re-cap: motor proteins - common molecular design

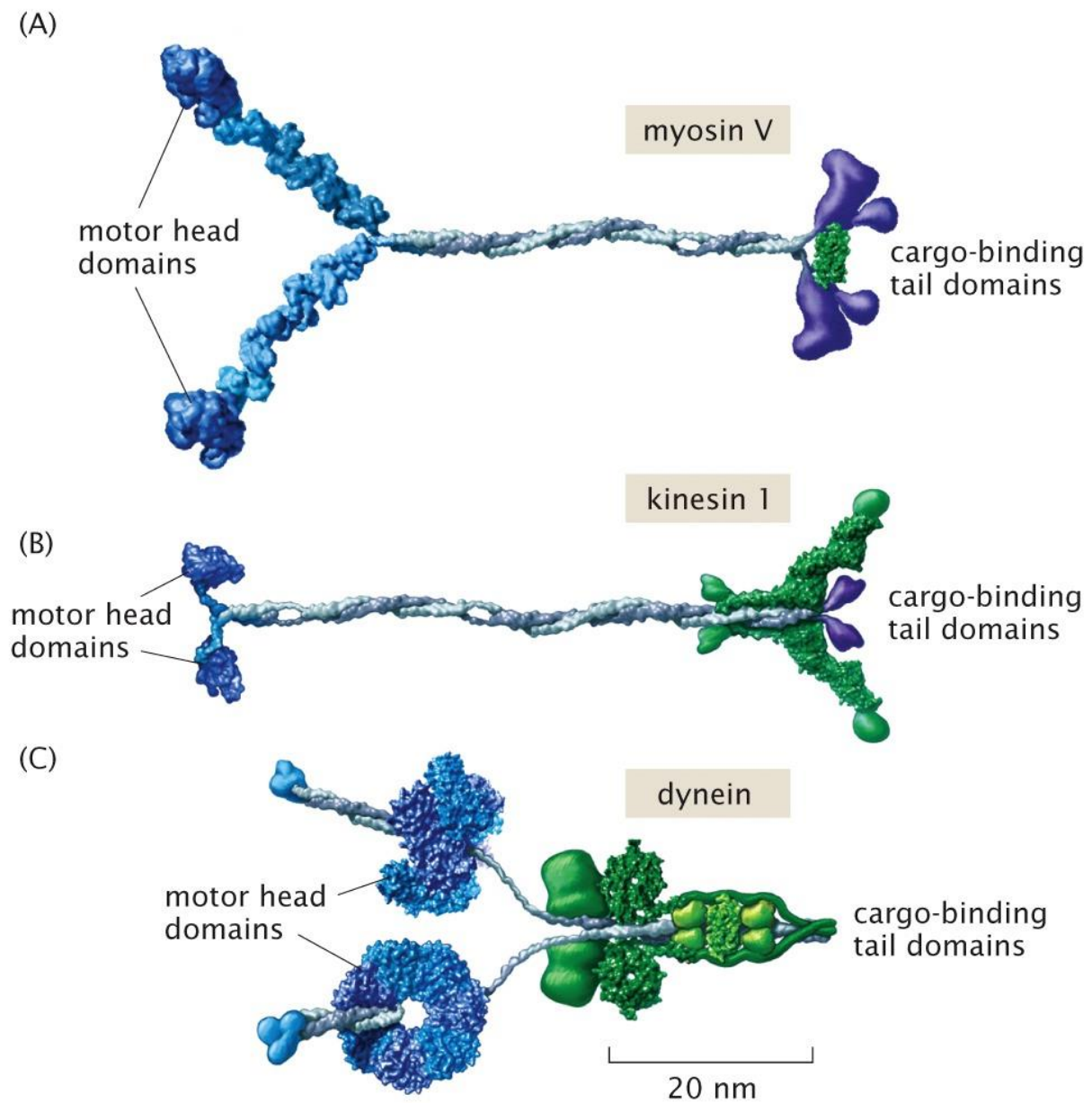


Figure 16.2 Physical Biology of the Cell, 2ed. (© Garland Science 2013)

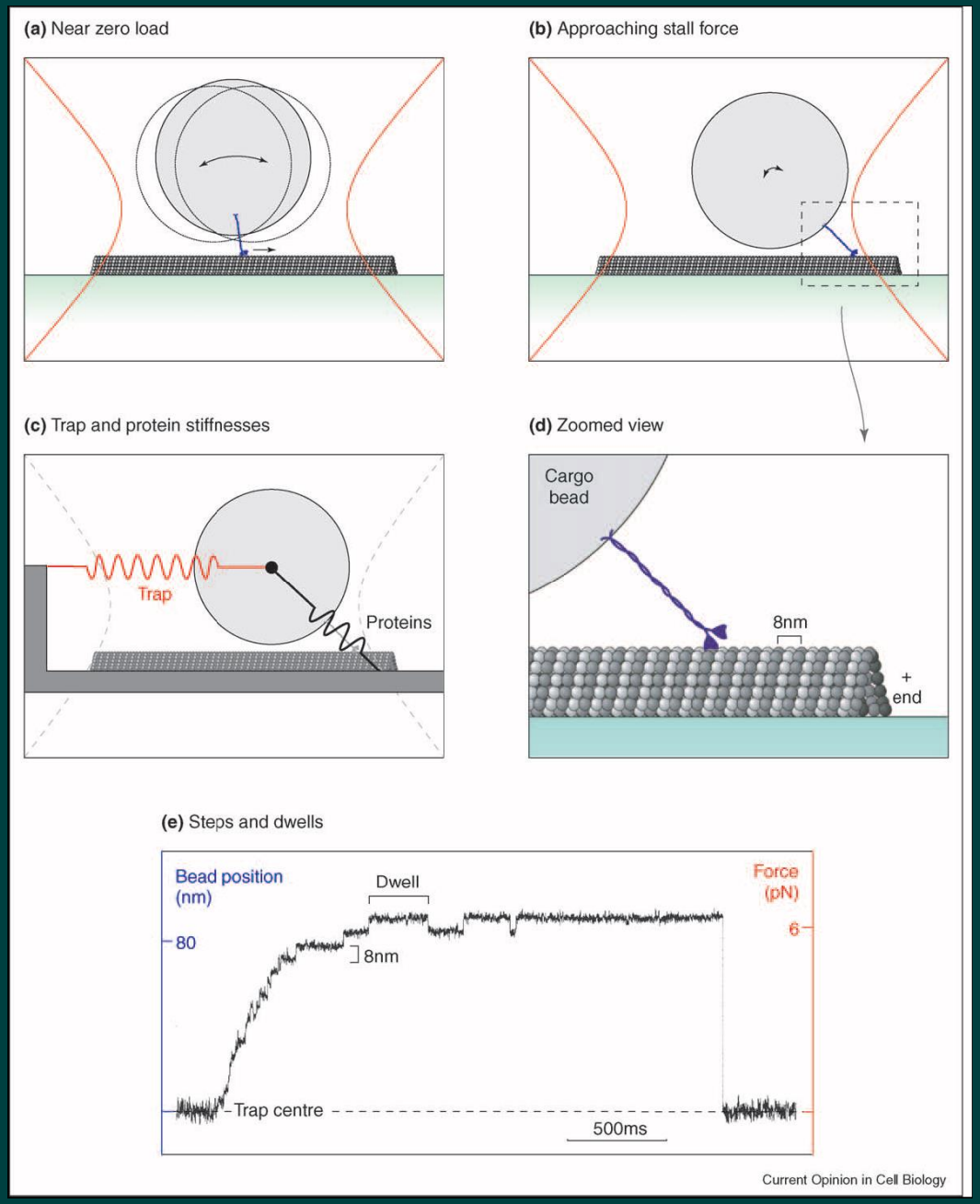
Biophysical properties of motors

step size

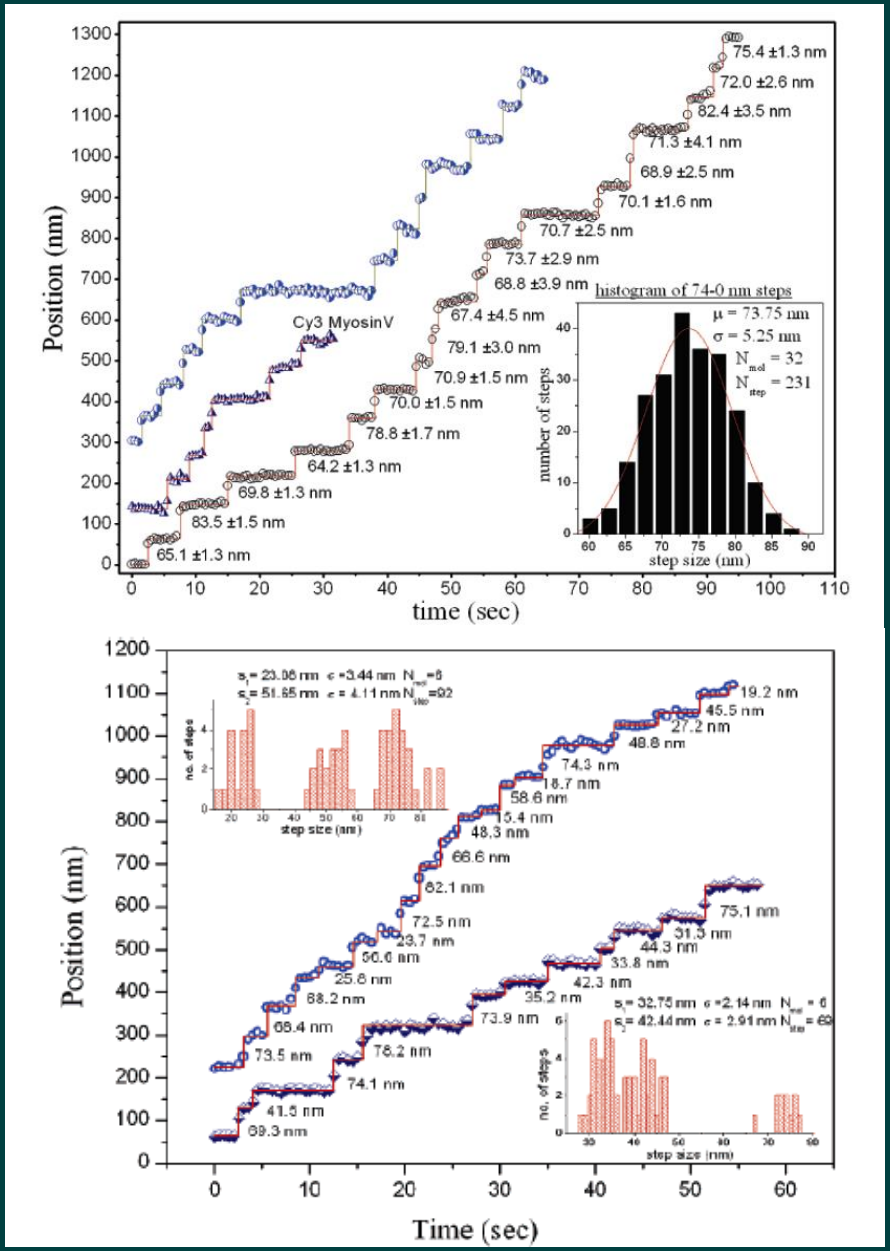
stall force

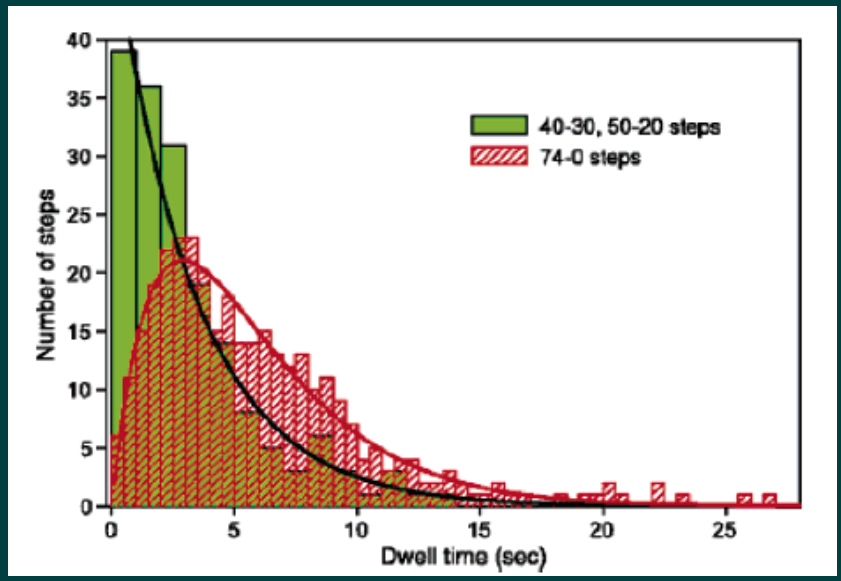
processivity: how many steps can motor take without detaching

measuring by trapping a bead attached to a motor



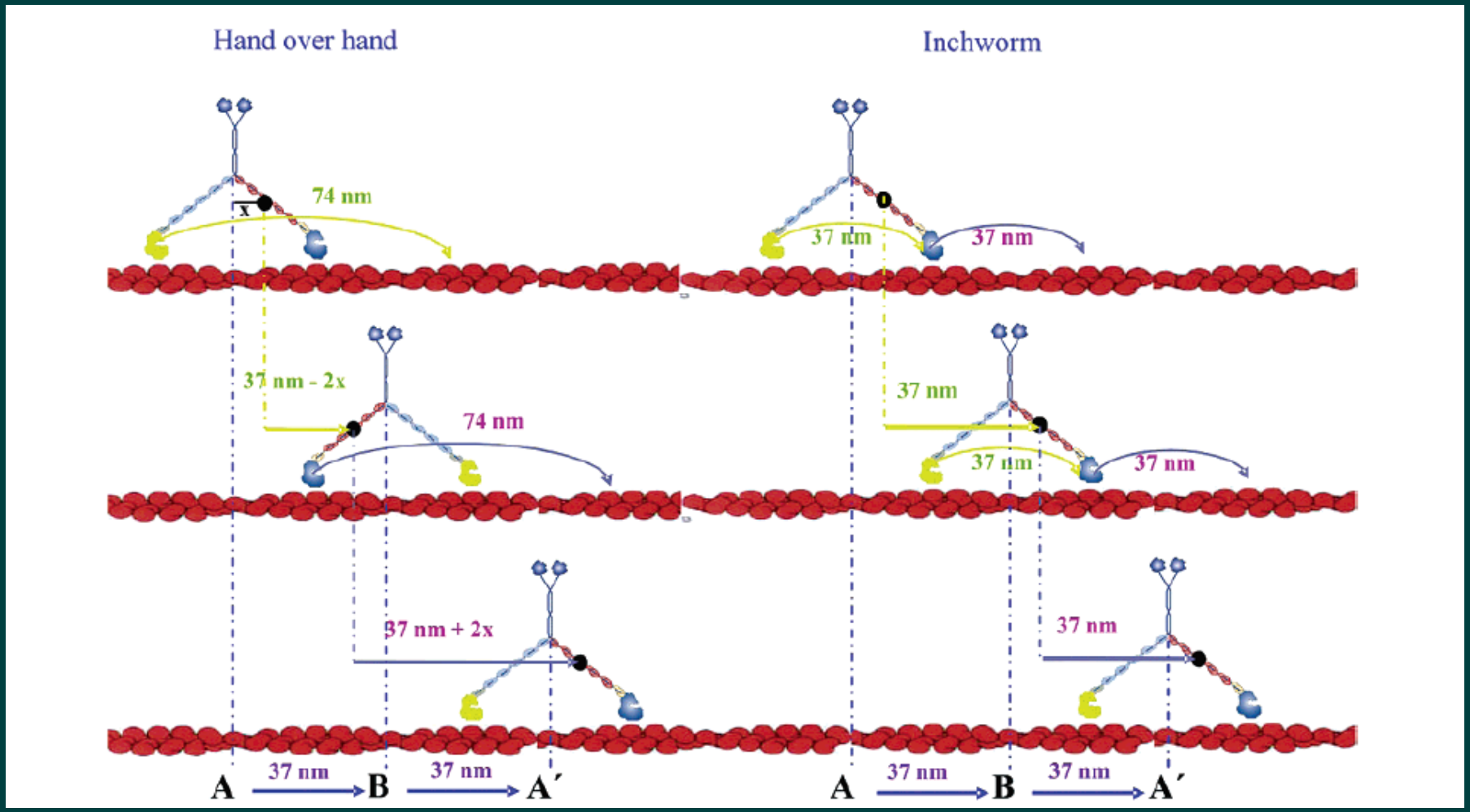
Measuring step sizes and dwell times by single molecule fluorescence (hand over hand mechanism)



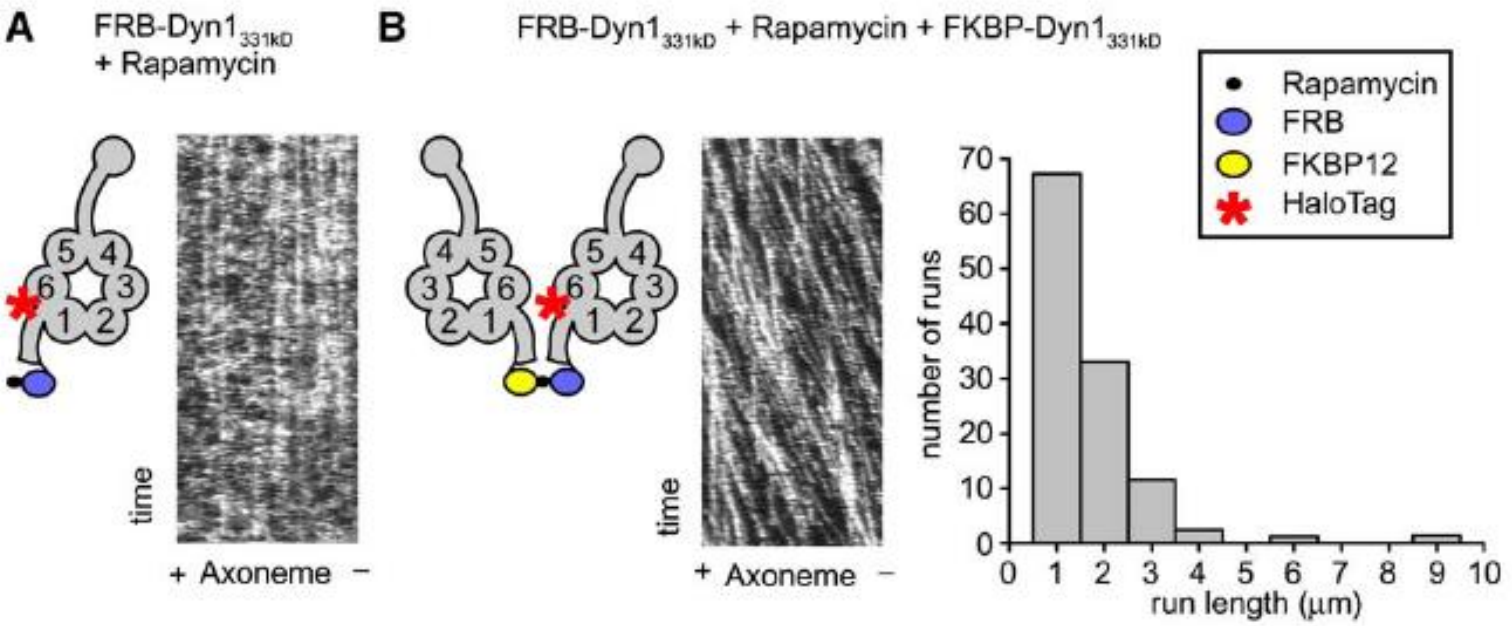


Yildiz and Selvin
Acc. Chem. Res., 2005

mechanisms of processivity



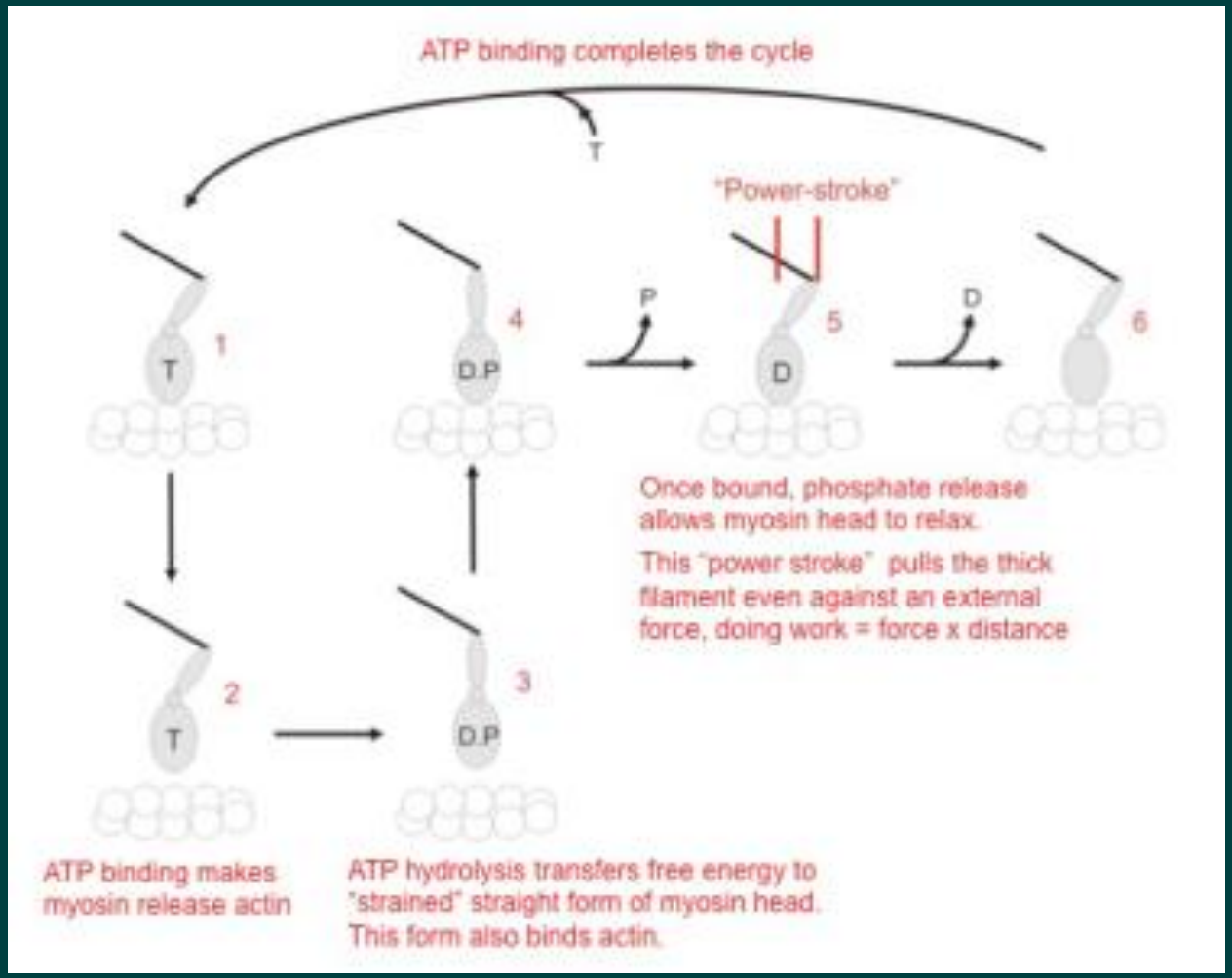
Dimerization is necessary for dynein processivity



Reck-Peterson et al., Cell, 2006

Now: Motor ATPase cycles:

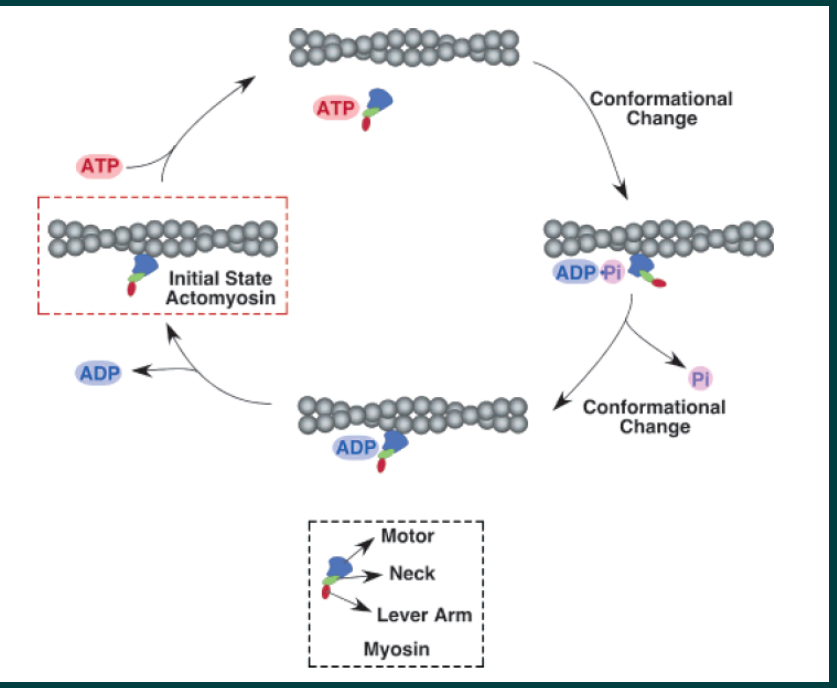
myosin cycle

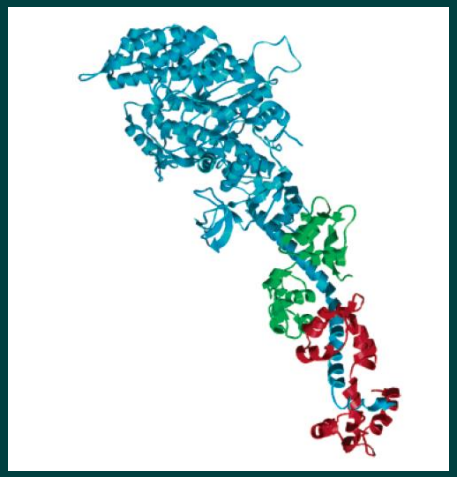


tightly bound without ATP (rigor mortis)

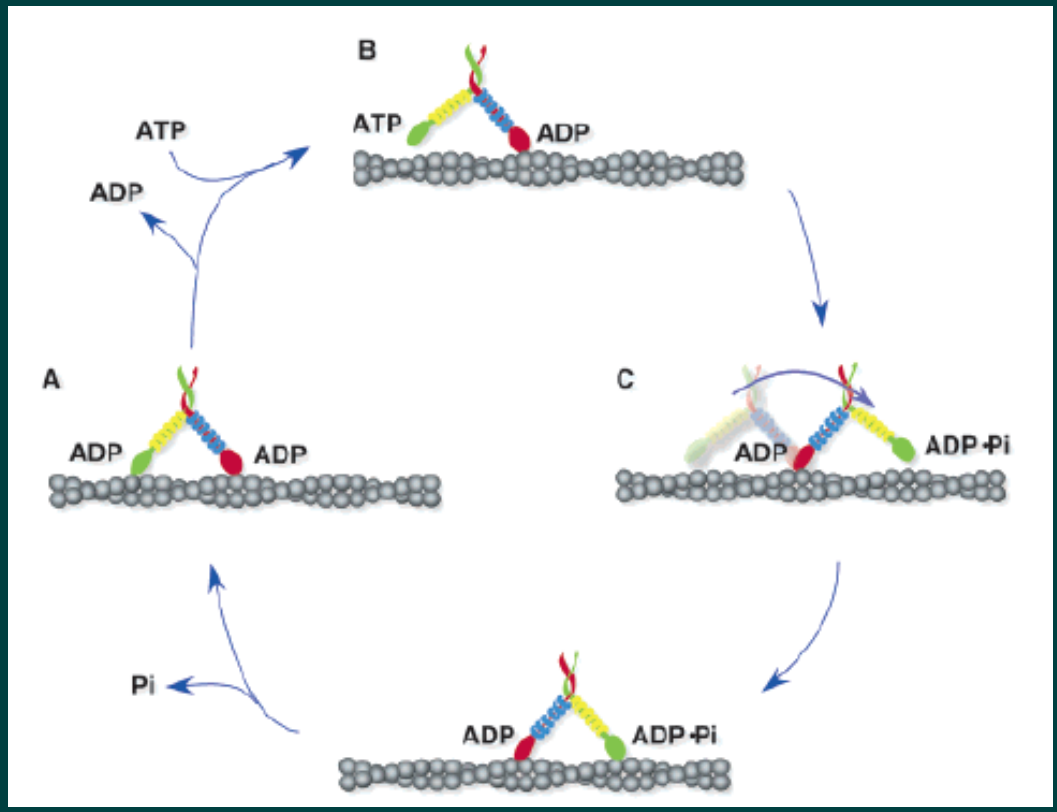
similar cycles of different myosins

Myosin II

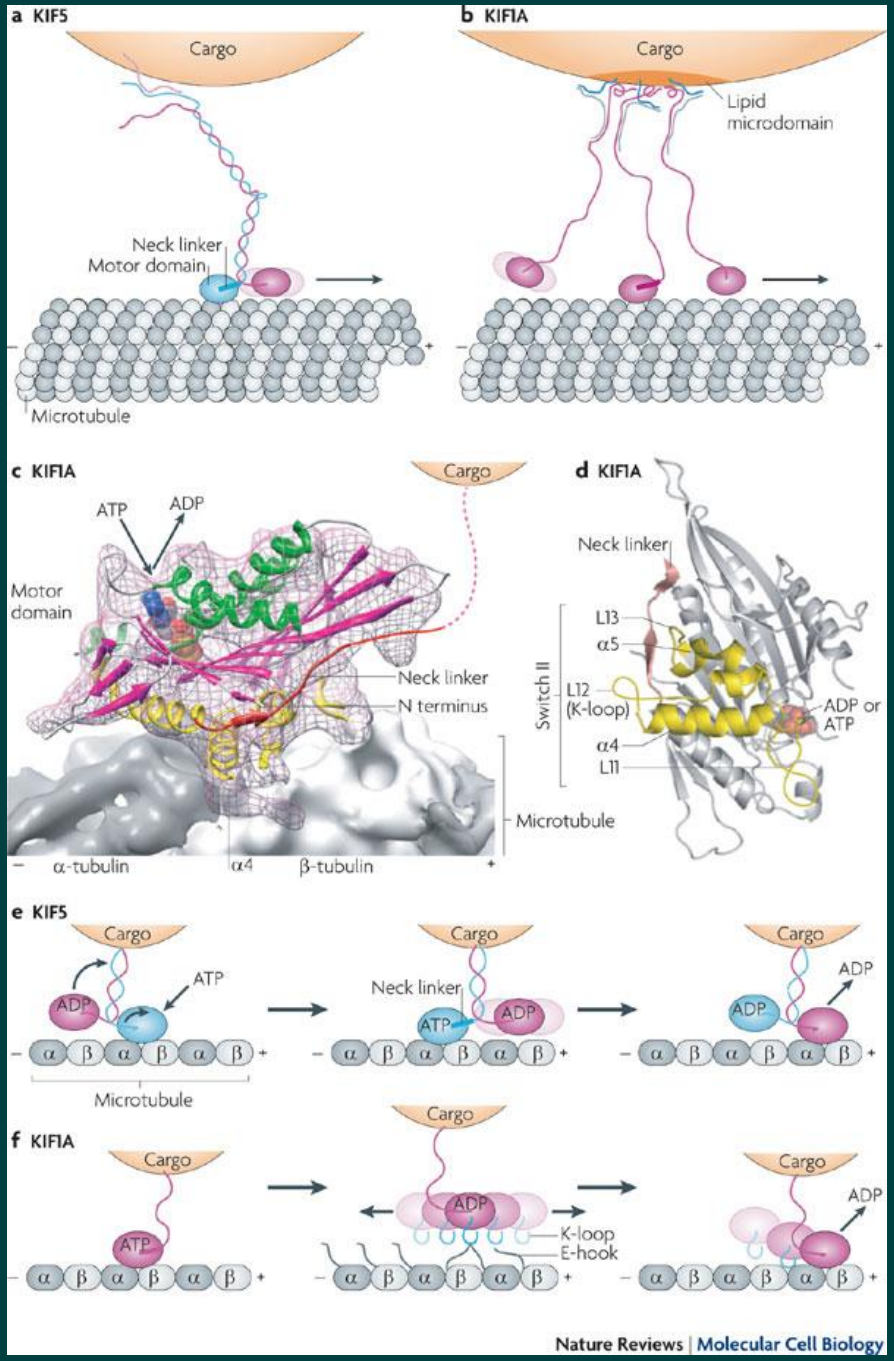




Myosin V



Kinbara and Aida, 2005



Kinesin cycle: unlike myosin, ATP-form is tightly bound to microtubule (method to isolate kinesin by cycling with non-hydrolysable ATP analog)

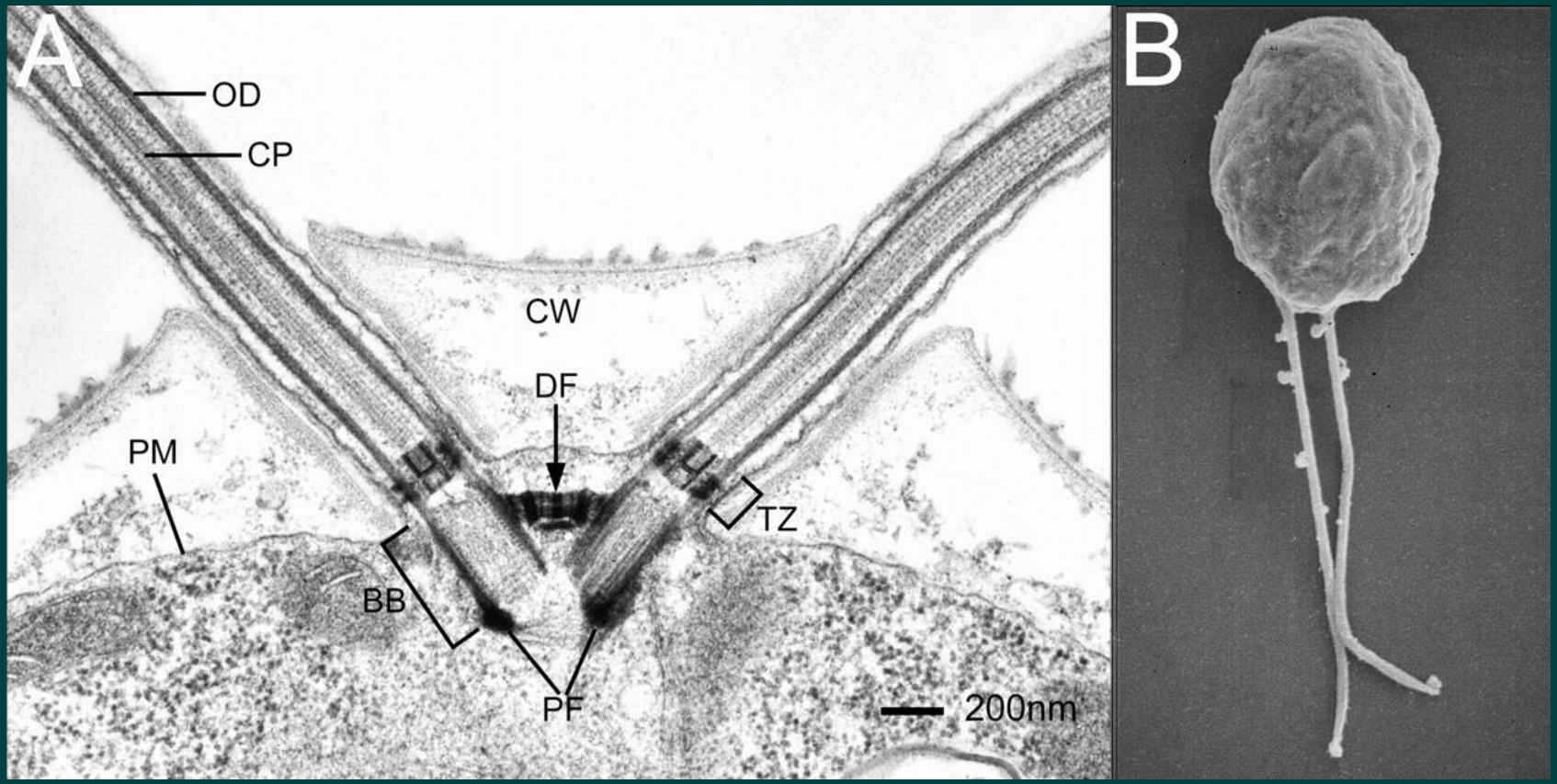
Hirokawa et al., 2009

what microtubule-dependent motors do in the cells (transport, mitosis)

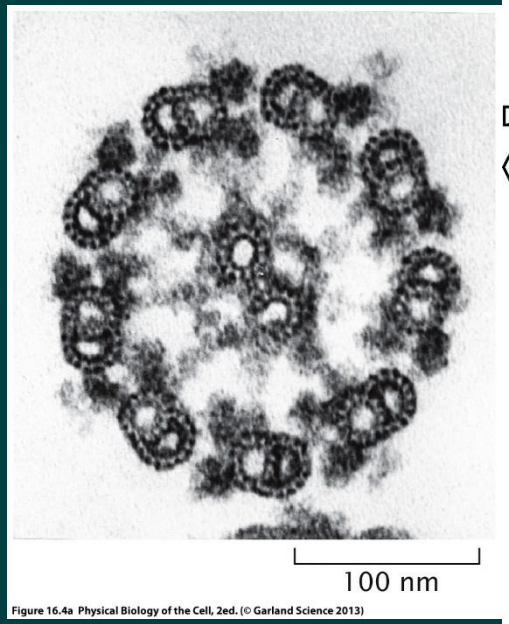
what if there are many motors on the same cargo?

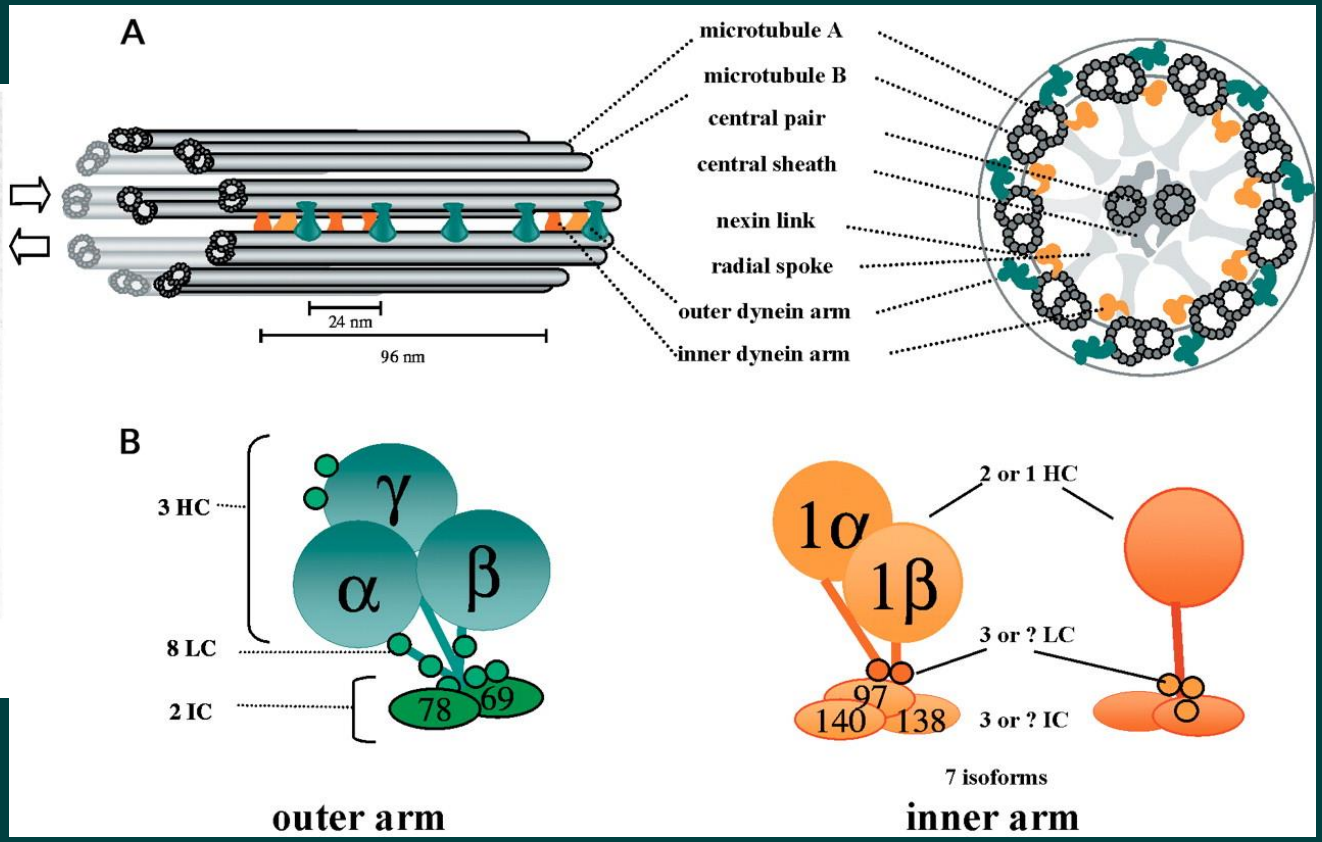
Cilia and flagella beating

Chlamidomonas cilia



axonemal structure





mechanism of cilia/flagella bending

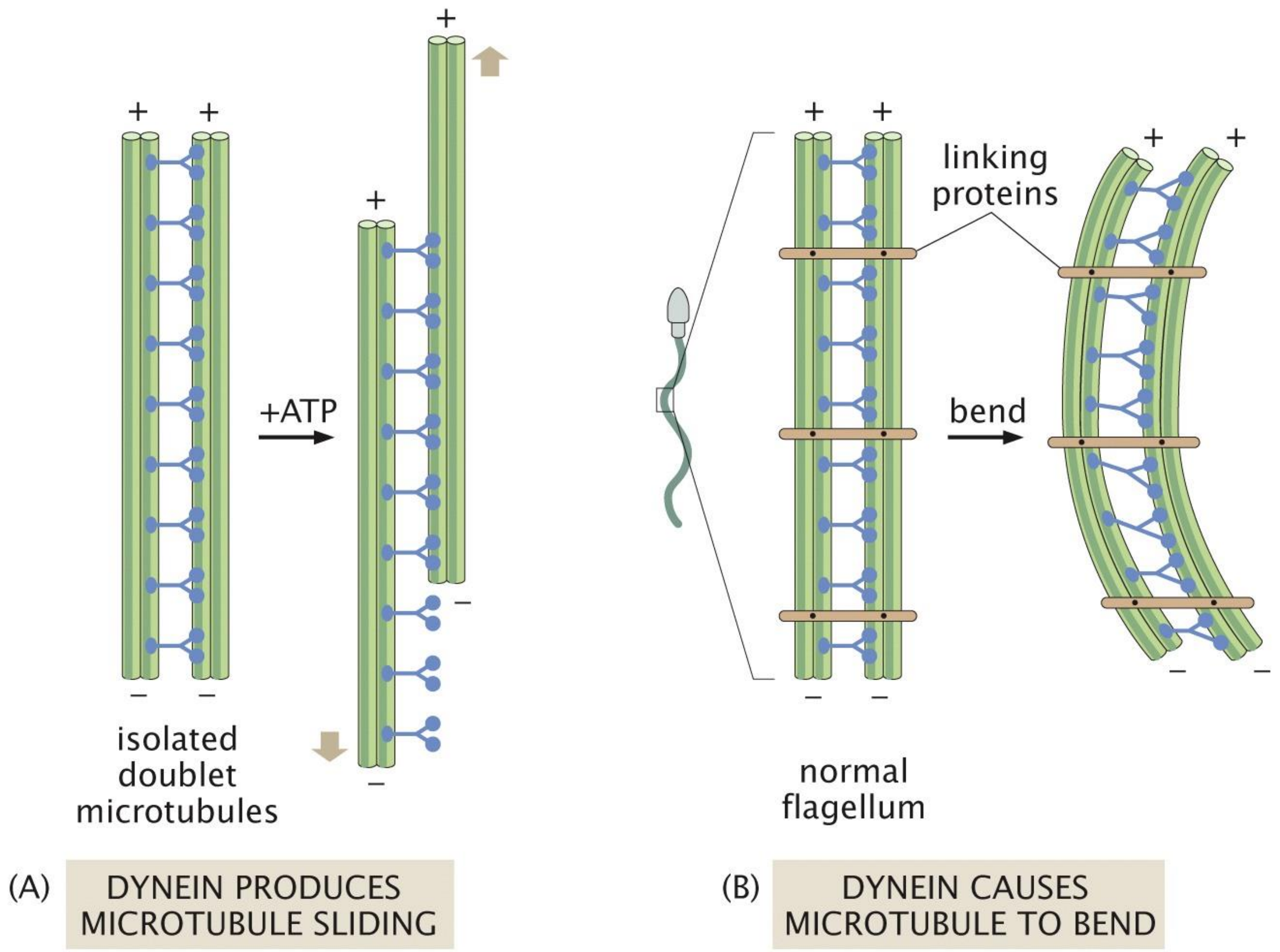
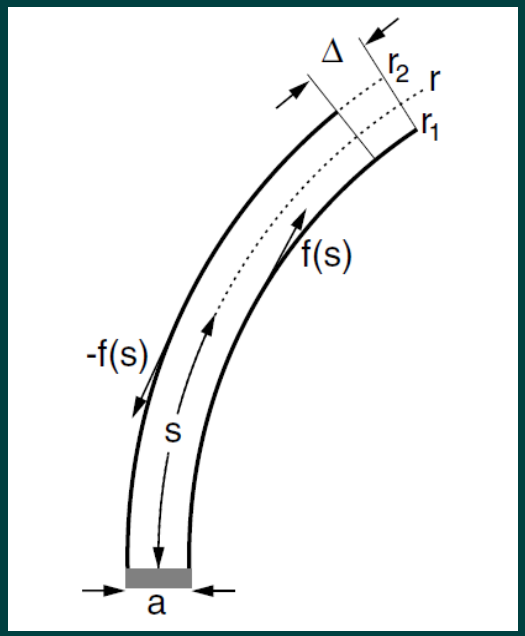


Figure 16.5 Physical Biology of the Cell, 2ed. (© Garland Science 2013)

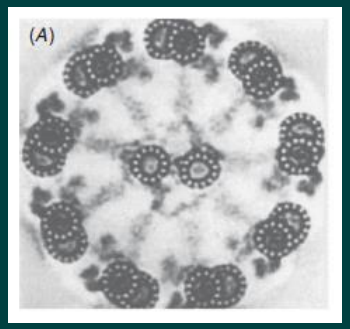
right picture is wrong

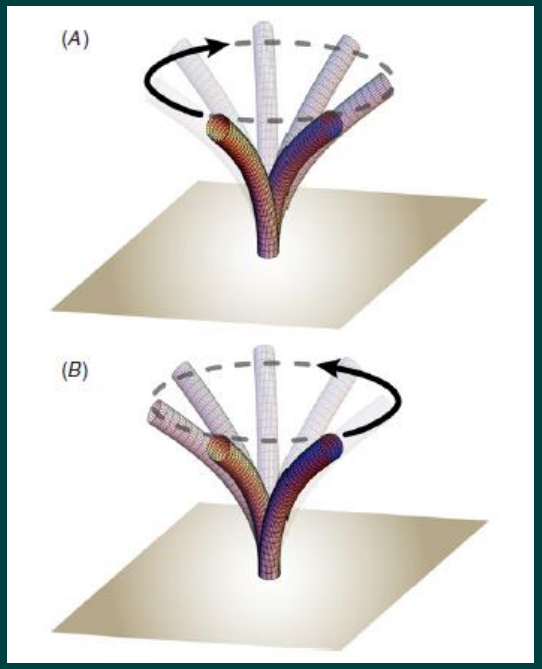
axonemal chirality results in twirling beat patterns

correct explanation



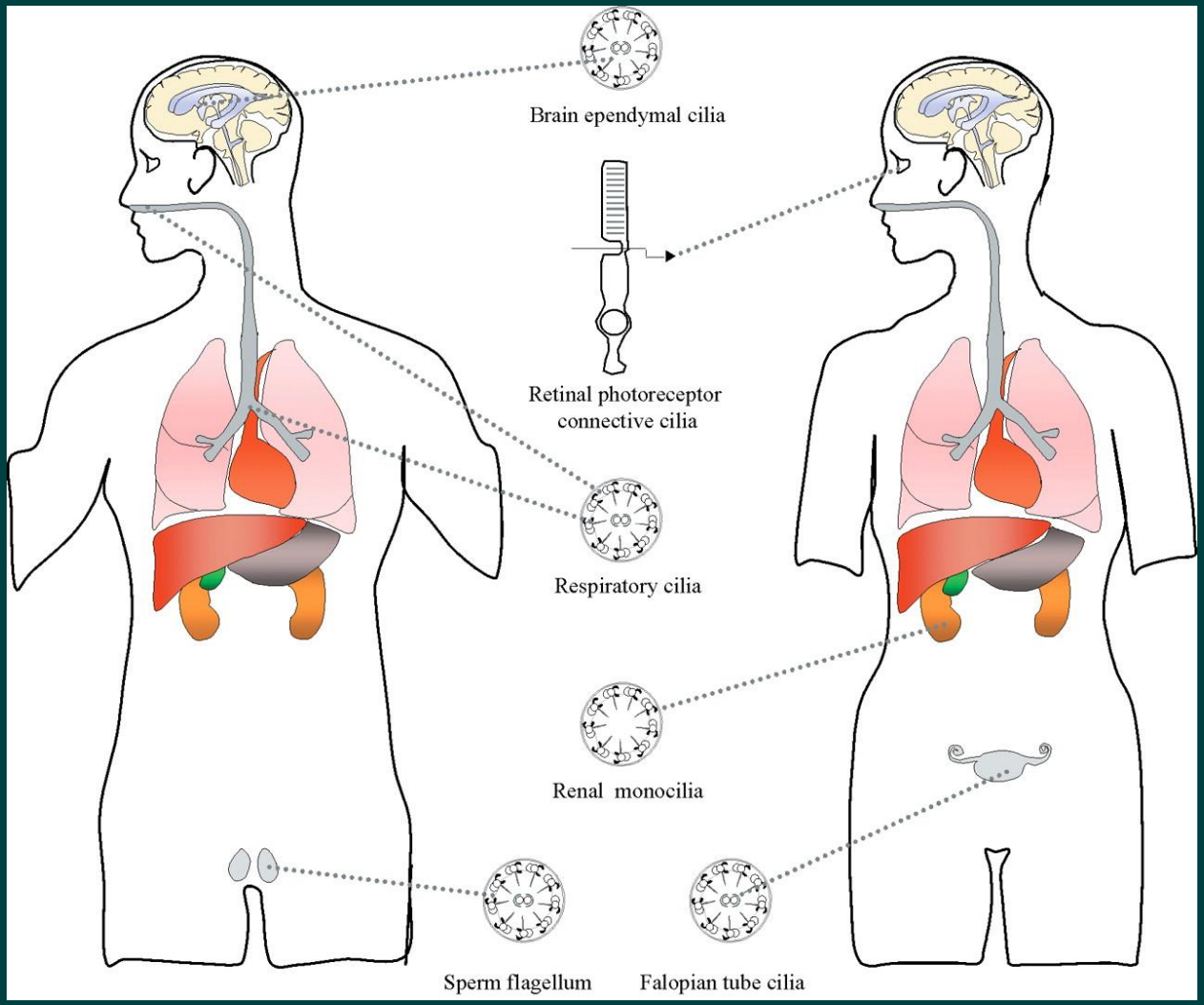
Camalet and Julicher, 2000





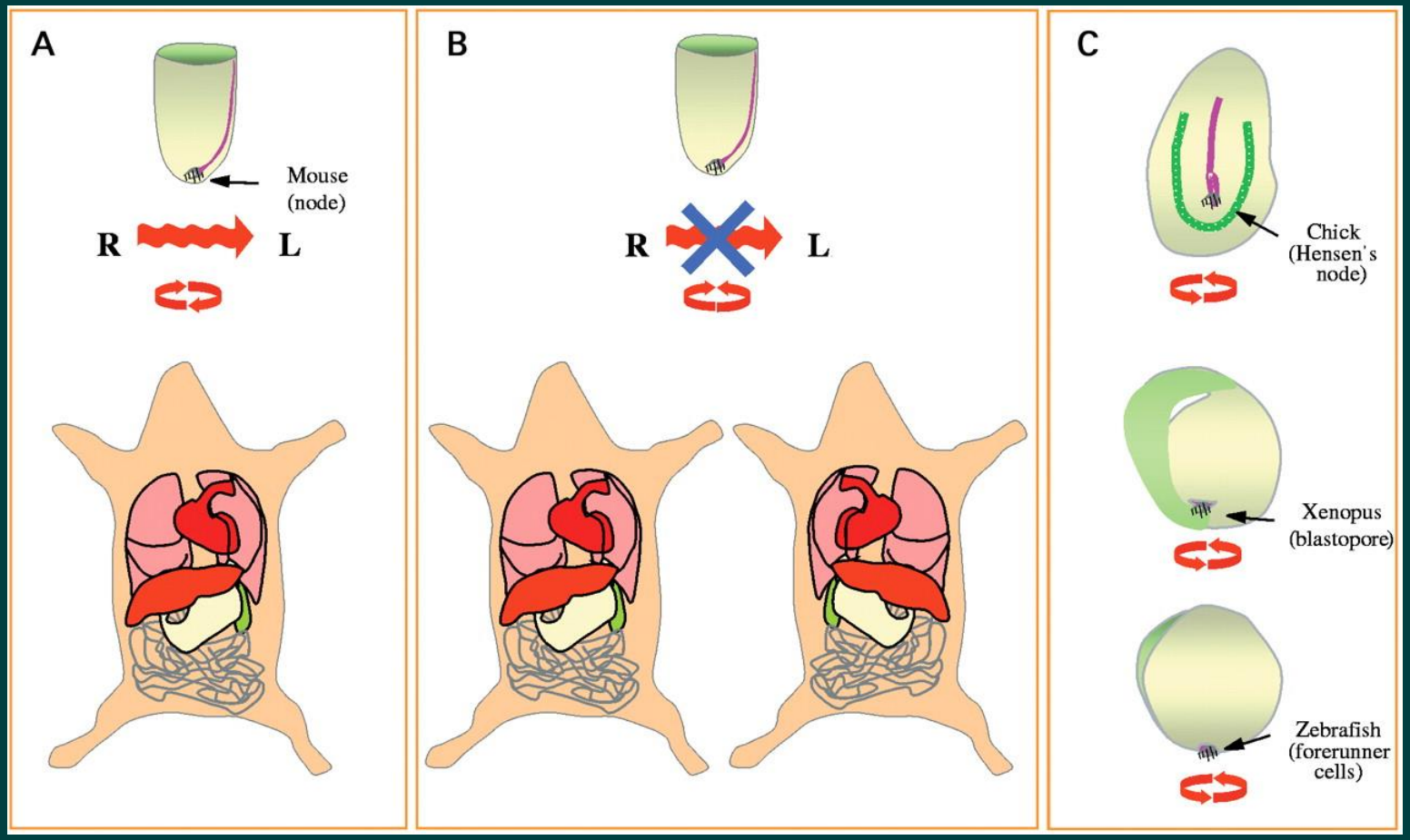
Hilfinger and Julicher, 2008

cilia in human body

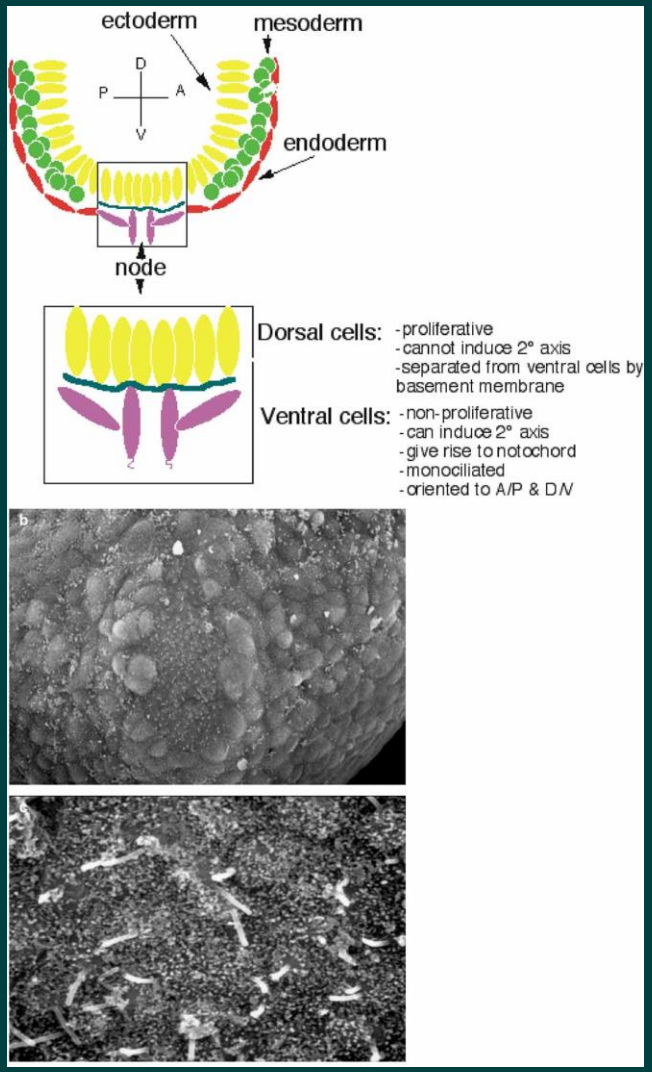


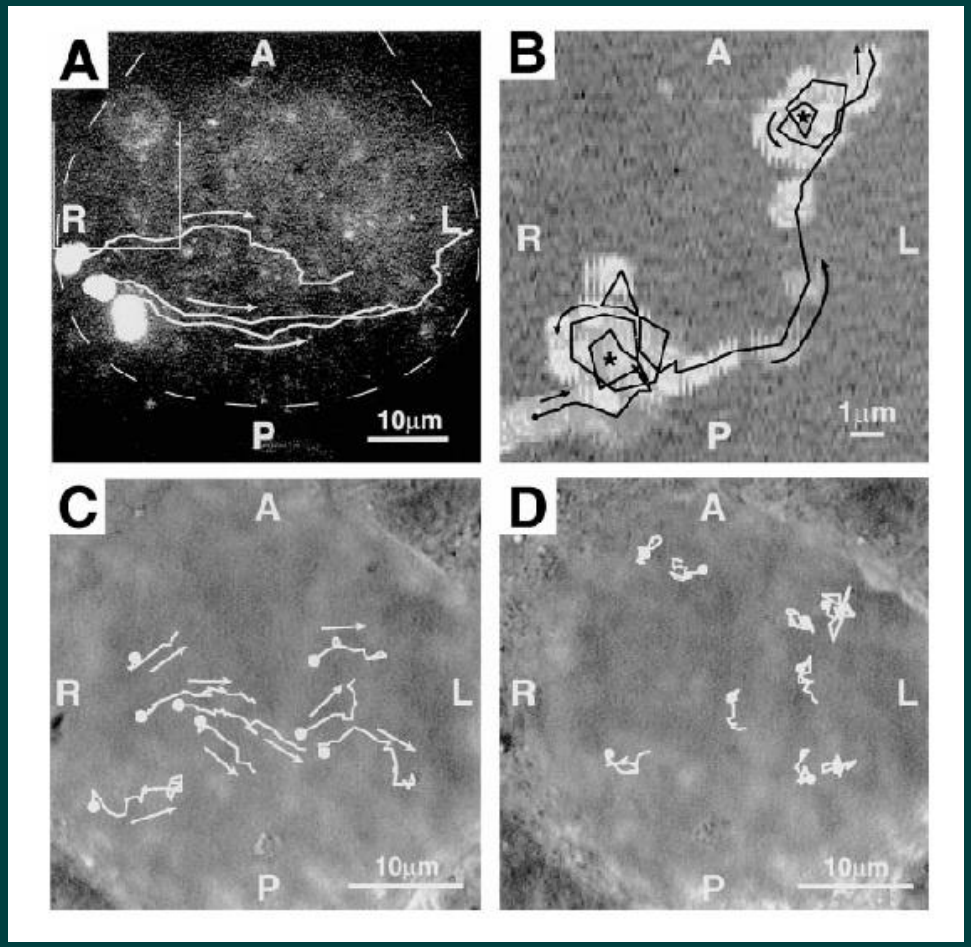
Kartagener syndrome (cilia dynein mutation): infertility, respiratory problems and left-right randomization

randomization of left-right asymmetry with loss of embryonal nodal flow

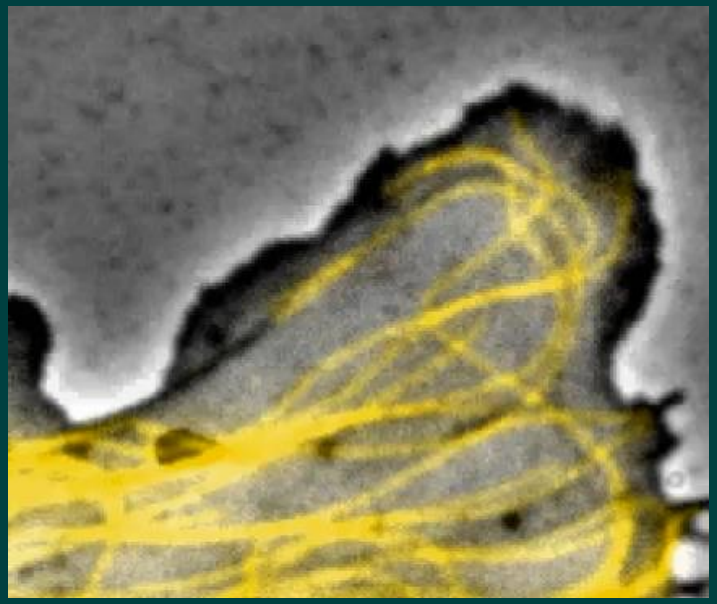


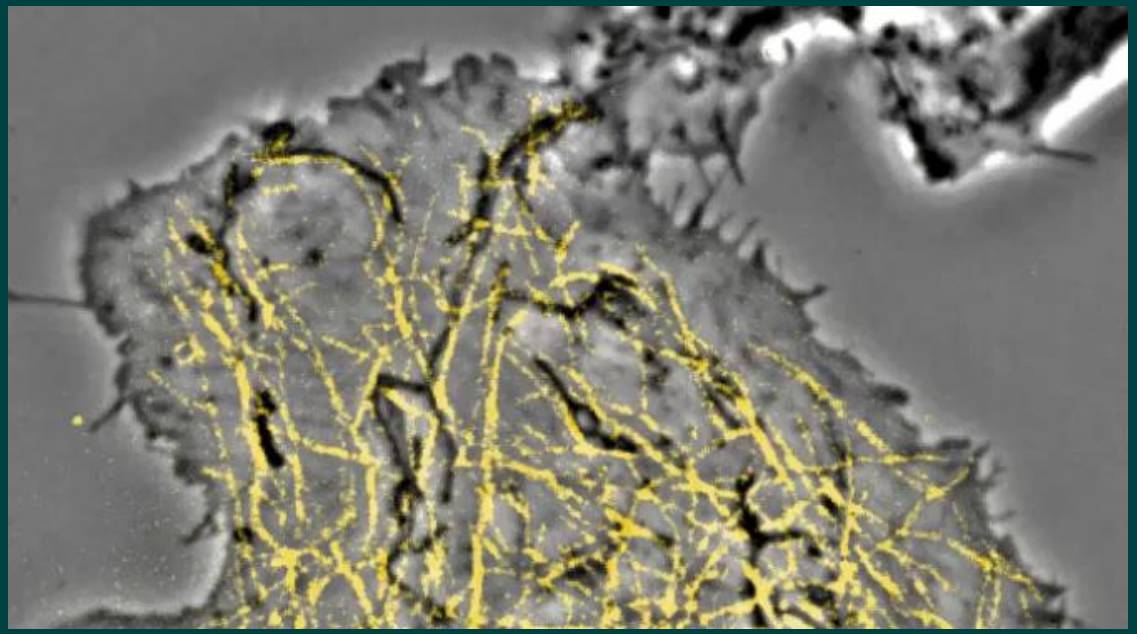
nodal flow


ectoderm
mesoderm
endoderm
node
D
P
A
V
Dorsal cells: -proliferative
-cannot induce 2° axis
-separated from ventral cells by basement membrane
Ventral cells: -non-proliferative
-can induce 2° axis
-give rise to notochord
-monociliated
-oriented to A/P & D/V


A
A
R
L
P
10μm
B
A
R
L
P
1μm
C
A
R
L
P
10μm
D
A
R
L
P
10μm

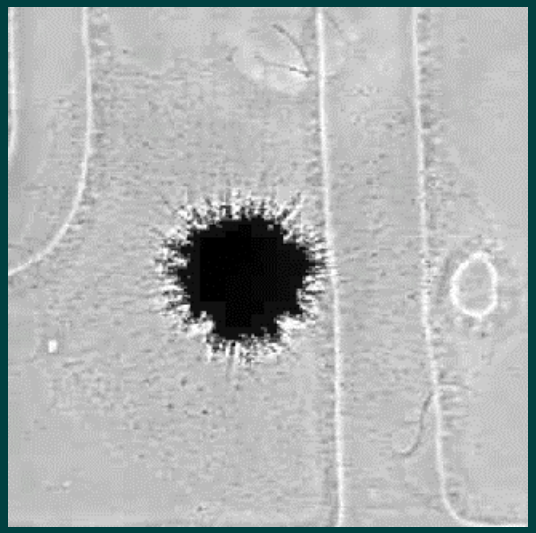
Transport and positioning of the organelles



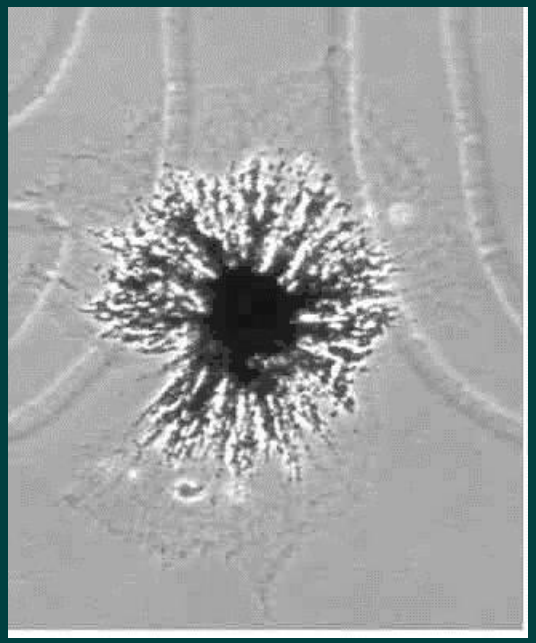


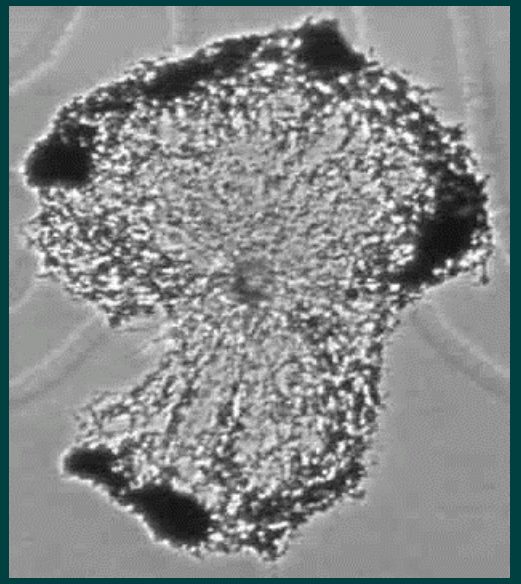
pigment granule transport and self-centering in fish melanophores

normal dispersion

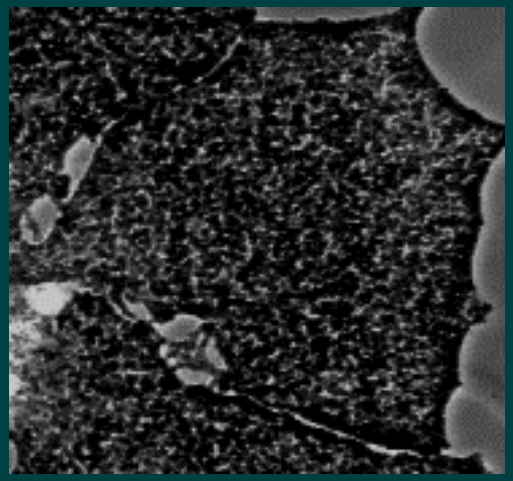


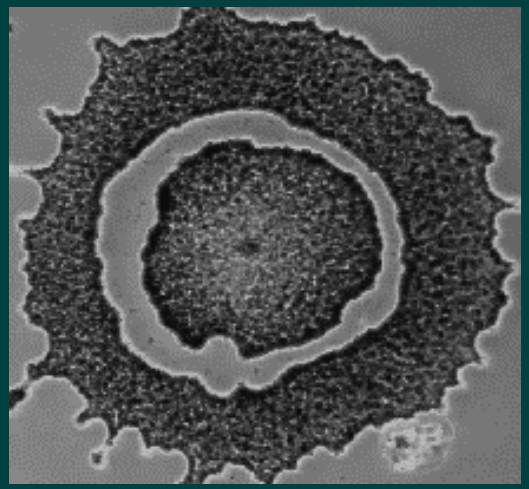
without actin





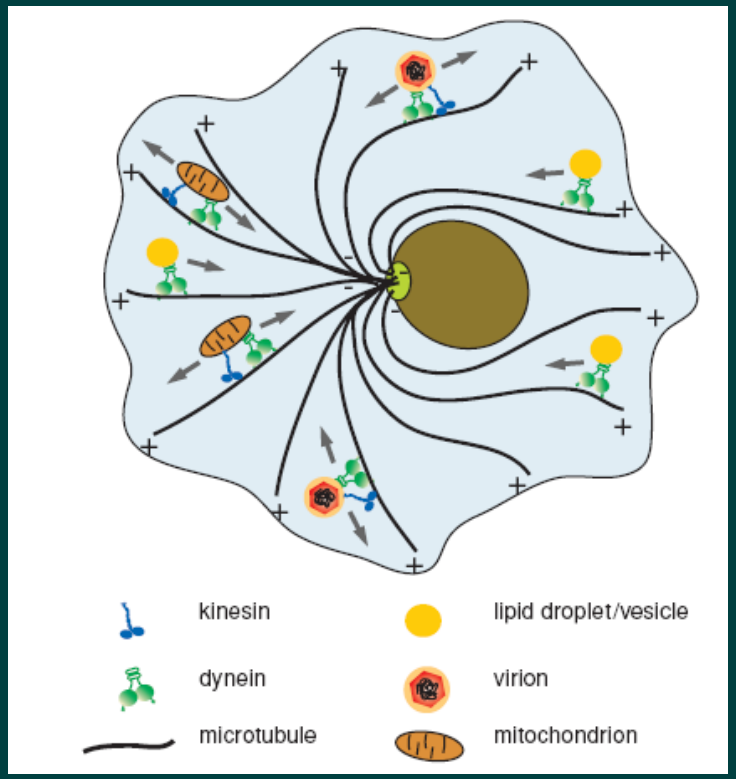
cell fragments

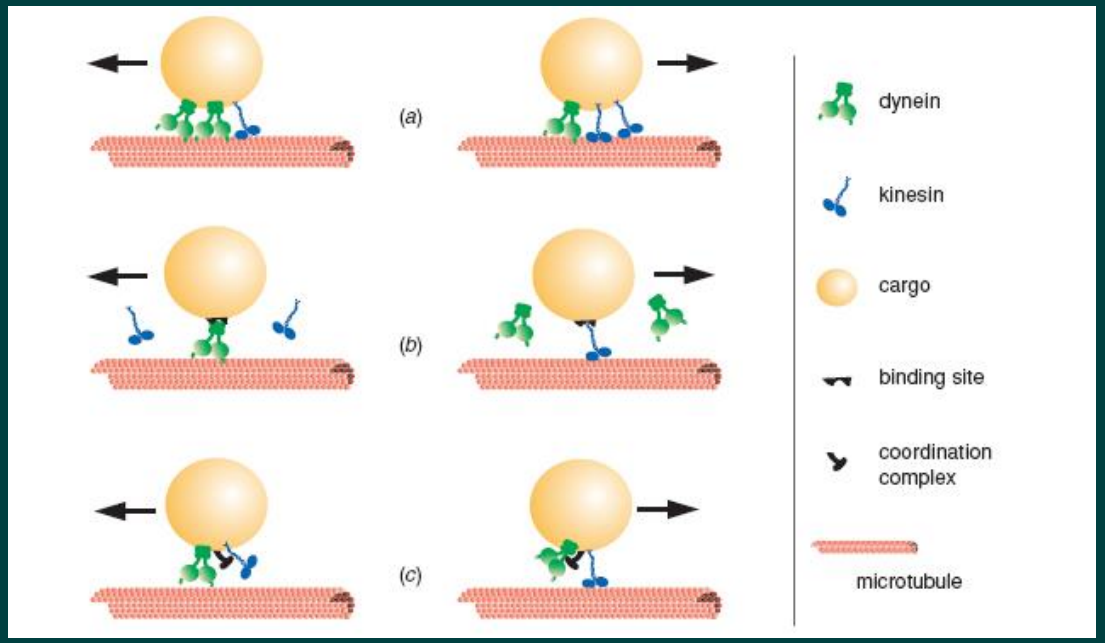




Rodionov and Borisy

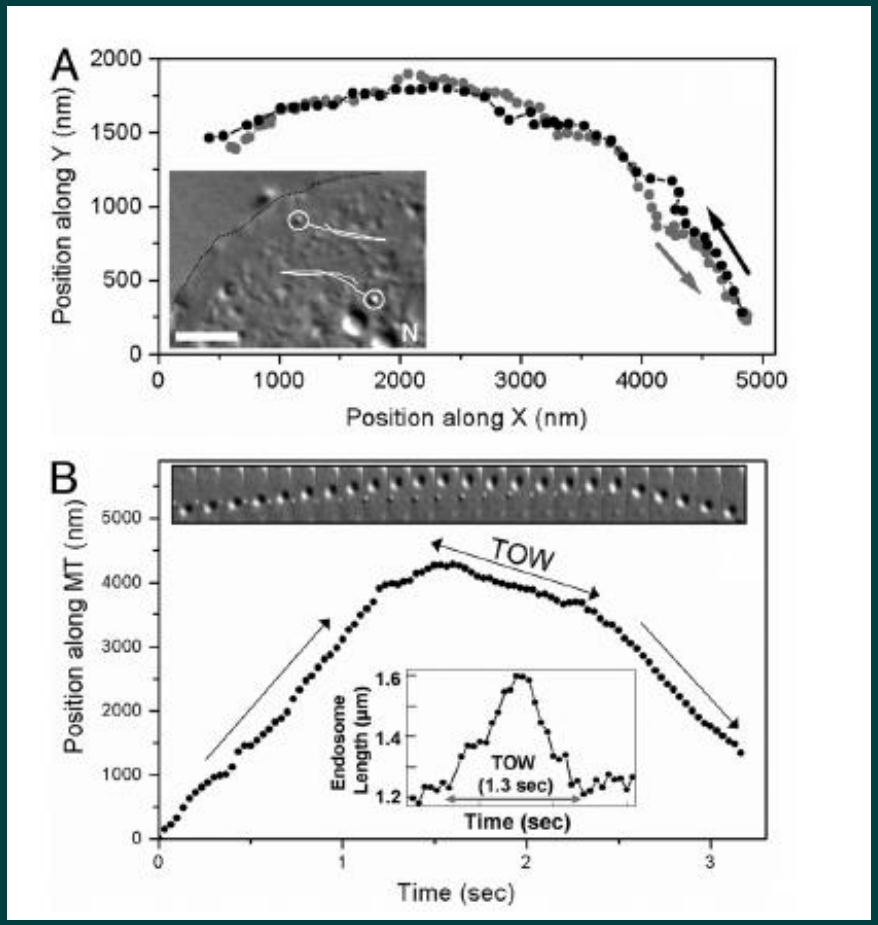
Bi-directionality of motor-mediated movements

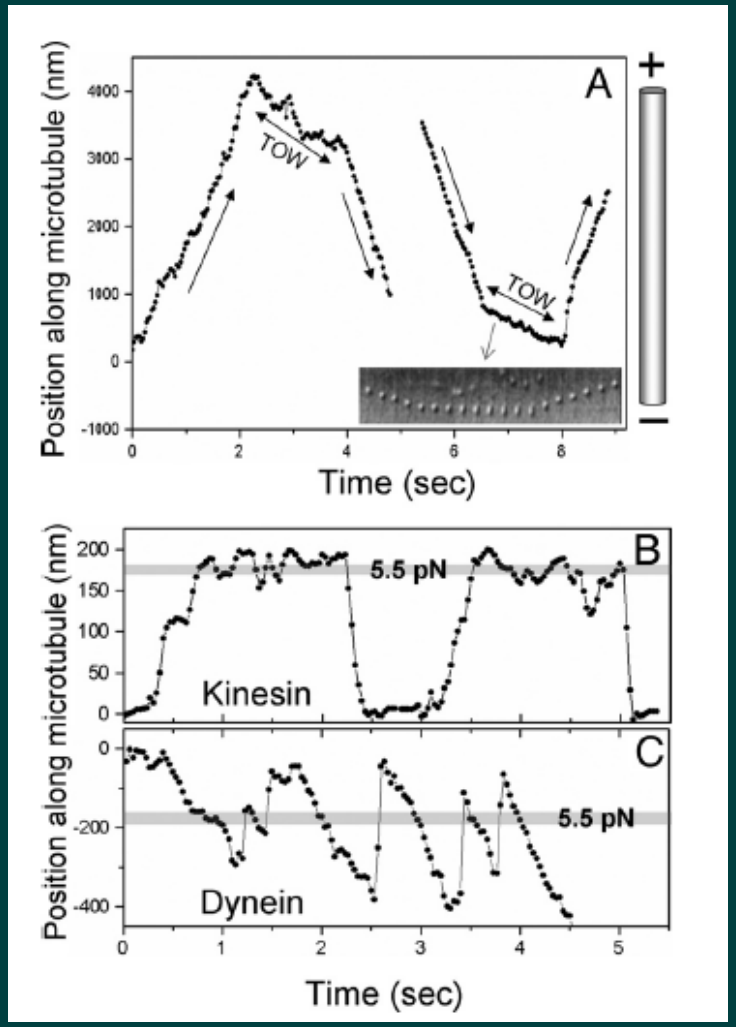




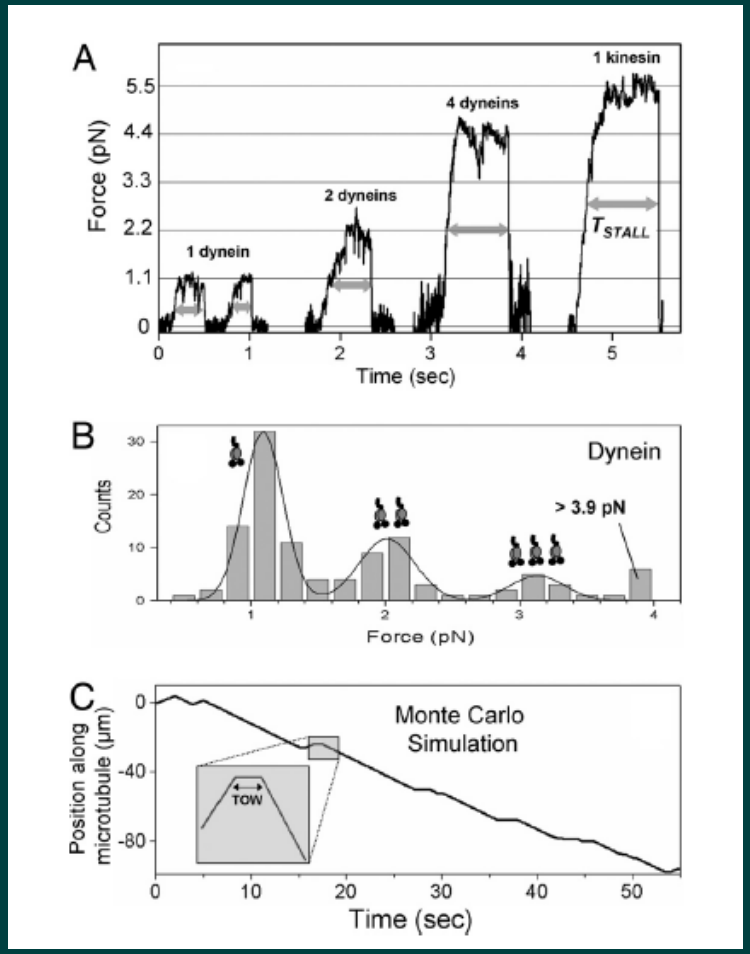
Gross, 2004

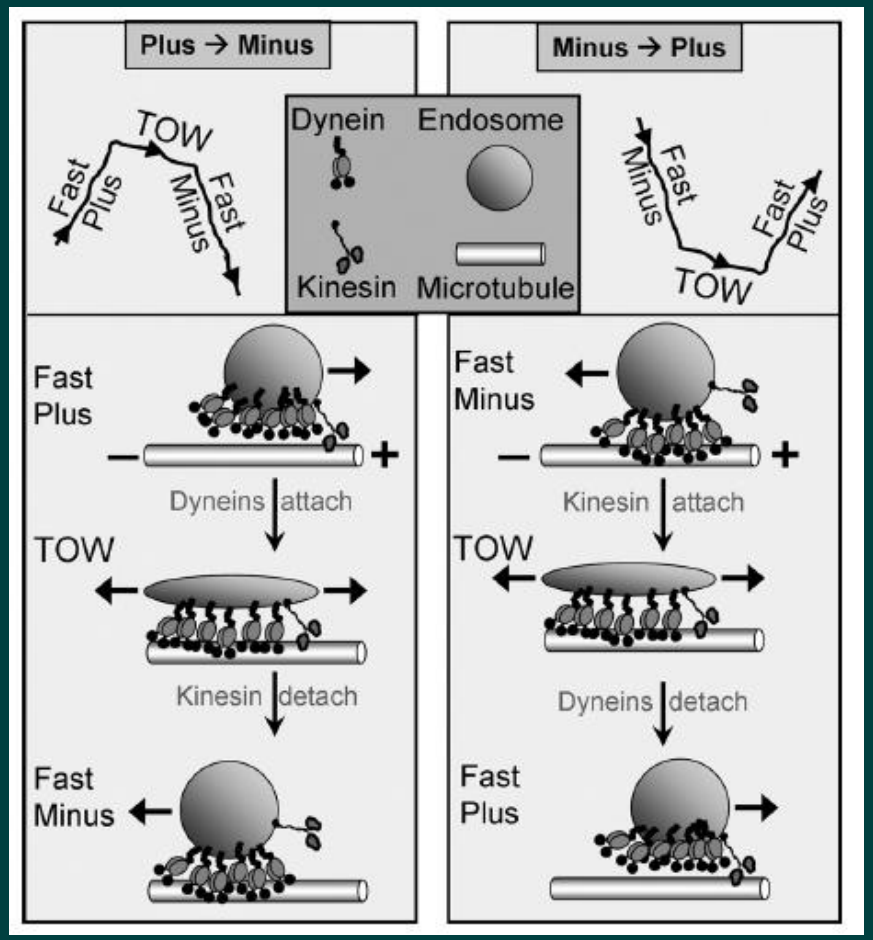
Tug of war (TOW) during change of direction





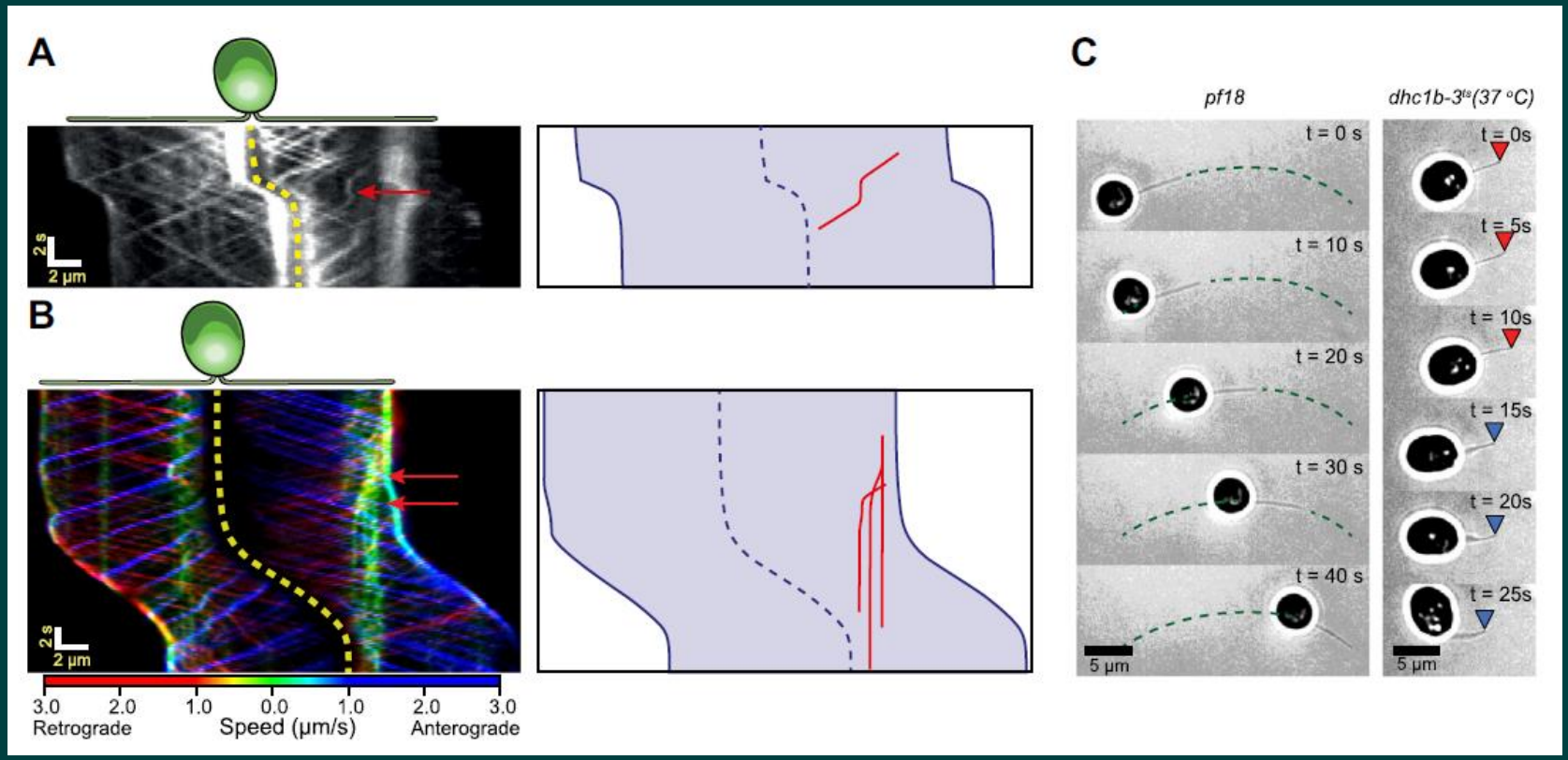
Soppina et al., PNAS, 2009





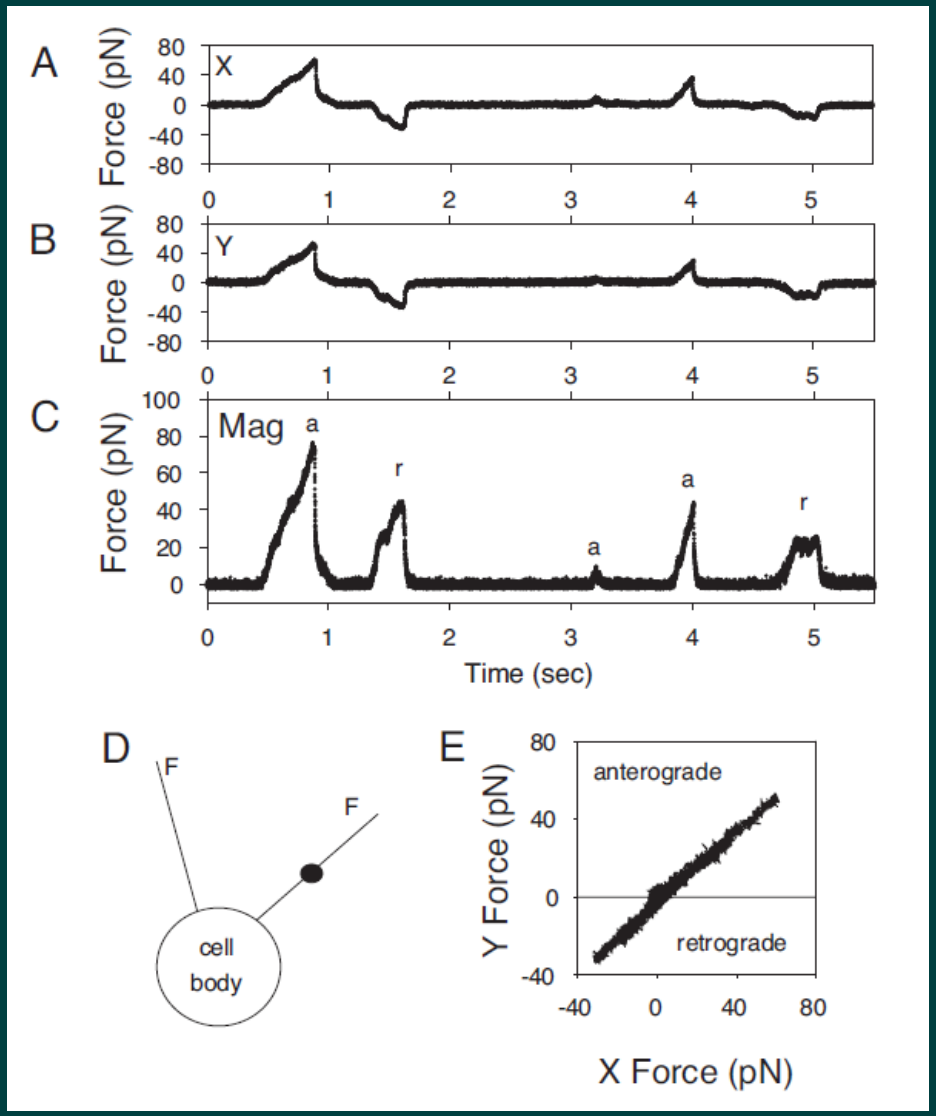
competition between many weak dyneins and a few strong kinesins

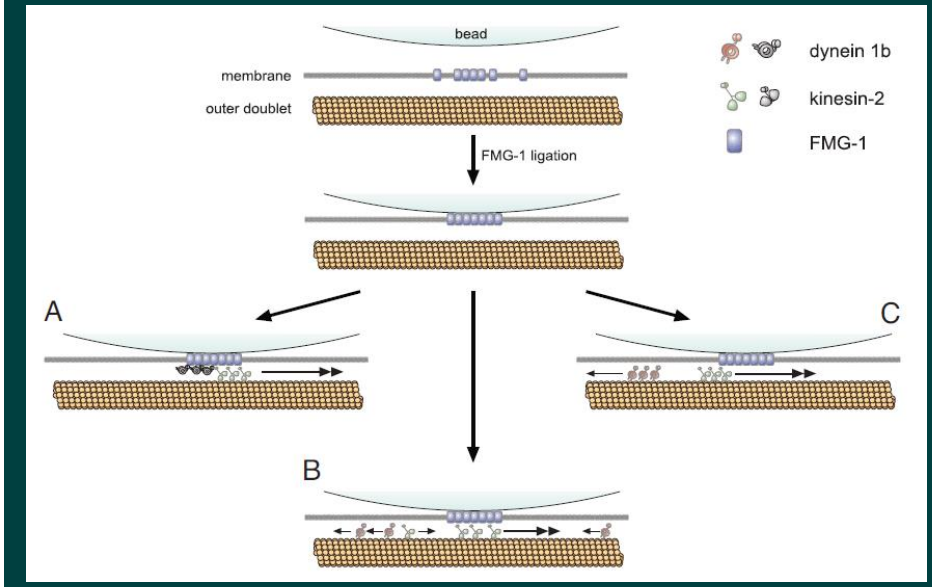
Intraflagellar transport drives surface gliding of flagellated cells



Shih et al., 2013

Transport events in flagellar surface transport do not overlap – no TOW





Laib et al., 2009

next time: cell division

Video Enhanced DIC Microscopy
of Mitosis in Newt Lung Cells
(Taricha granulosa)

Victoria Skeen,
Robert Skibbens, and
E. D. Salmon

University of North Carolina at Chapel Hill
(see Skibbens et al., 1993, J. Cell biol.
122:859-875)
Frame Time = HR:MIN:SEC

Salmon lab. web site