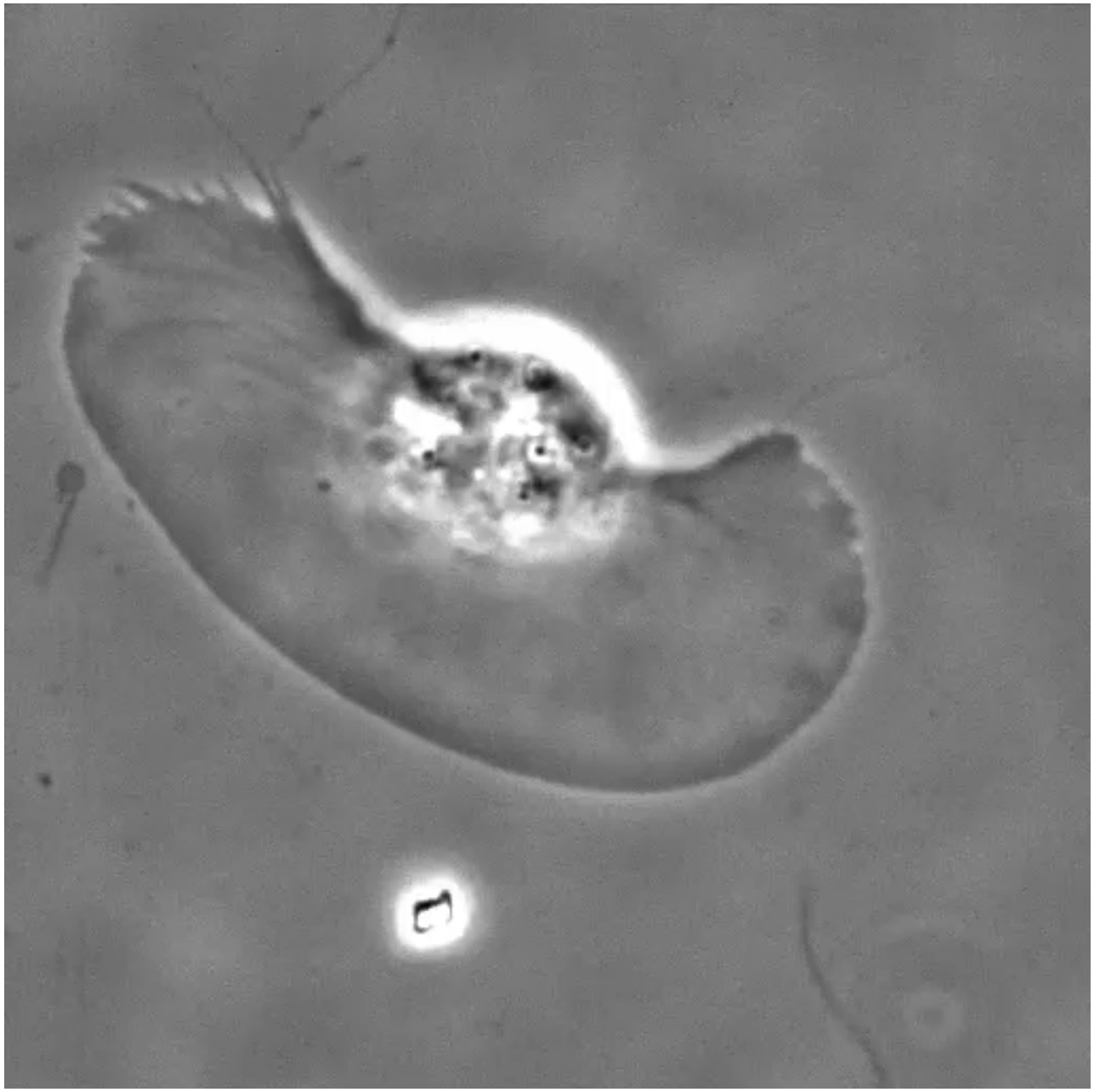
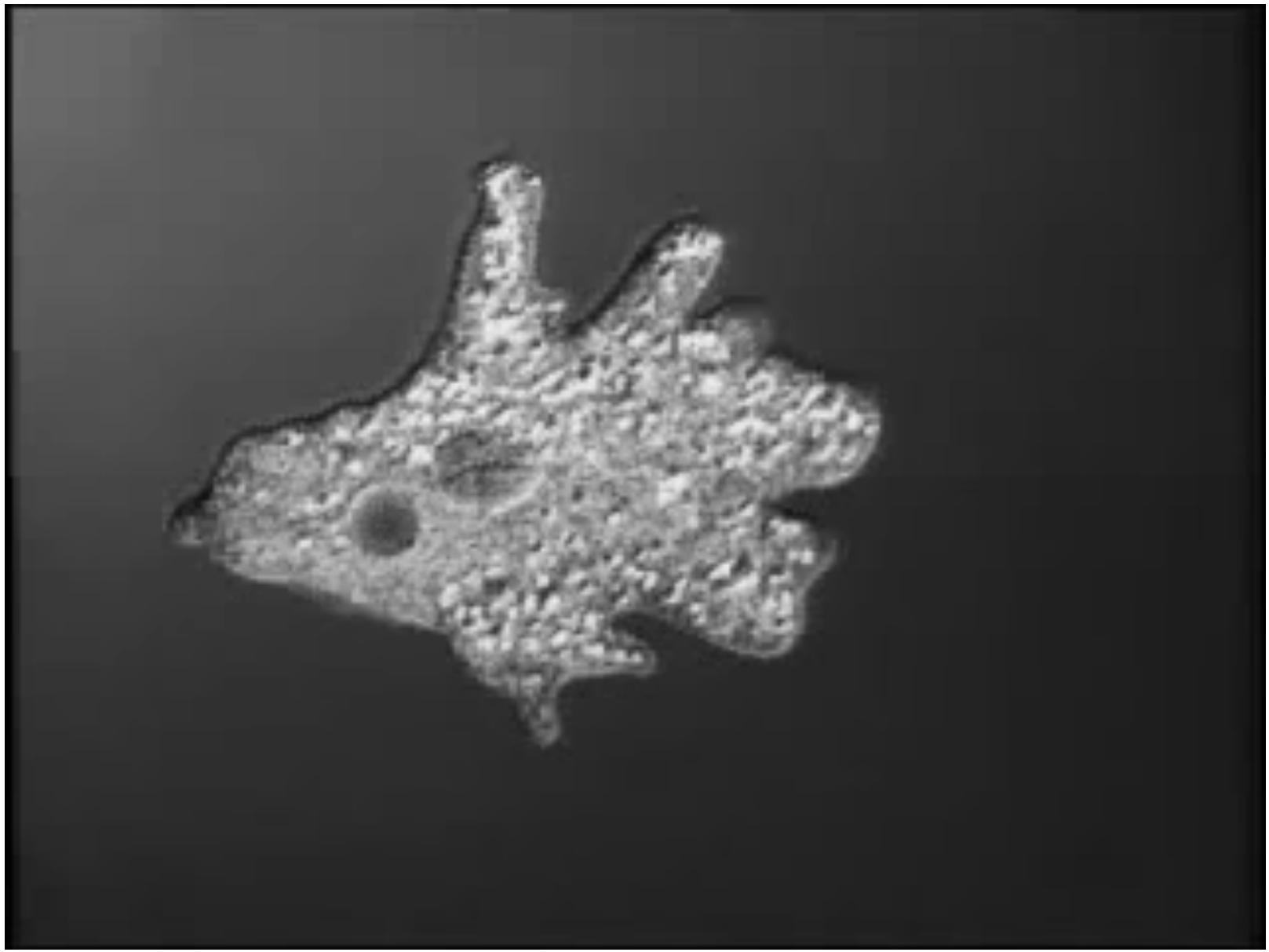
Cell motion



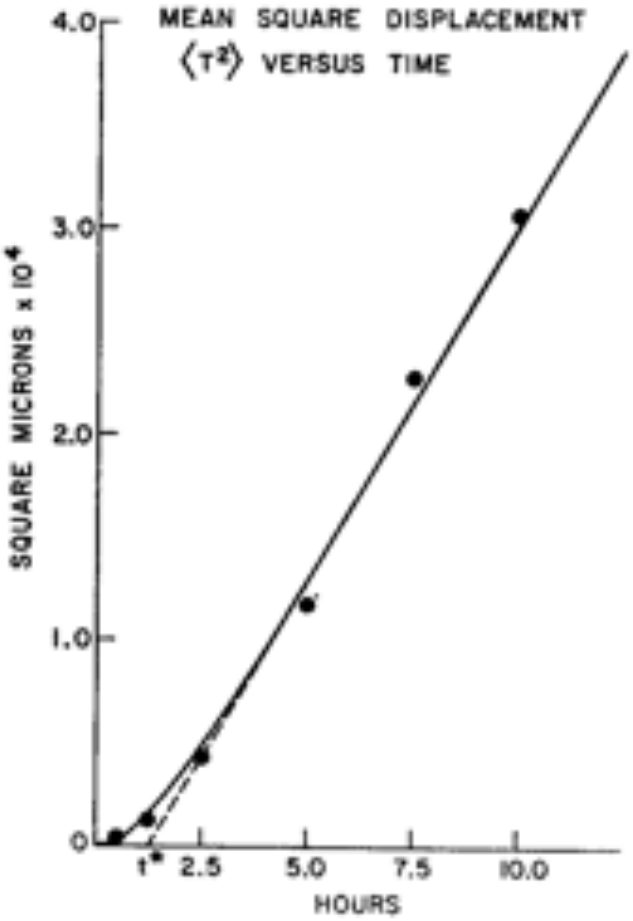
Keratocytes

lamellipodium

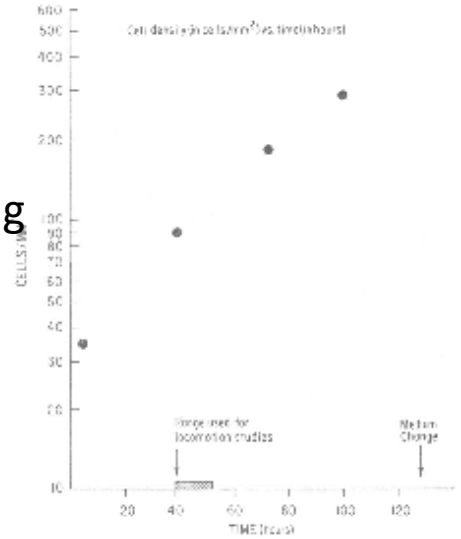
Crawling amoeba (pseudpodia).



Cell motion as persistent random motion



Exponential growth (doubling time ~ 30 h)



Time

$$\langle T^2 \rangle = 4D^*\,(t - t^*(1 - \exp\,(-t/t^*)))$$

for large t,

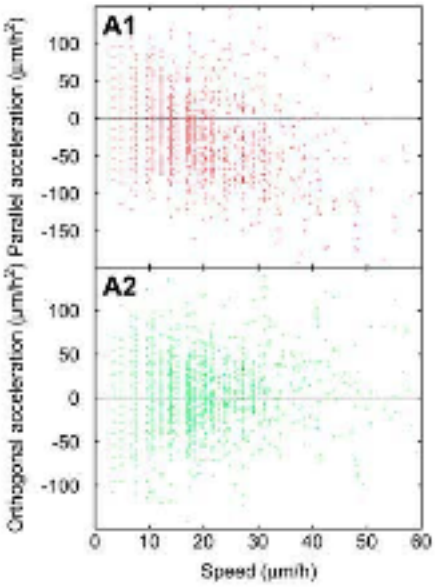
$$\langle T^2 \rangle = 4D^*(t - t^*).$$

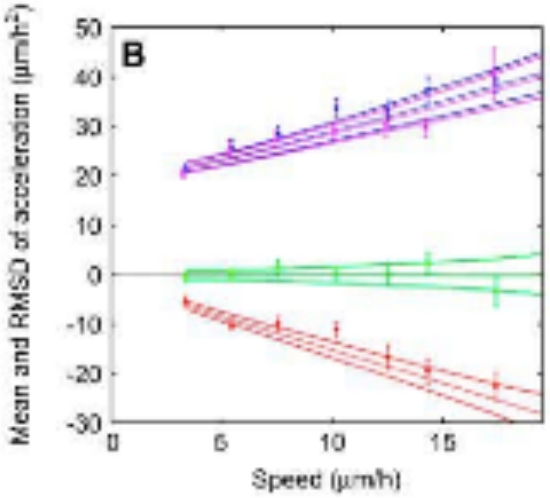
Mouse fibroblasts

Gail and Boone, Biophys J (1970)

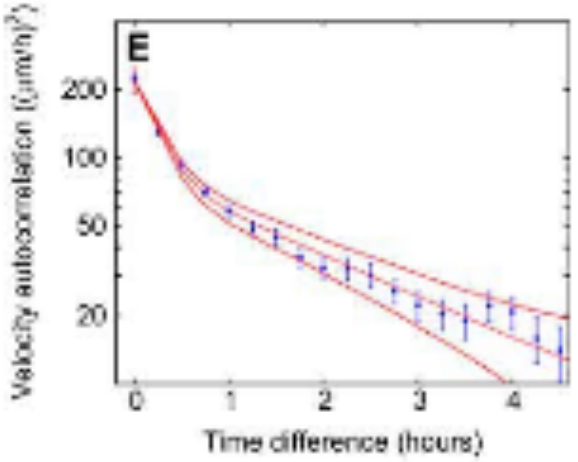
A refined random motion model

(Selmeczi et al, Biophys J 2005)





Mean of both components and MSD



Two exponentials in <v(0)v(t)>

Acceleration (// or $\perp$ to v)

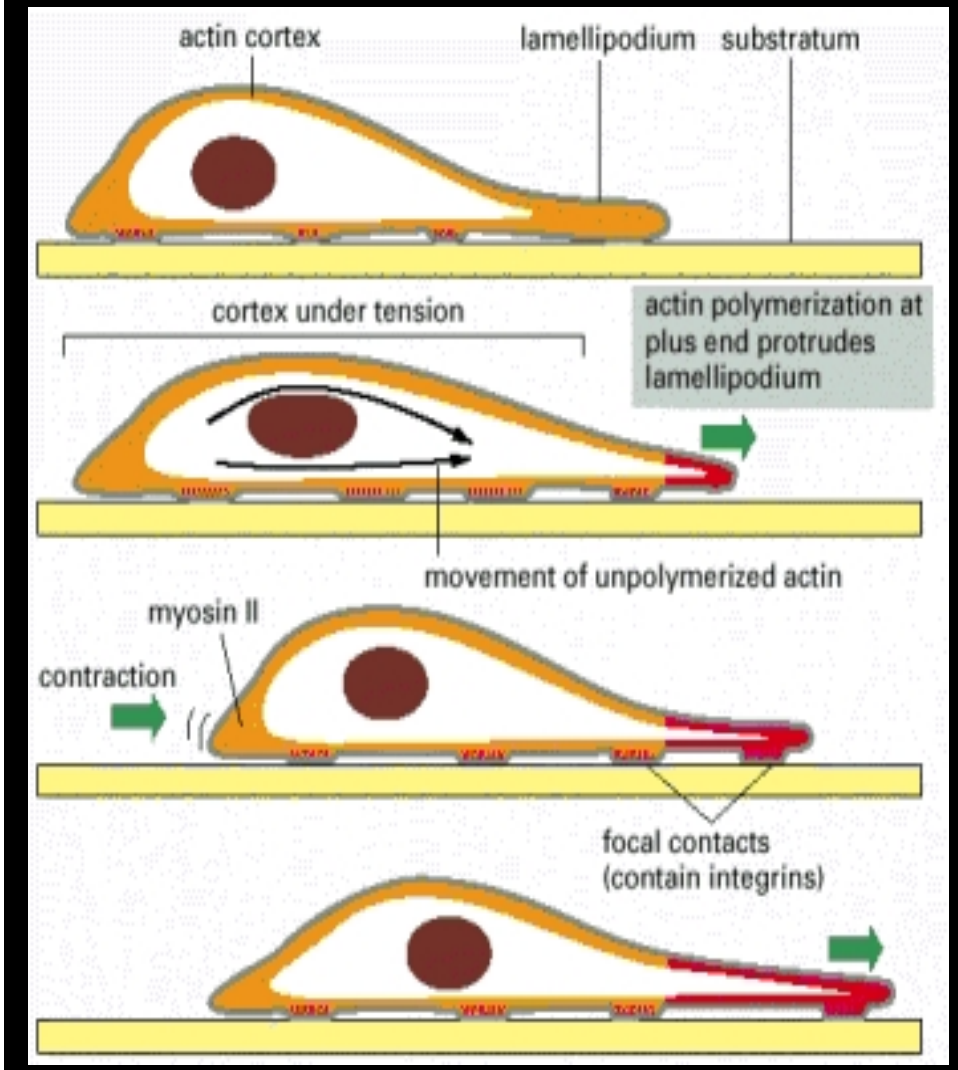
$$\frac{d\mathbf{v}}{dt} = -\beta\mathbf{v} + \alpha^2 \int_{-\infty}^{t} dt' \exp[-\gamma(t-t')]\mathbf{v}(t') + \sigma(|\mathbf{v}|)\,\xi(t)$$

-Memory kernel

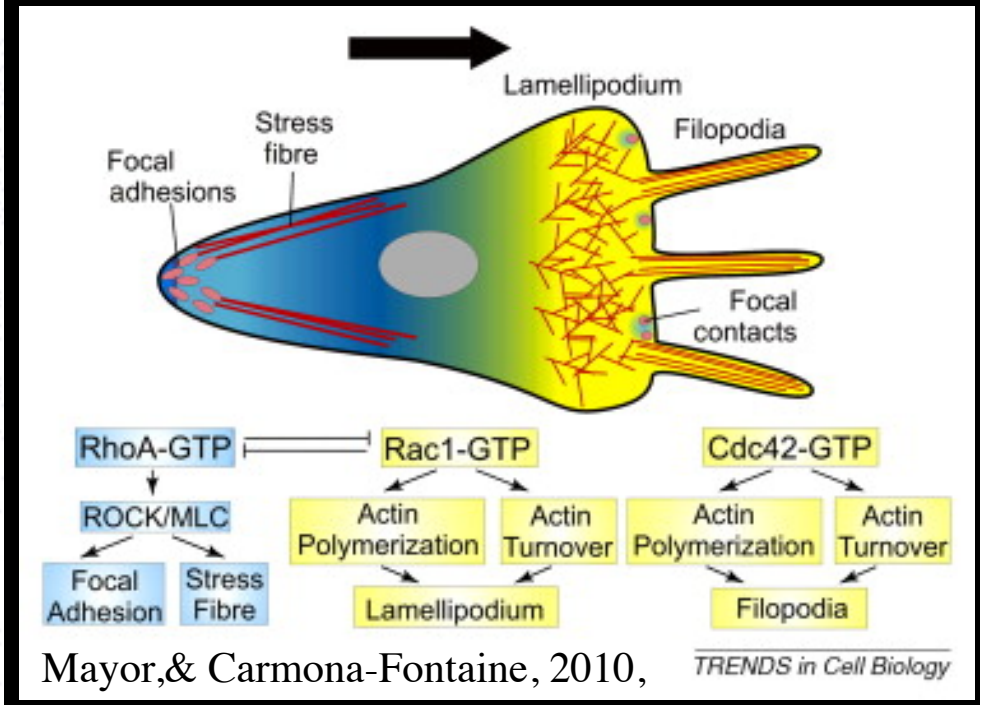
-Velocity dependent noise $\sigma(v) = s_0 + s_1 v$

	HaCaT
α (1/h)	1.5
β, respectively β_0 (1/h)	4.1
β_1 (1/μm)	–
γ (1/h)	1.0
σ_0 (μm/h$^{3/2}$)	11
$\sigma_{1\parallel}$ (1/h$^{1/2}$)	1.3
$\sigma_{1\perp}$ (1/h$^{1/2}$)	1.3

Basic view



MBC, Alberts et al

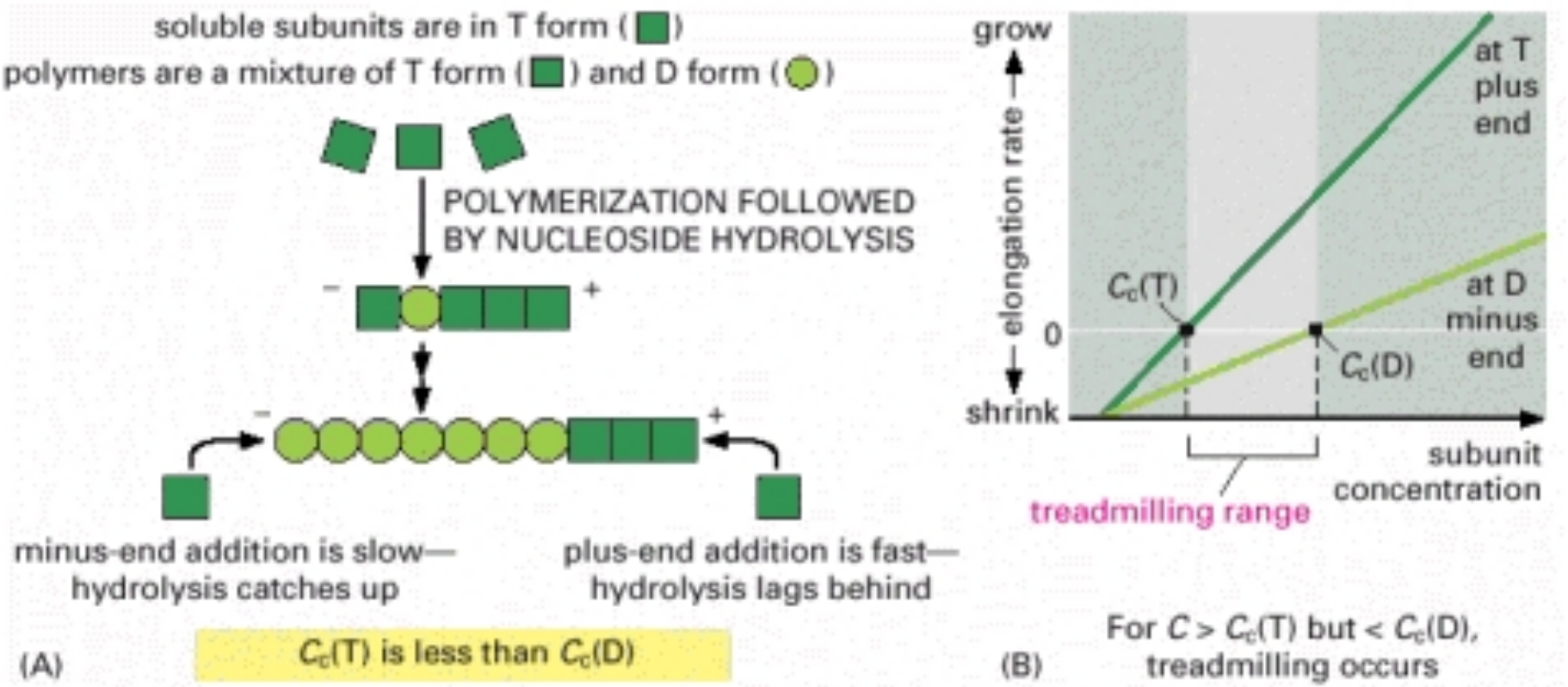


Mayor,& Carmona-Fontaine, 2010,

Many interesting questions:

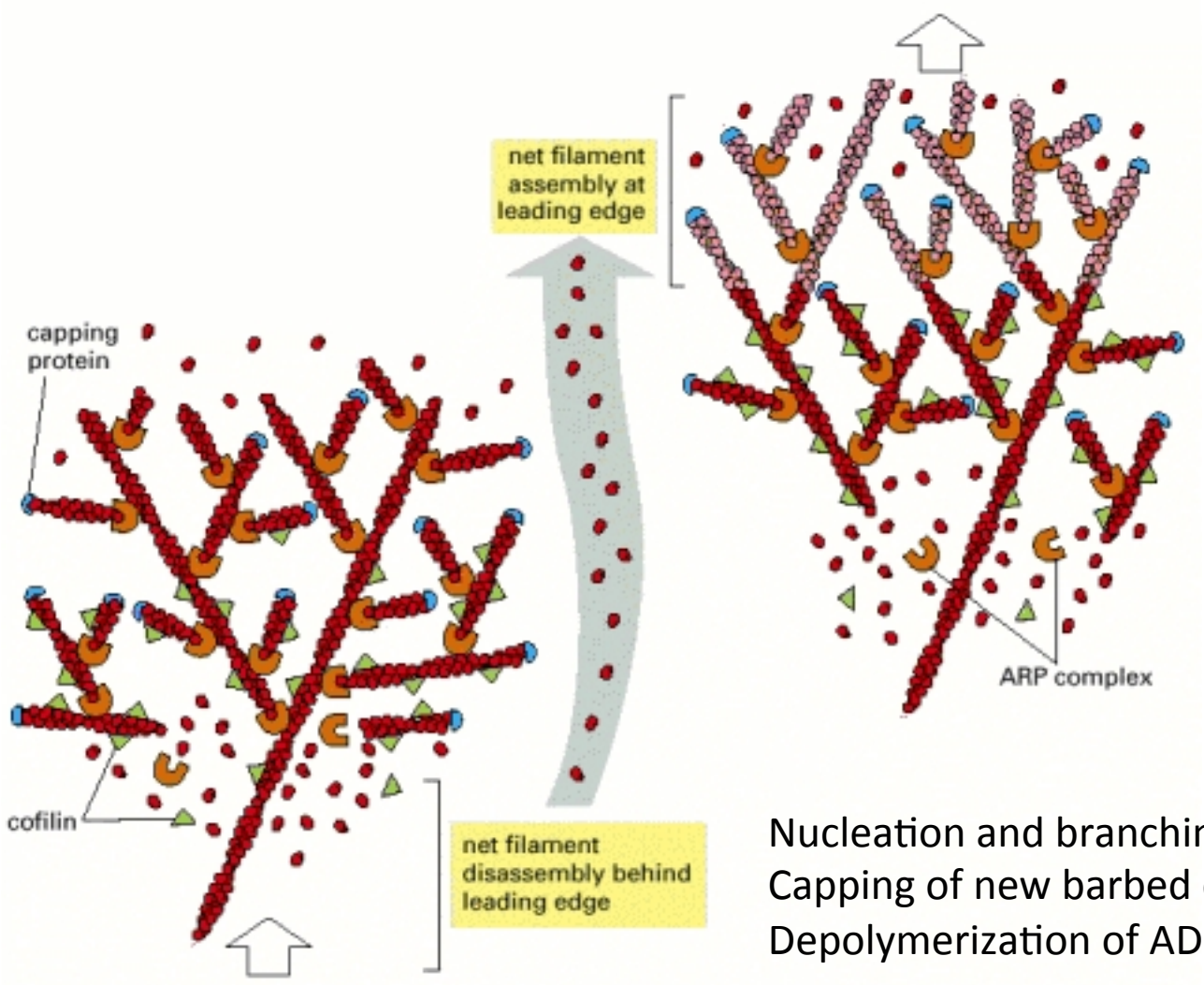
-establishment of polarity
-propulsion mechanism
-origin of stochasticity,
-…

F-actin treadmilling in vitro



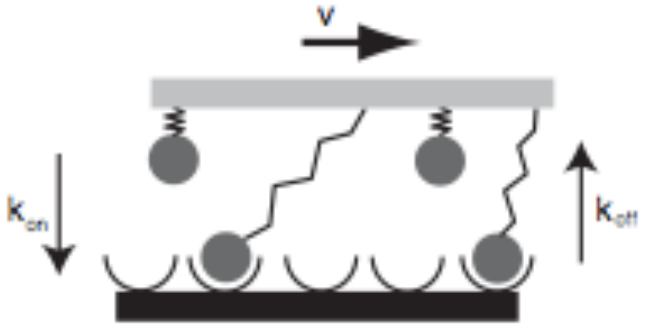
Alberts et al, MCB

Model for treadmilling of the actin meshwork at the leading edge (Alberts et al, MCB)



Nucleation and branching : ARP complex
Capping of new barbed end
Depolymerization of ADP-actin by cofilin

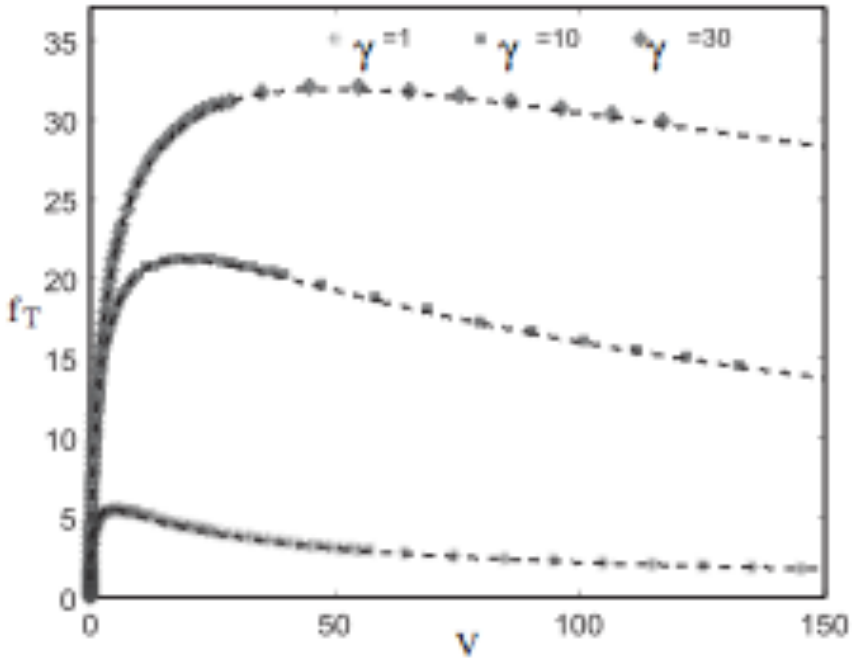
Propulsive force from adhesion and retrograde flow



$$V = rv/k_0$$

$$\frac{rF_T}{\kappa} = N_t \frac{M(1/V)}{E_1(1/V) + (V/\gamma)e^{-1/V}},$$

$$E_1(x) = \int_0^\infty dy e^{-xe^y}, \qquad M(x) = \int_0^\infty dy y e^{-xe^y}.$$

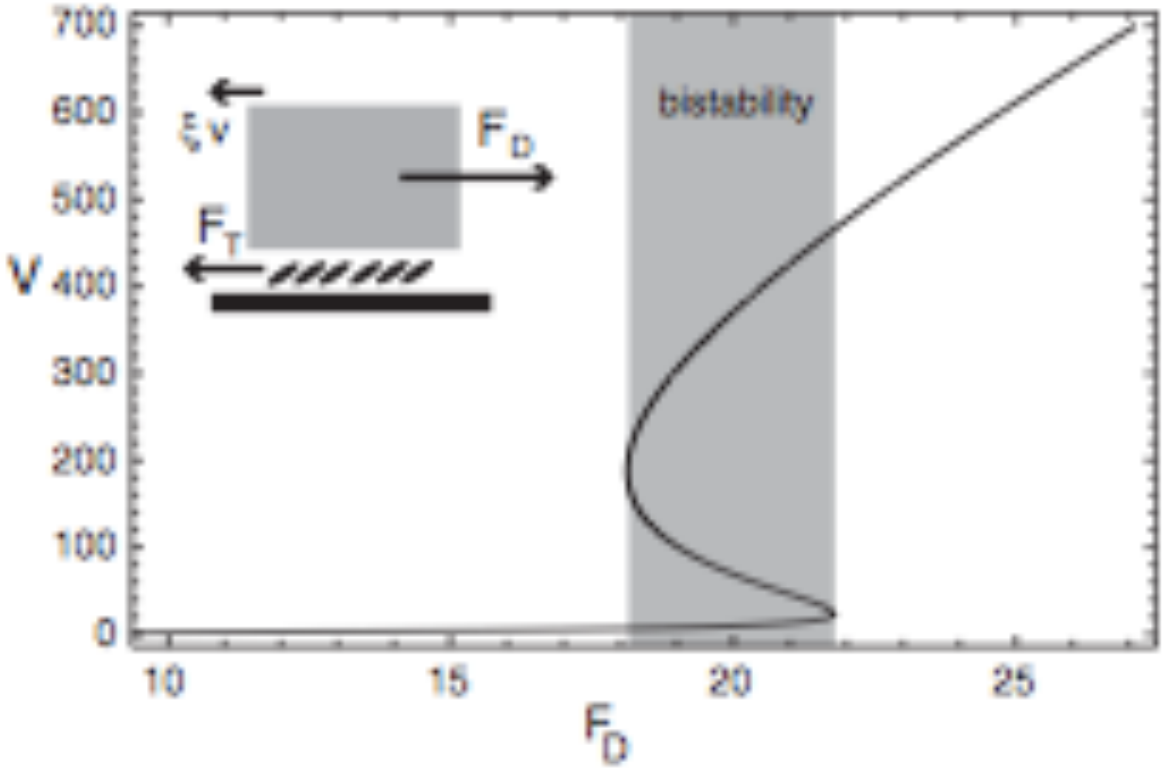


Biphasic relation : the traction force
-increases for slow velocities
-decreases for large velocities

Schwarz and Safran, Rev Mod Phys (2013)

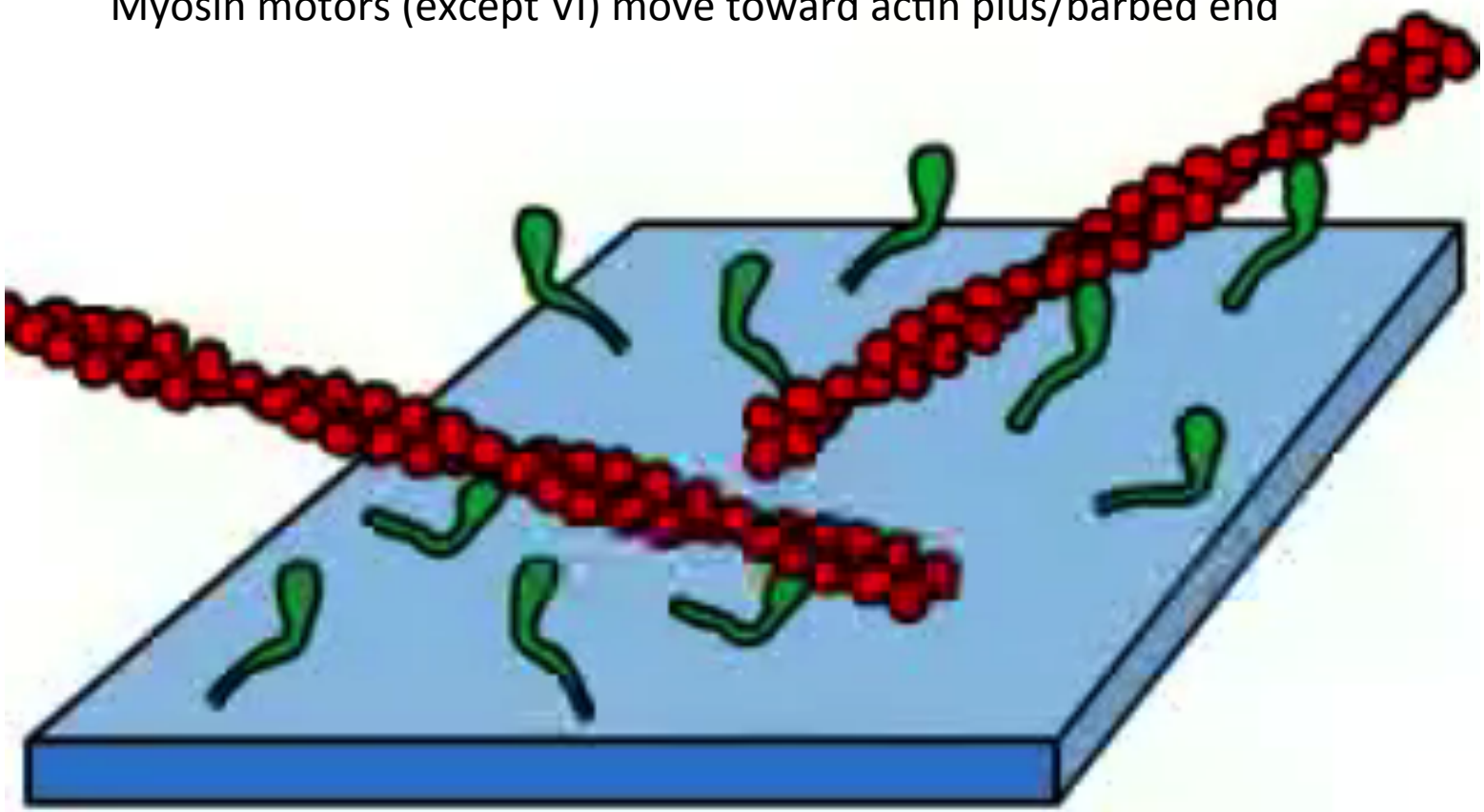
Stick-slip behavior

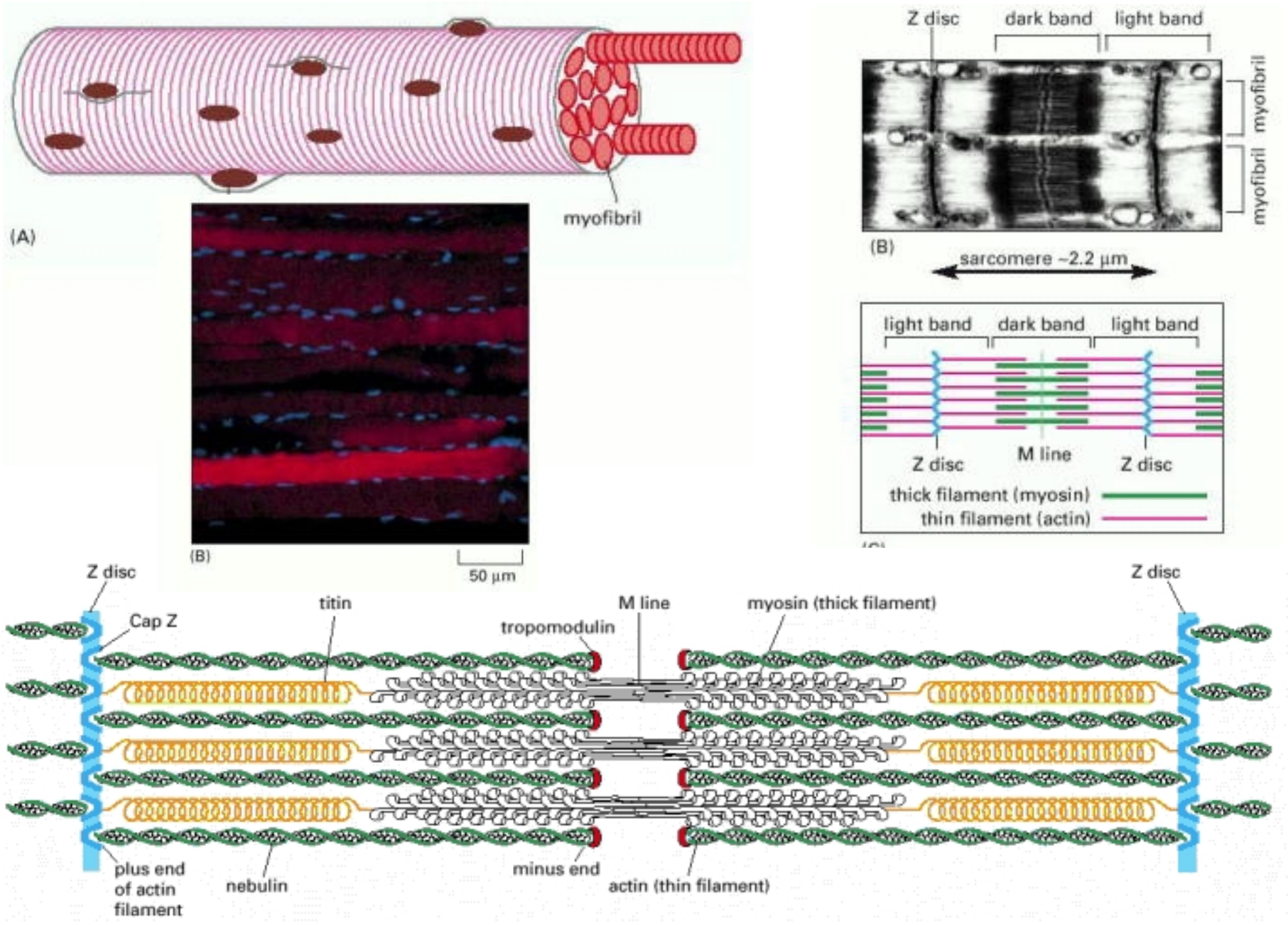
$$F_D = F_T(v) + \xi v$$



Actin filaments on a surface covered by myosin

Myosin motors (except VI) move toward actin plus/barbed end



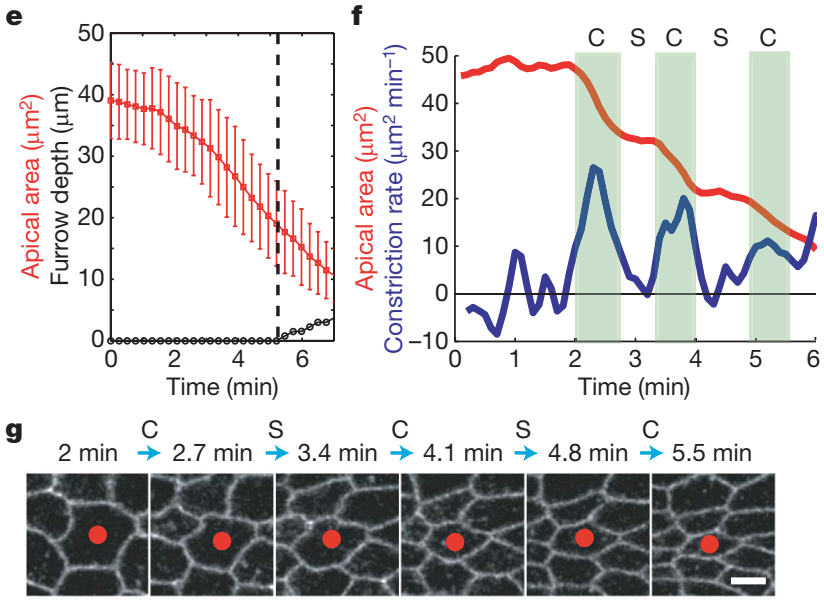


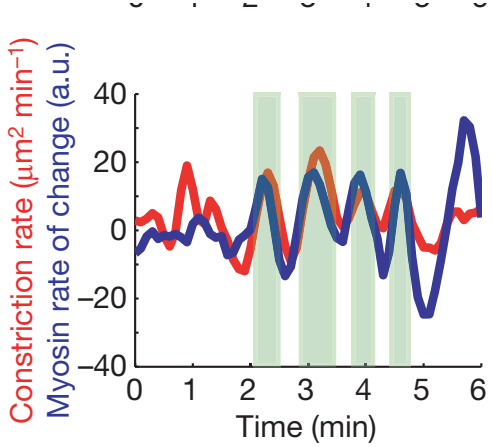
Skeletal muscle cell and sarcomeres (Alberts et al, MCB)

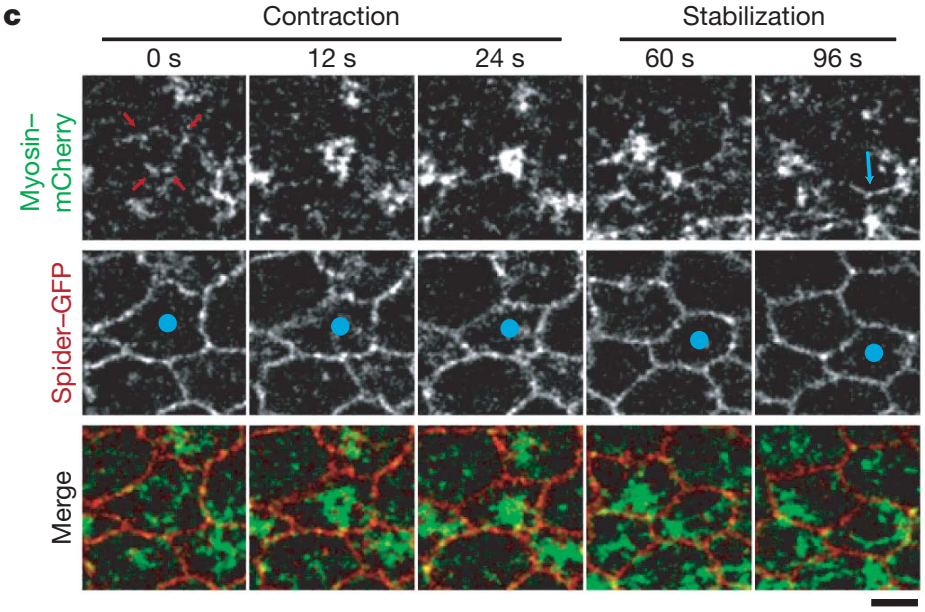
Pulsed contractions of an actin–myosin network drive apical constriction

Adam C. Martin[1,2], Matthias Kaschube[3,4] & Eric F. Wieschaus[1,2]

NATURE | Vol 457 | 22 January 2009



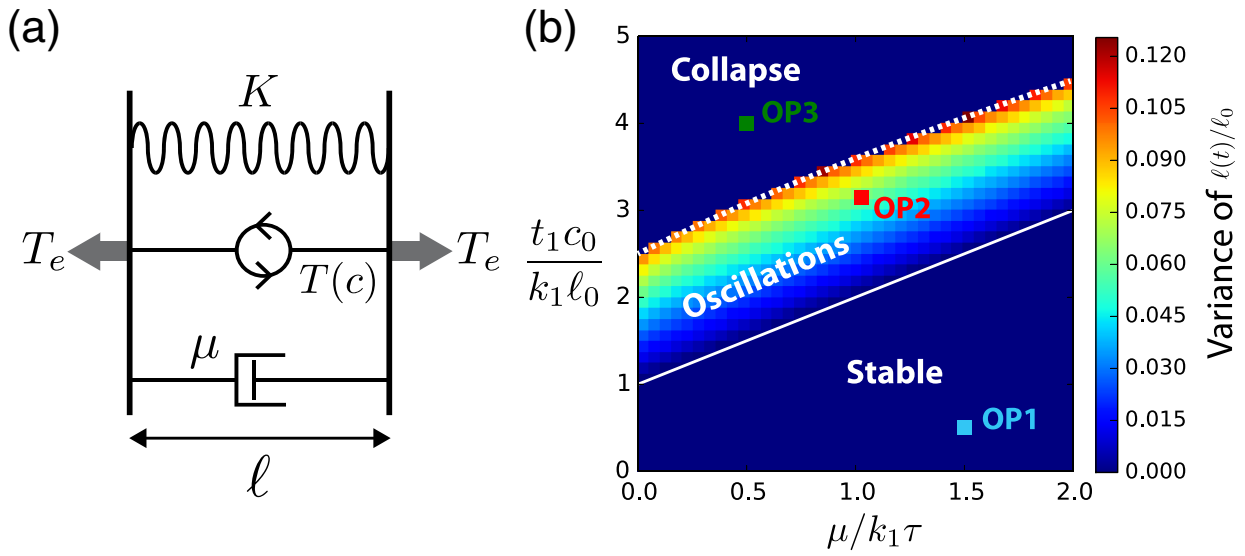




Spontaneous Oscillations of Elastic Contractile Materials with Turnover

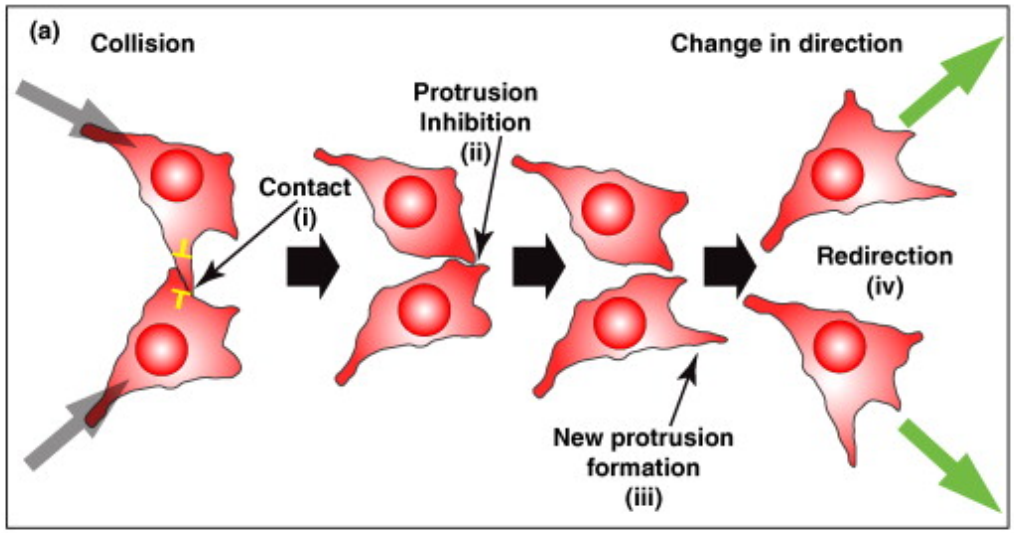
Kai Dierkes,[1,2] Angughali Sumi,[1,2] Jérôme Solon,[1,2] and Guillaume Salbreux[3]

PRL **113,** 148102 (2014)



Interacting cells : contact inhibition of locomotion

L Loeb (1921), Abercombie and Heaysman (1953),…



Mayor & Carmona-Fontaine,
Nature 2008, Trends CB 2010

Signalling vs mechanical interactions