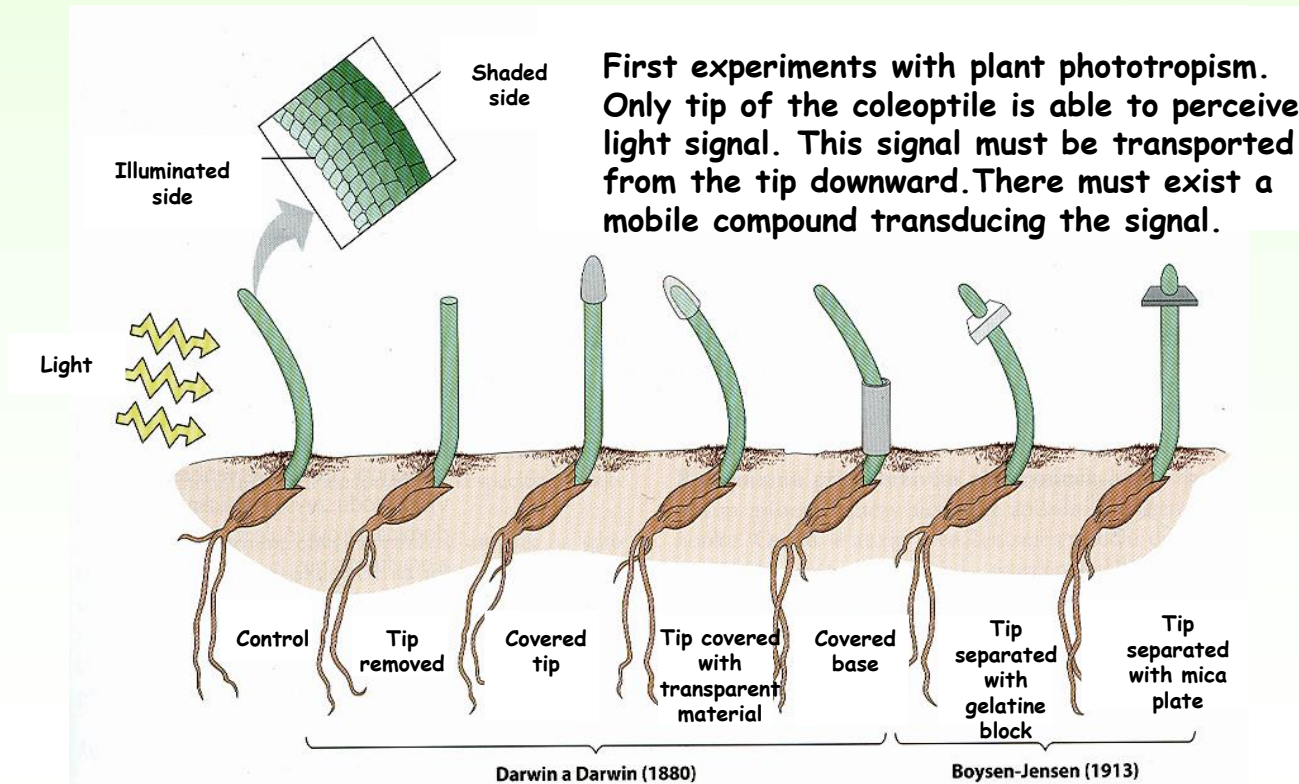


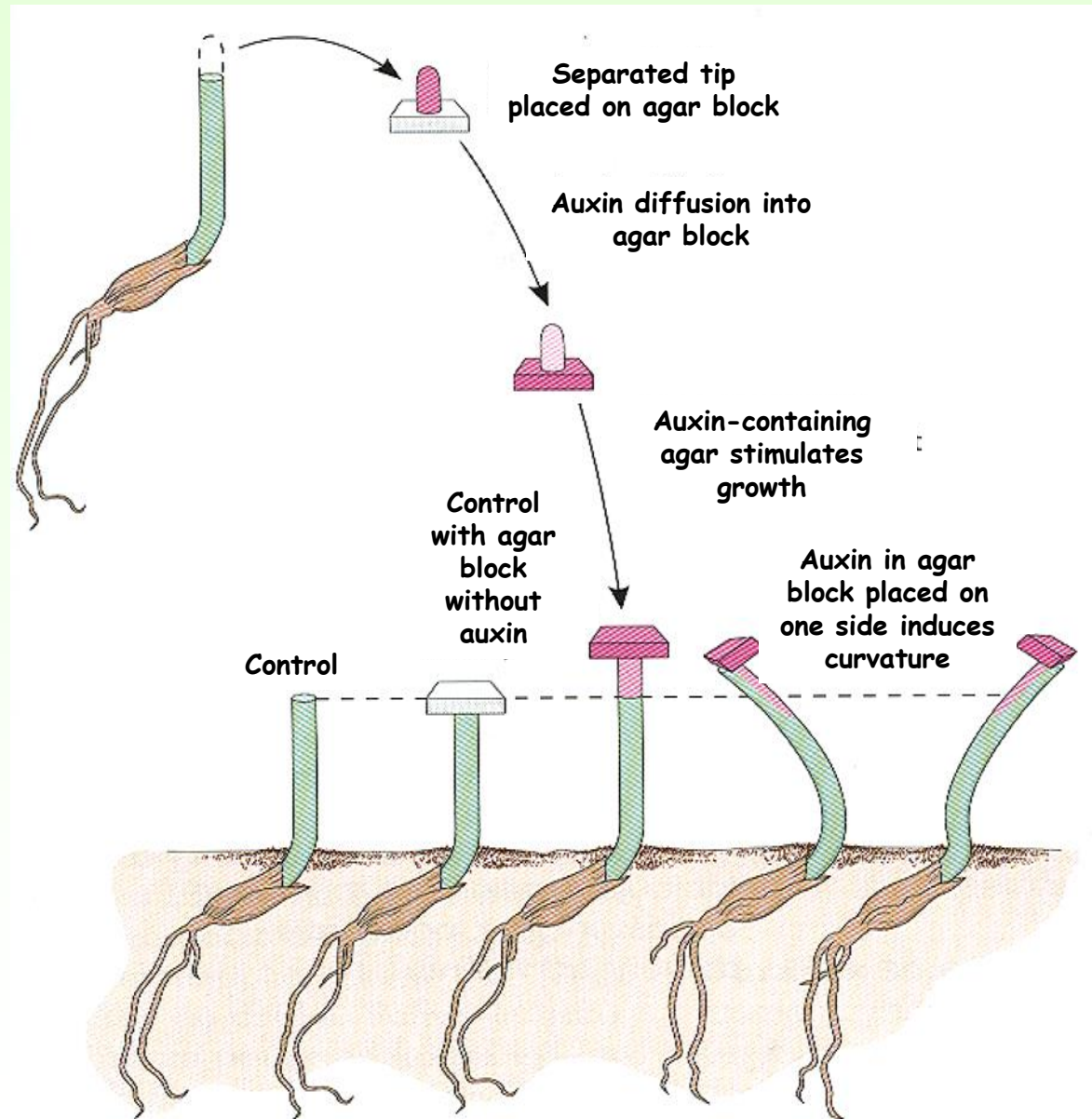
Auxin - discovery

- The oldest known phytohormone
- Darwin 1880, Boysen-Jensen 1913, Went 1928 - *Avena* coleoptile tests demonstrated the existence of the effective compound that induces cell elongation (auxein=growth in Greek)
- Kögl 1933 - identification of the compound in human urine as indole-3-acetic acid (IAA), 1946 confirmed in higher plants



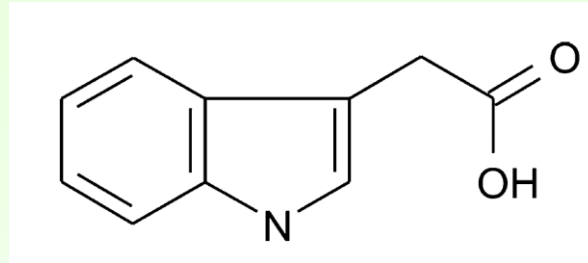
Auxin - discovery

- F.W. Went,
1924-1928, *Avena*
curvature test

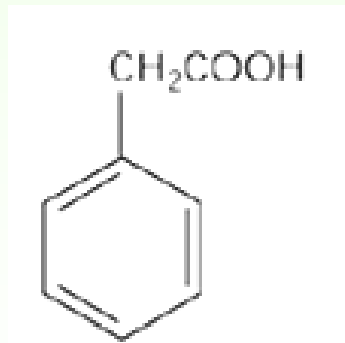


Auxins - low molecular weight organic acids

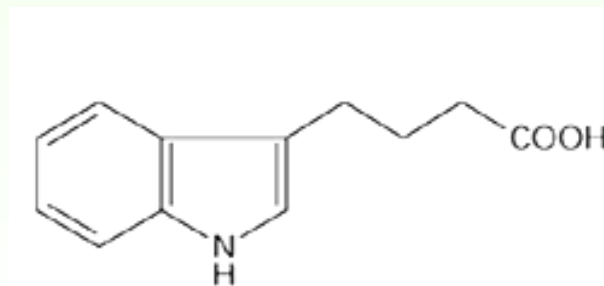
- Native auxins are weak organic acids, biosynthesis in young, dividing cells, i.e. in meristems, embryos and developing fruits.



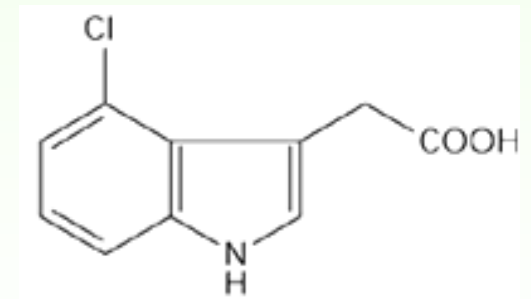
Indole-3-acetic acid (IAA)



Phenylacetic acid

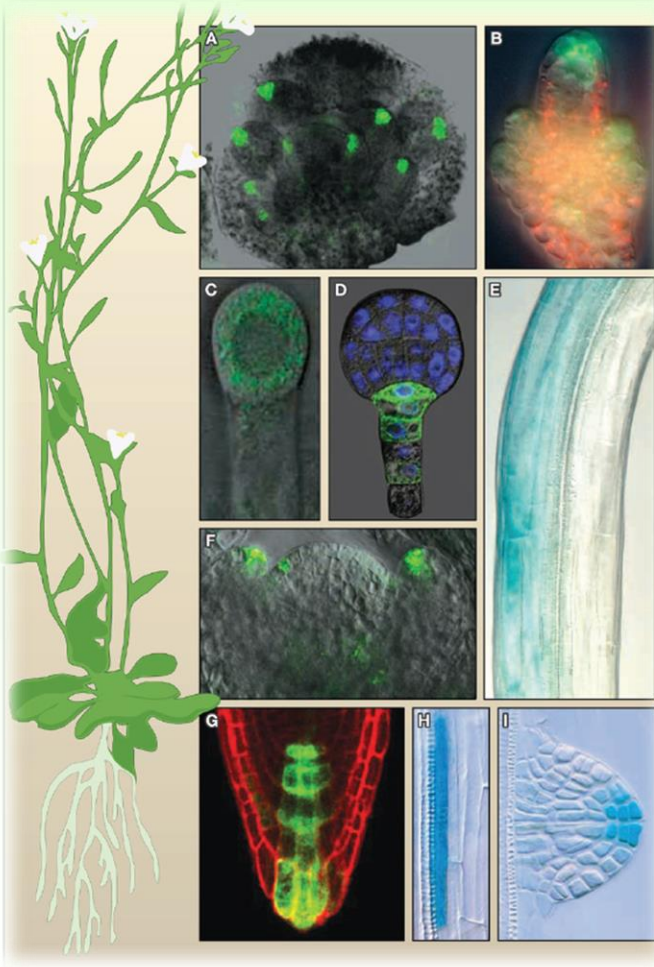


Indole-3-butyric acid (IBA)

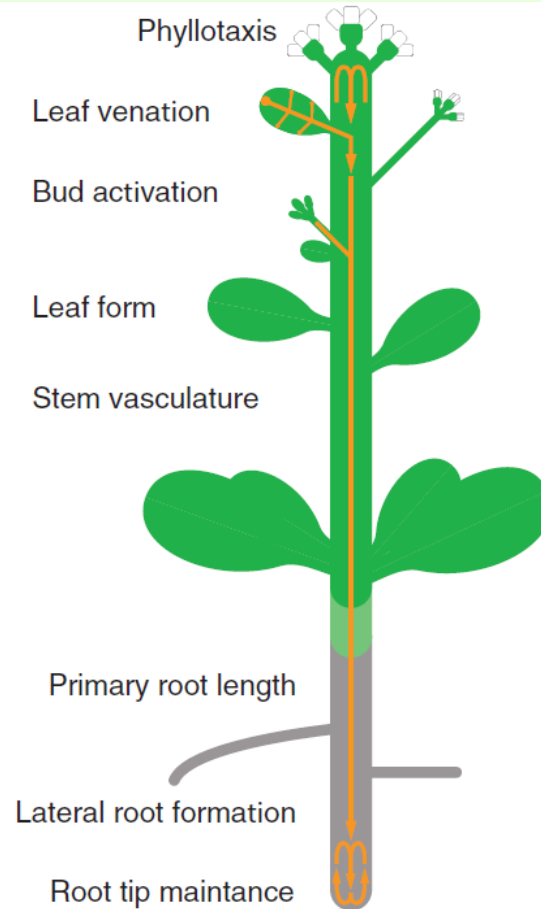


4-Chloroindole-3-acetic acid

Auxin - the „morphogen“ of seed plants

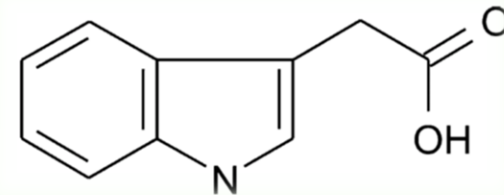


Vanneste and Friml, Cell 136, 1005-1016, 2009

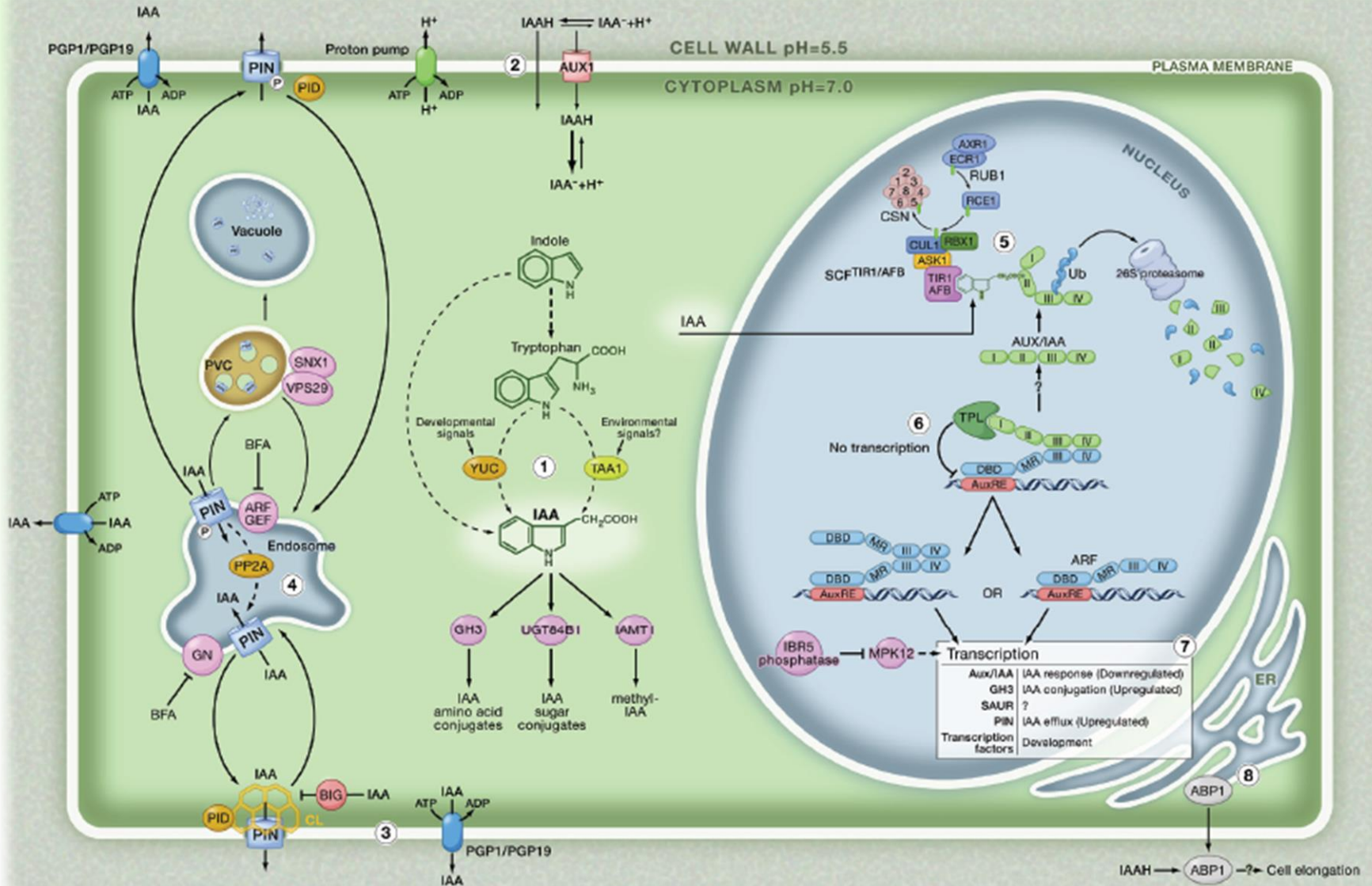


Lacek et al., eLS, 2017

Auxin
(indole-3-acetic acid, IAA)
weak organic acid



Auxin action

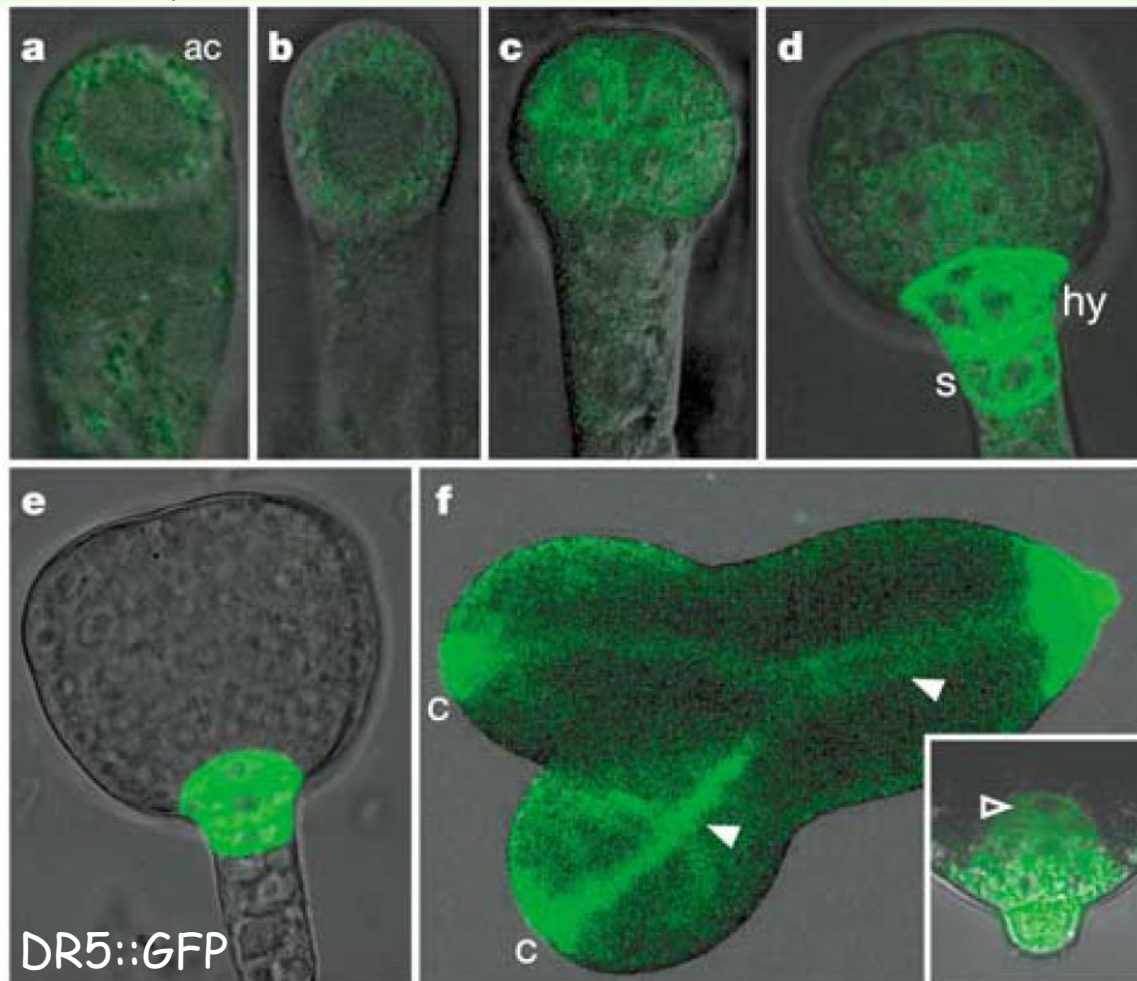


Auxin - physiological effects

- It plays the role in almost all stages of plant development from the embryogenesis, through the correct development of roots, stems, leafs and flowers, to the fruit development and abscission

Embryogenesis

- auxin in the apical cell after the zygote cell division, later on the maximum is shifted into the hypophysis and uppermost suspensor cell



Auxin - physiological effects

- It is essential for the cell division in the in vitro-grown plant cell suspensions



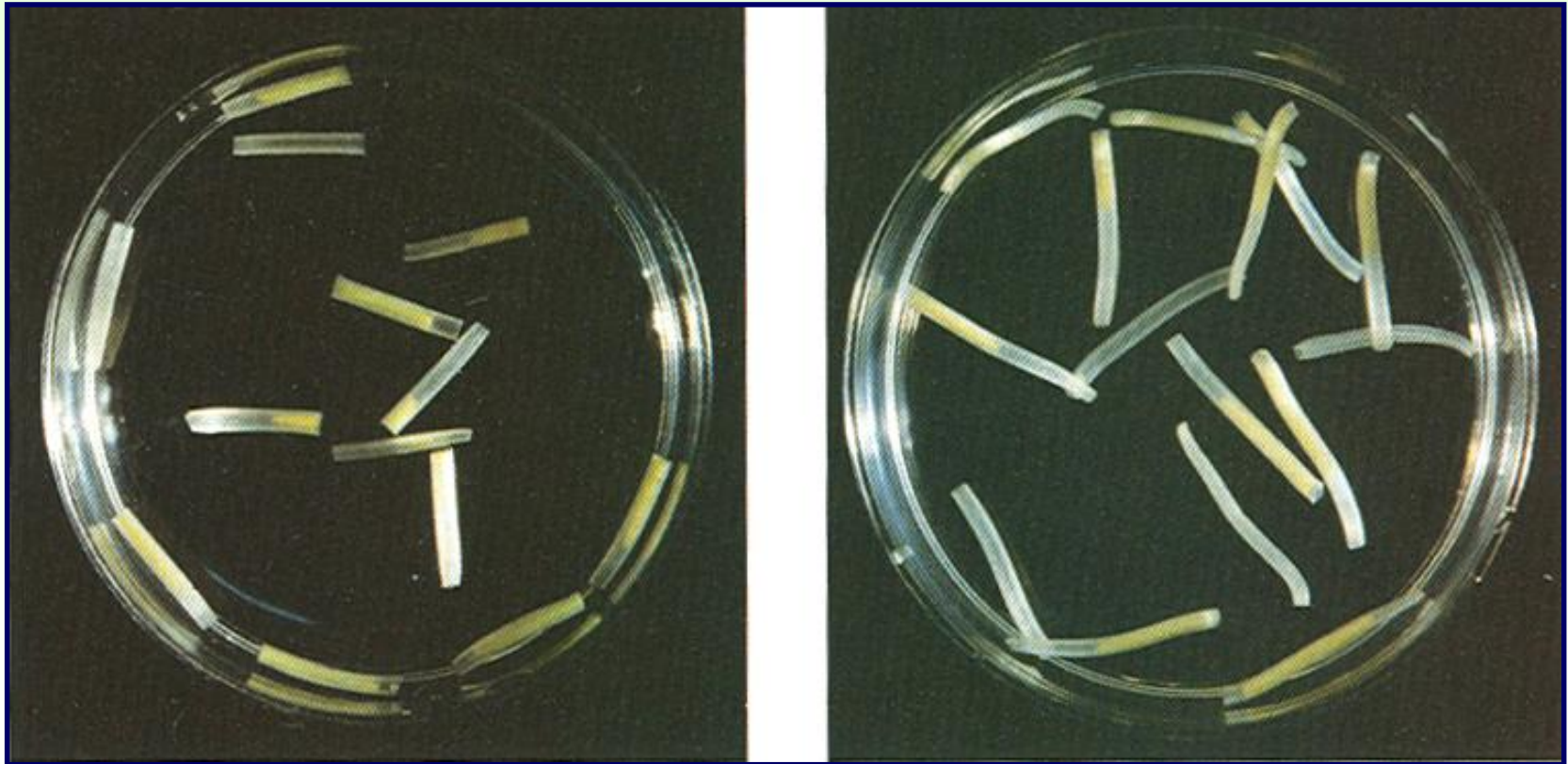
Suspension culture of tobacco BY-2

Auxin - physiological effects

- Stimulation of elongation growth - oat coleoptile segments

H₂O

IAA

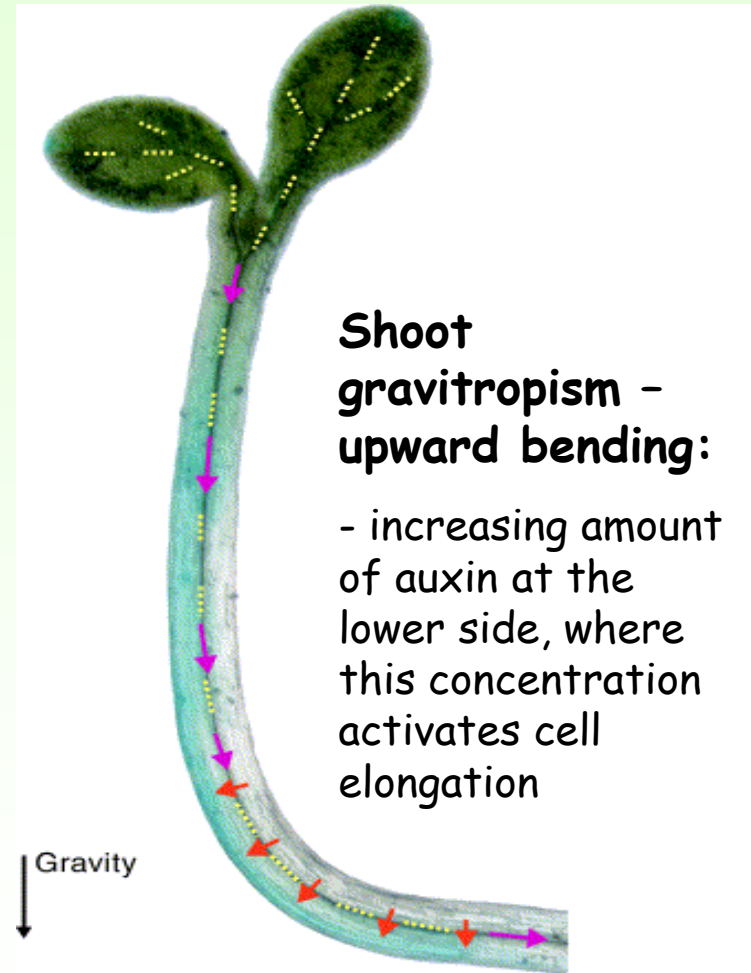
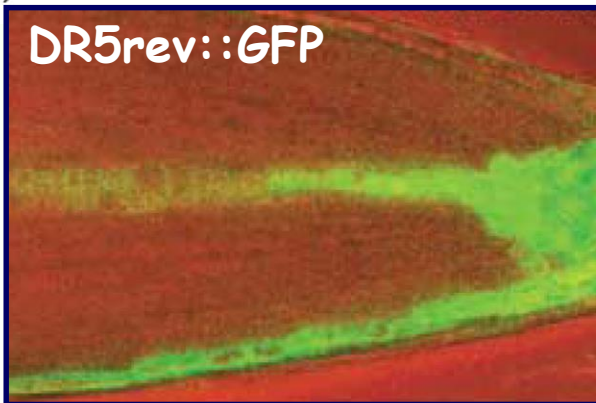
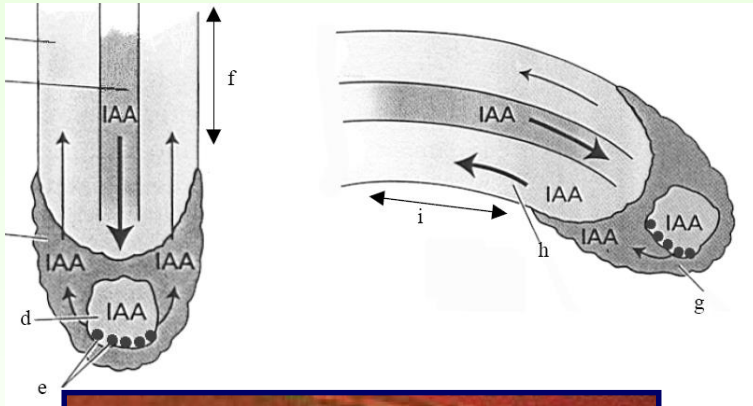


Auxin - physiological effects

- Regulation of tropisms - root positive gravitropism and shoot negative gravitropism

Root gravitropism - downward bending:

- increasing amount of auxin at the lower side, where this concentration inhibits cell elongation



Shoot gravitropism - upward bending:

- increasing amount of auxin at the lower side, where this concentration activates cell elongation

Auxin - physiological effects

- Regulation of tropisms - shoot phototropism:
 - accumulation of auxin at the shaded side of the stem, where this concentration stimulates cell elongation
 - auxin relocation is seemingly related to the phosphorylation cascades triggered by light perception with phototropin

DR5::GUS

← light



Auxin - directional transport

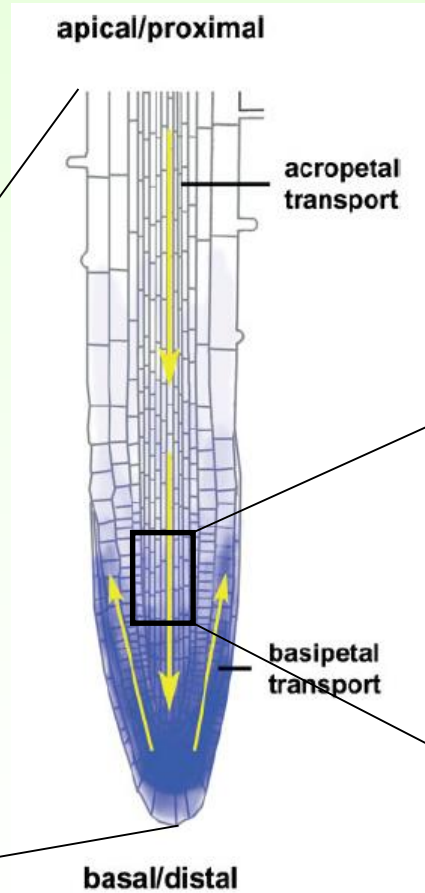
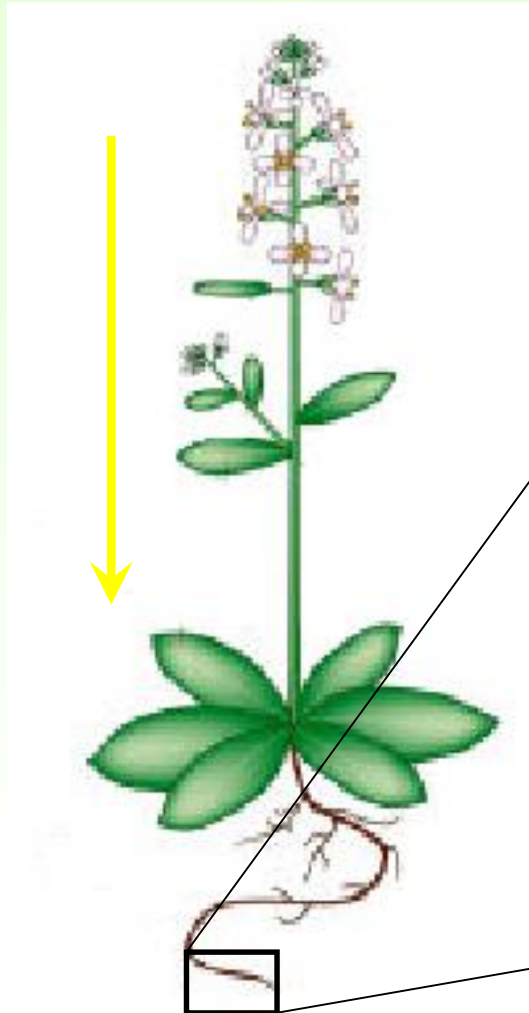
Plant

Root

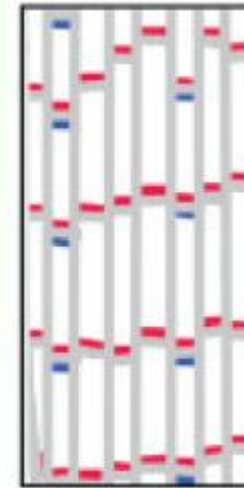
→ Direction of auxin flow

■ Auxin efflux carrier

■ Auxin influx carrier



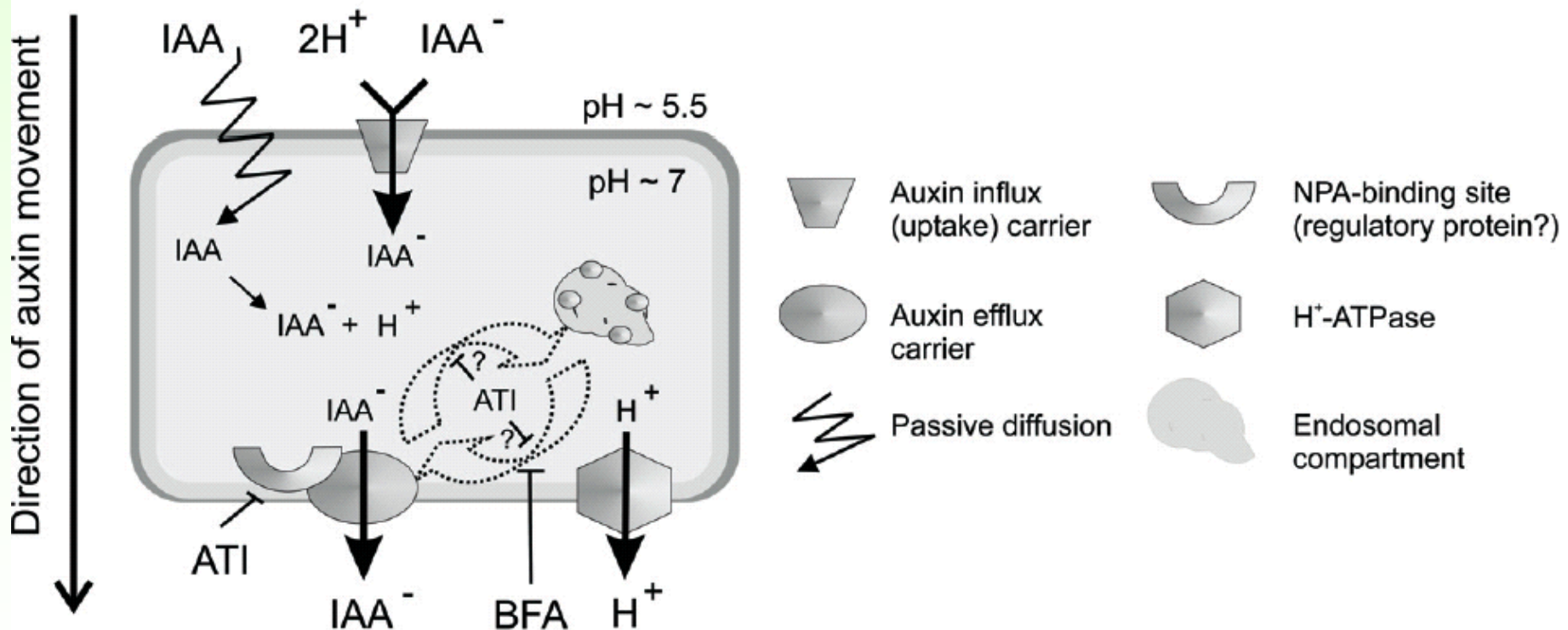
**Parenchyma
protophloem cells**



(Modified from Grebe, BioEssays 26, 719, 2004)

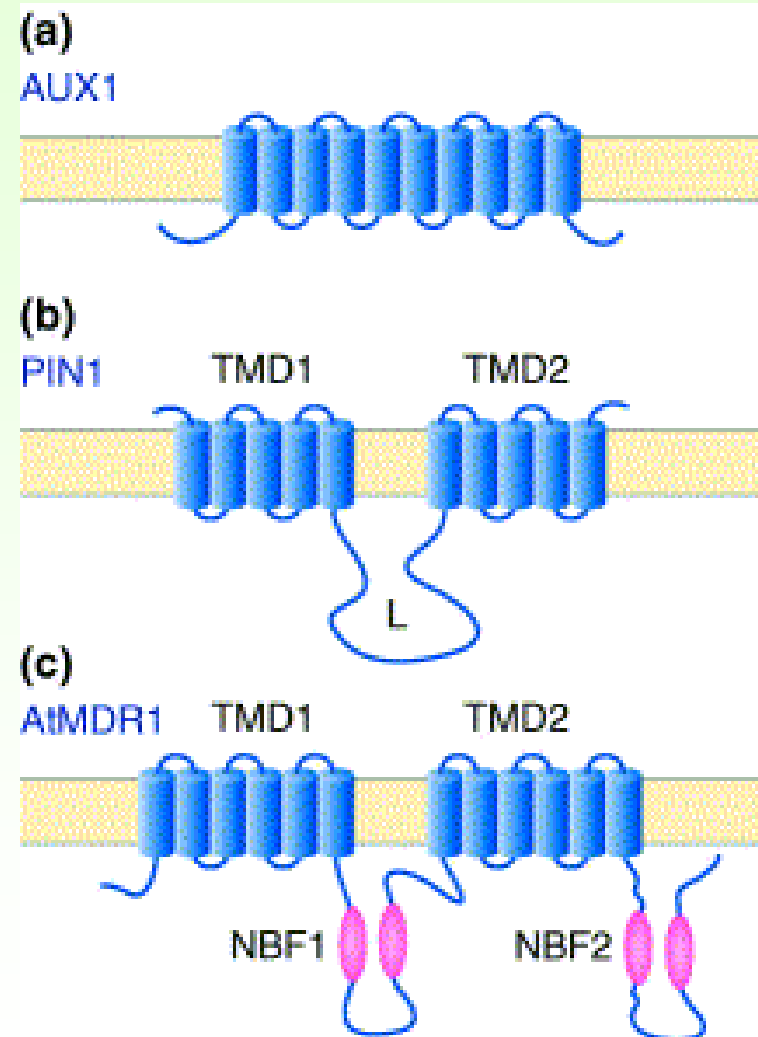
Auxin - directional transport

- Besides long distance transport in vasculature, specializes auxin influx and efflux carriers are used for transport of auxin across membrane

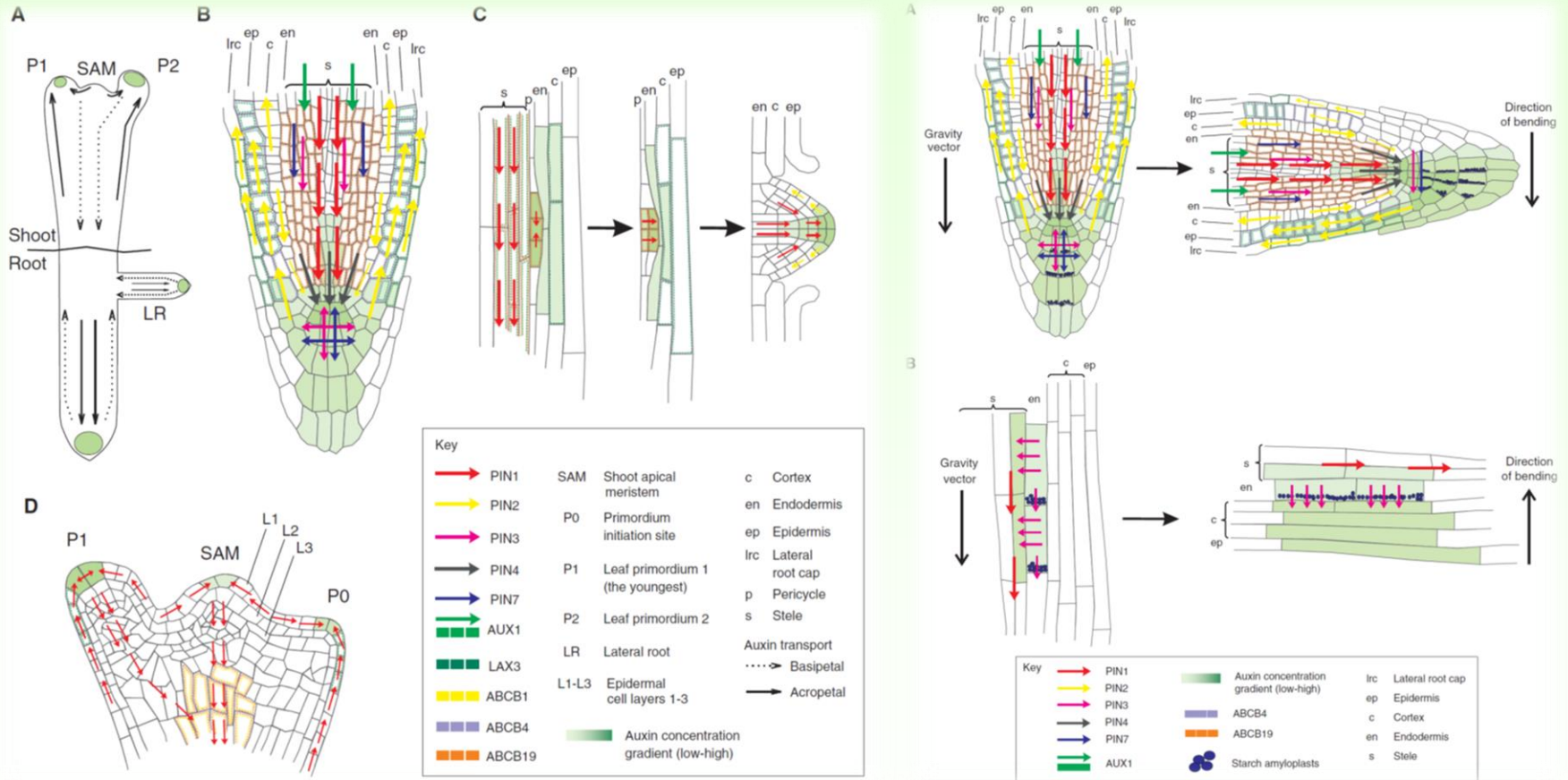


Auxin - directional transport

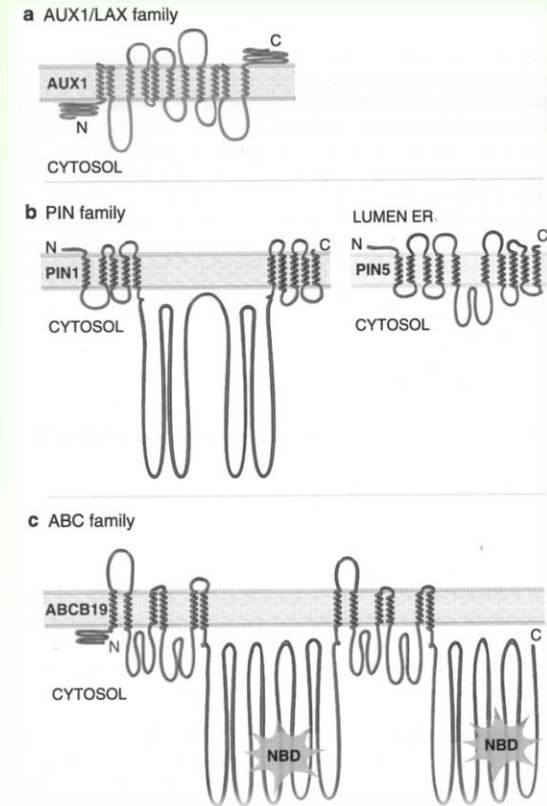
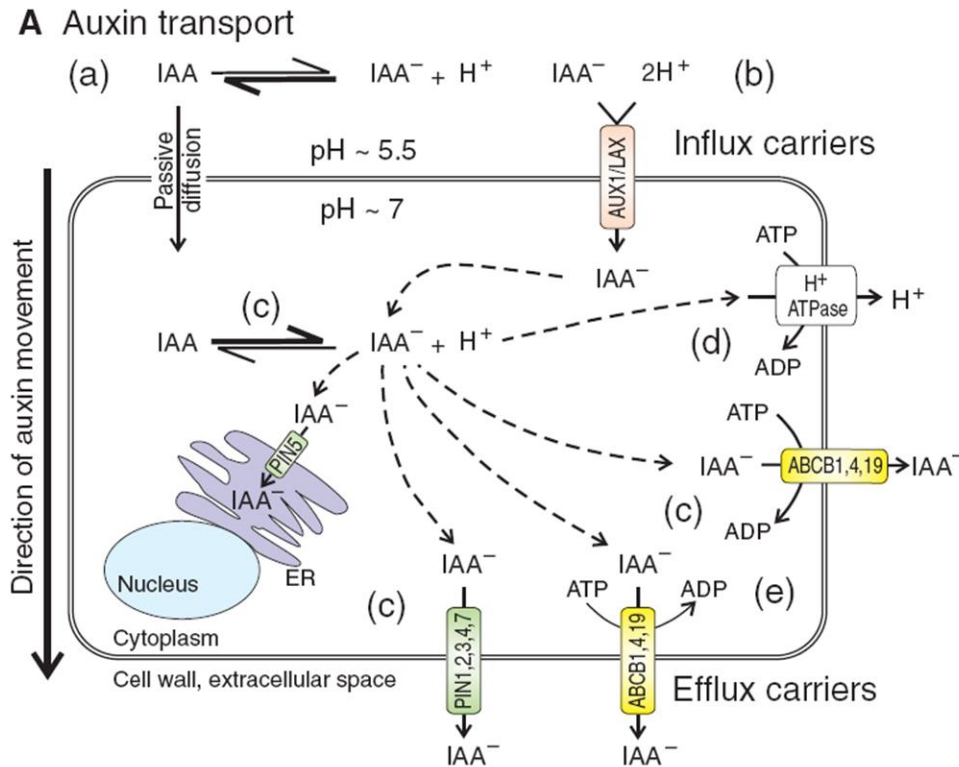
- Besides passive diffusion in undissociated form molecules of auxin (**IAA⁻**) are transported across membrane by specialized active transporters:
 - **AUX1/LAX** - auxin influx carriers **(a)**
 - **PINs** - auxin efflux carriers **(b)**. Contain two transmembrane domains and one hydrophilic regulatory loop.
 - **MDRs (PGPs)** - auxin efflux carriers **(c)**. Contain two transmembrane domains (**TMD**) and two nucleotide binding folds (**NBF**) for ATP binding.



Co-operation of auxin transporters *in planta*



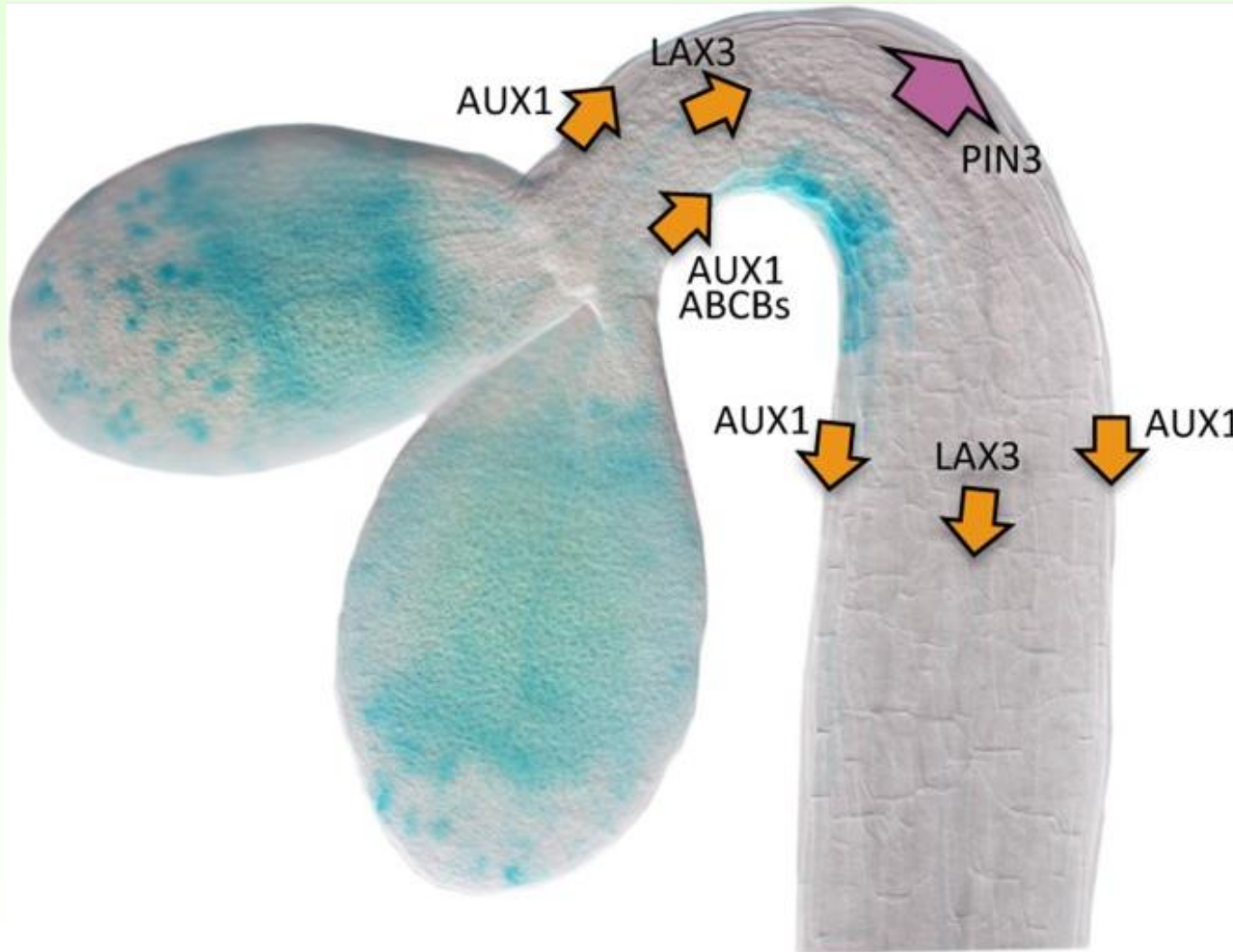
Transport of auxin across membranes



Petrášek and Friml, *Development* 136, 2675-2688, 2009

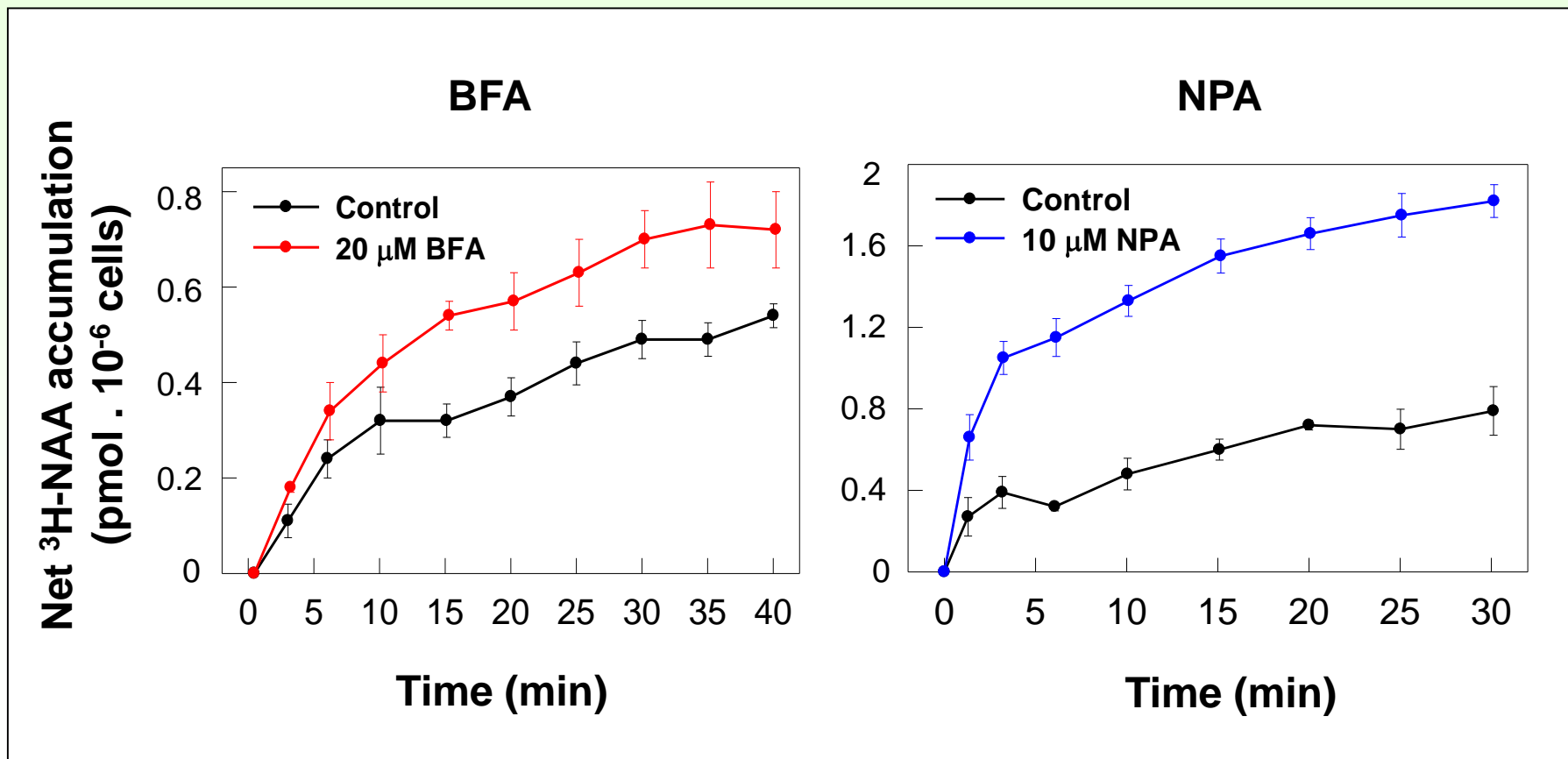
Petrášek et al., *Signaling and Communication in Plants* 7, 255-290, Springer, 2011

Carrier-mediated auxin influx during apical hook development



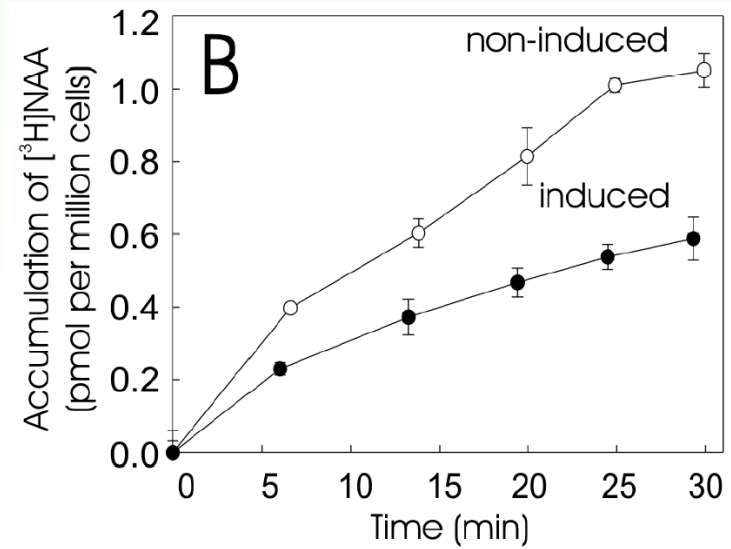
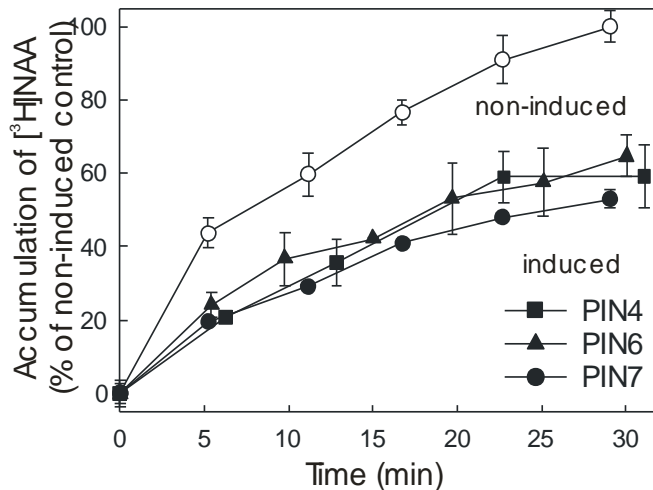
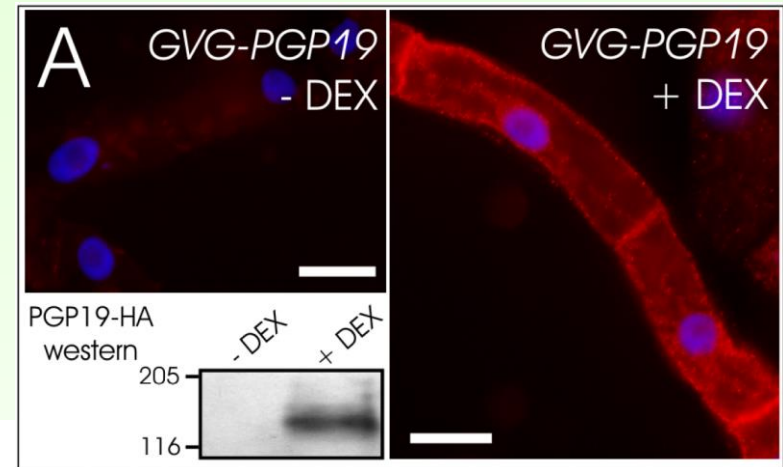
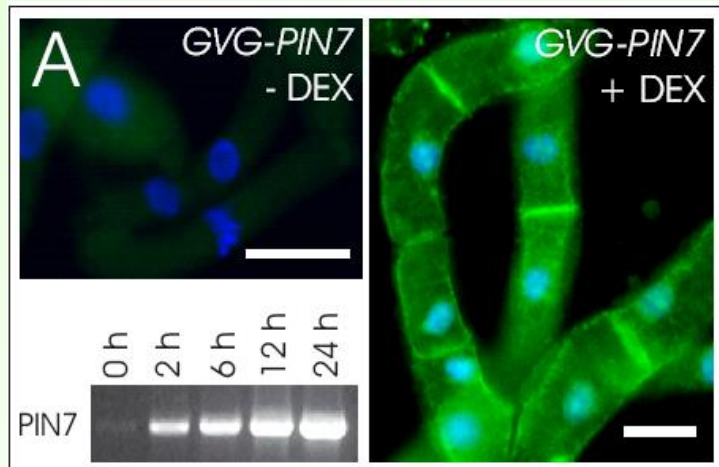
Auxin - directional transport

- The dynamics of the accumulation of radiatively-labelled auxin inside tobacco cells reflects the activity of auxin carriers as well as diffusion across membrane. After inhibition of auxin efflux carrier with NPA or BFA, auxin is accumulated inside cells.



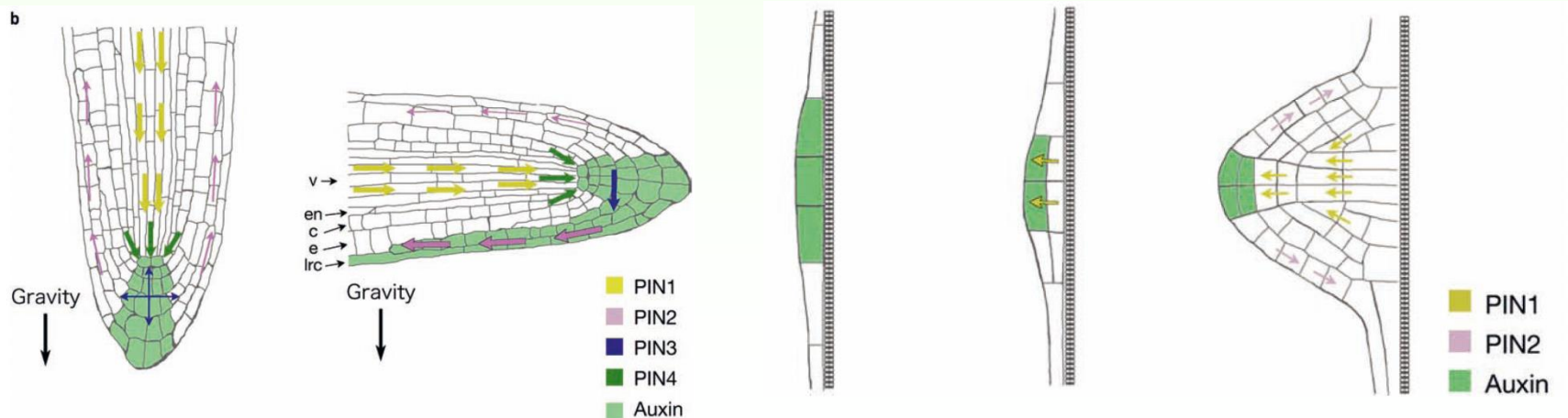
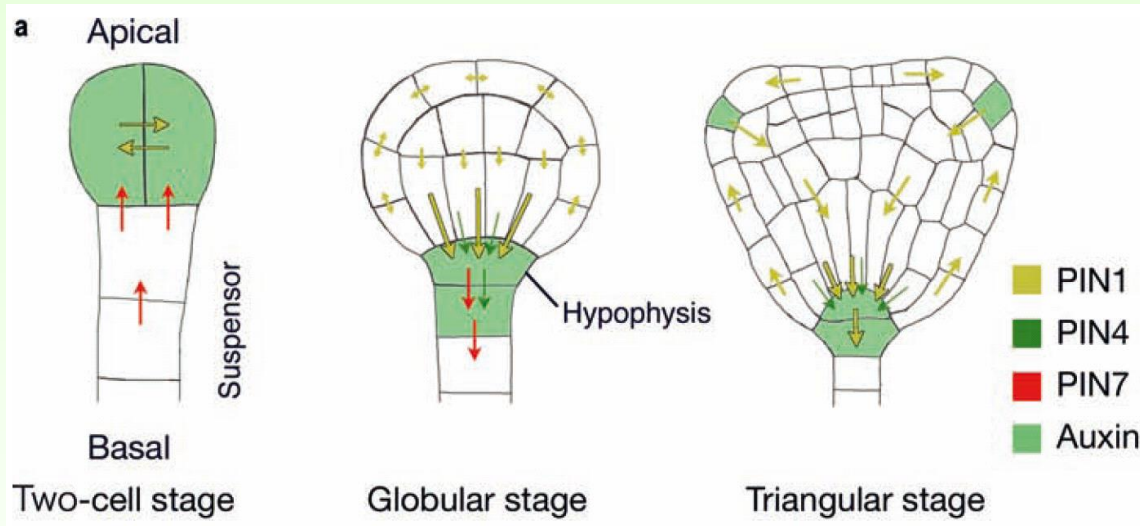
Carrier-mediated auxin efflux

- PIN and PGP auxin efflux carriers expressed in model tobacco cells transport auxin out of cells (cells accumulate less of auxin)



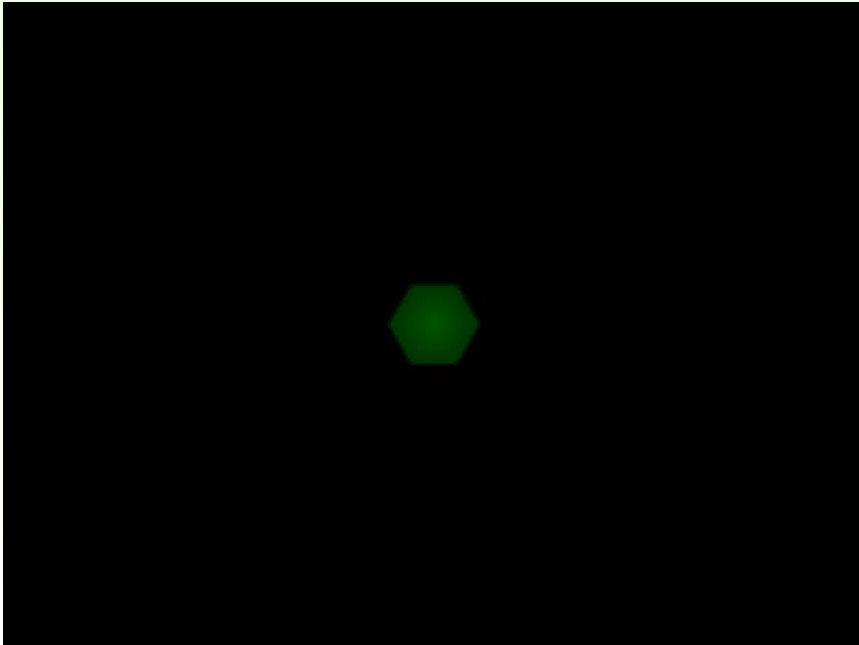
Auxin as morphogen

- Setting and maintenance of plant morphogenesis is under the control of IAA gradients

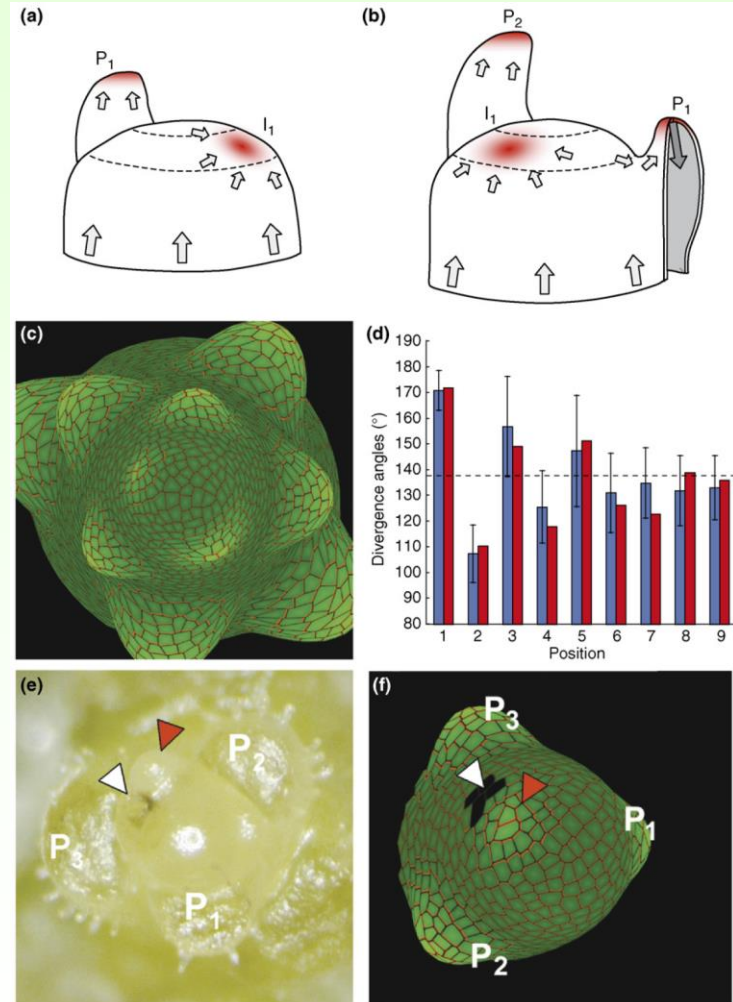


Auxin as morphogen

- Phyllotaxis is influenced by the directional flow of auxin maintained by auxin transporters



Smith, R.S. et al. PNAS 103, 1301–1306, 2006



Kuhlemeier et al., Trends Plant Sci 12, 143 -150, 2007.