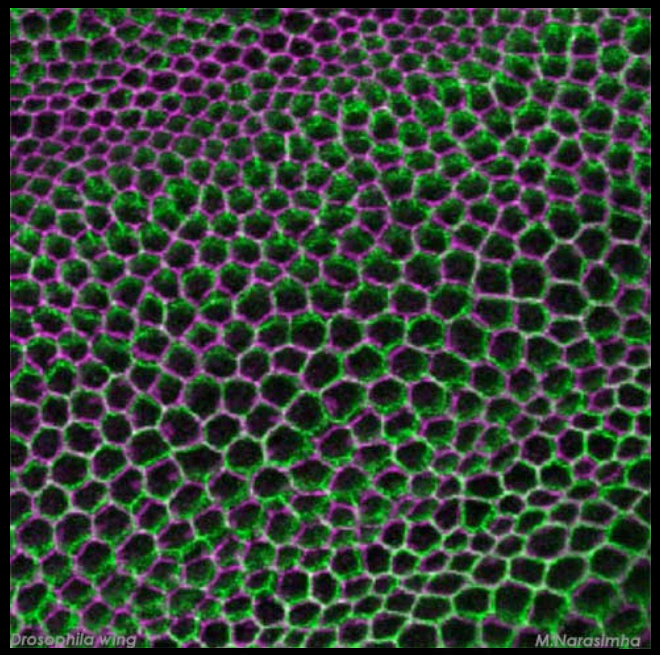
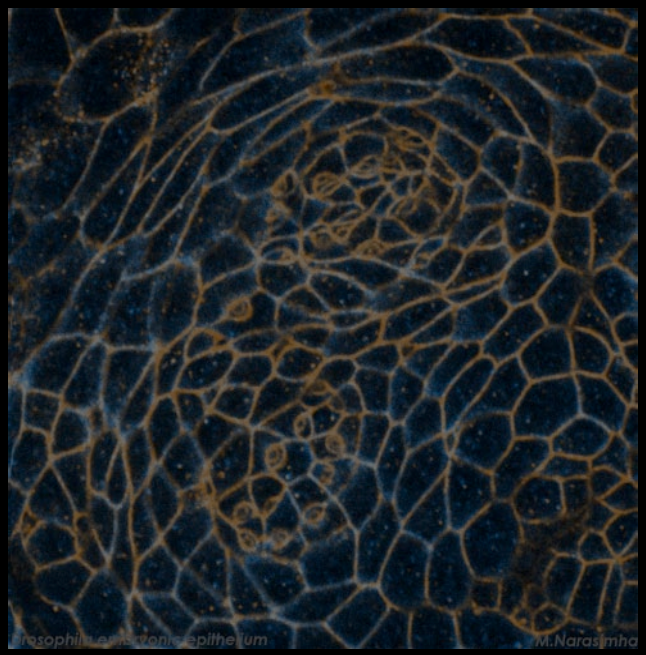
On the importance of cellular interfaces in pattering living aggregates:

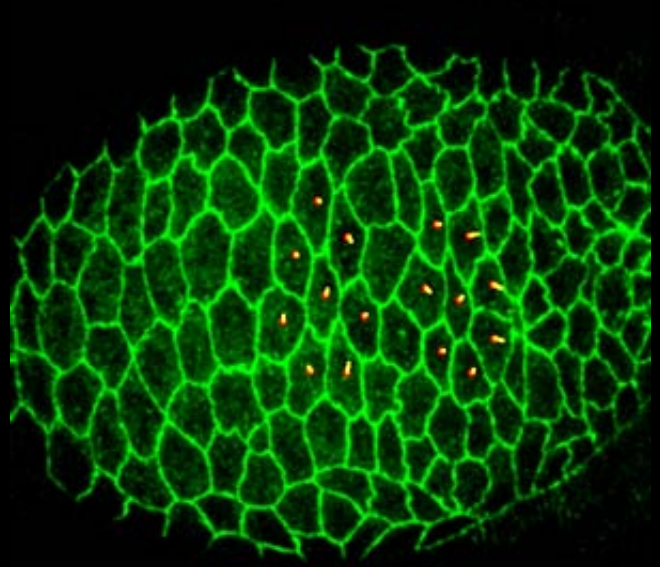
Maithreyi Narasimha, TIFR Mumbai

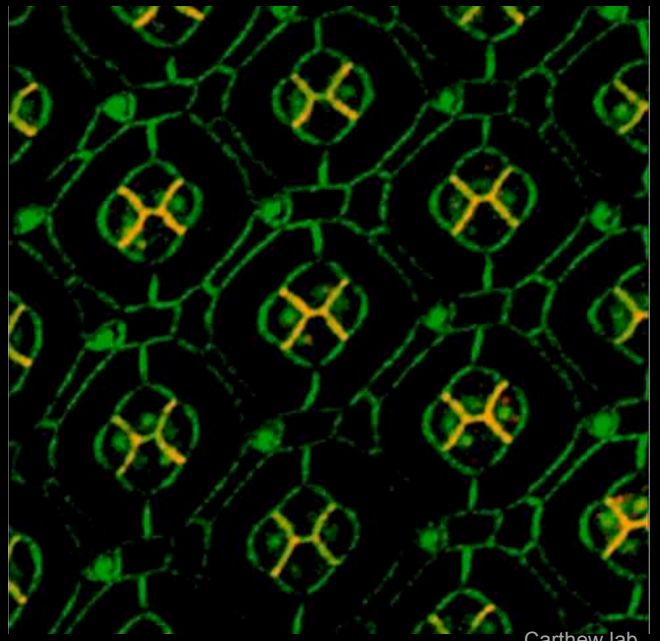
NAG 2010 Bengaluru July 2010

Tissues: living aggregates with complex patterns





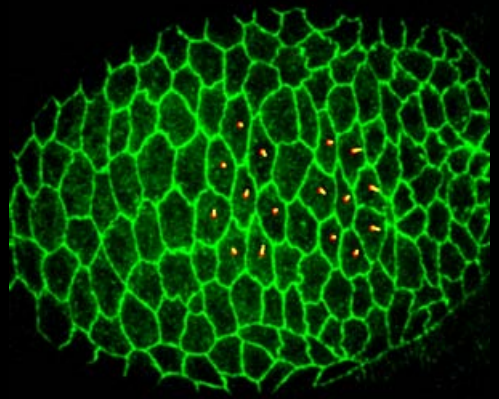




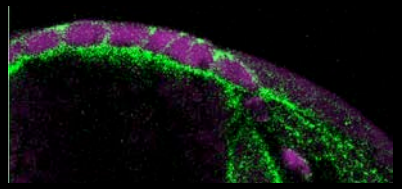
Form
Function

Information
Integration

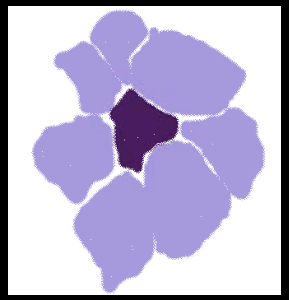
Tissue



Topology



Interfaces



Diversity

Multiple
levels

Cells

Dynamics

Molecules

How to pattern living aggregates:
where is it written?

Mechanisms that generate diversity of tissue form and function

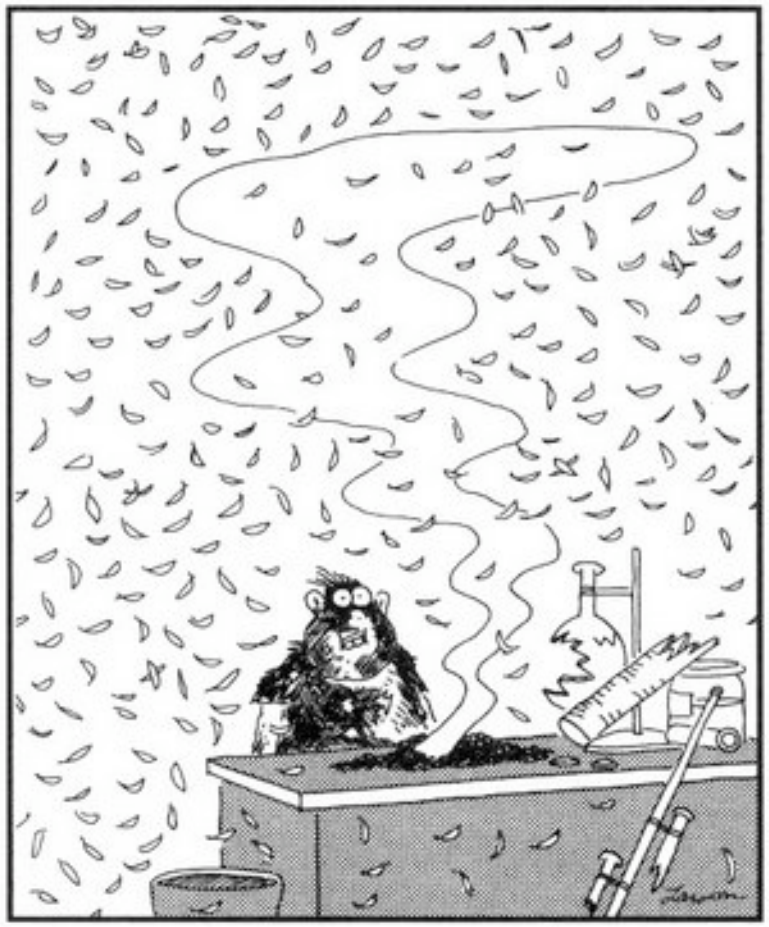
Basis of tissue reorganisation

Understanding disease: cancer spread, wound healing

Great moments in evolution: Multicellularity

Comparisons of several independently evolved pairs of multicellular and unicellular relatives indicate that transitions to multicellularity are typically associated with increases in genes involved in cell differentiation, cell-cell communication, and adhesion.

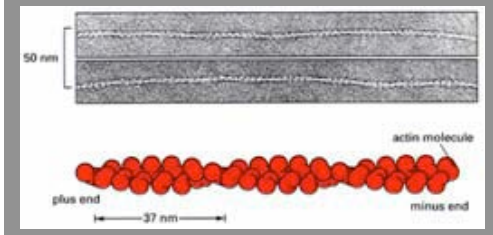
Antonis Rokas
Annual Review of Genetics,2008



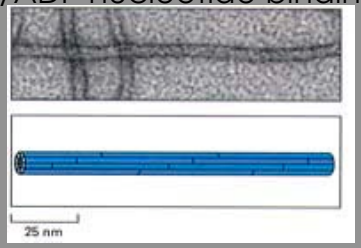
God as a kid tries to make a chicken in his room.

Cell Adhesion Molecules:

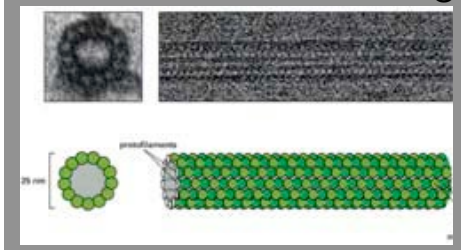
enabling aggregation and communication



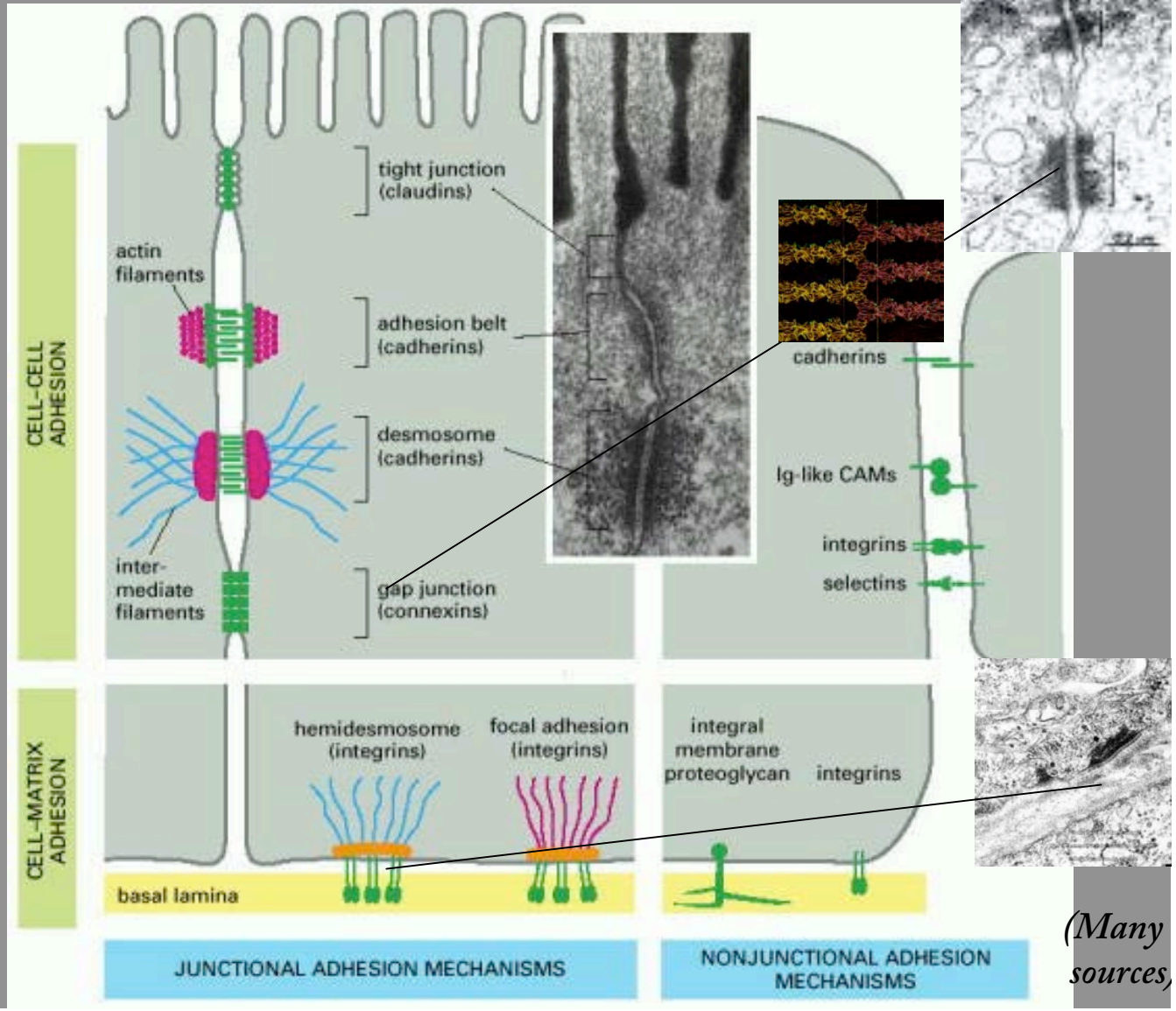
Ø 5-9 nm
- polar filaments (+/- end)
- actin monomers
- ATP/ADP nucleotide binding



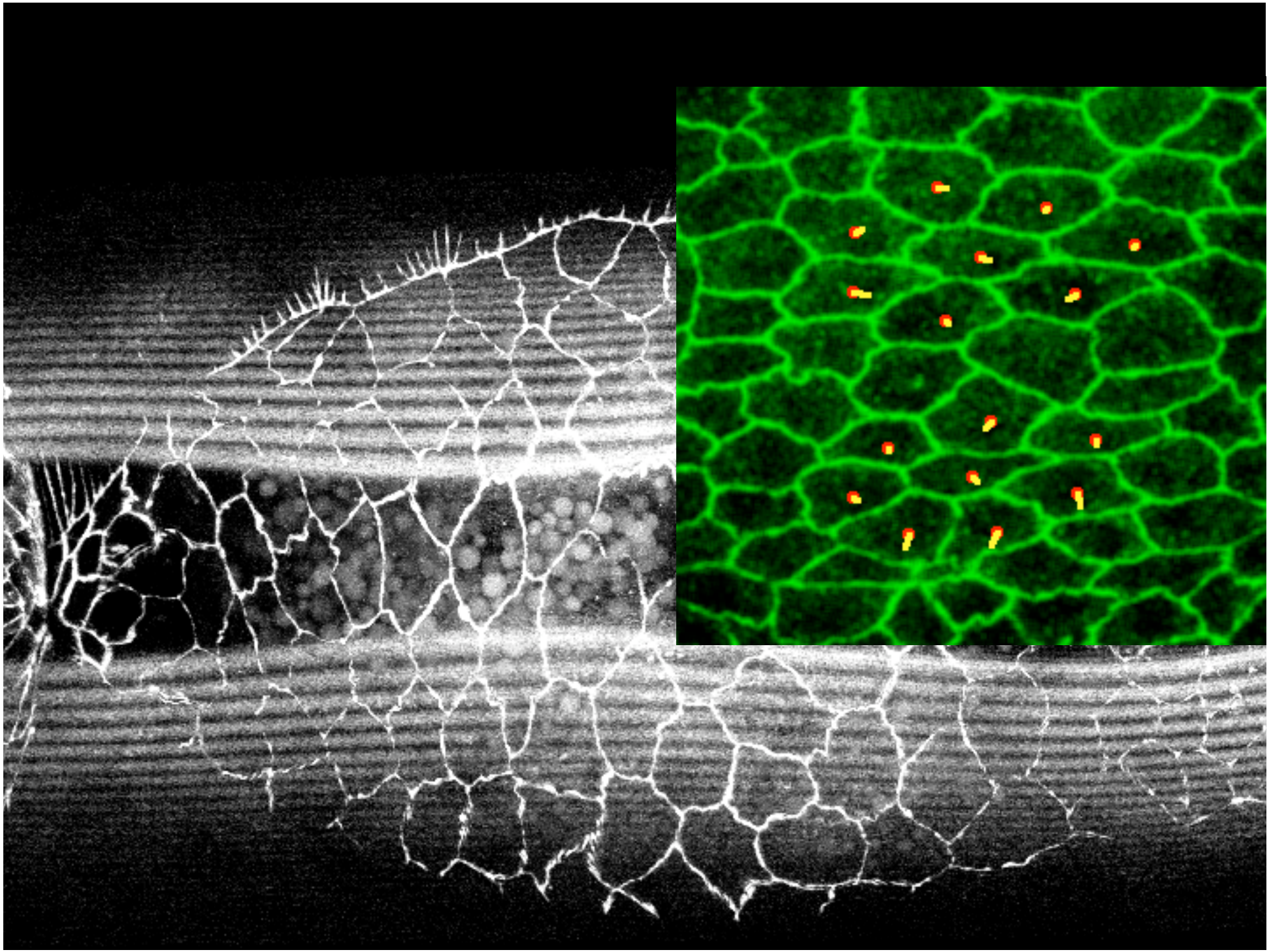
Ø 10 nm
- non-polar filaments
- tetramers
- no nucleotide binding



Ø 25 nm
- polar filaments (+/- end)
- α/β tubulin hetero-dimers
- GTP/GDP nucleotide binding

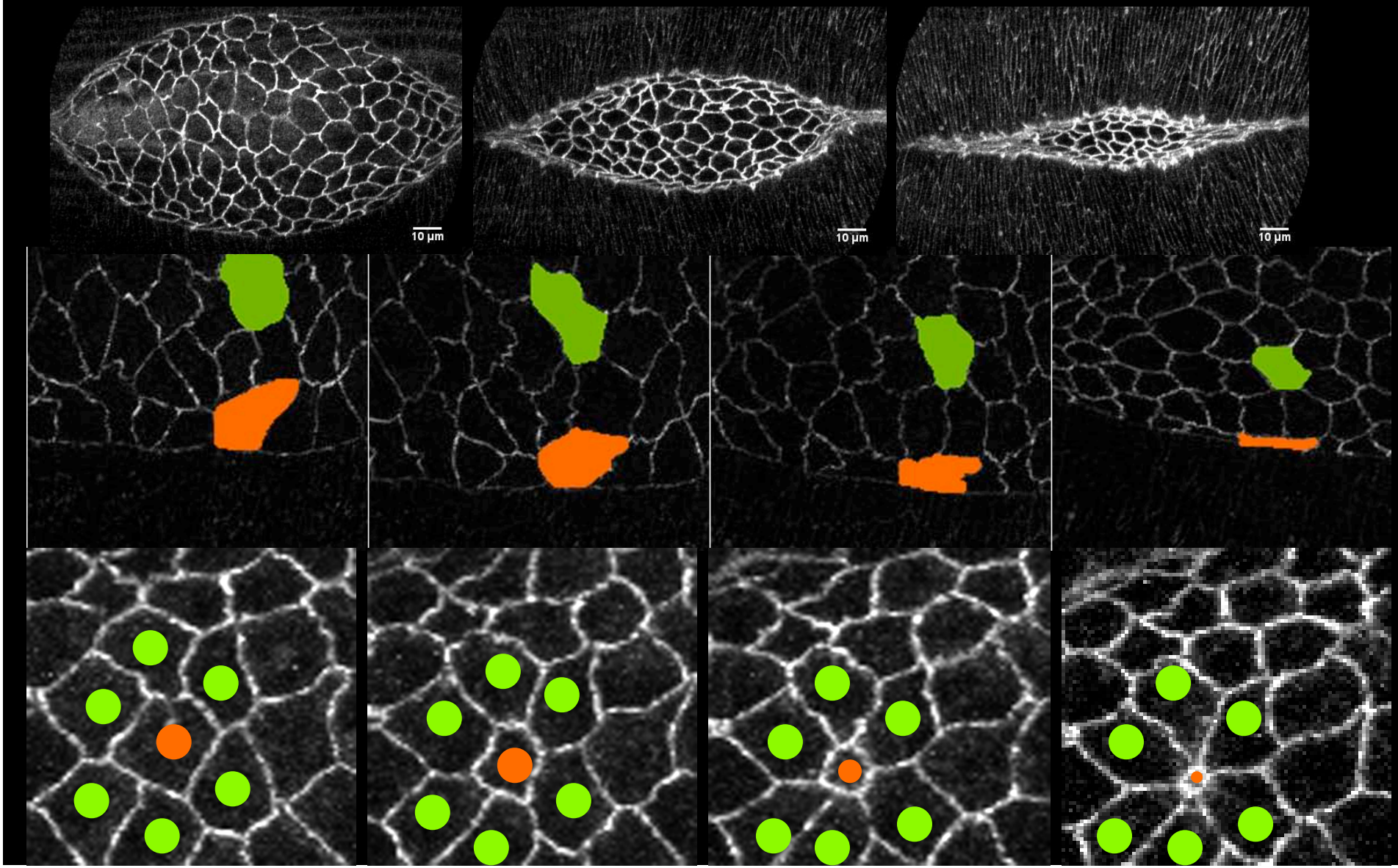


(Many sources)

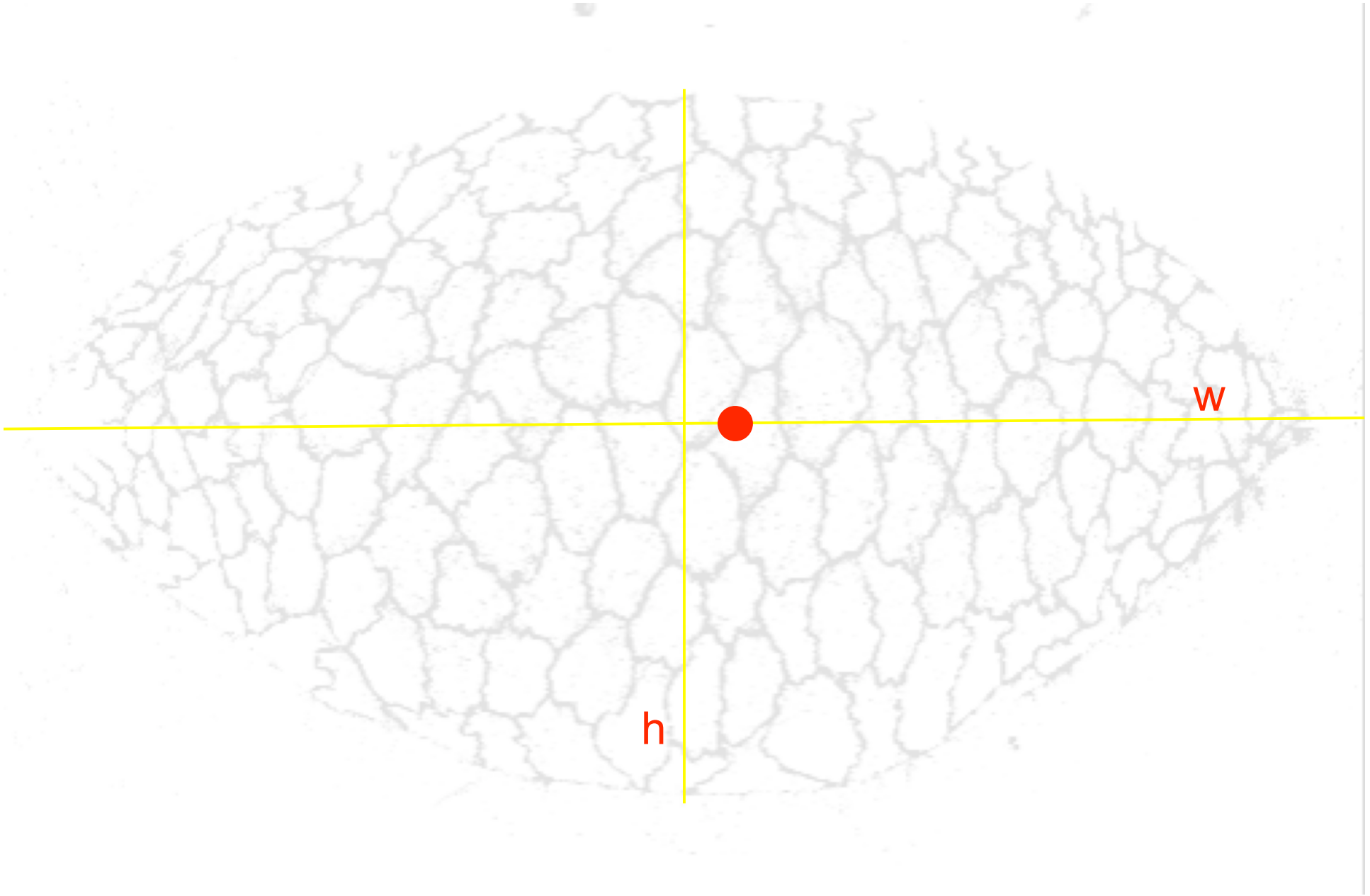


Evolution of pattern:

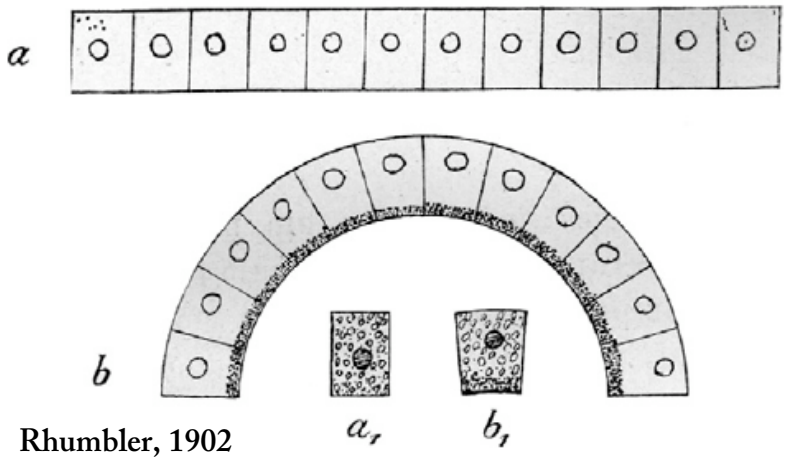
complex, coordinated spatiotemporal dynamics



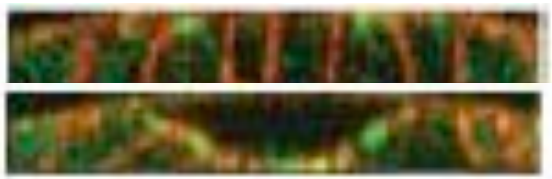
How is heterogeneity in spatiotemporal dynamics patterned and accomodated in tissues?


w
h

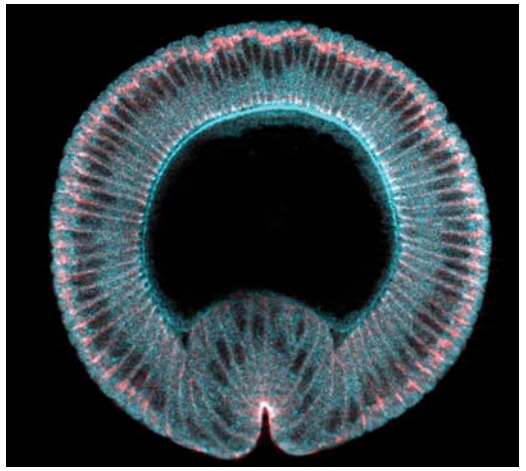
Apical constriction



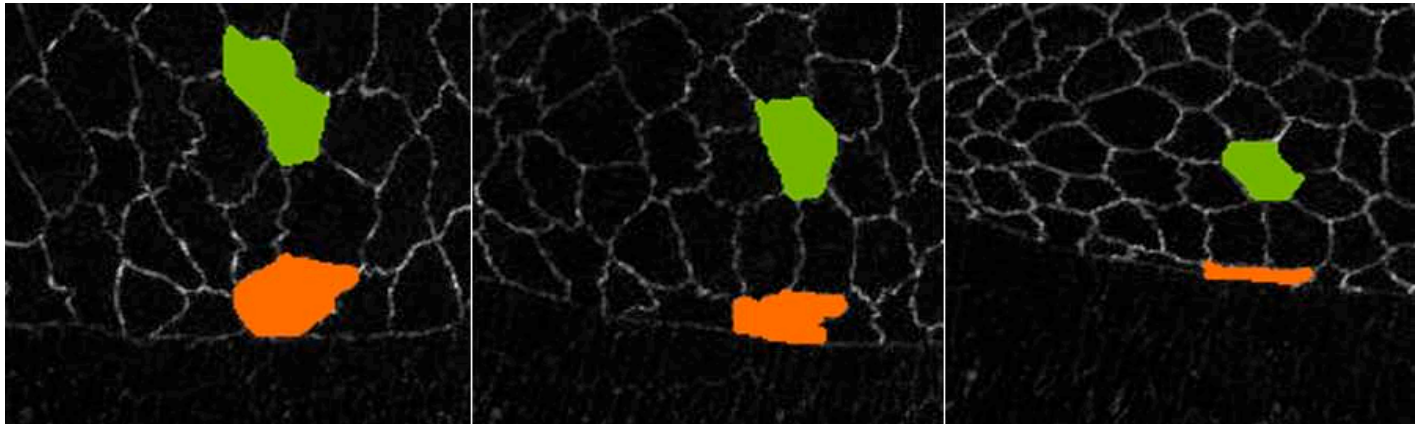
Rhumbler, 1902



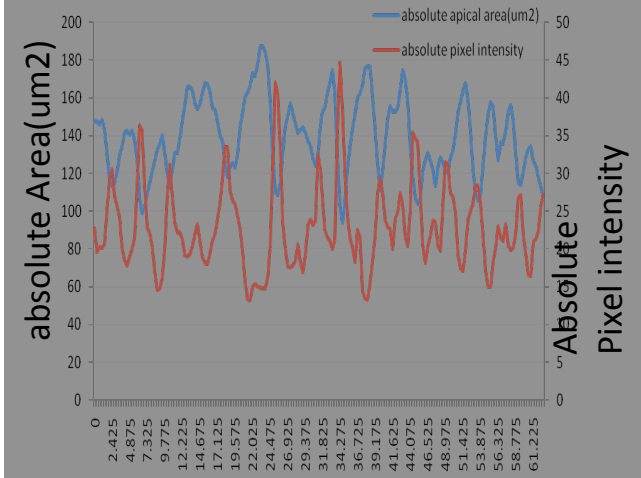
Martin, Wieschaus 2009

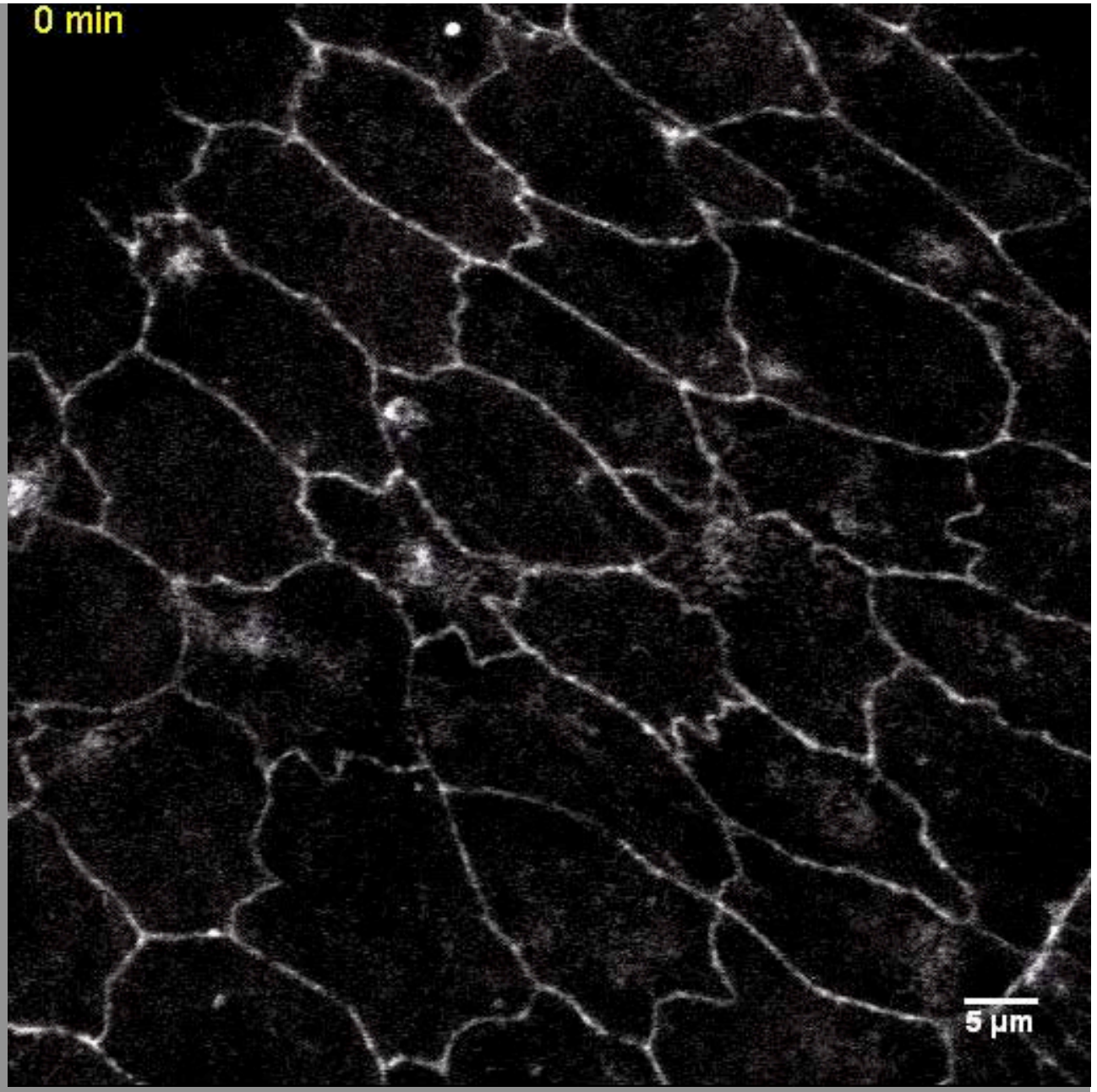


Koelsch, Leptin 2008



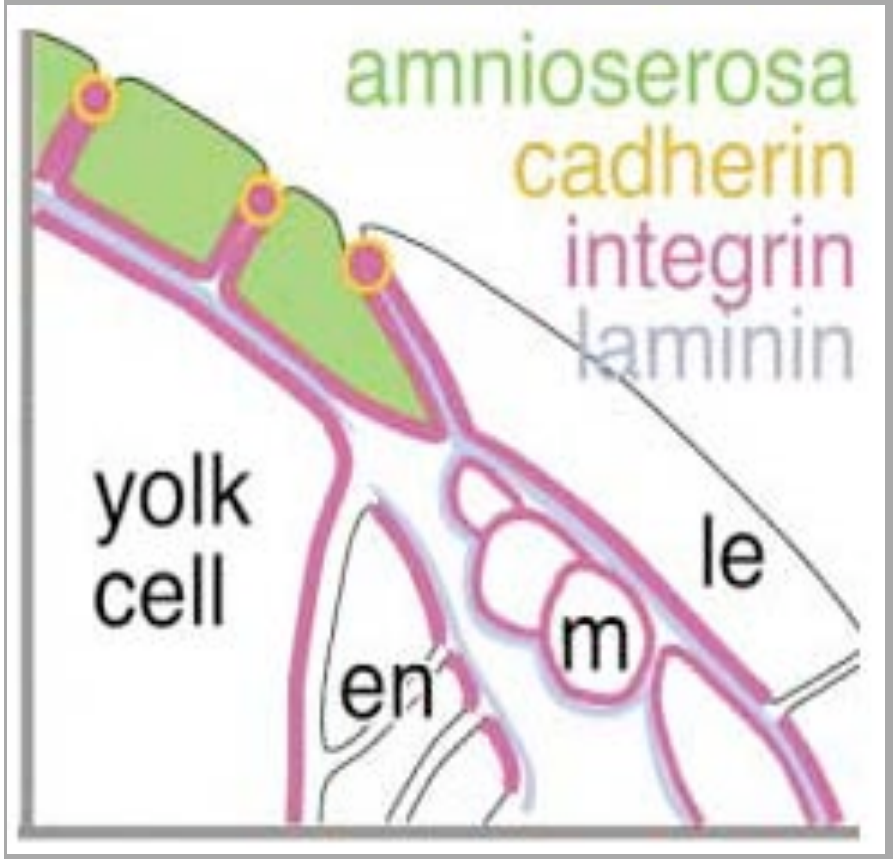
Surat Saravanan

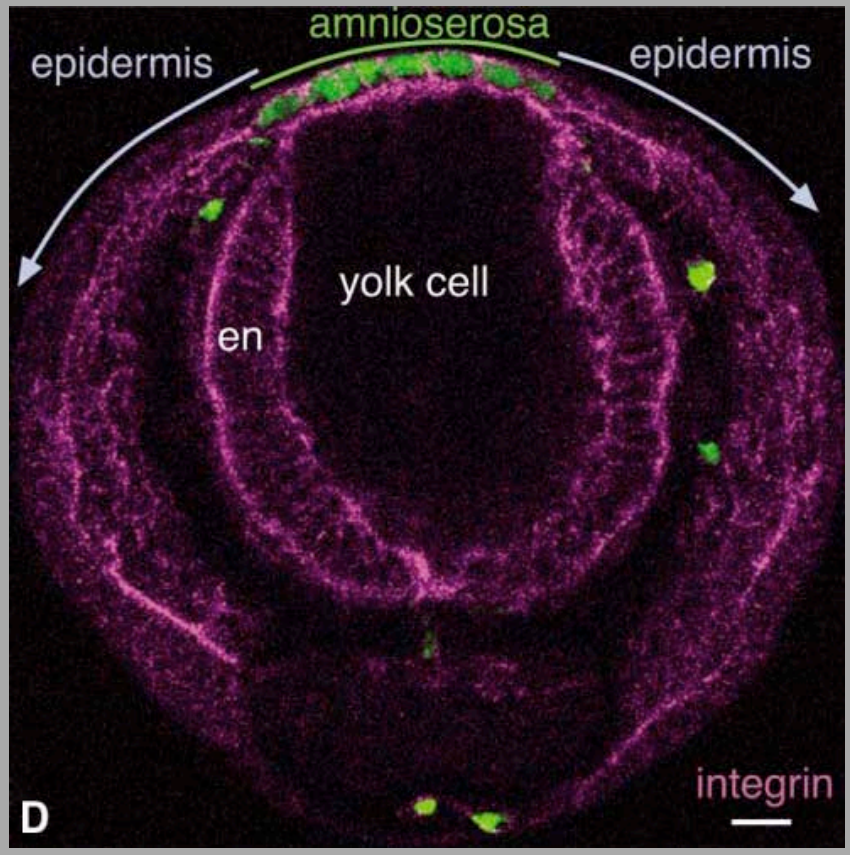




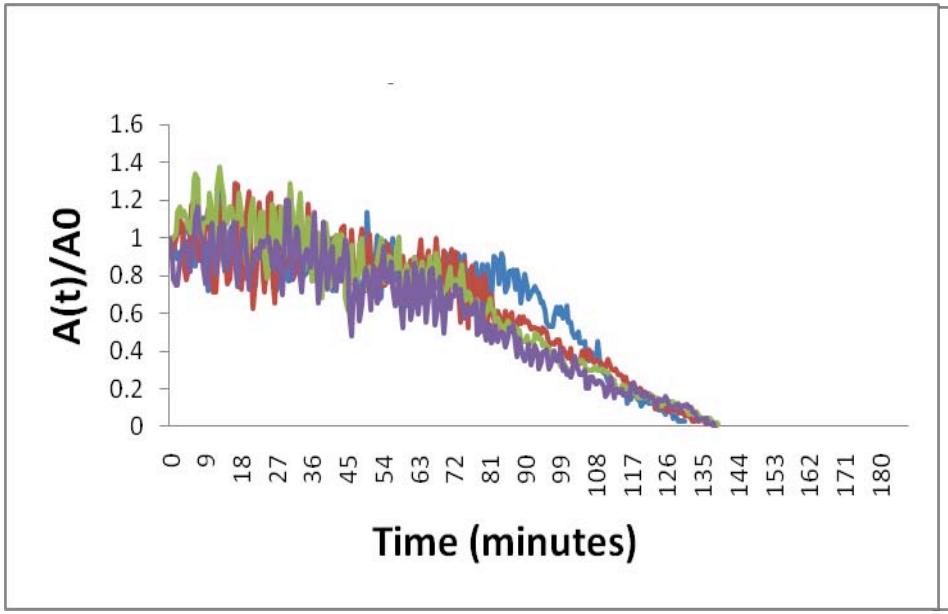
Surat Saravanan

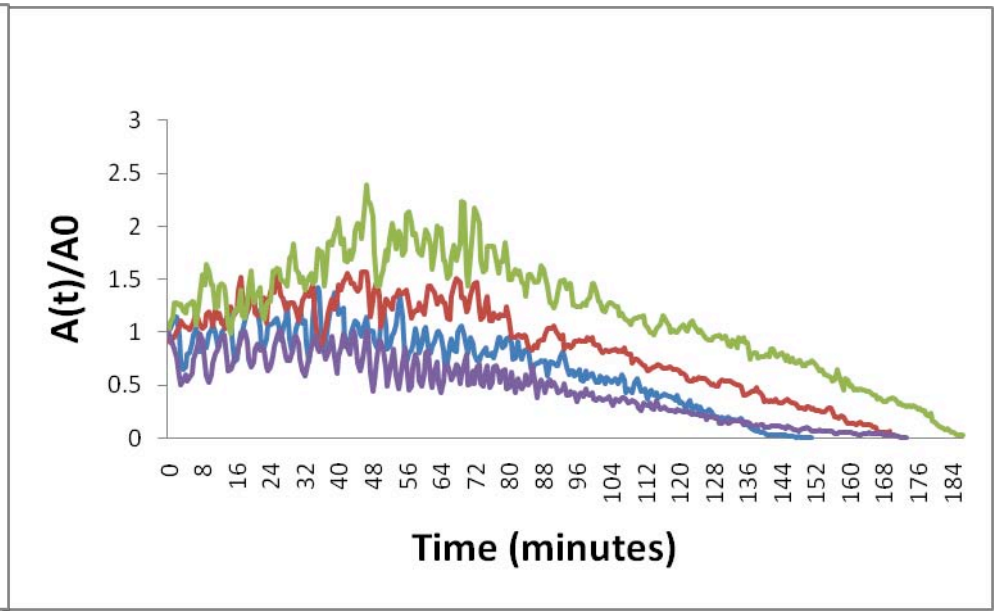
Cells at the boundary





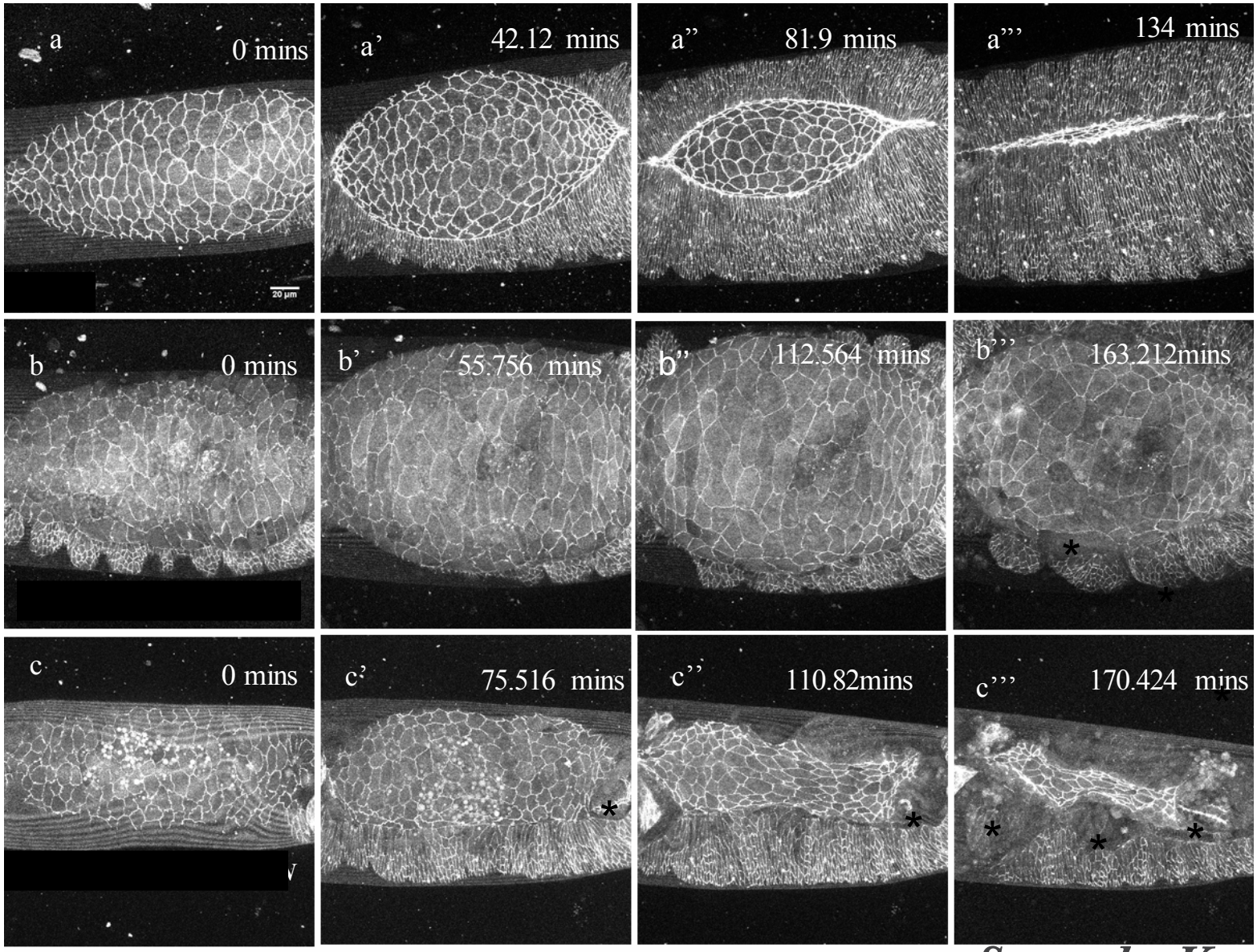
Narasimha and Brown, 2004


A(t)/A0
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0 9 18 27 36 45 54 63 72 81 90 99 108 117 126 135 144 153 162 171 180
Time (minutes)

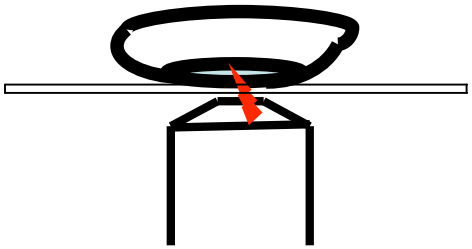

A(t)/A0
3
2.5
2
1.5
1
0.5
0
0 8 16 24 32 40 48 56 64 72 80 88 96 104 112 120 128 136 144 152 160 168 176 184
Time (minutes)

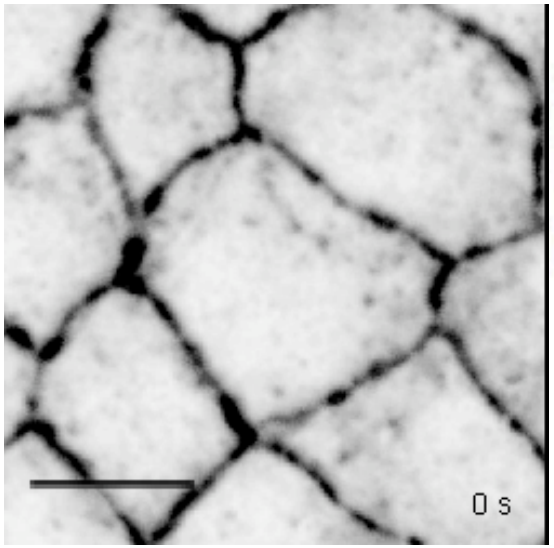
Gopi Shah

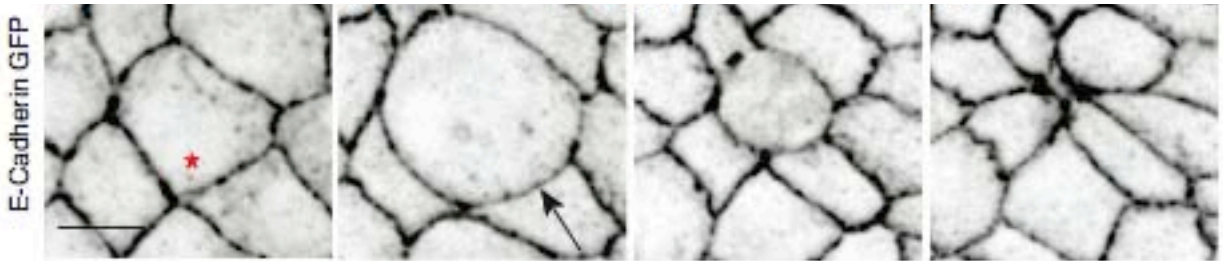
Altered cell dynamics across the interface



Sumegha Kapoor







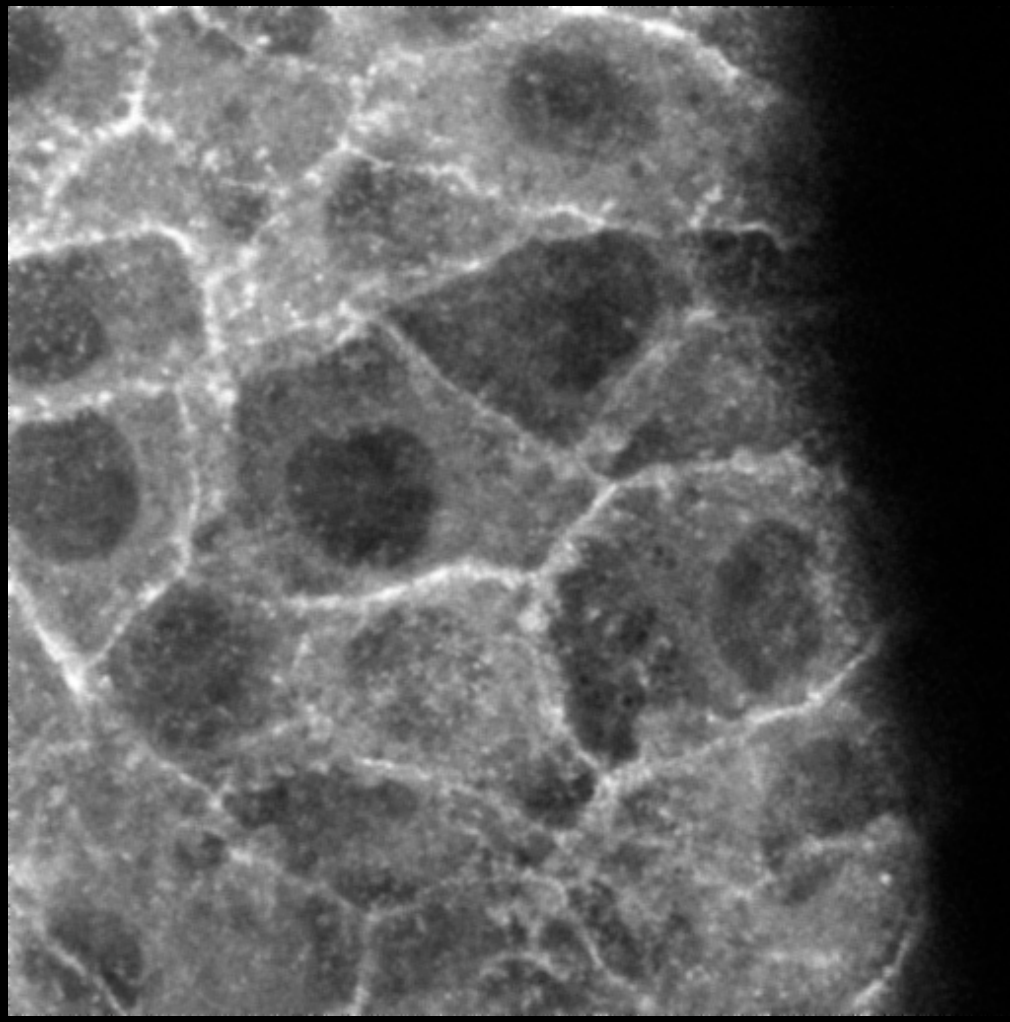
Meghana C

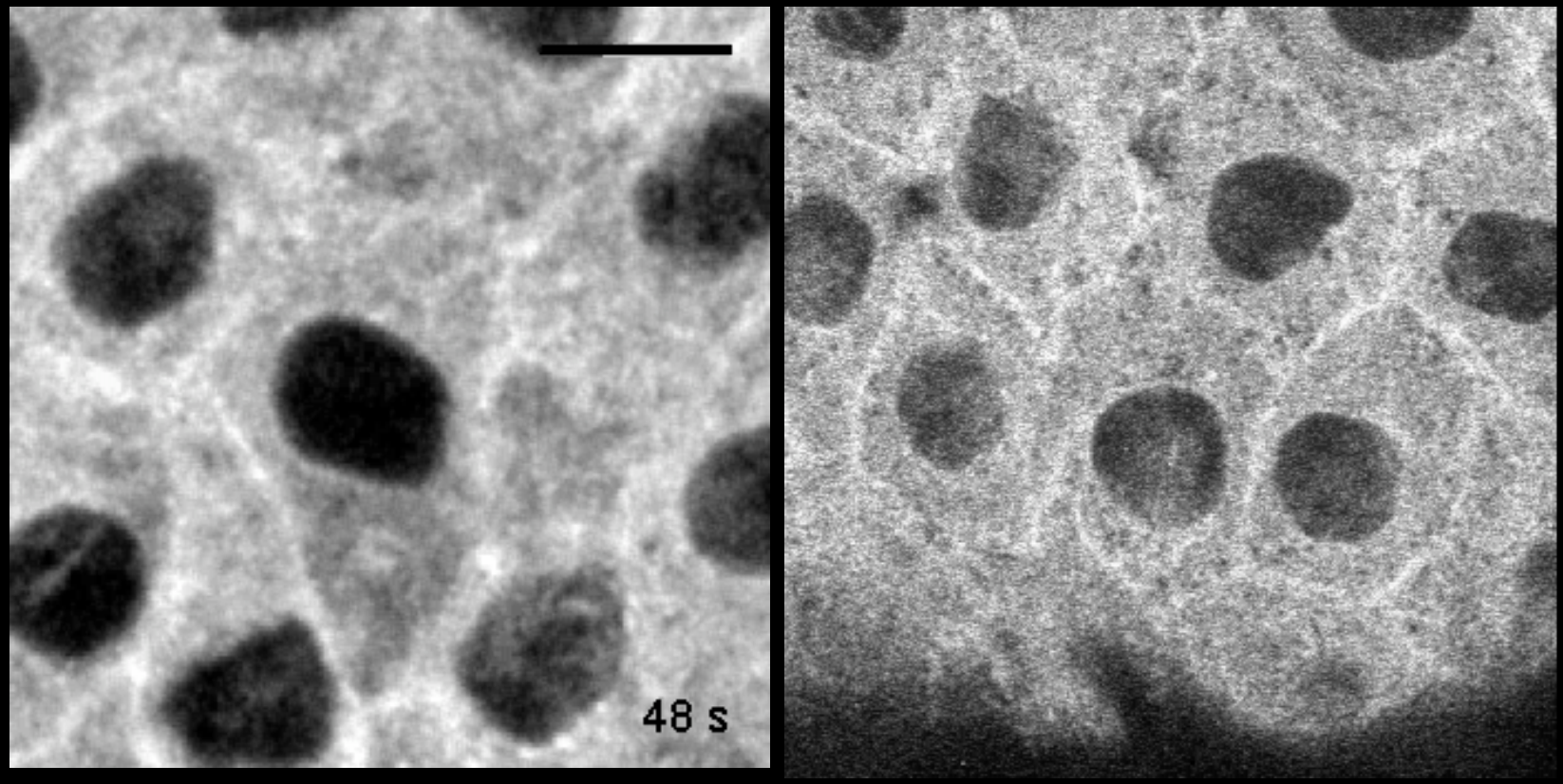
Nisha Ramdas

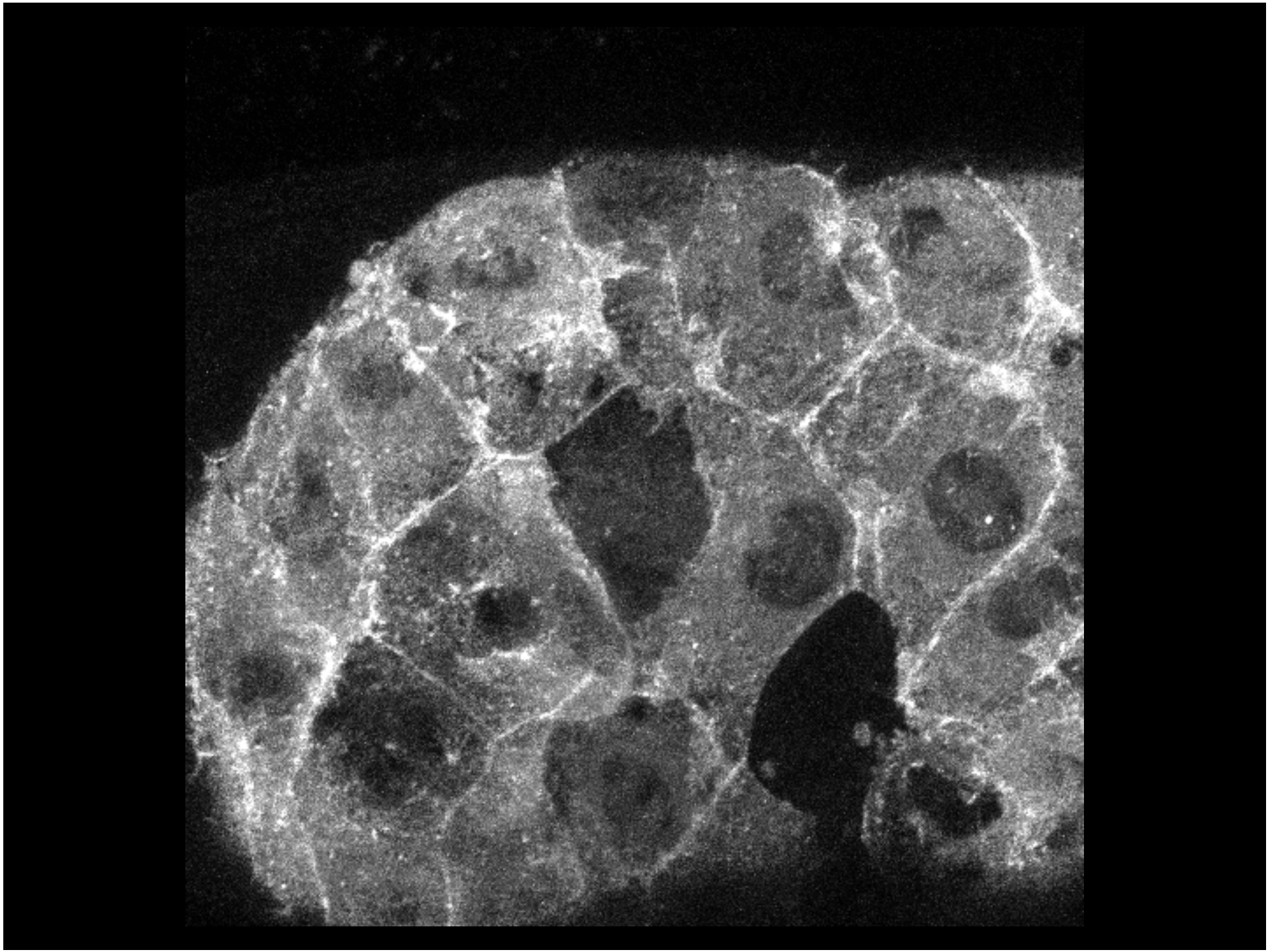
Feroz Hameed

GV Shivashankar

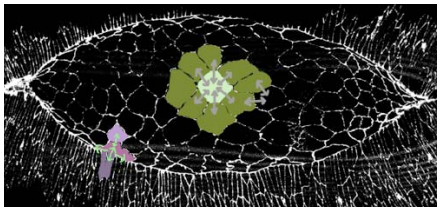
Madan Rao

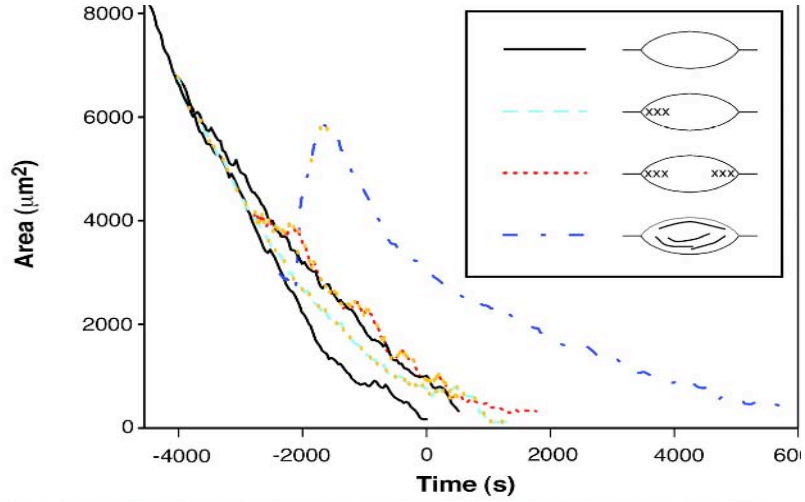



48 s

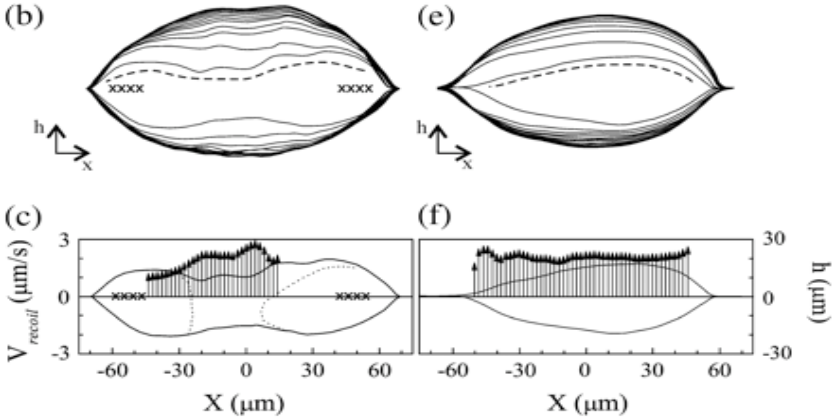


Force hierarchies and Resilience

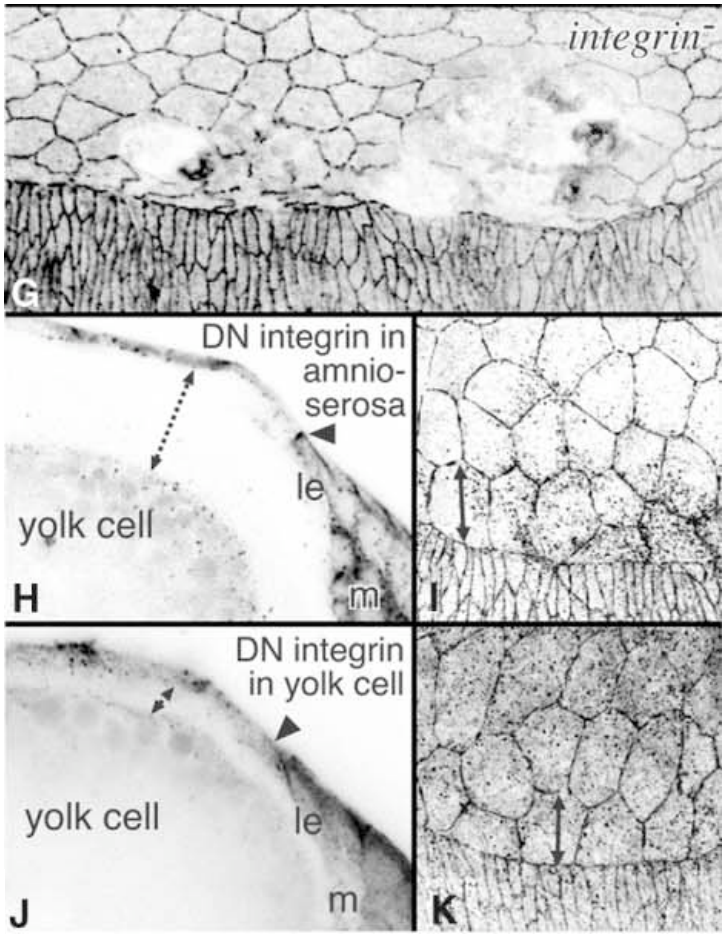




Hutson et al , 2004



Peralta et al , 2007



Narasimha and Brown 2004

Stresses → Signals

Signals → Stresses

Meghana C

Sumegha Kapoor

Sonia Muliyil

Surat Saravanan

Gopi Shah

Priyamvada Chugh

Somesh Upadhyay

GV Shivashankar

(NCBS/NUS)

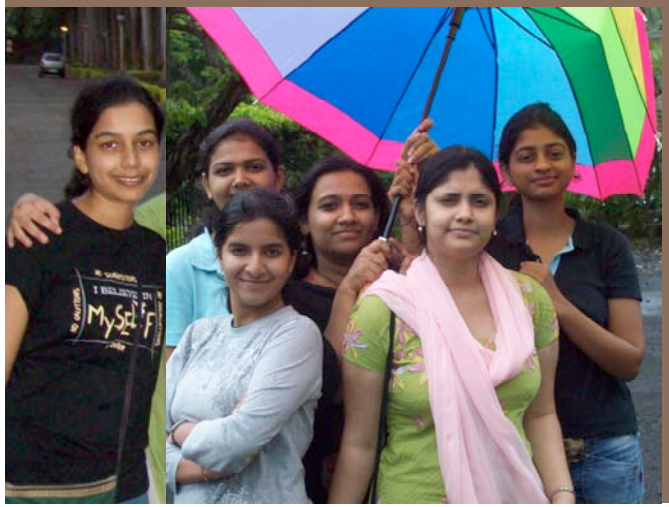
Madan Rao

(NCBS, RRI)

Srikanth Sastry

(JNCASR)

L Venkatkrishnan (NAL)



TIFR, Royal Society (UK)