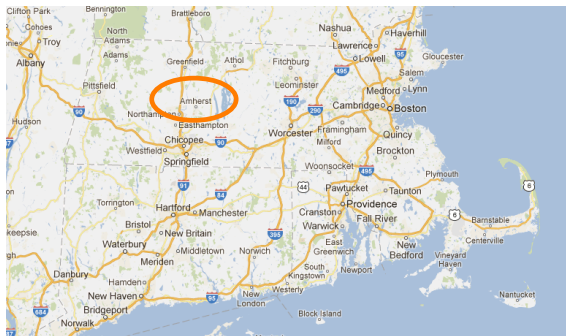




How do oats,
peas, beans,
and barley
grow?

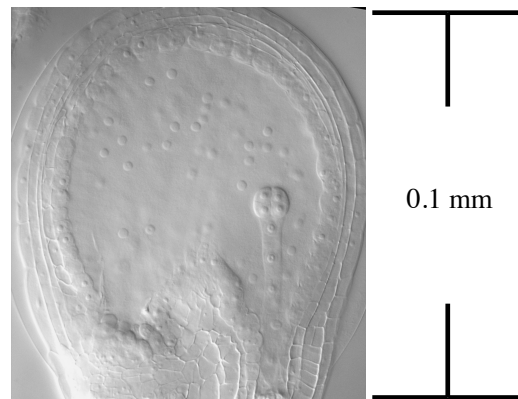
Phoebe Traquair, 1890's <http://www.als.uk/traquair/>



The University of Massachusetts at Amherst



Maria
Sybilla
Merian



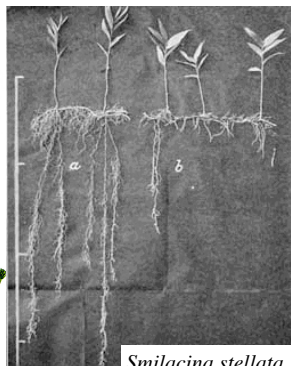
http://www.mediadesk.uzh.ch/articles/2011/Muetterliche-Gen_e.html



Forb

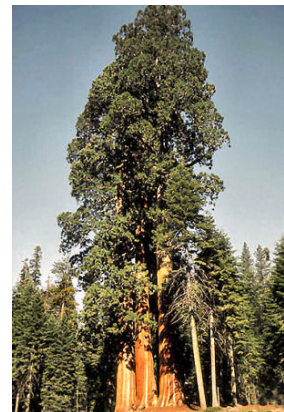


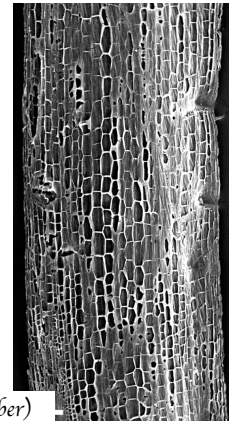
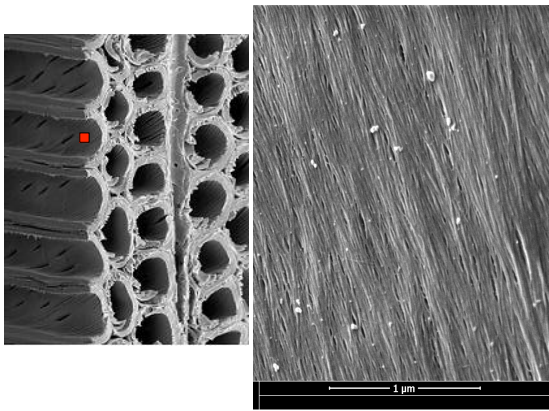
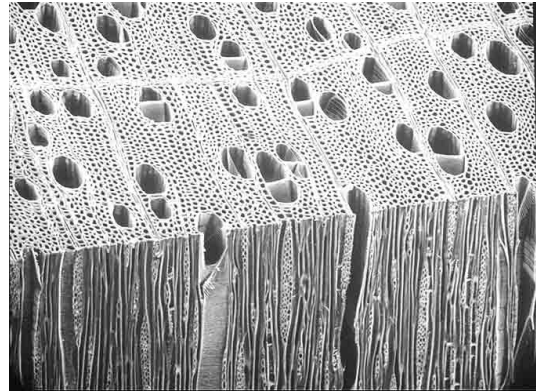
Karl Blossfeldt



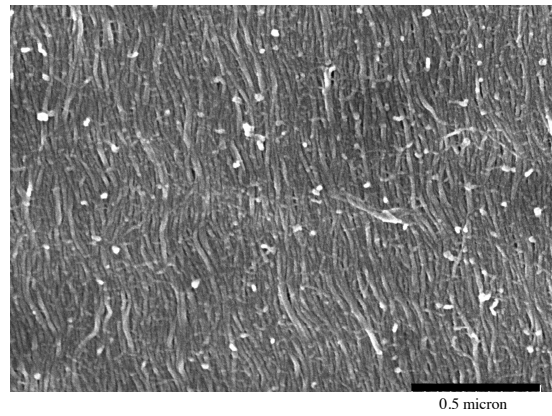
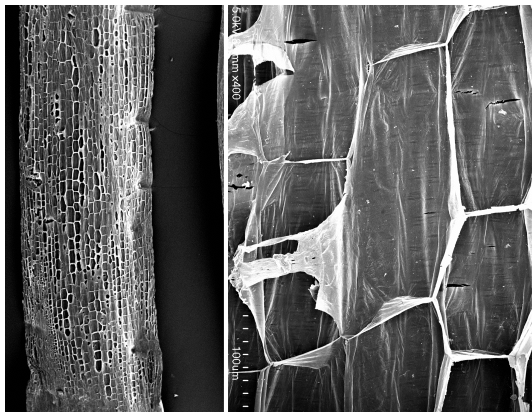
Smilacina stellata

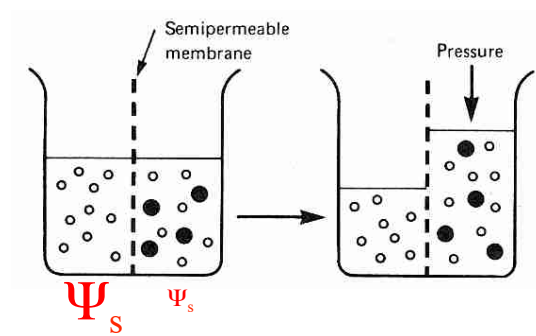
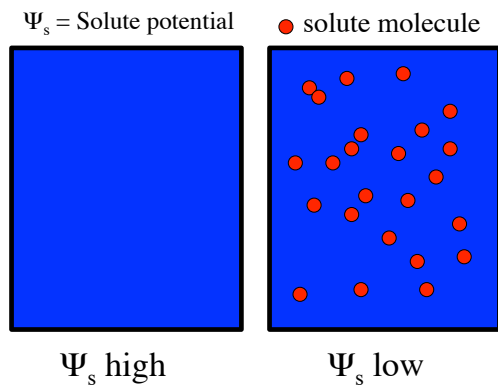
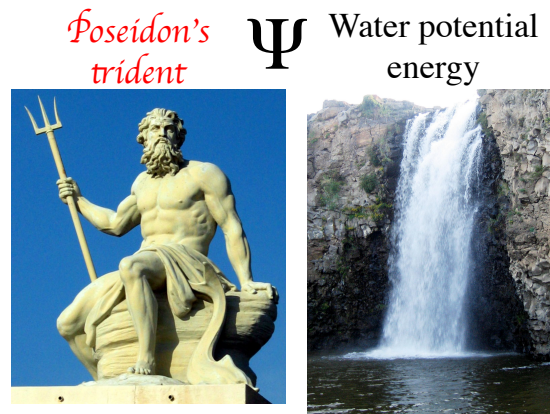
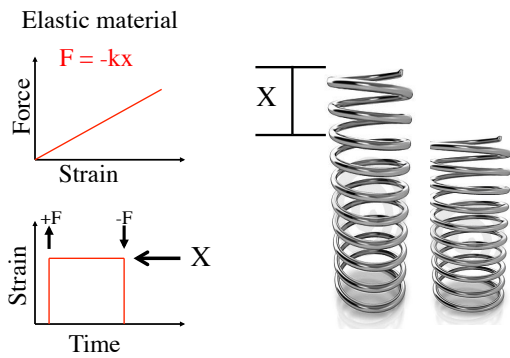
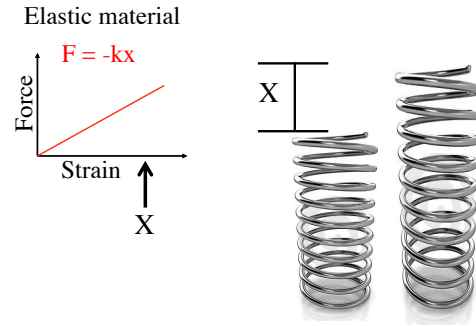
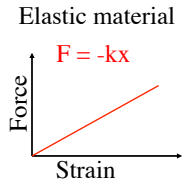
J. E. Weaver, Root Development of Field Crops





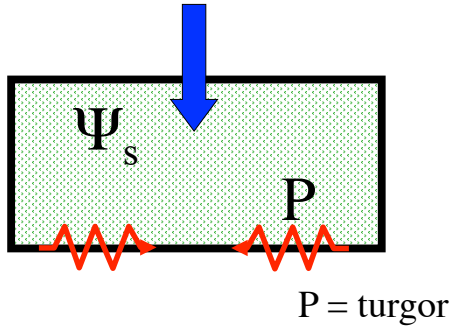
Cucumis sativus (cucumber)





<http://seys-science.wikispaces.com/3+Osmosis>

Non-growing plant cell

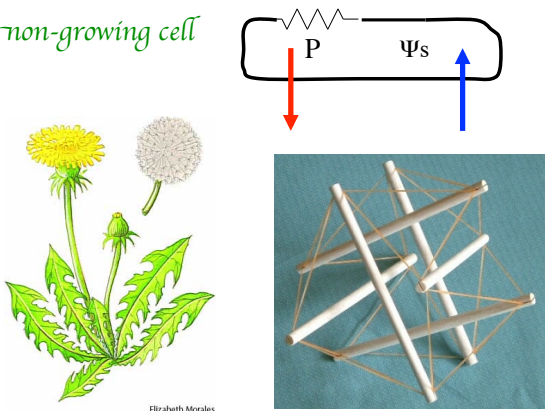


0.2 to 0.3 MPa

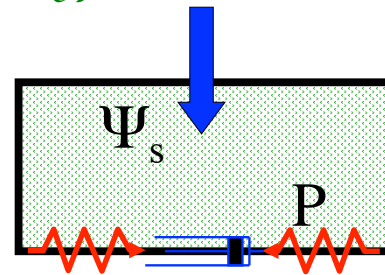


0.2 to 1 MPa

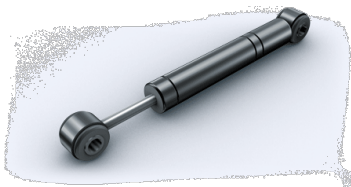
non-growing cell



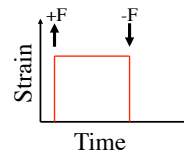
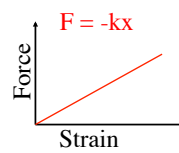
Growing plant cell



the DASHPOT

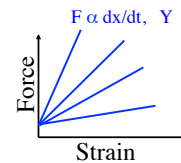


Elastic material

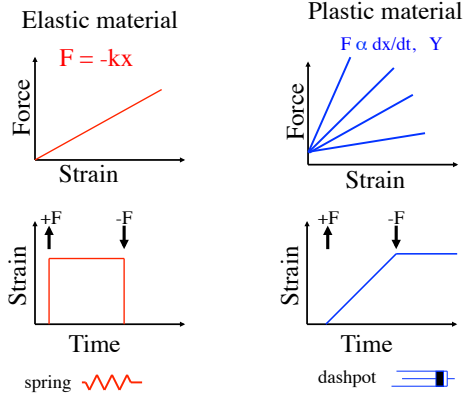


spring

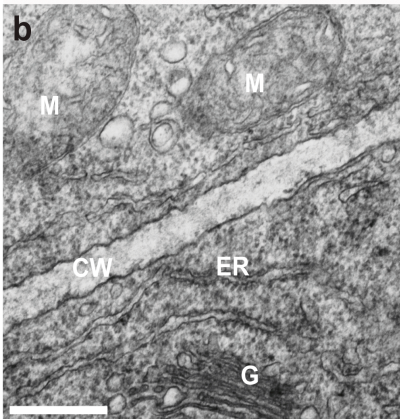
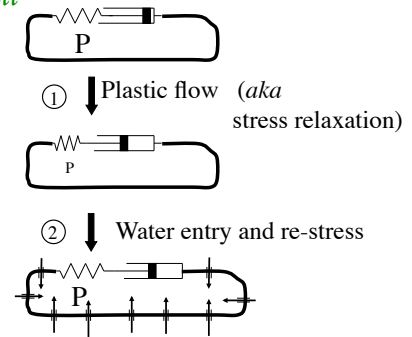
Plastic material



dashpot

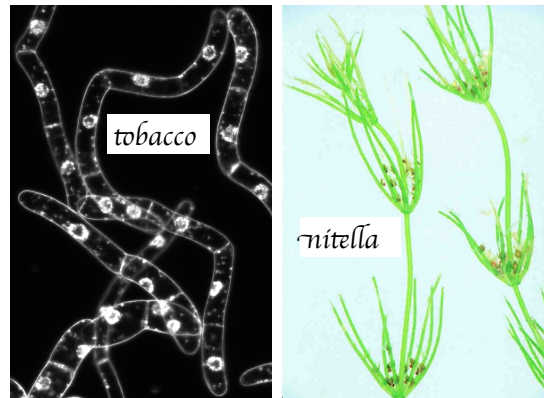


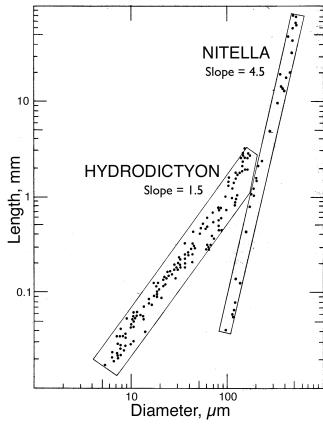
growing cell



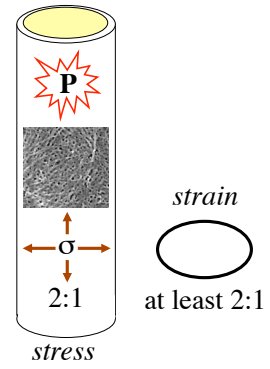
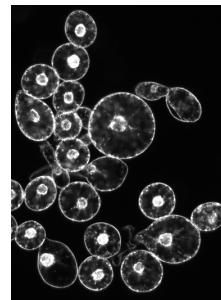
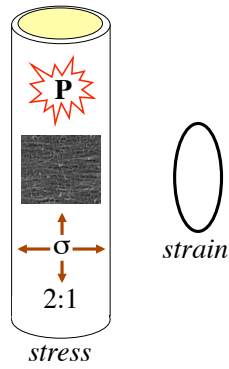
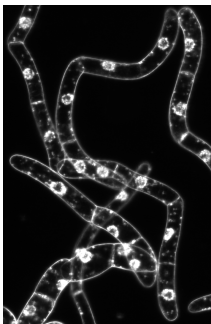
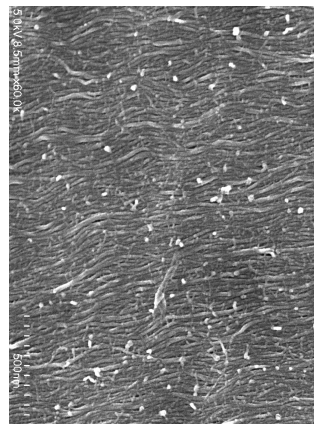
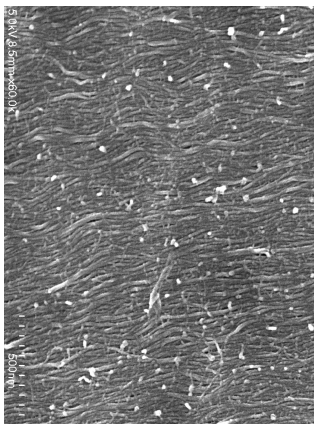
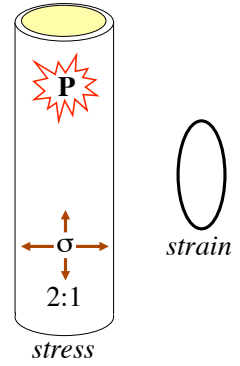
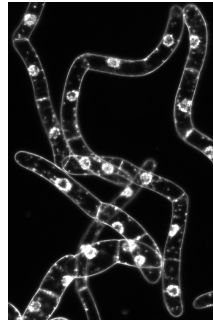
Wu Shuang

- Growth helps plants acclimate
- Plant cells have low water potential
- Plant cells are pressurized
- Growth reflects the controlled movement of water

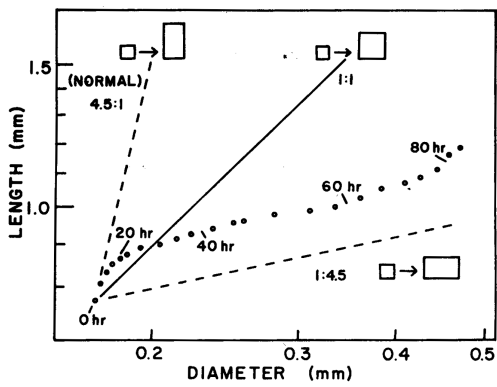
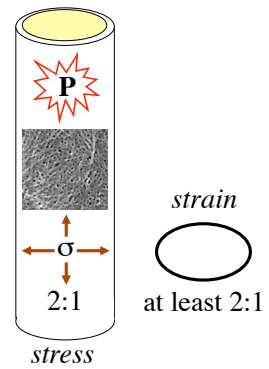
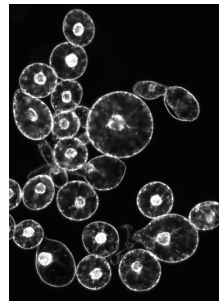




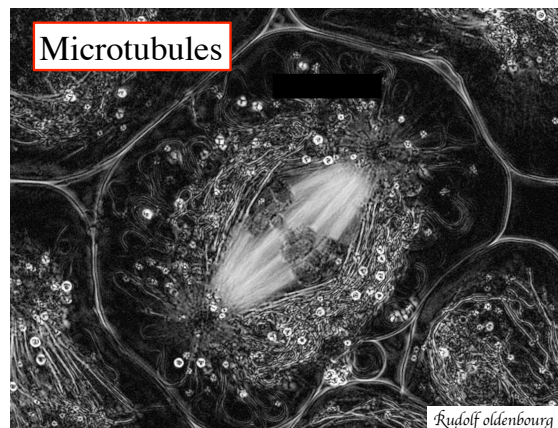
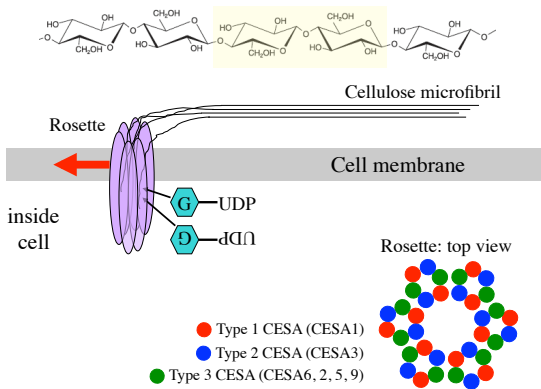
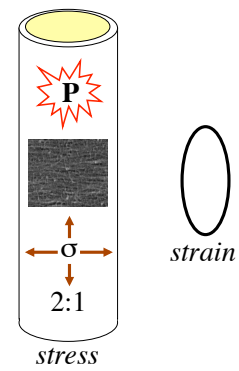
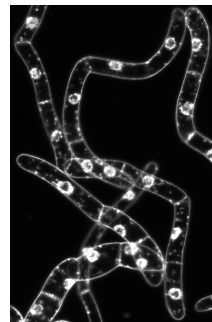
Paul Green 1964
Brookhaven Symp.

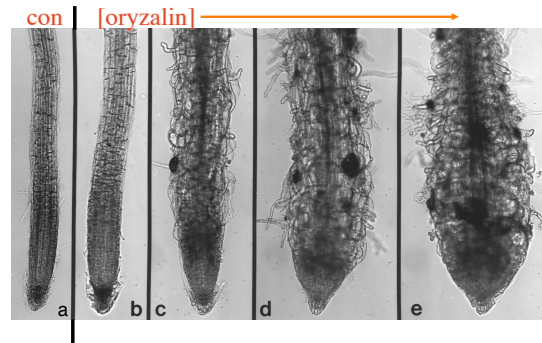
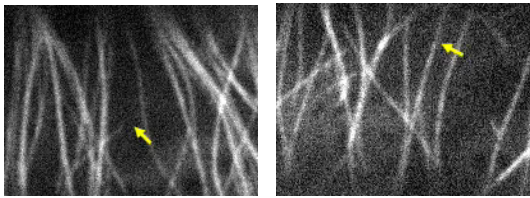
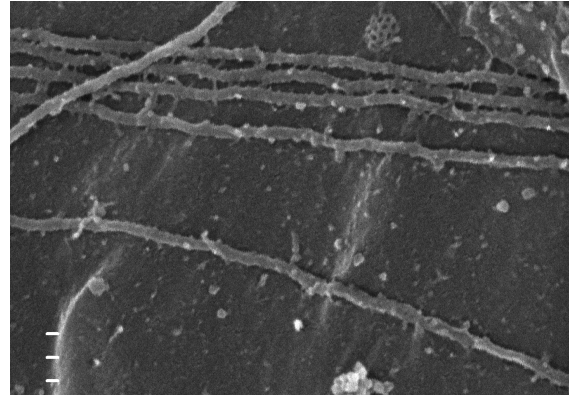
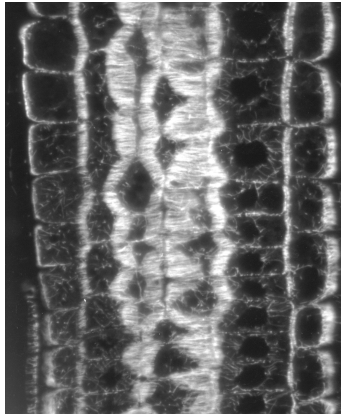


Poisson's ratio

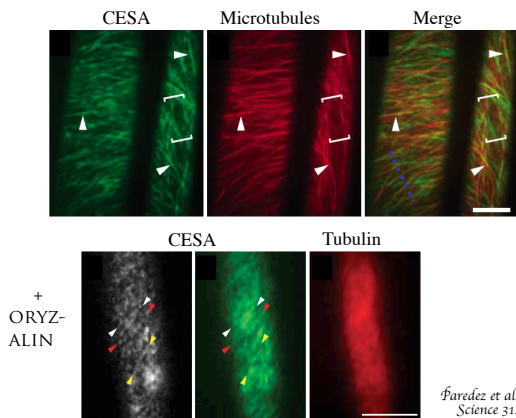


Green et al. 1970 Ann. NY Acad. Sci.

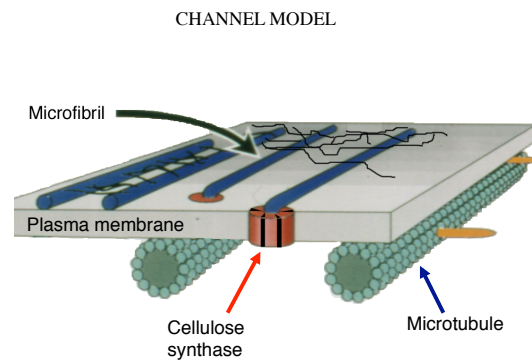




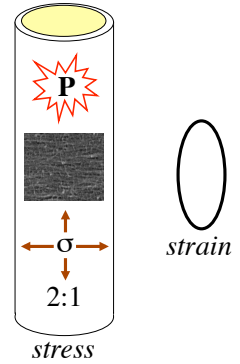
Takashi Murata



Paredes et al. 2006
Science 312: 1491



- Plant cells grow anisotropically
- Cell walls are mechanically anisotropic
- Cellulose microfibrils govern cell wall mechanical properties
- Microtubules organize microfibrils



Maria Sybilla Merian