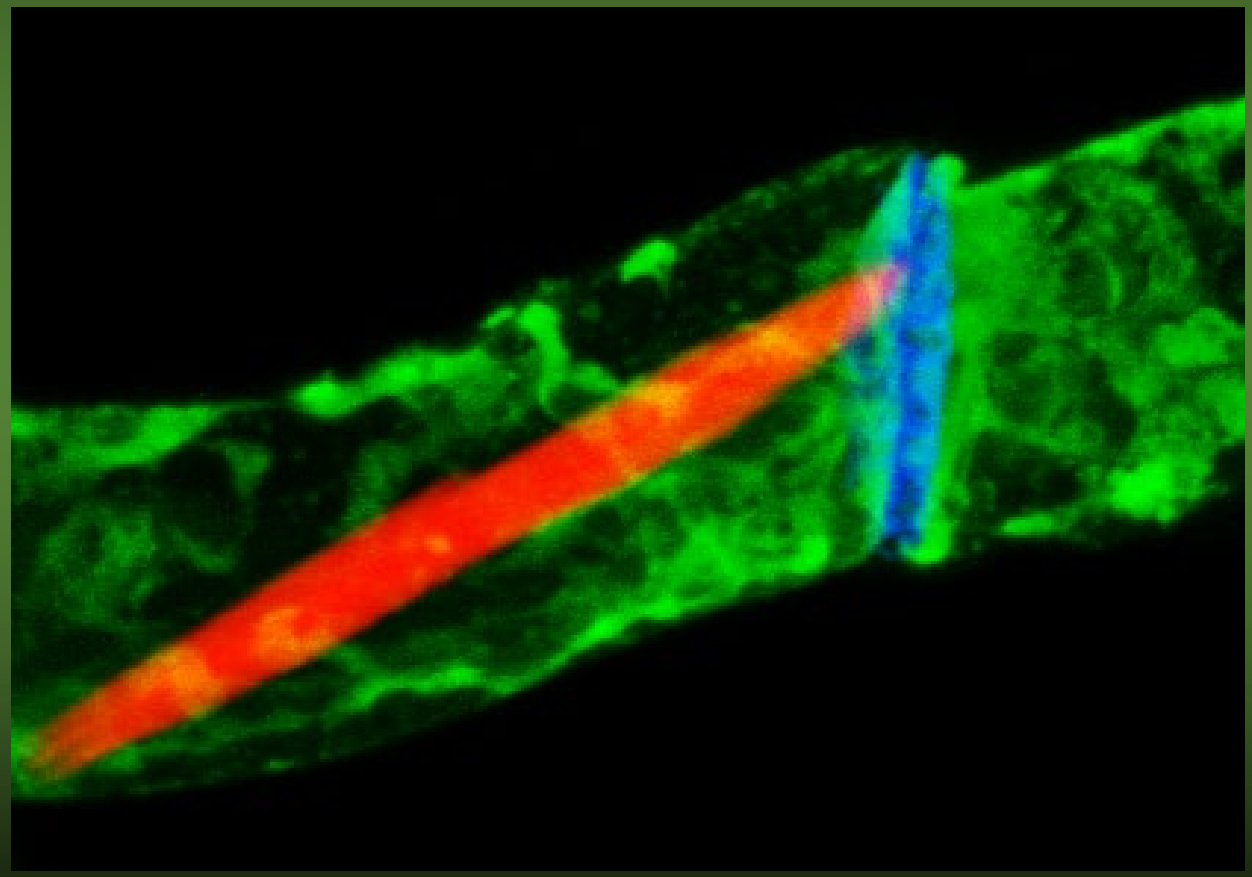
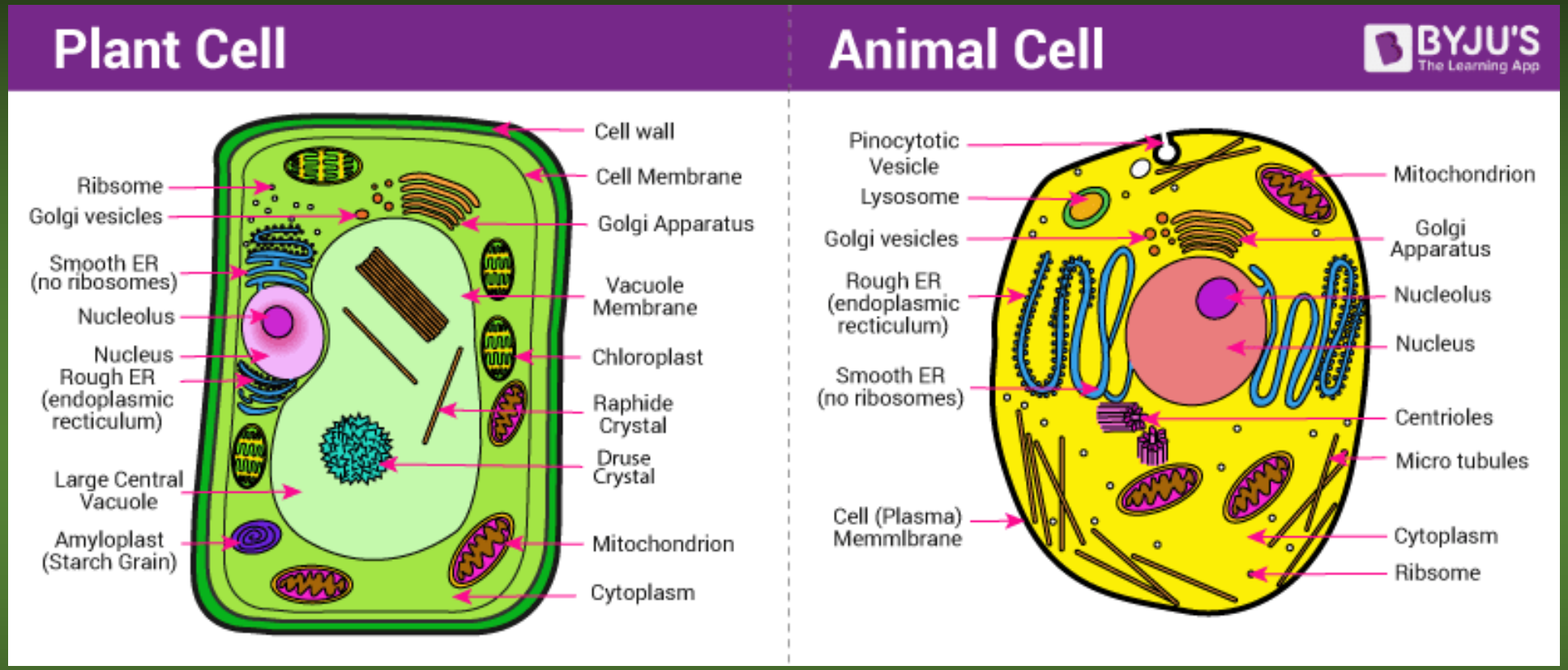
WASHINGTON STATE UNIVERSITY

PLASMODESMATA – NANOPORES IN PLANT TISSUES

Michael Knoblauch, Washington State University, Pullman



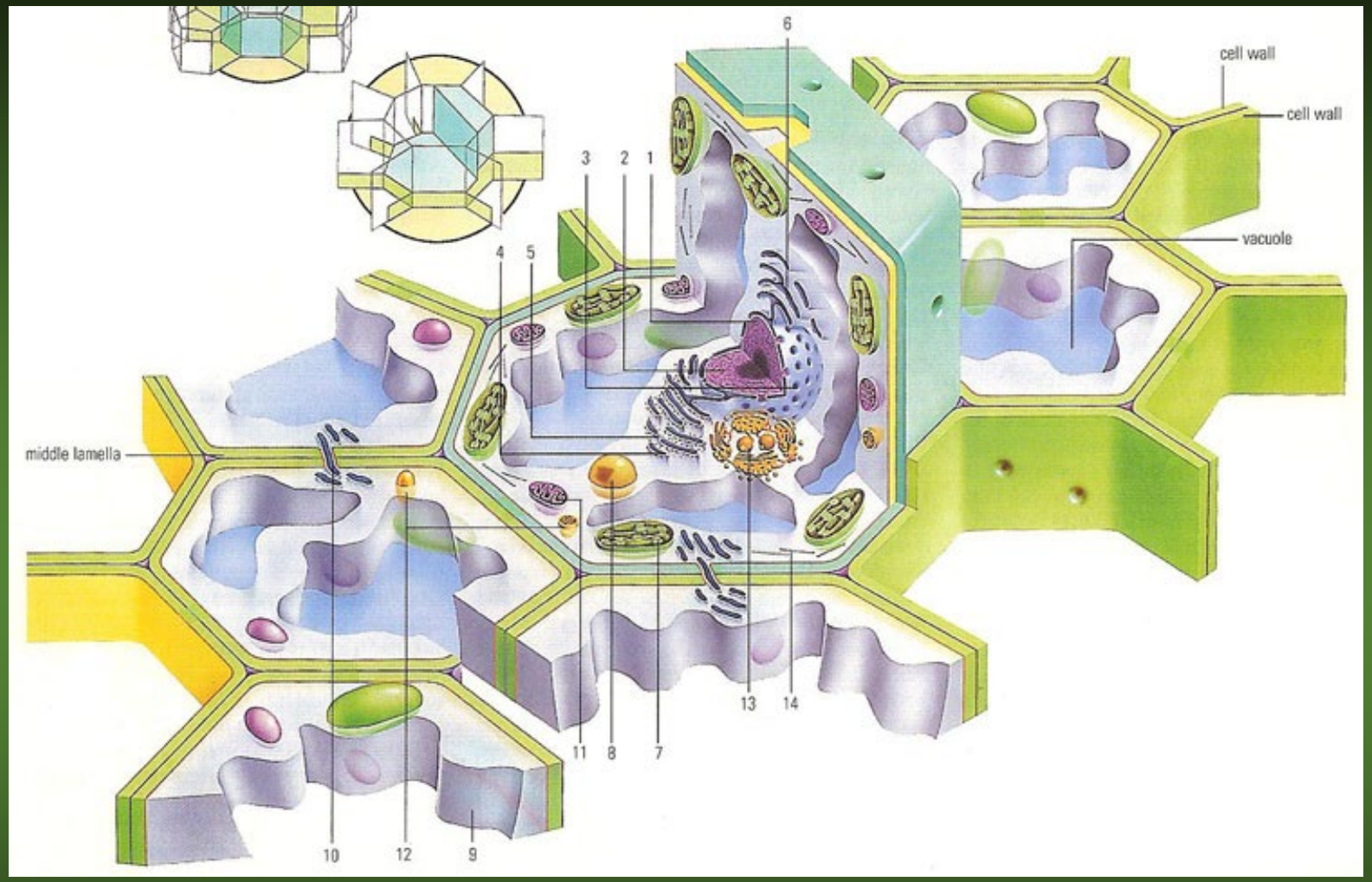
Plant- Versus Animal Cells



From: https://byjus.com/biology/difference-between-plant-cell-and-animal-cell/

Mimosa pudica

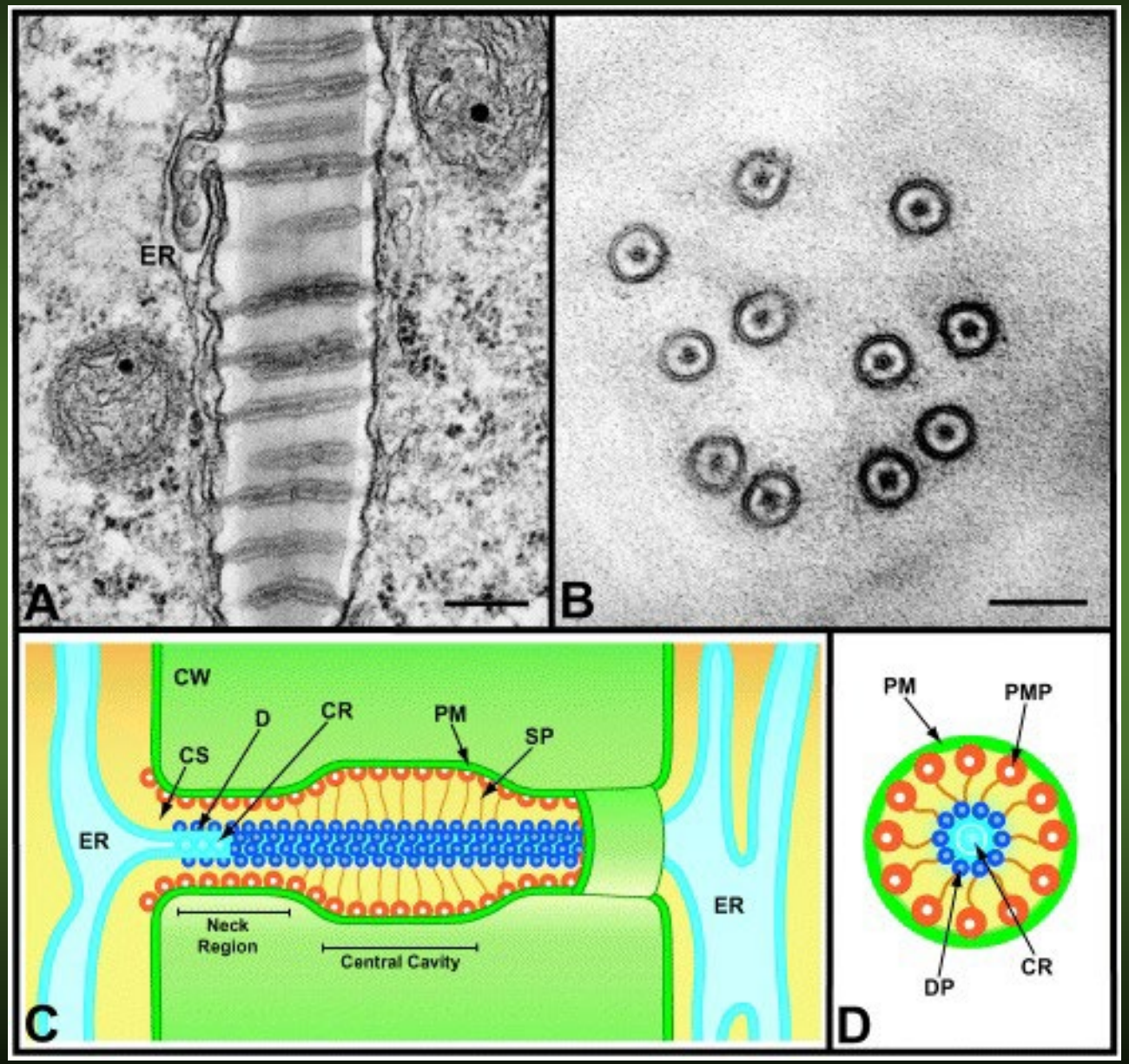
Plant Cell Connections - Plasmodesmata



From:
https://www.daviddarling.info/encyclopedia/P/plant_cell.html

PD model

Peters WS, Jensen KH, Stone HA, Knoblauch M. Plasmodesmata and the problems with size: Interpreting the confusion. J Plant Physiol. 2021

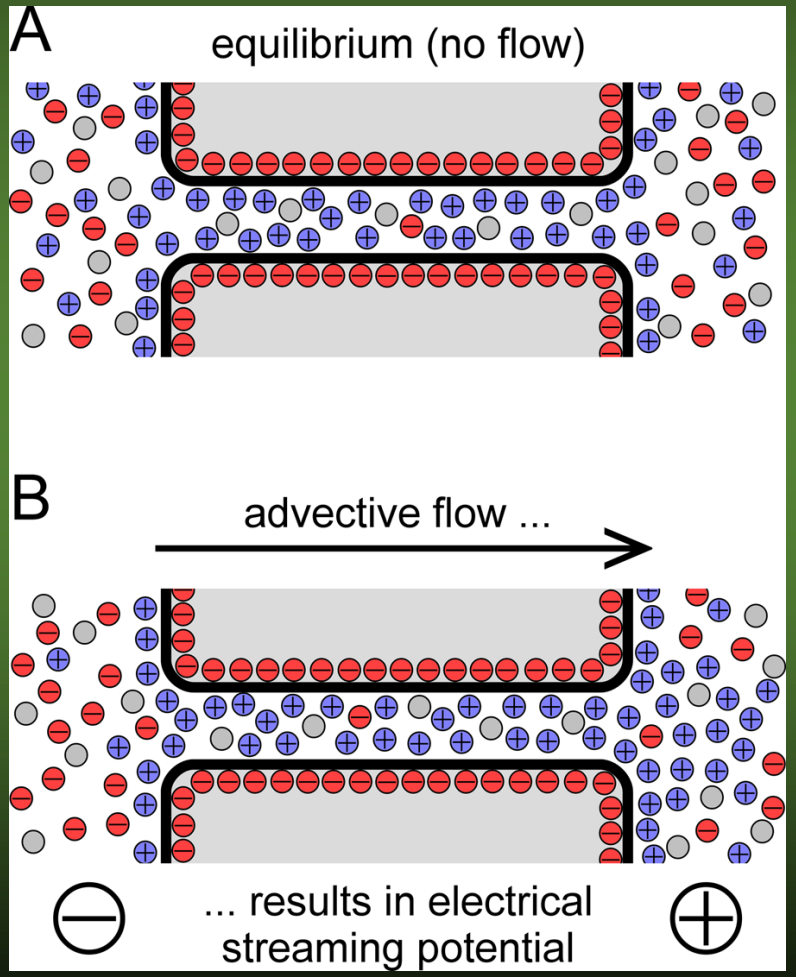


Plasmodesmata and the control of symplastic transport
A. G. ROBERTS, K. J. OPARKA
First published: 20 January 2003

“Based on model in Ding et al. 1992”

Selectivity of plasmodesmata

Terry and Robards “Hydrodynamic radius alone governs the mobility of molecules through plasmodesmata”. Planta 1987 171, 145-57.)

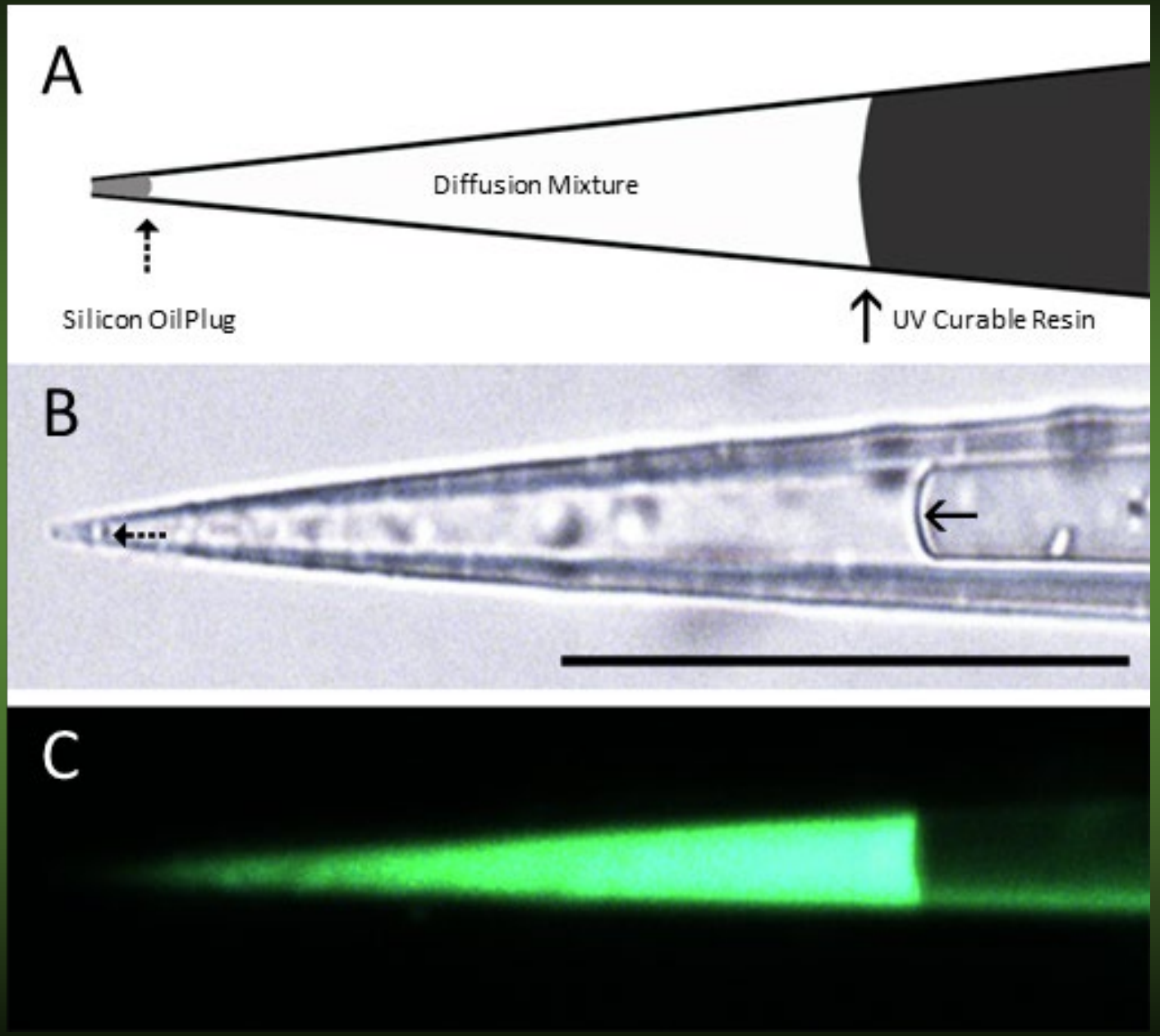


Peters WS, Jensen KH, Stone HA, Knoblauch M. Plasmodesmata and the problems with size: Interpreting the confusion. J Plant Physiol. 2021

Howard Stone, Mechanical and Aerospace Engineering. Princeton University

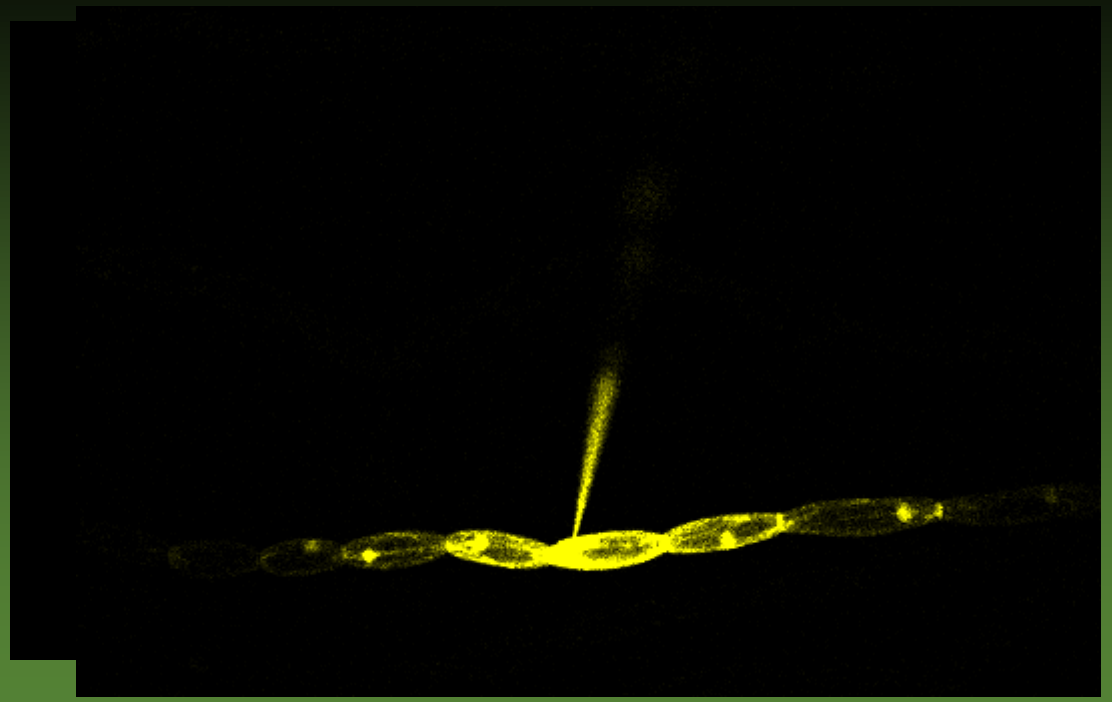
Kaare H. Jensen, Physics. Technical University of Denmark

Diffusive Injection Micropipette (DIMP)

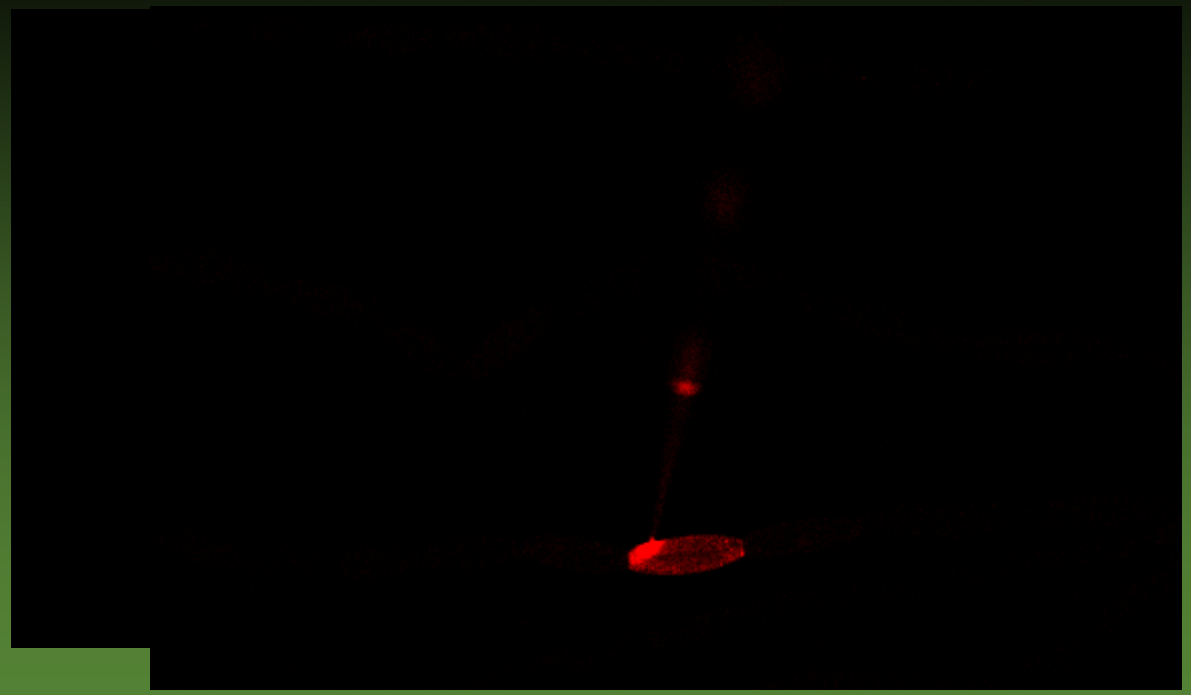


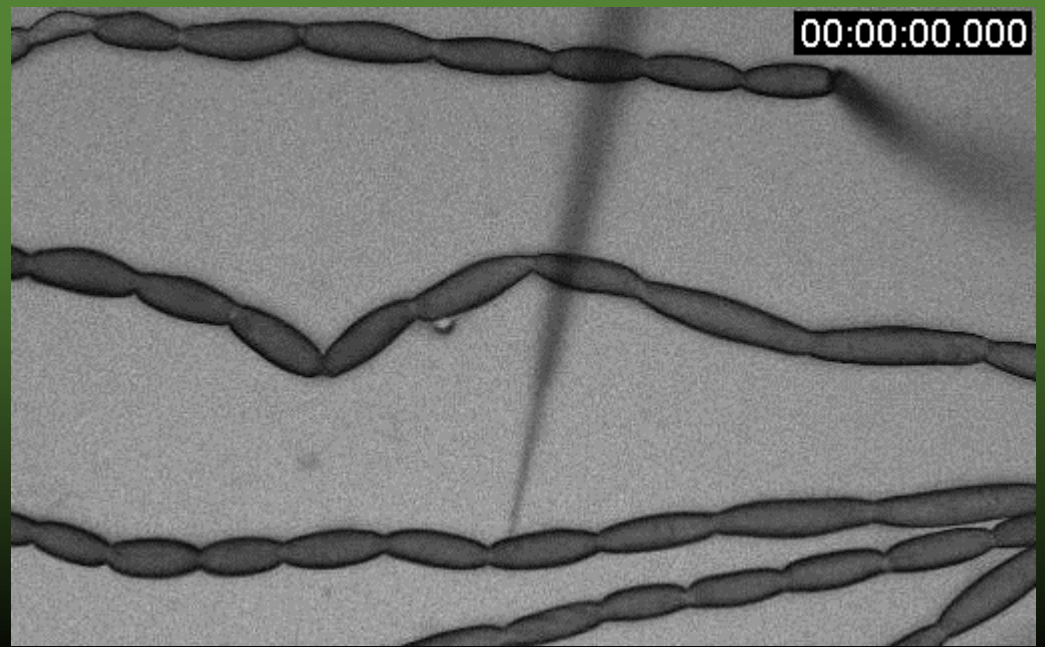
Dr. Alex Howell

HPTS



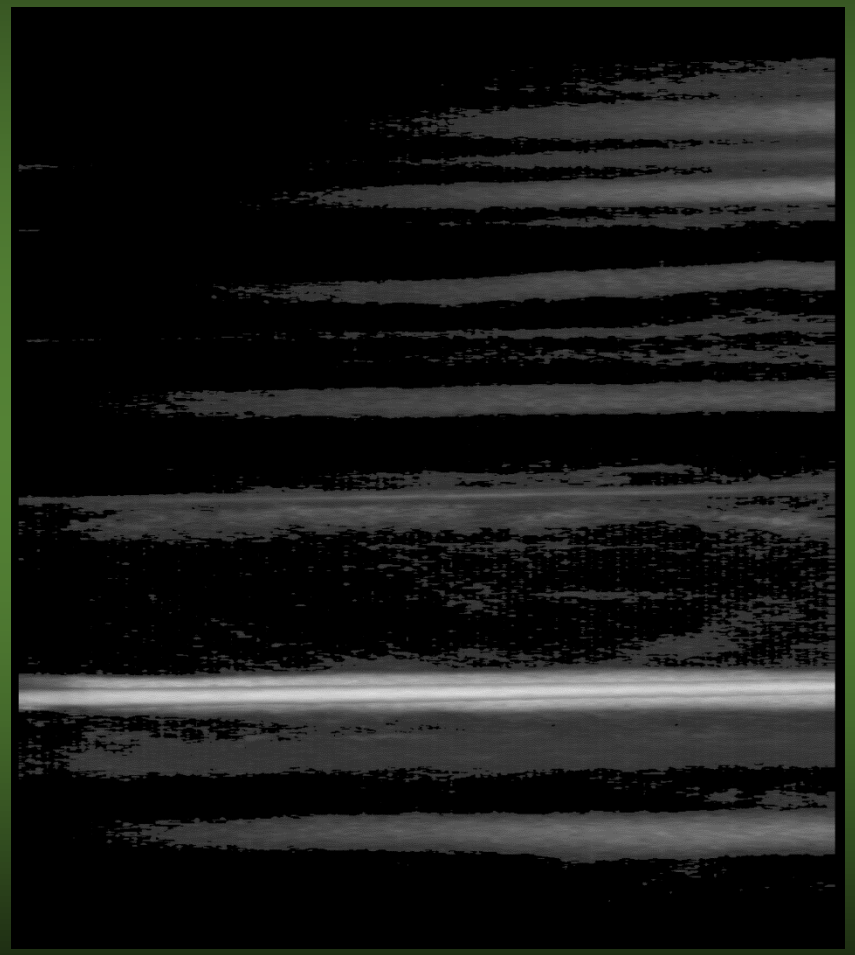
Cy5

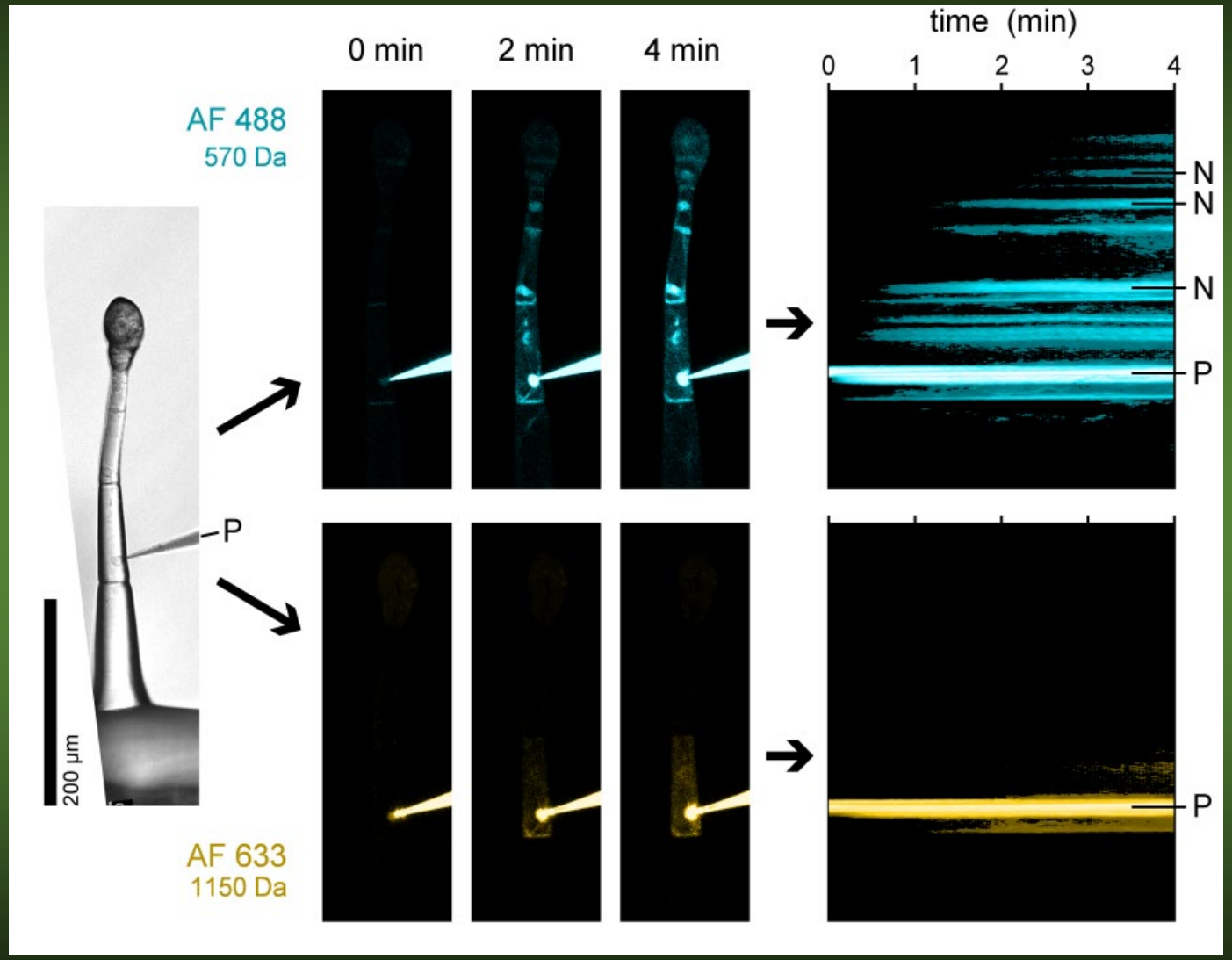


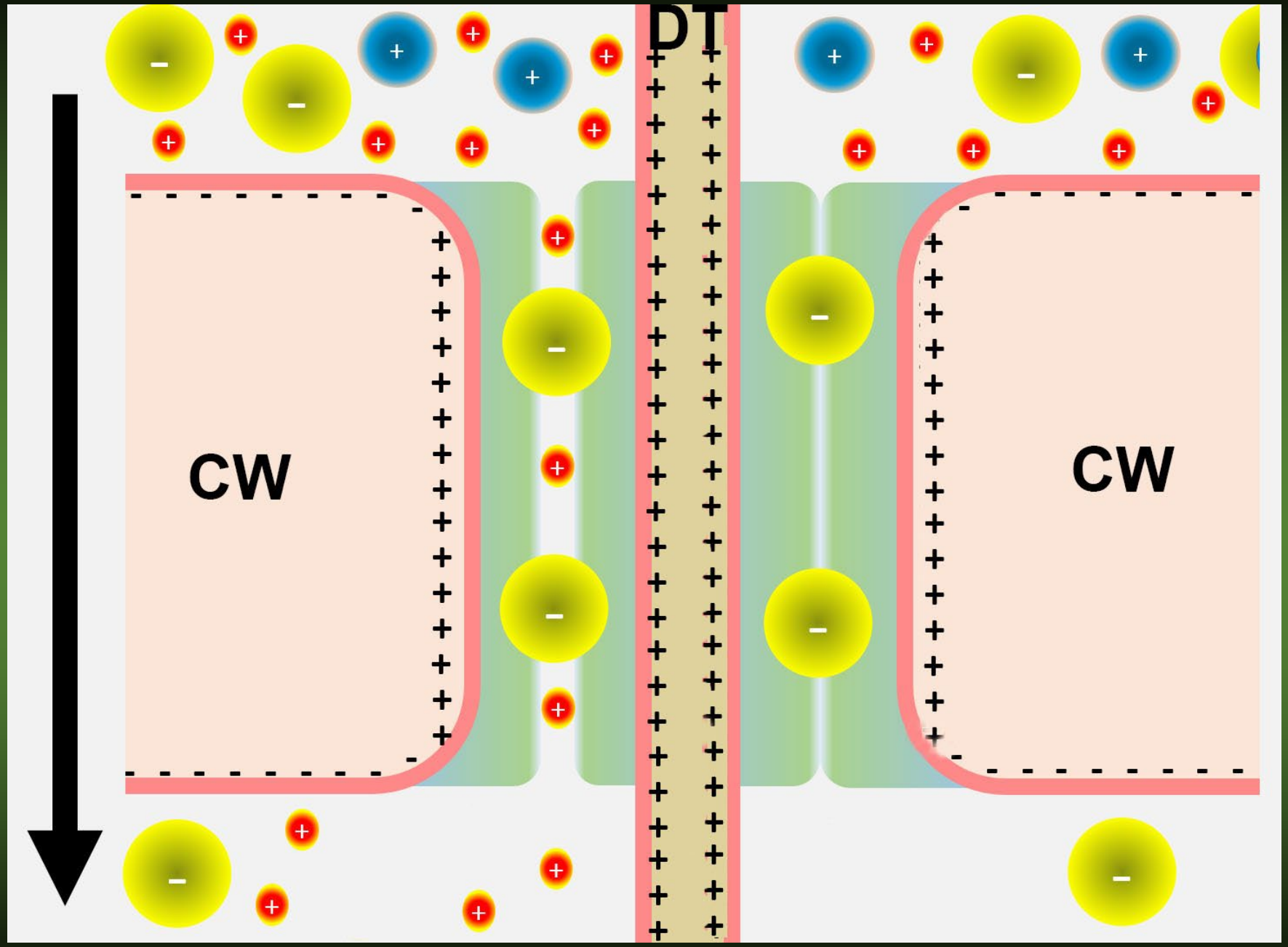


DIMP Analysis

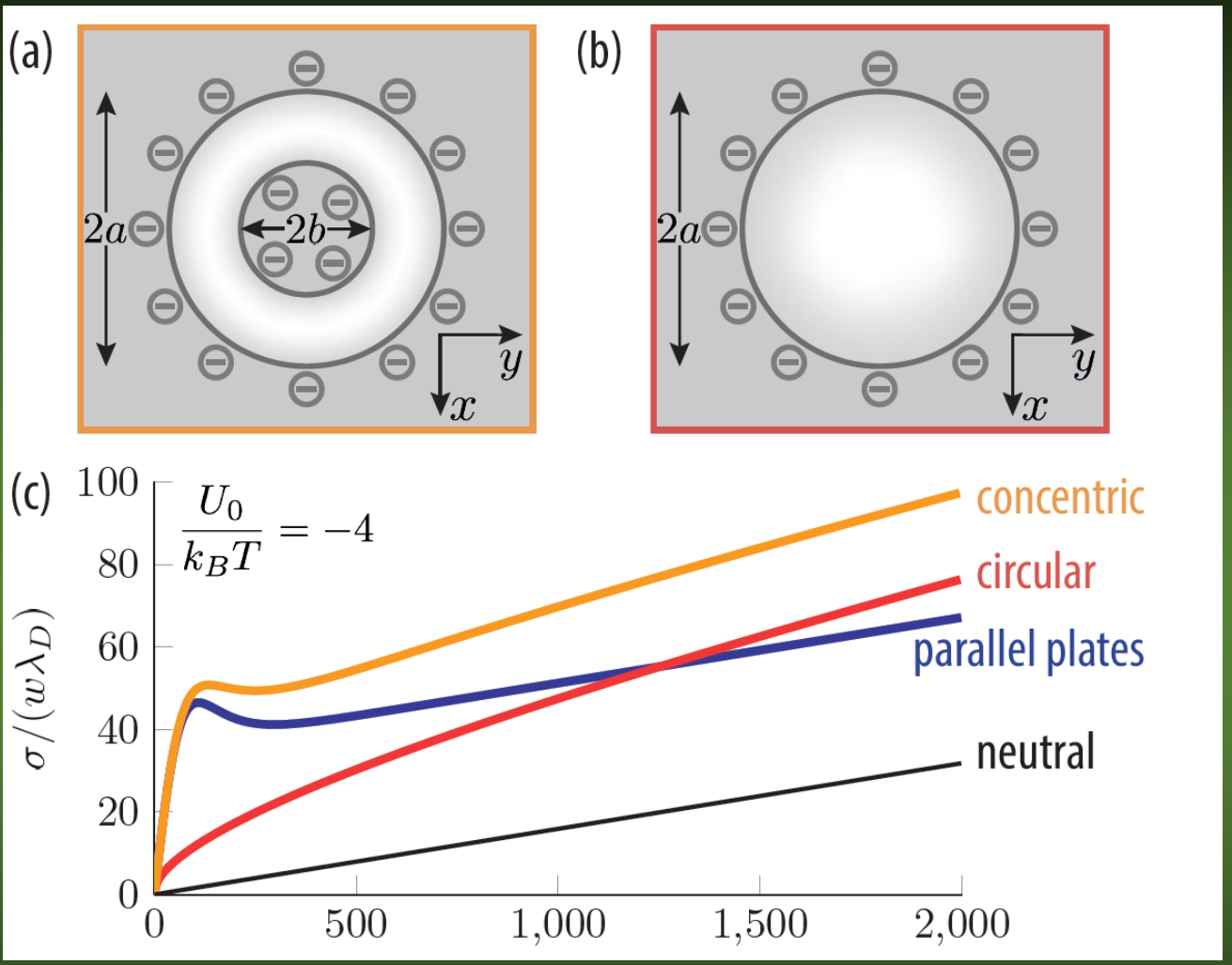
time



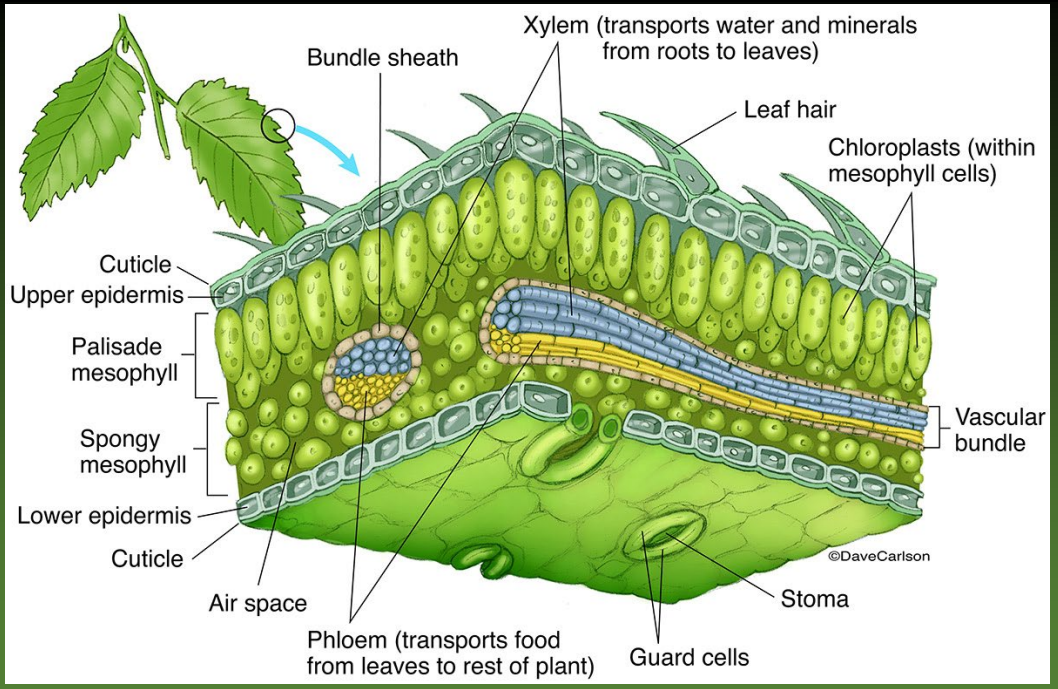



DT
CW
CW

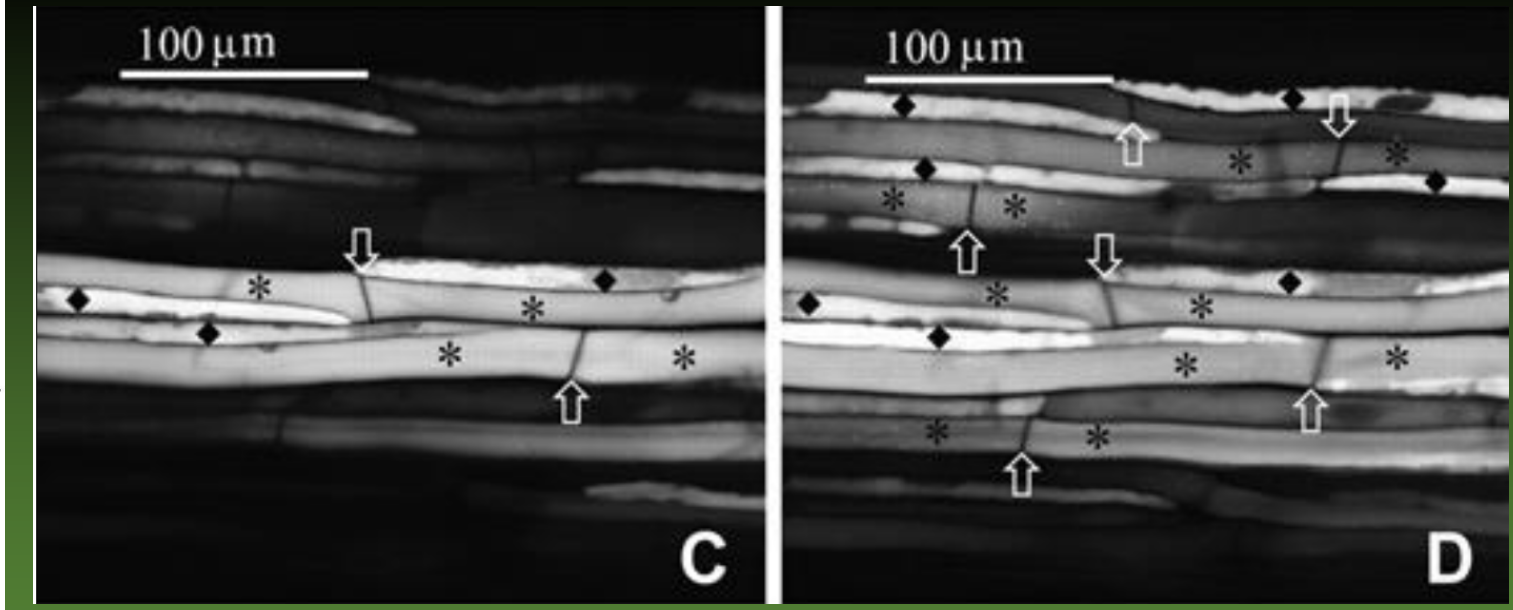
Surface enhanced diffusion



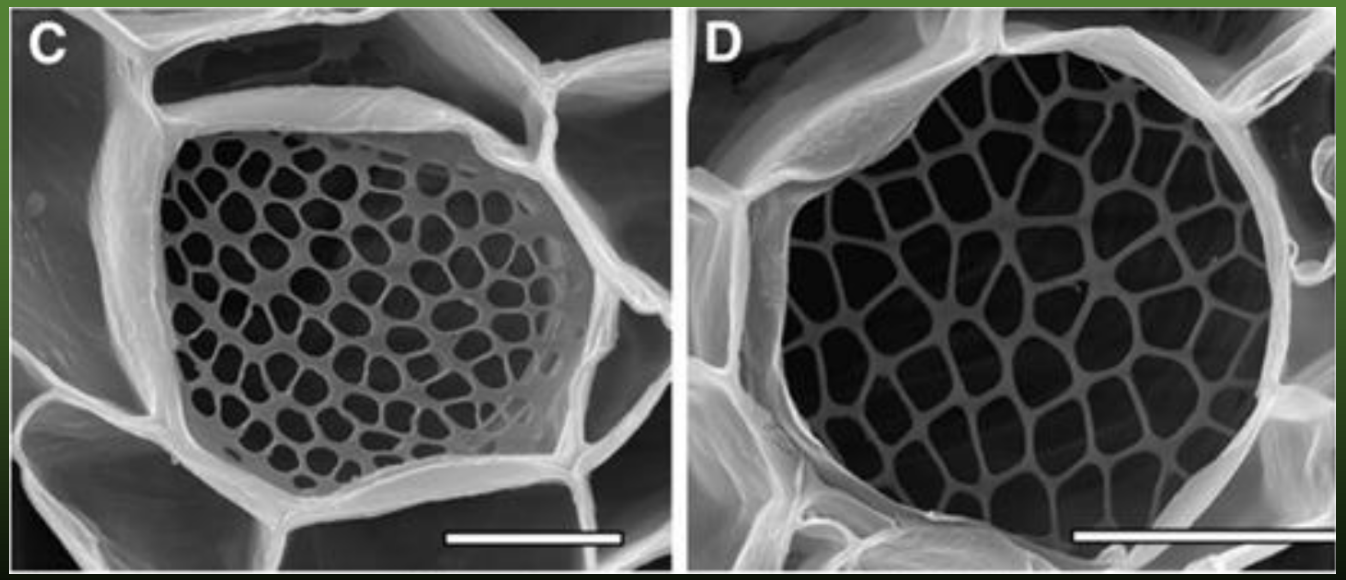
Anneline H. Christensen, Ankur Gupta, Guang Chen, Winfried S. Peters, Michael Knoblauch, Howard A. Stone, and Kaare H. Jensen 2023 Locally optimal geometry for surface-enhanced diffusion Phys. Rev. E 108, 045101-2023



From: https://www.carlsonstockart.com/images/xl/Leaf-Structure_labeled.jpg

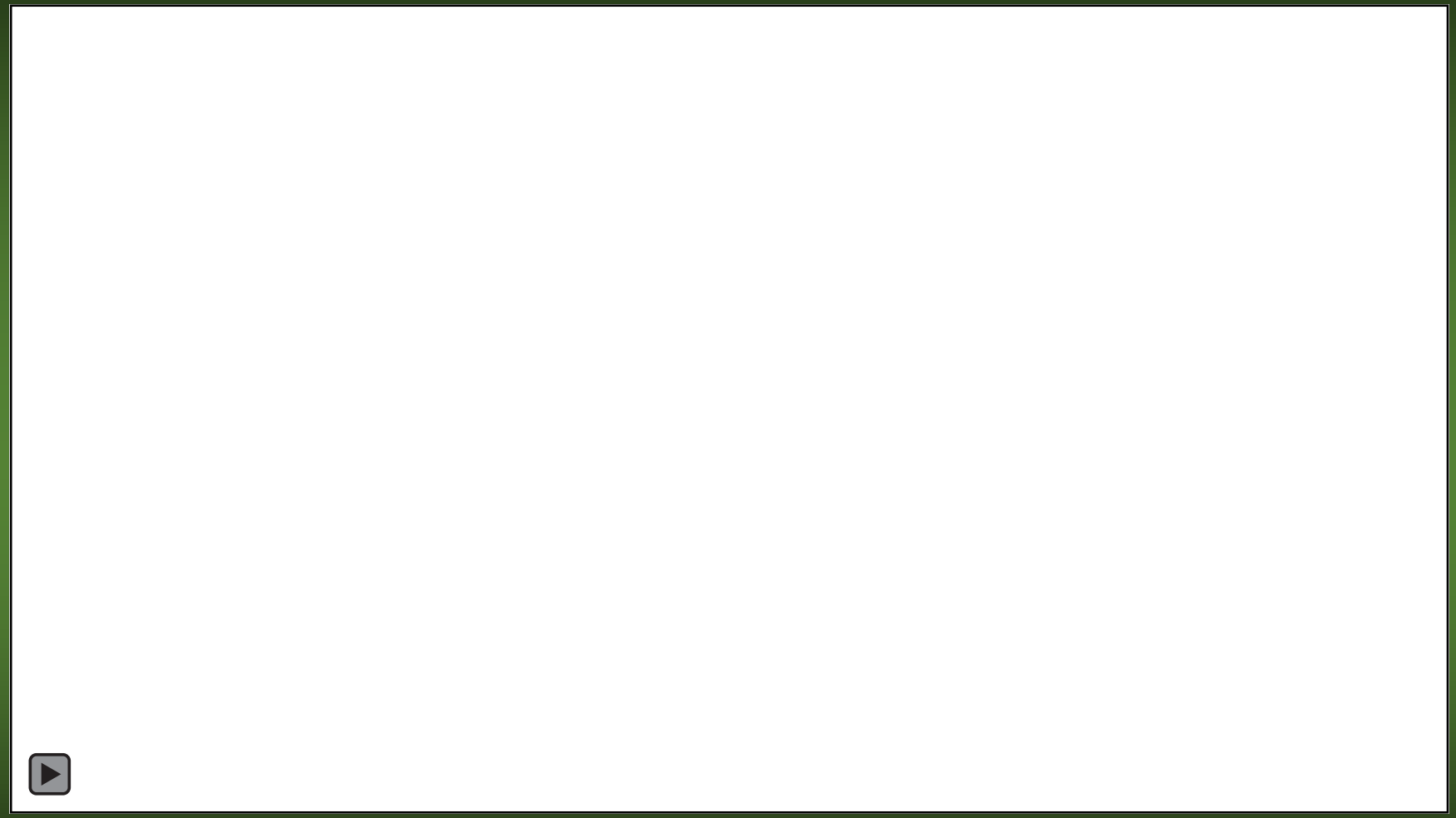


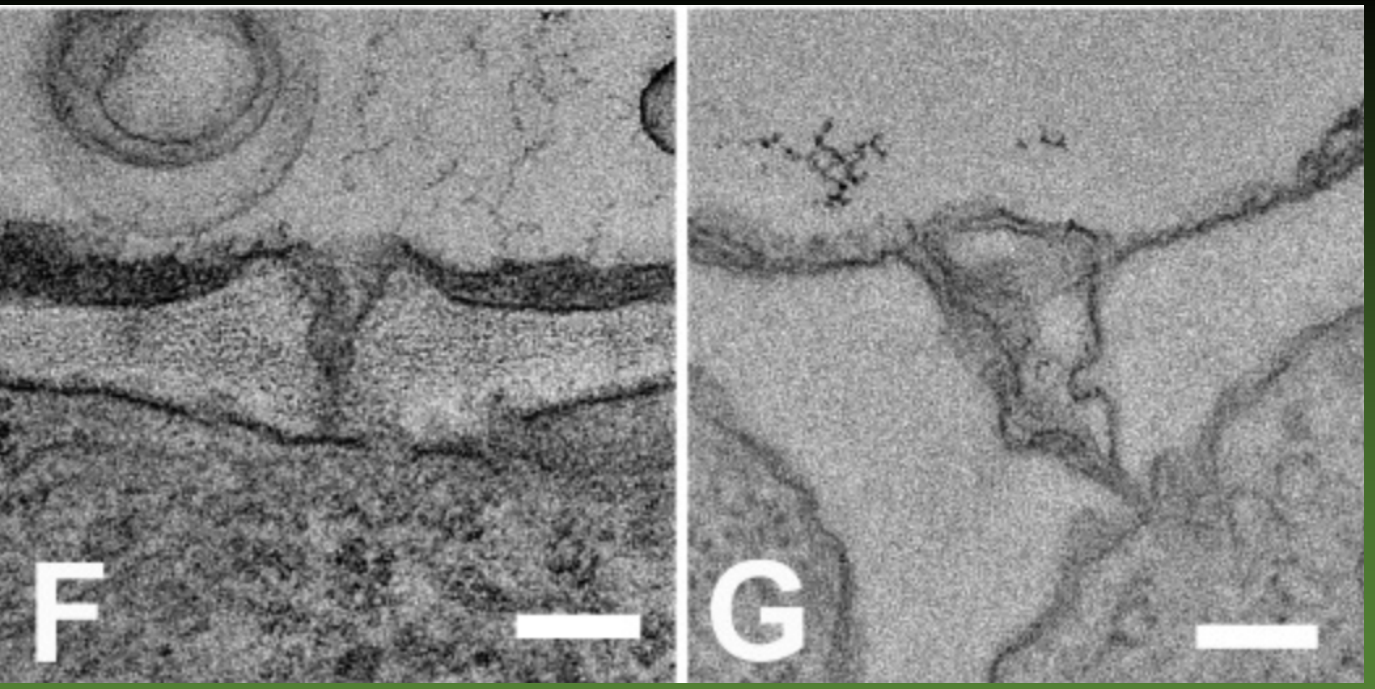
Knoblauch M, VanBel AJE. Sieve tubes in action. The Plant Cell, Volume 10, Issue 1, January 1998, Pages 35–50



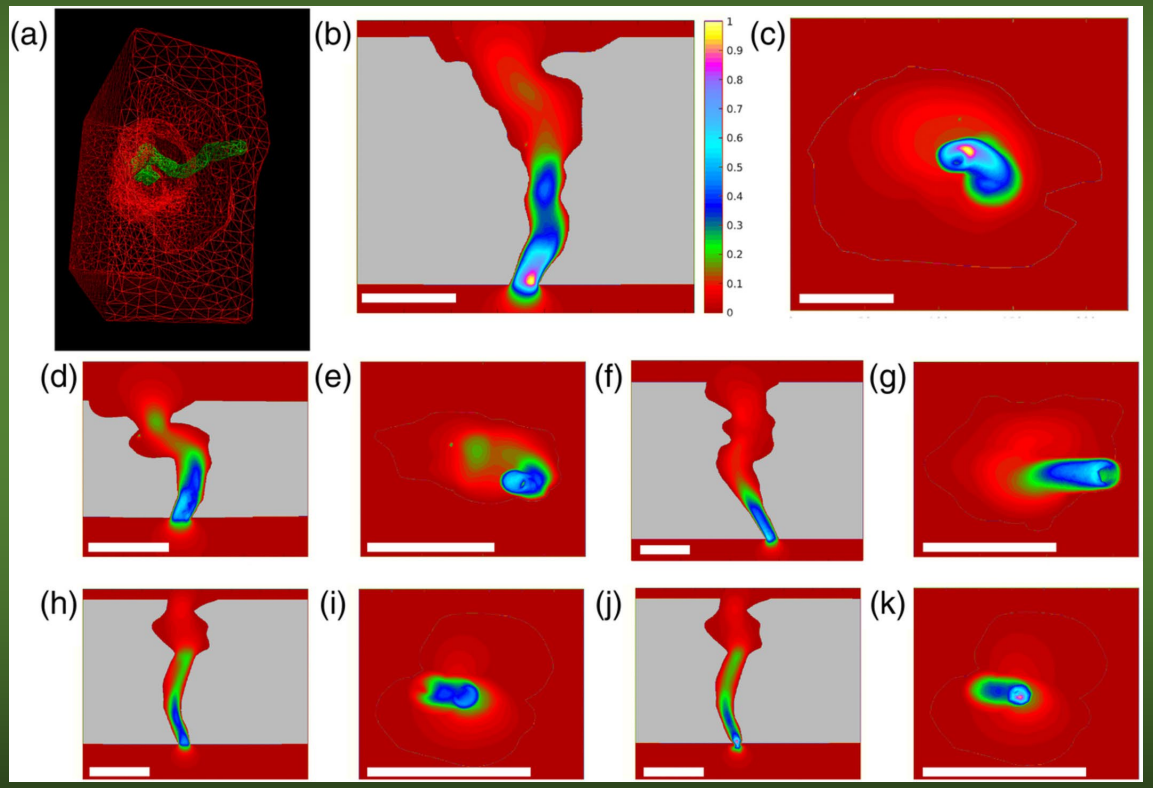
Mullendore, DL, Windt C, Van As H, Knoblauch M 2010 Sieve tube geometry in relation to phloem flow. The Plant Cell, Volume 22, Pages 579–593

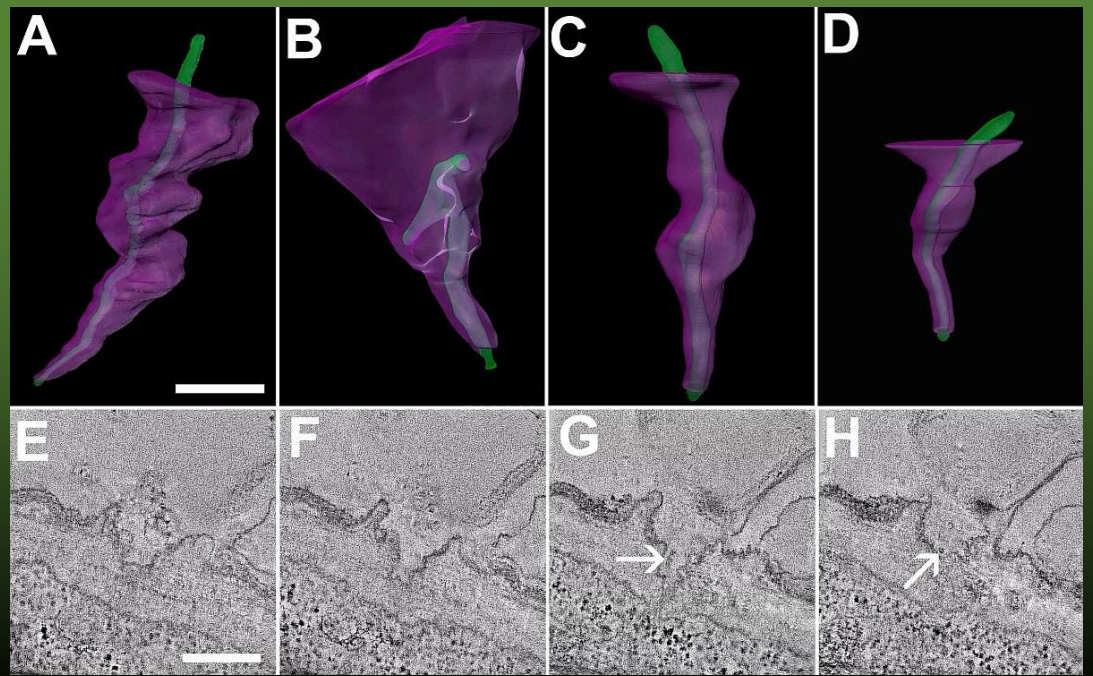
Phloem unloading





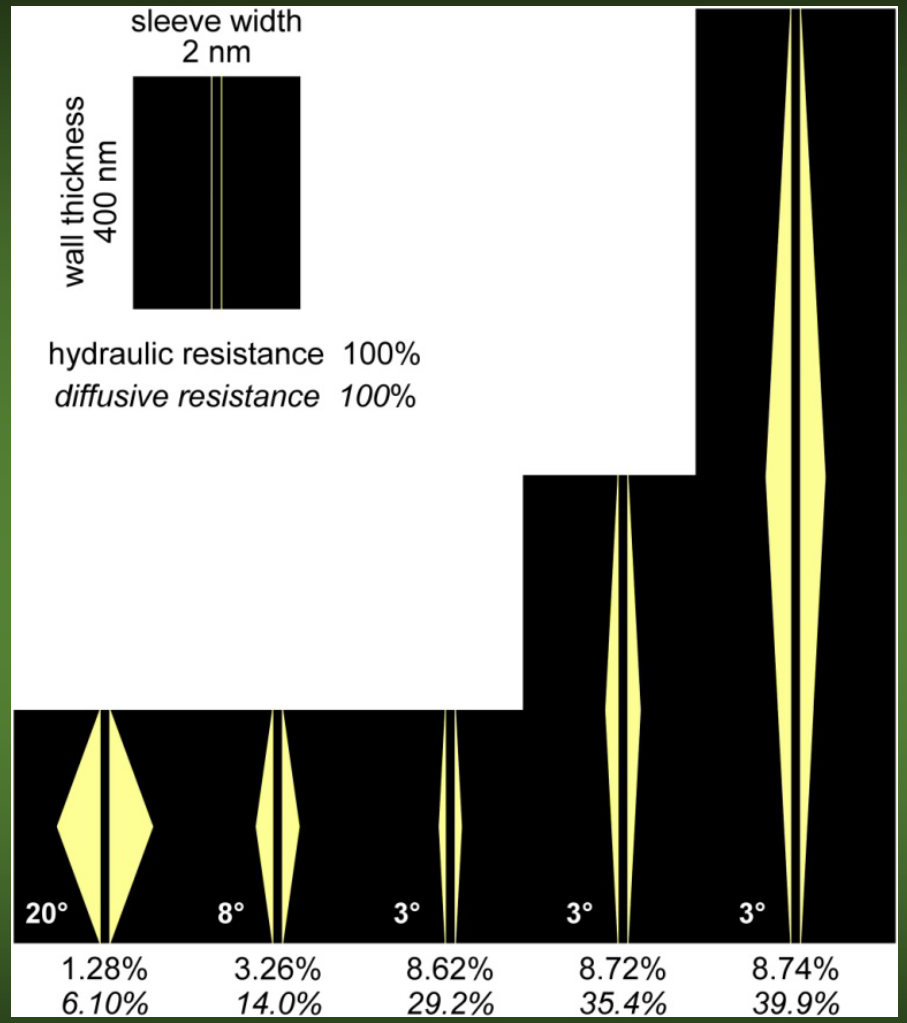
Ross Elliott et al. 2017 eLife Feb 23:6:e24125.





Ostermeyer et al. 2022, **Diversity of funnel plasmodesmata in angiosperms: the impact of geometry on plasmodesmal resistance, Plant Journal, 2022, 110, 707-719.**

Effect of geometry on PD resistance



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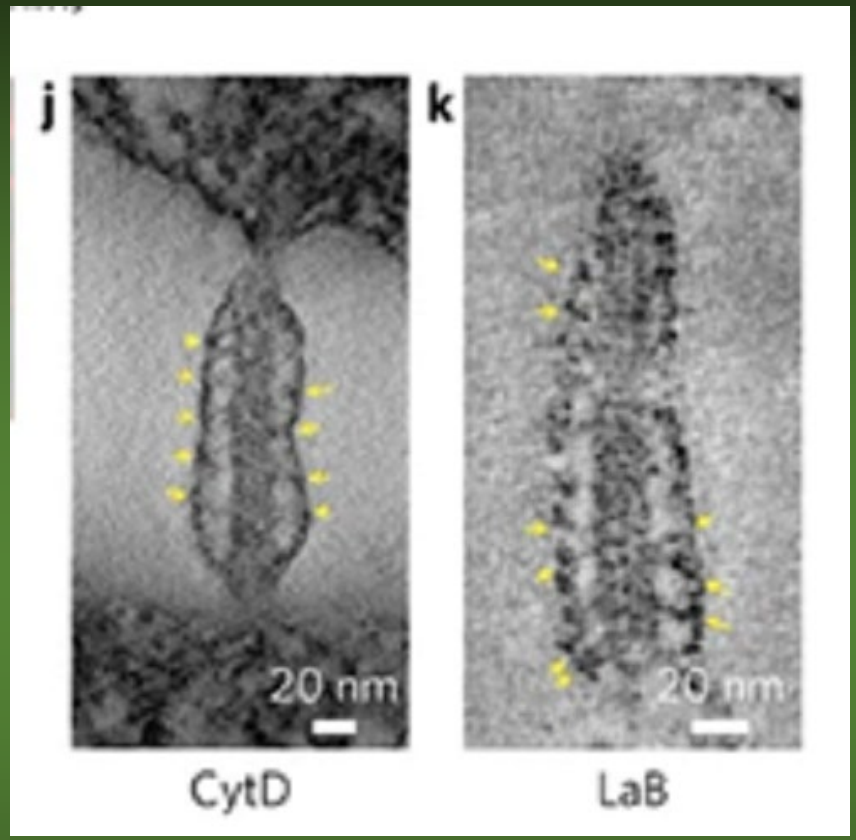
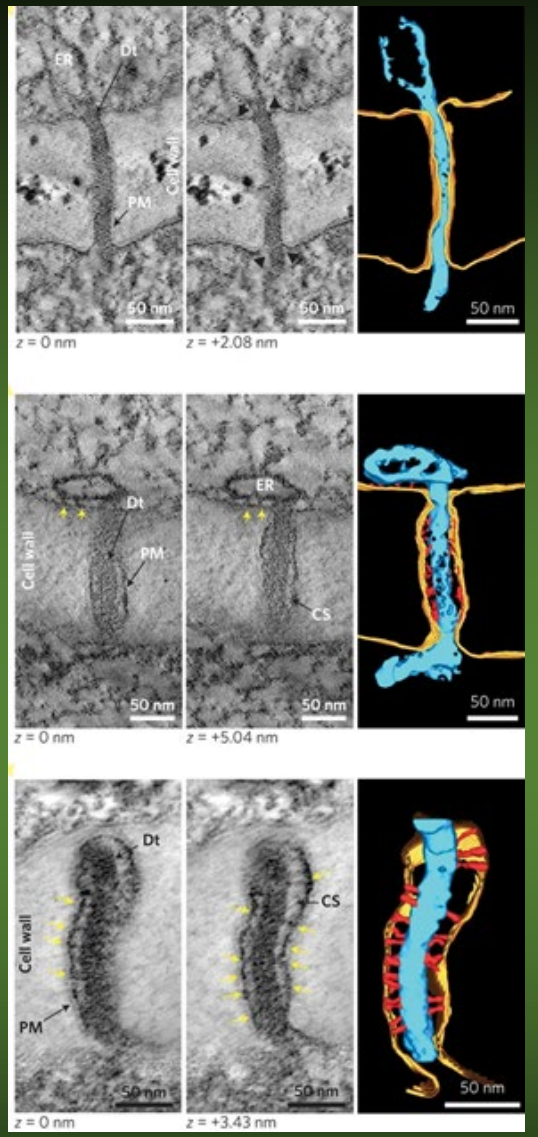
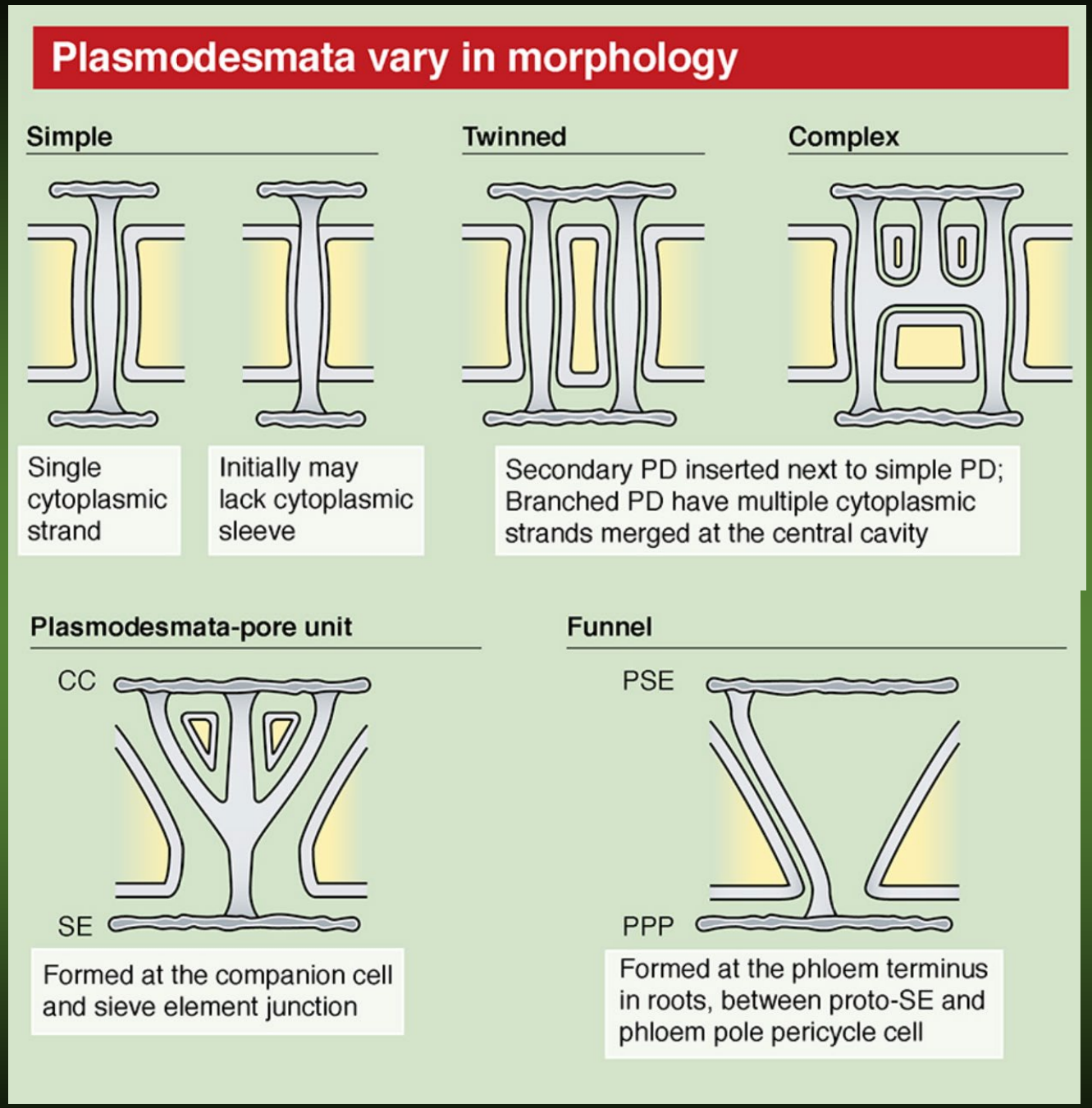




From: Nicolas, W., Grison, M., Trépout, S. *et al.* Architecture and permeability of post-cytokinesis plasmodesmata lacking cytoplasmic sleeves. *Nature Plants* **3,** 17082 (2017). https://doi.org/10.1038/nplants.2017.82

Plasmodesma Diversity



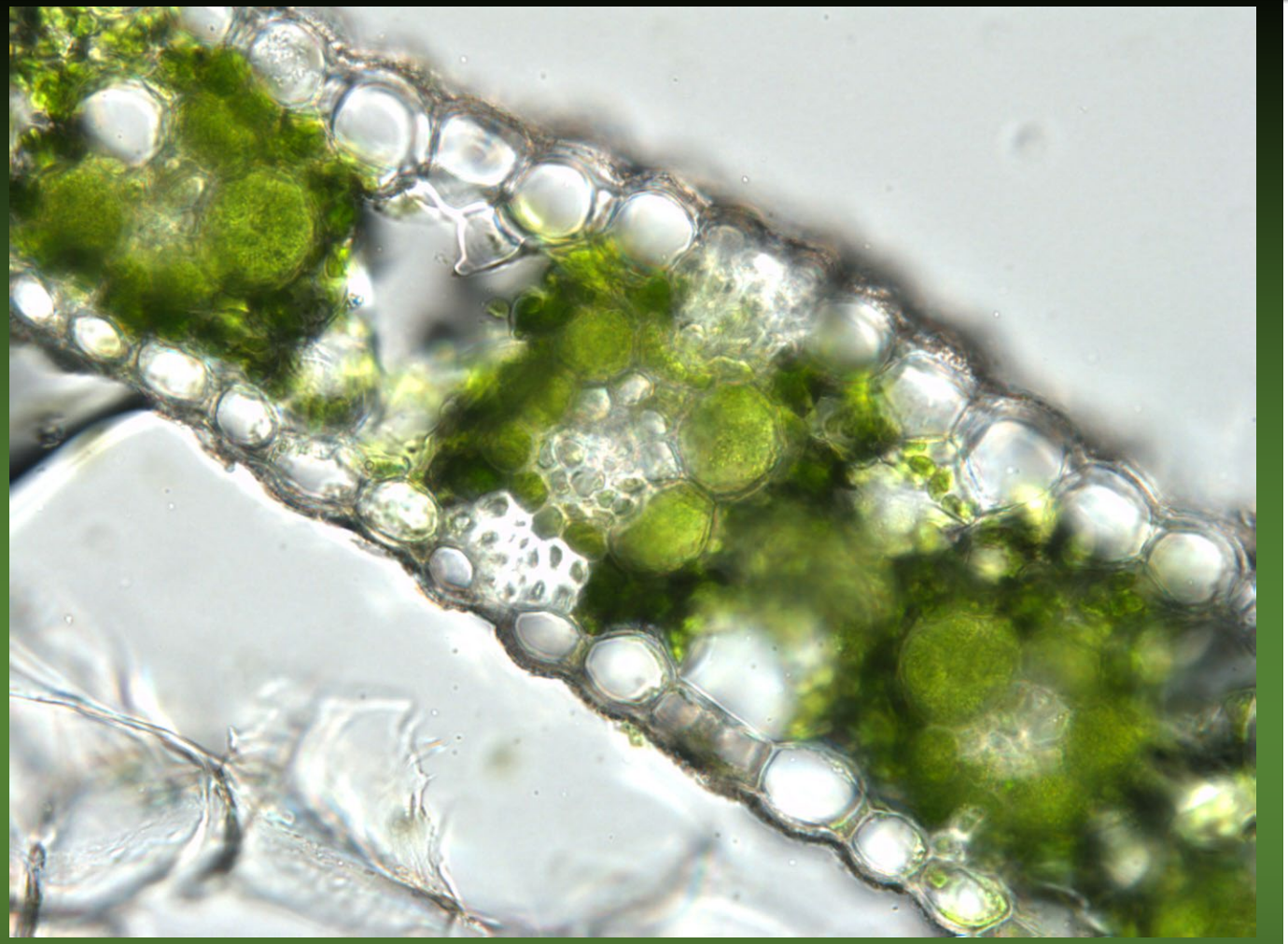
Ross E. Sager, Jung-Youn Lee; Plasmodesmata at a glance. *J Cell Sci* 1 June 2018; 131 (11): jcs209346. doi: https://doi.org/10.1242/jcs.209346

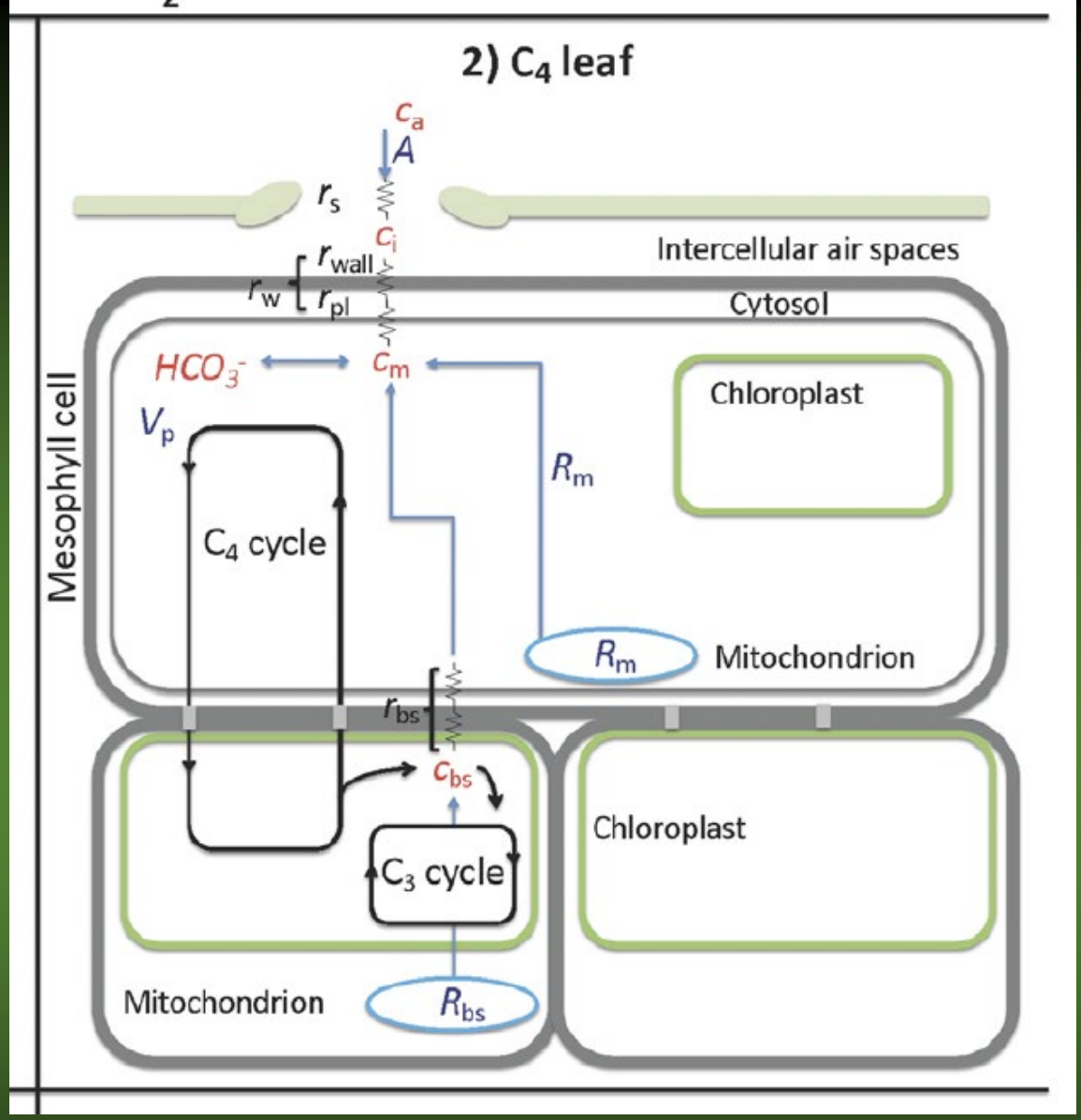
We need artificial modifiable probes!

We tested commercially available, coated, water soluble quantum dots and nanoclusters. But all soluble probes we were able to acquire immediately bind to cellular components and do not remain soluble in the cytoplasm.

Probes need to be in the range of 0.5 nm to 10 nm diameter. Surface coatings need to be adjustable

https://www.bu.edu/articles/2017/quantum-dots-breast-cancer-tumors/





Probes to monitor fluxes in leaves (e.g. CO_2, H_2O)

Thanks to:

WSU

- Tim Ross-Elliott
- Alex Howell
- Viktoriya Vasina
- Vincent James
- Brittney Wager
- Jan Knoblauch
- Dan Mullendore
- Sierra Beecher
- Aaron Brookhouse
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Karl Oparka (Edinburgh)
Missy Holbrook (Harvard)
Yka Helariutta (Cambridge UK)
Kaare Jensen (Copenhagen)
Howard Stone (Princeton)
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