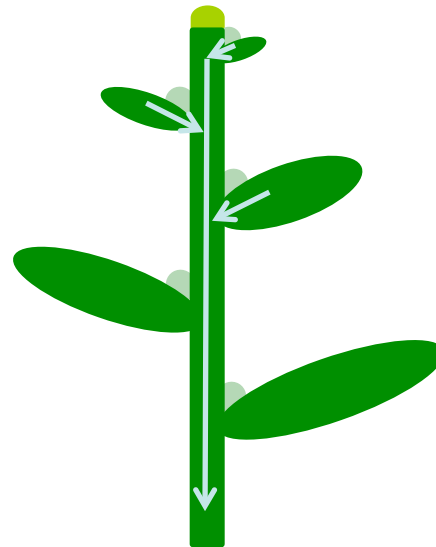
Primary shoot apical meristem  
Makes phytomers

Incipient leaf

Phytomer  
Axillary meristem  
Leaf  
Stem segment



Shoot made of phytomers



Shoot system made of shoots





# The Sainsbury Laboratory Cambridge University



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Catherine Taylor

Phloem

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Urszula Kania

Hugo Tavares

Alice Thomas

Stephanie Smith

Rachel Burrows

Maaïke de Jong

Wojtek Palubicki

Hayley McCulloch

Raj Pasam

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