

Master 2 ICFP - Physics of Multicellular Systems

Lesson 5

From cell to tissue tension

Hervé Turlier - February 21st 2022

Preliminaries

Recap of practical info

- Website with teaching material (slides, references, TDs)

<https://hturlier.github.io/M2ICFP/>

- **5 Lessons on tissue mechanics**

- Lesson 5: From cell to tissue tension
 - Lesson 6: Discrete (vertex) models of multicellular systems (2D/3D)
 - Lesson 7: Continuous models - dissipation, dynamics, rheology
 - Lesson 8: Continuous models - tissue growth and homeostasis
 - Lesson 9: Mechanochemical coupling

- **For practicals**

- First 3 ones (TDs 5-7) related to the content of the lesson of the same day.
 - The 2 last ones (TDs 8-9): one project among 2 propositions; in groups of 3-4; will be evaluated by a restitution of project's results = exam

Tissue tension

Steinberg's differential adhesion hypothesis (DAH)

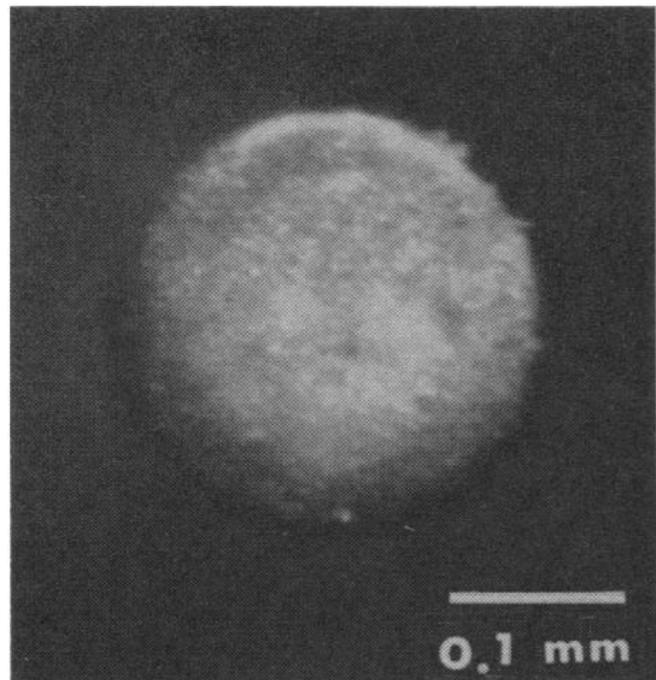
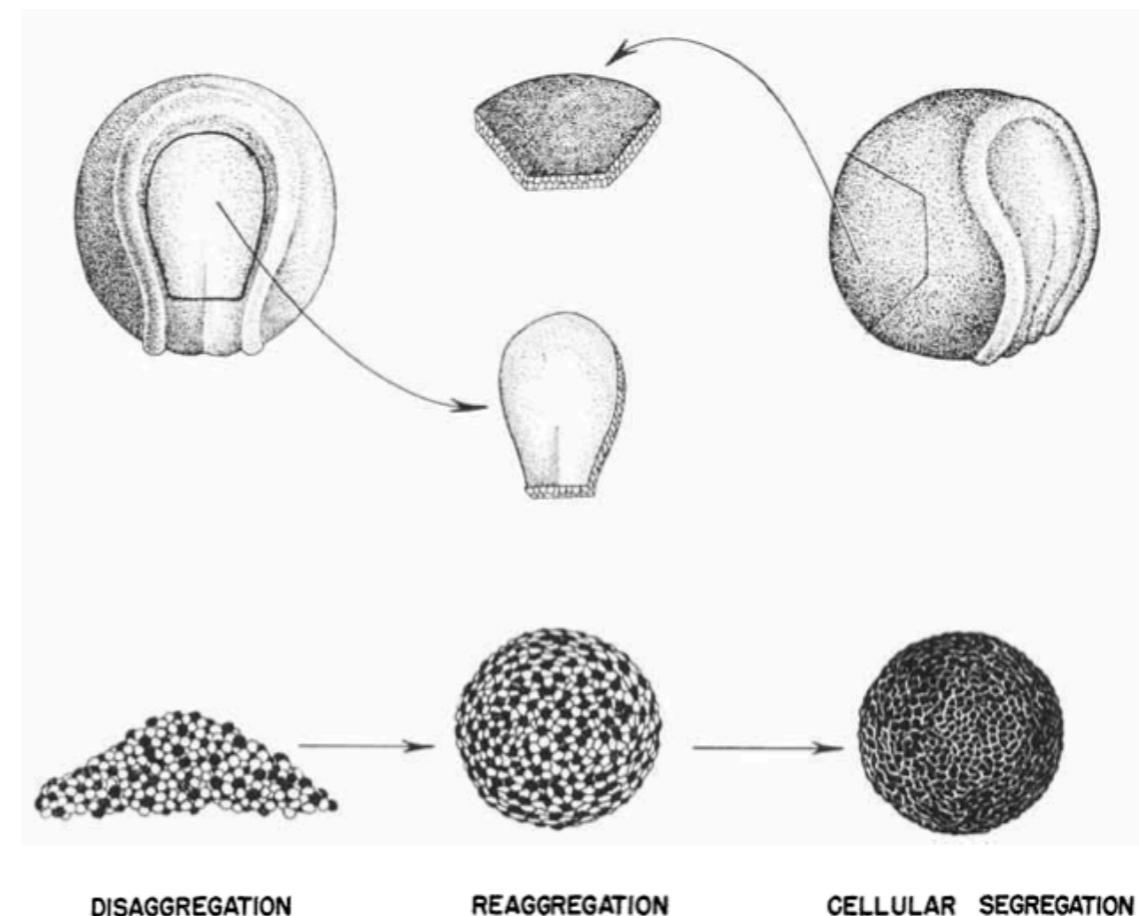


Fig. 1. An initially jagged fragment of liver that has assumed a spherical shape. Isolated from a 5-day chick embryo, it has been maintained in liquid medium at 37°C for 2 days under constant gyration. The same result is obtainable in a stationary culture.

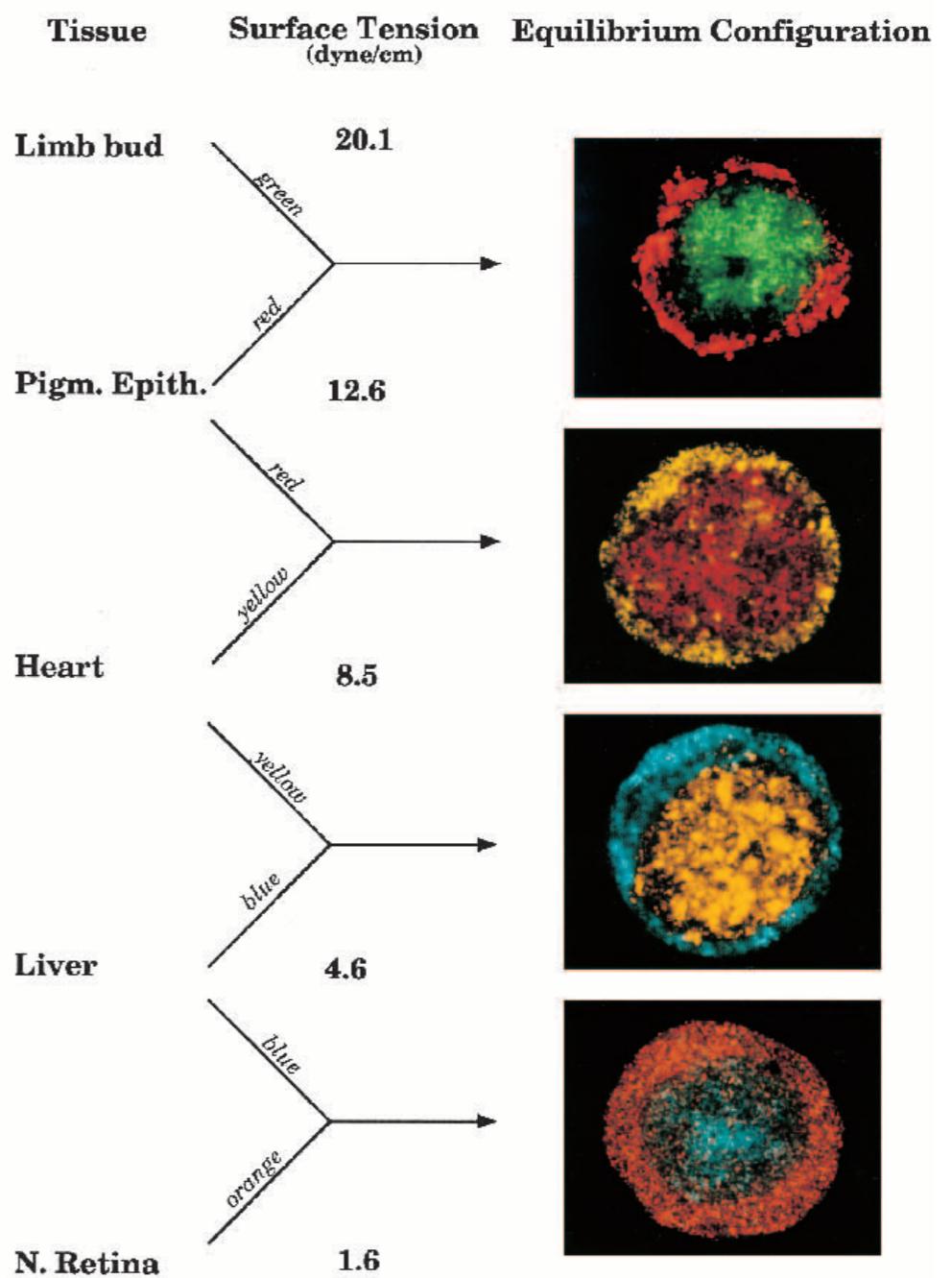
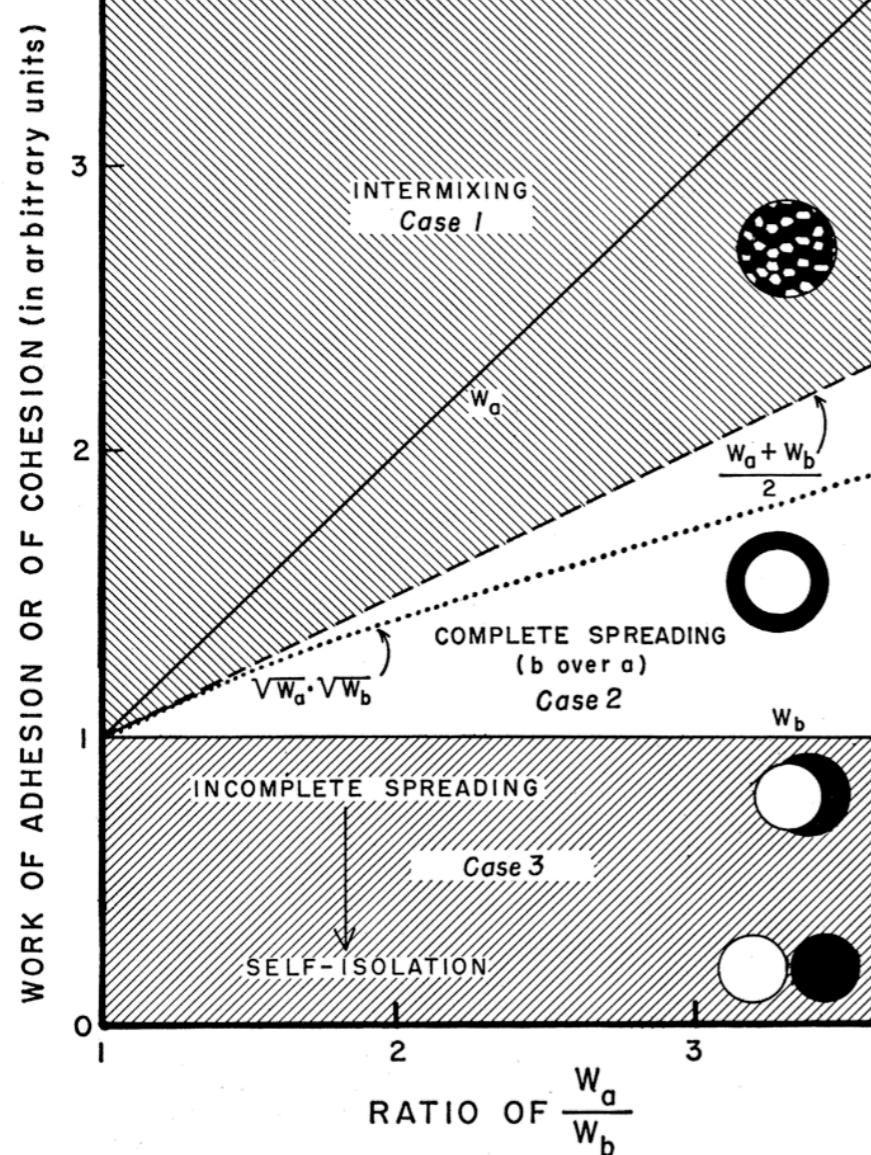


Steinberg *Science* 1963

Townes & Holtfreter *J Exp Zool* 1955

Tissue tension

Theory of sorting

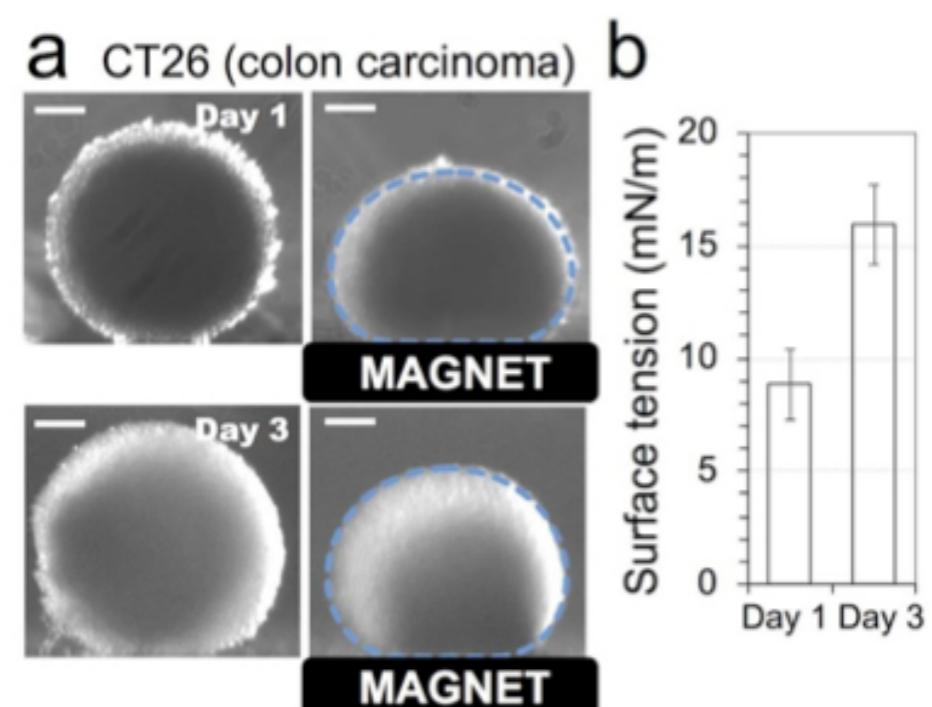
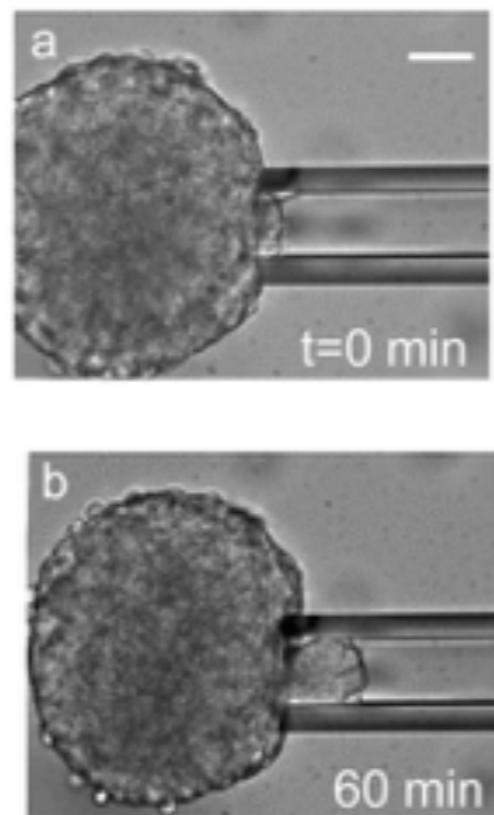
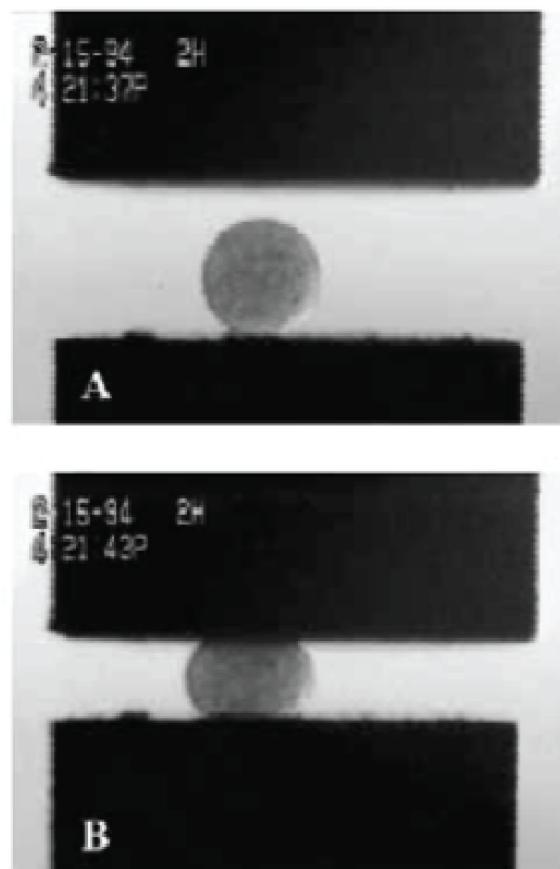


Steinberg Science 1963

Foty et al. Development 1996

Tissue tension

Measurement



Foty et al.
Physical Review Letters 1994

Guevorkian et al.
Physical Review Letters 1994

Mazuel et al.
Physical Review Letters 2015

Tissue tension

Differential adhesion or tension hypothesis?

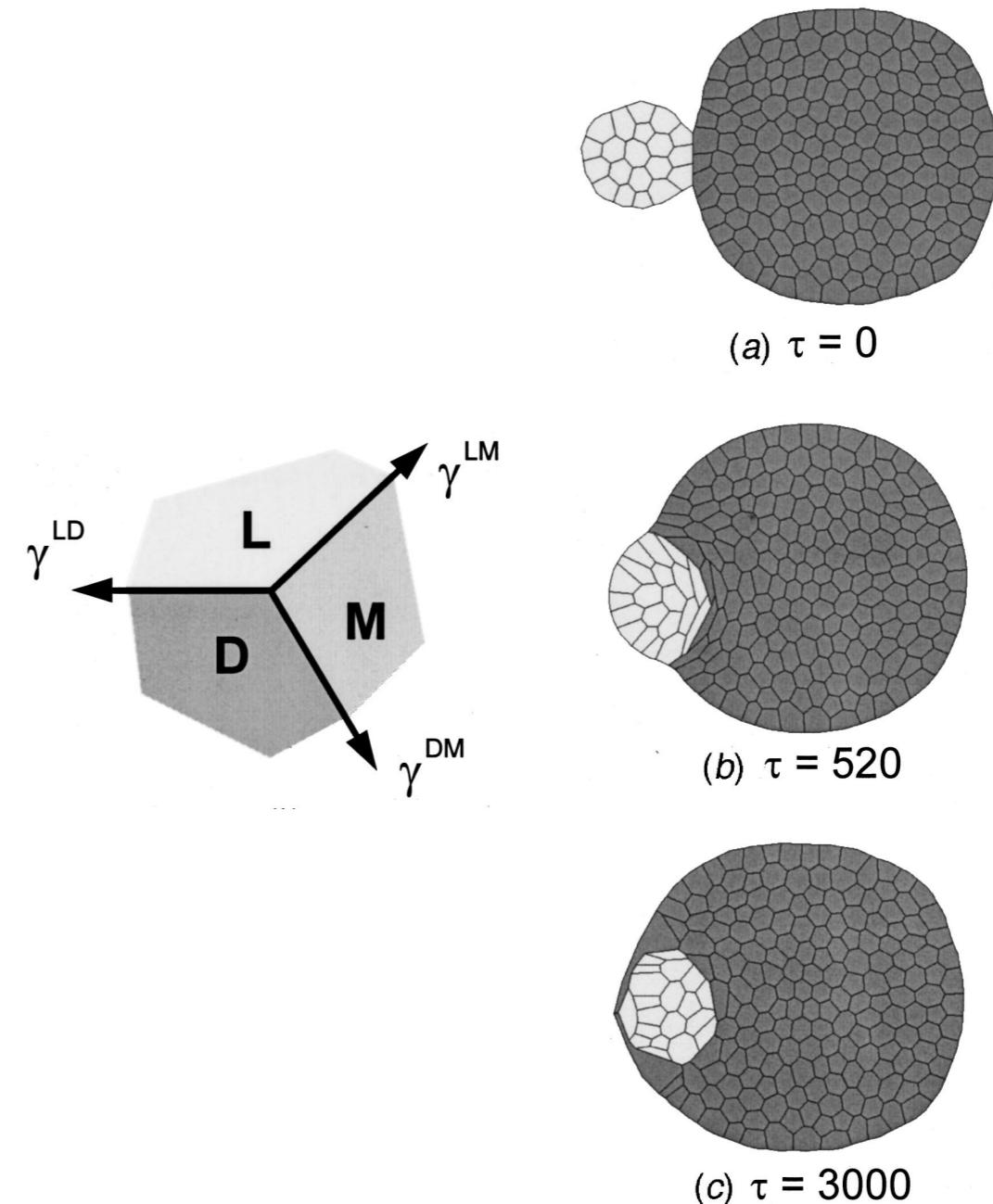
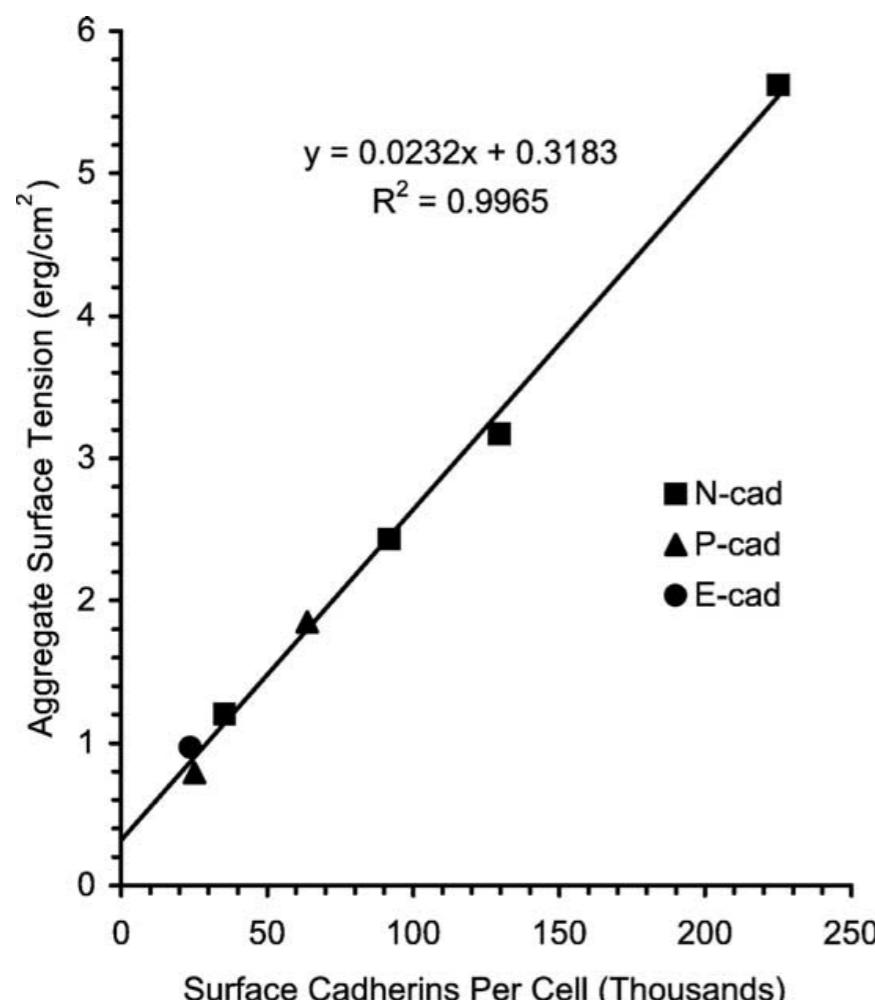
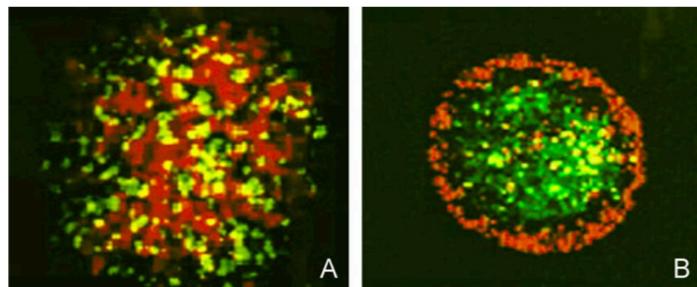
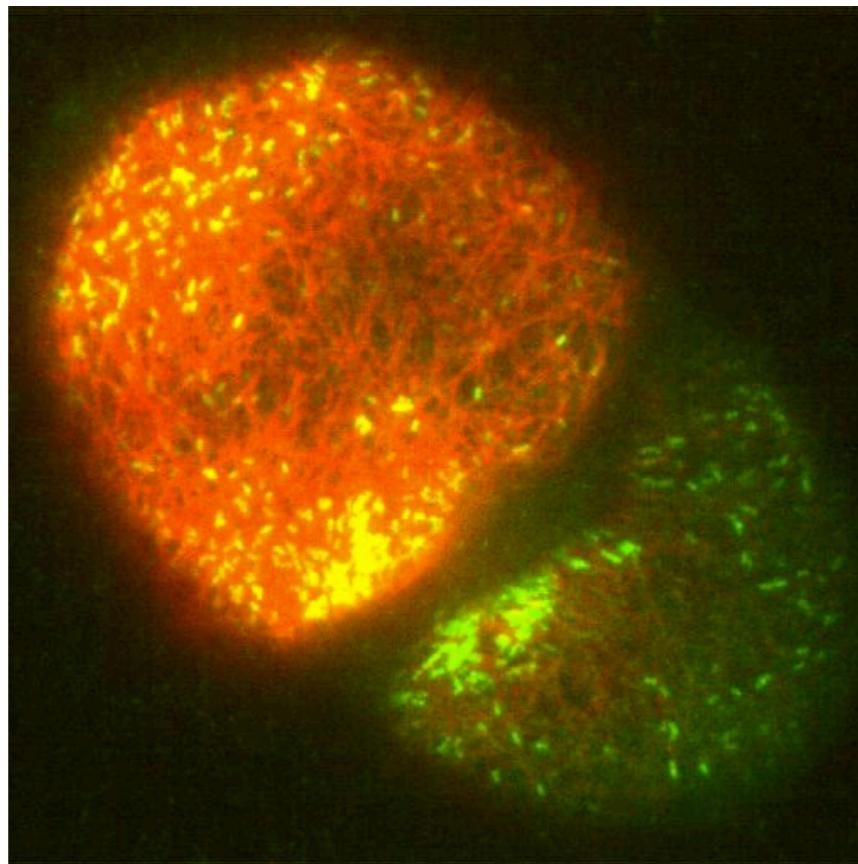
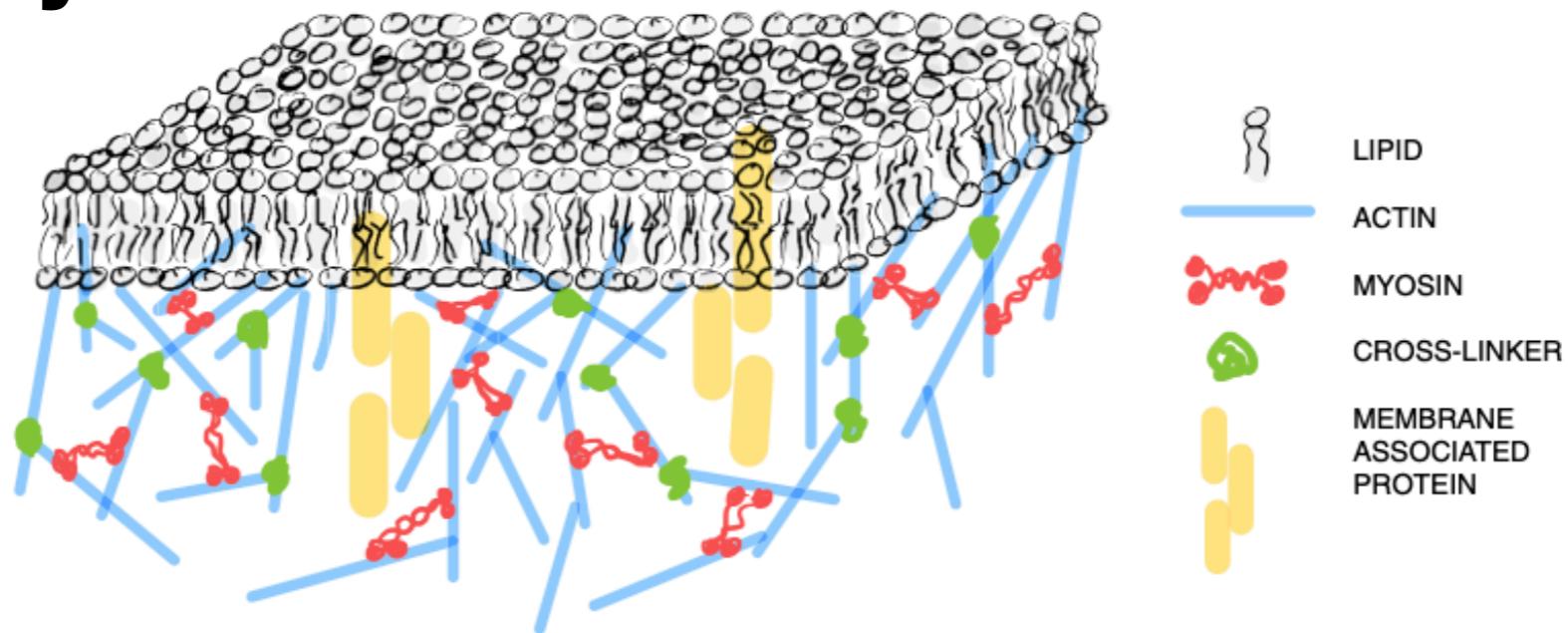


Fig. 8 Total engulfment of one type of tissue (L) by another (D) ($\gamma^{LL}=\gamma^{DD}=5$, $\gamma^{LD}=25$, $\gamma^{LM}=150$, $\gamma^{DM}=70$)

Cortical tension

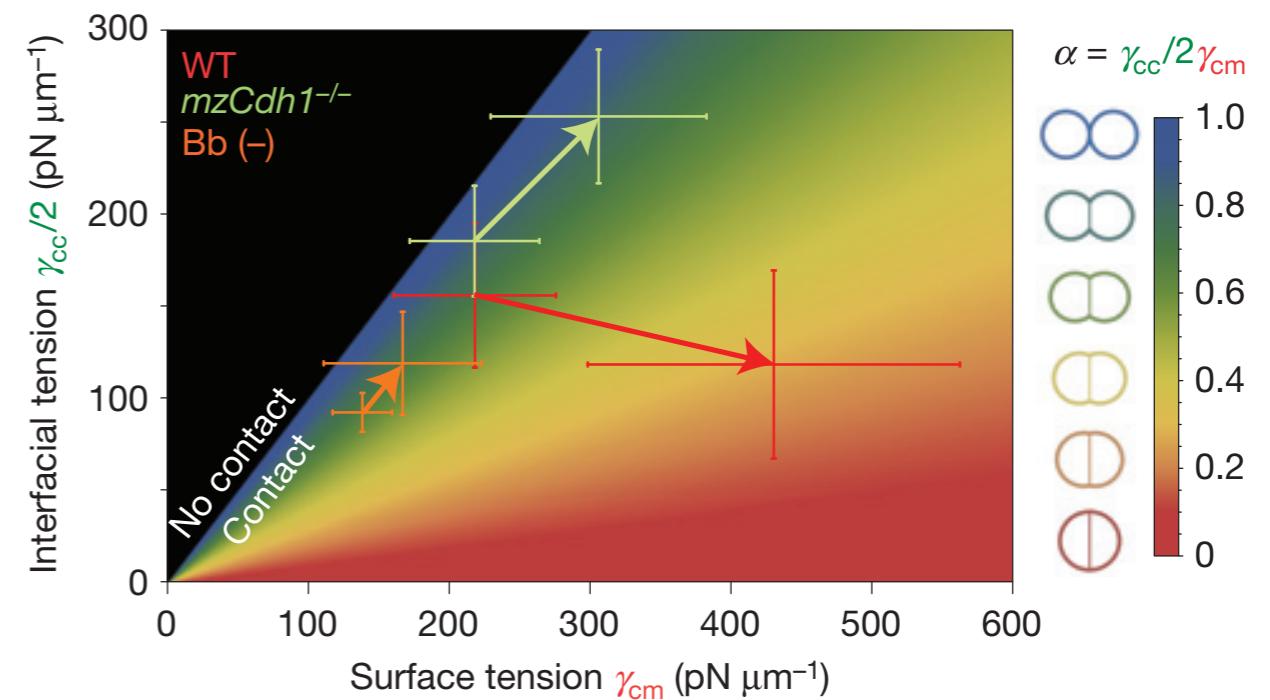
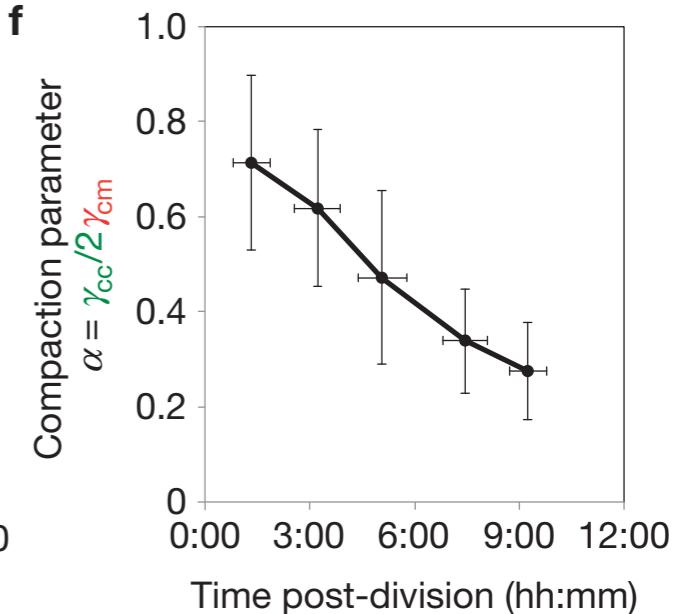
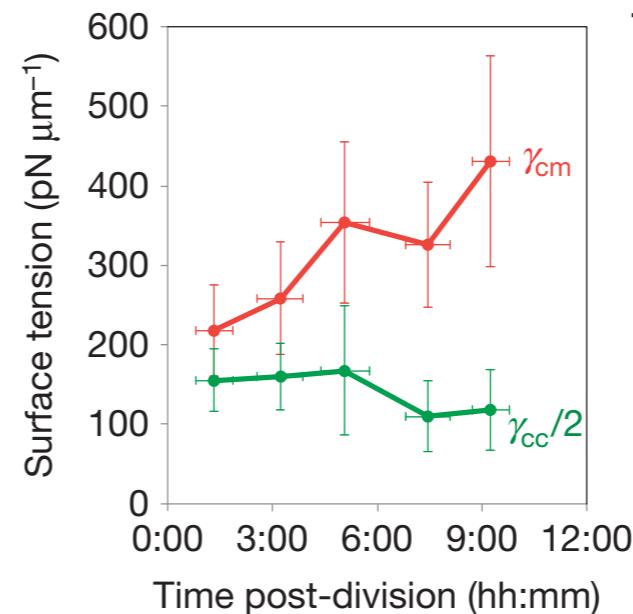
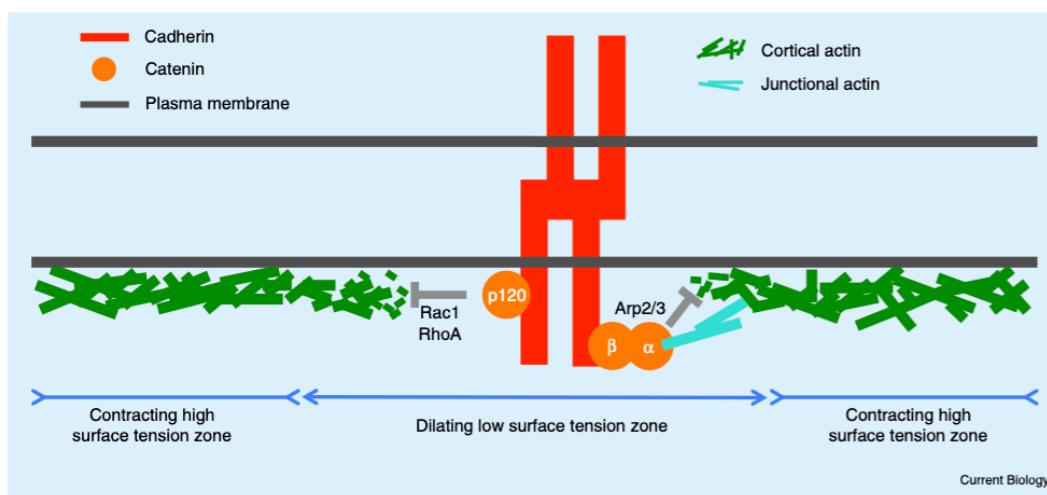
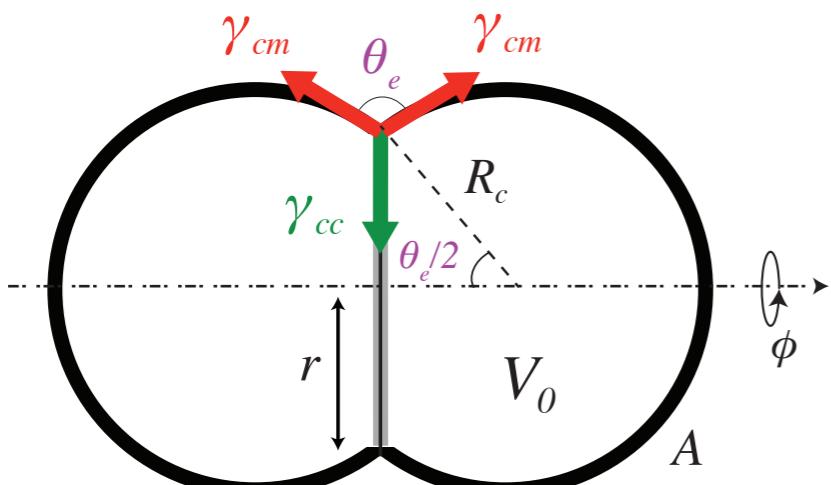
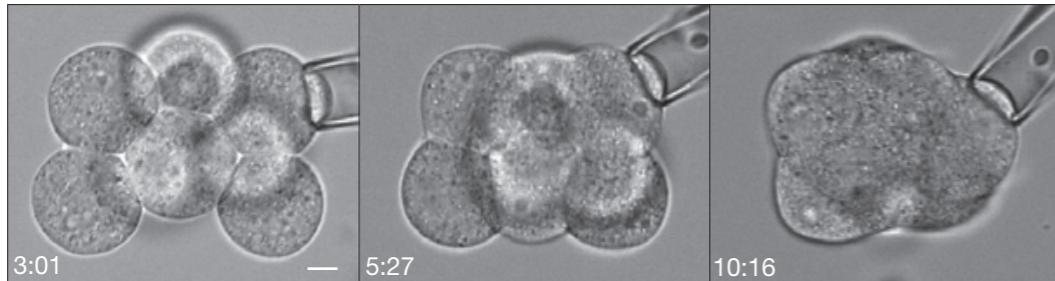
Contractility



F. Robin lab, Sorbonne U

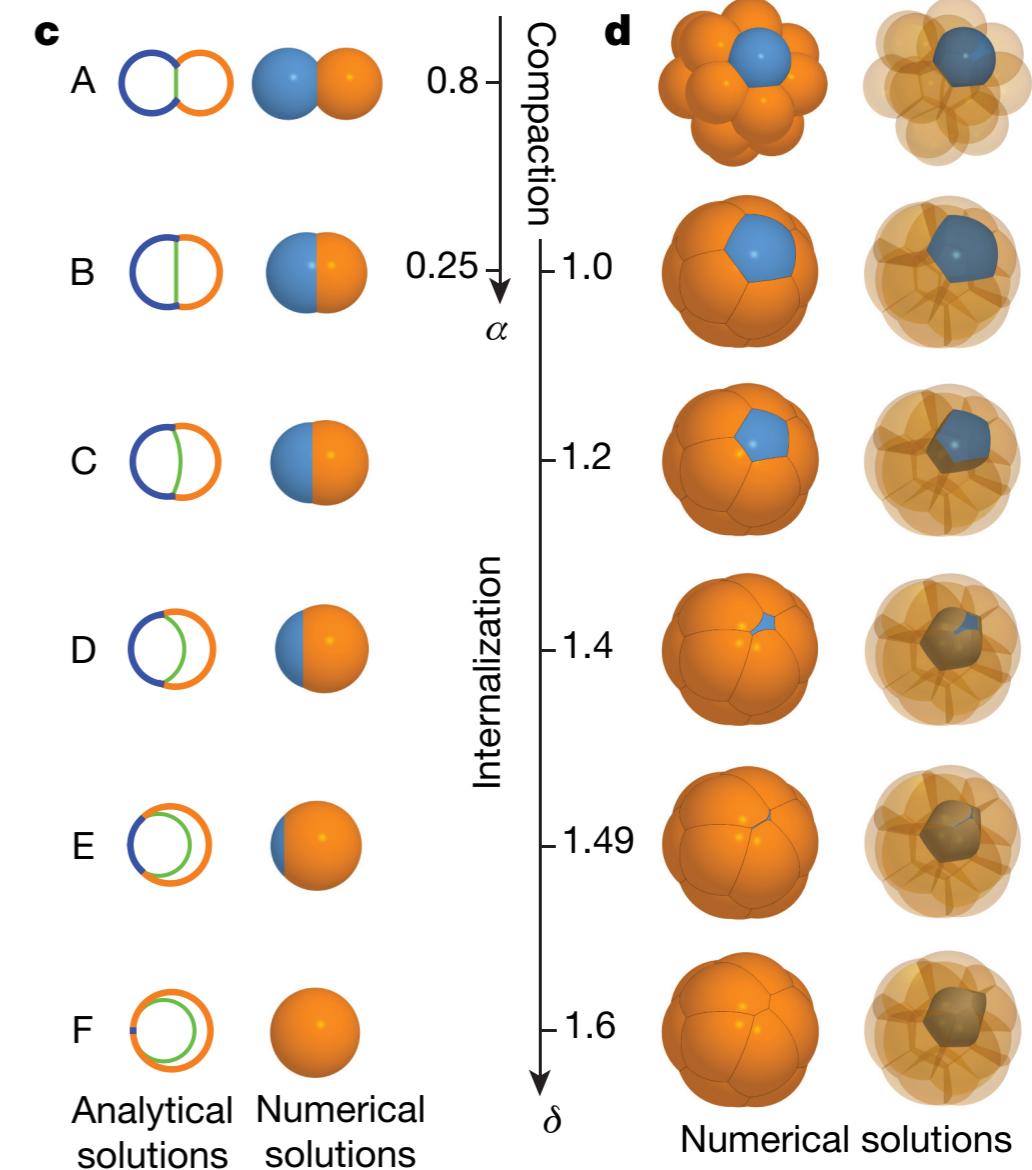
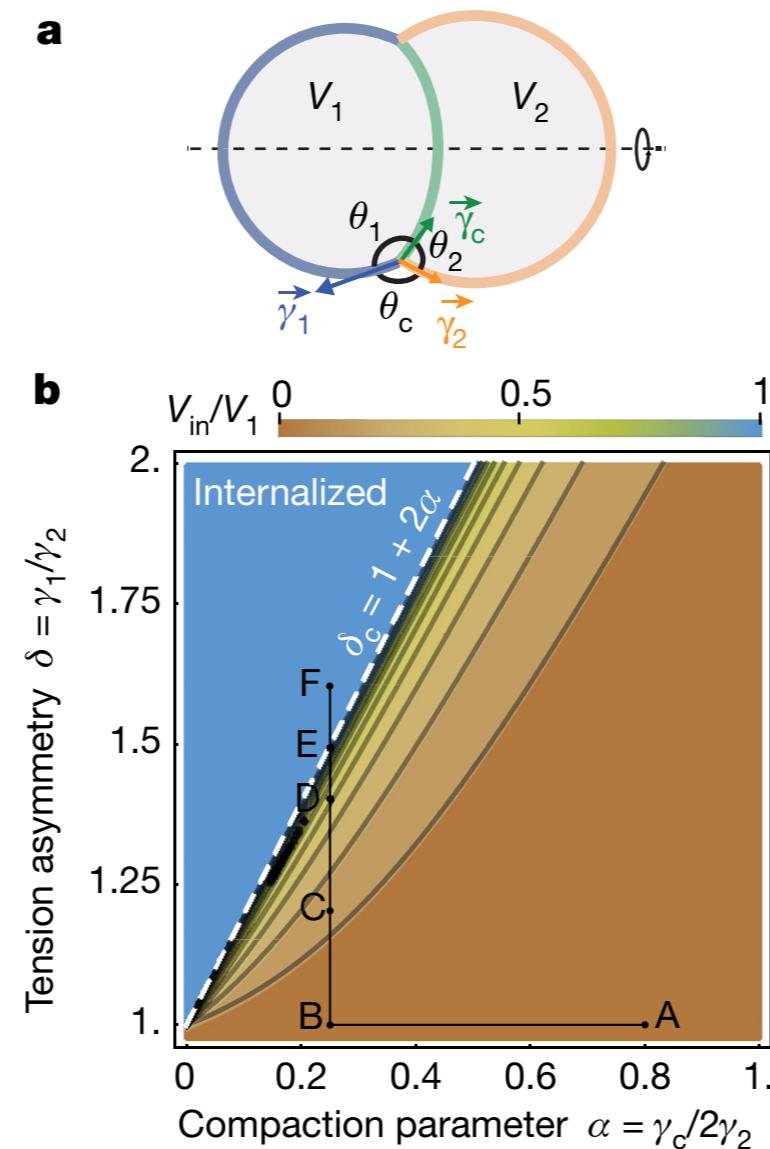
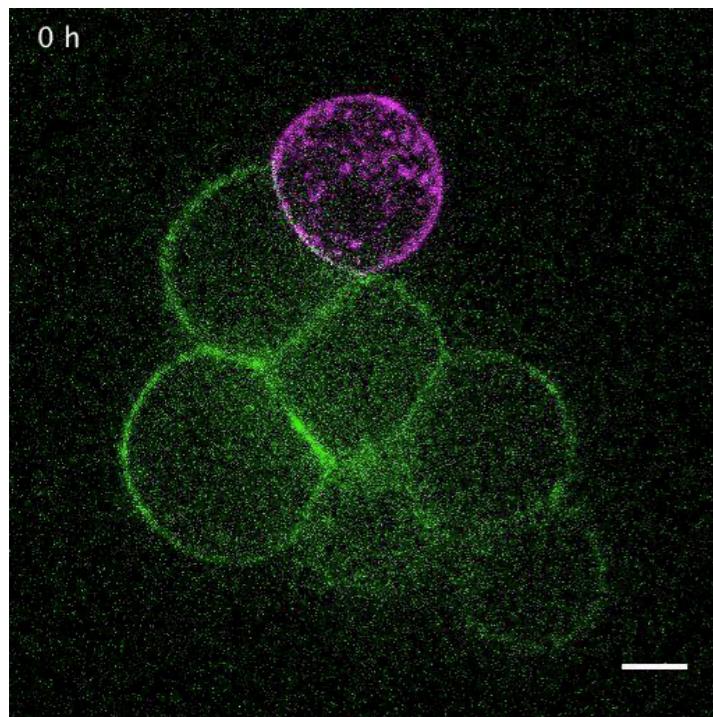
Cortical tension

Compaction and adhesion coupling



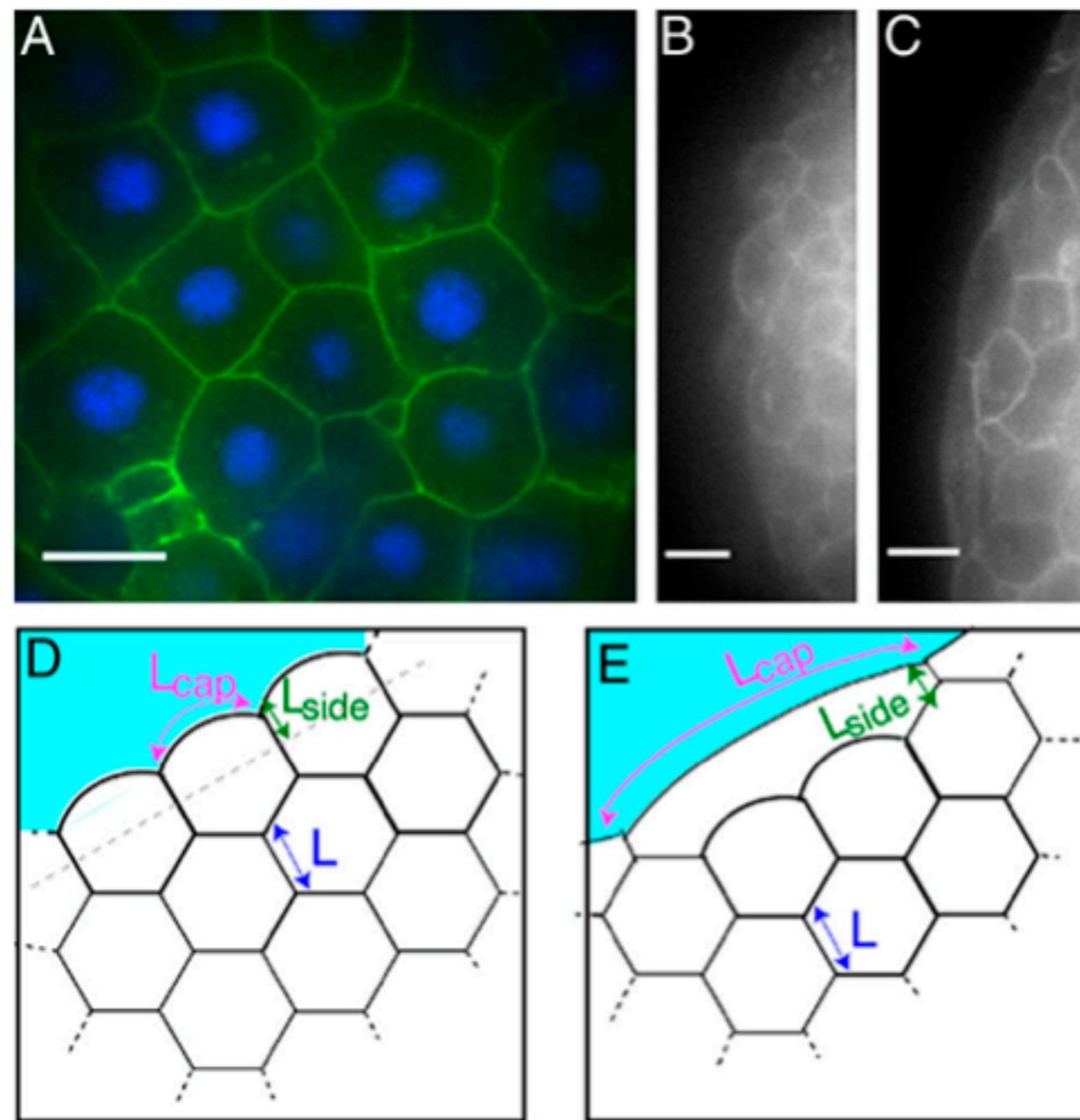
Cortical tension

Cell sorting (single cell engulfment)



Tissue tension

Lisa Manning's 2D model



Manning et al. PNAS 2010

Tissue tension

Lisa Manning's 2D model

