ME 411 / ME 511

Biological Frameworks for Engineers

Class Organization

- Homework 4 due on Wed

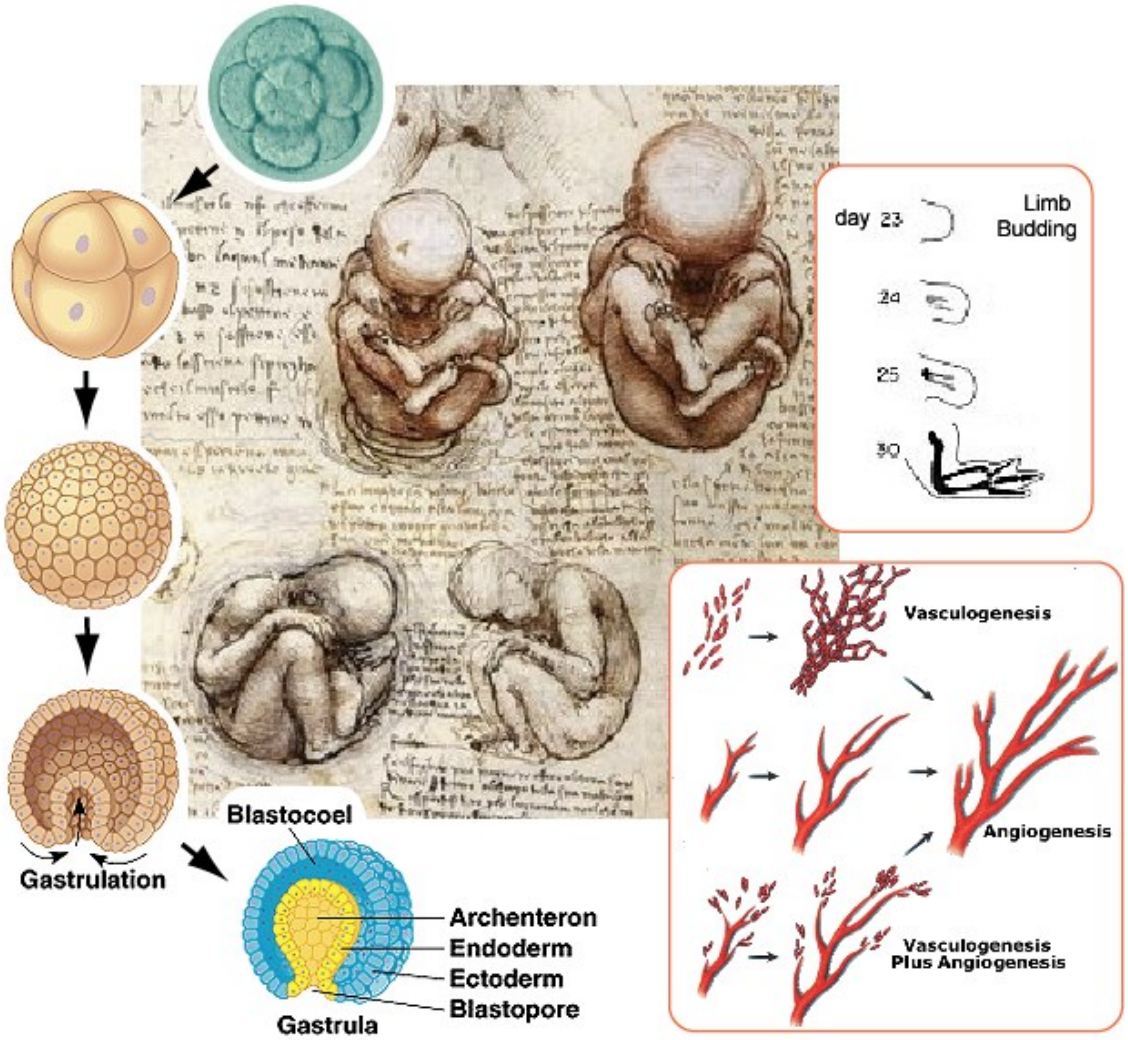
Biological Frameworks for Engineers

ME 411 / ME 511

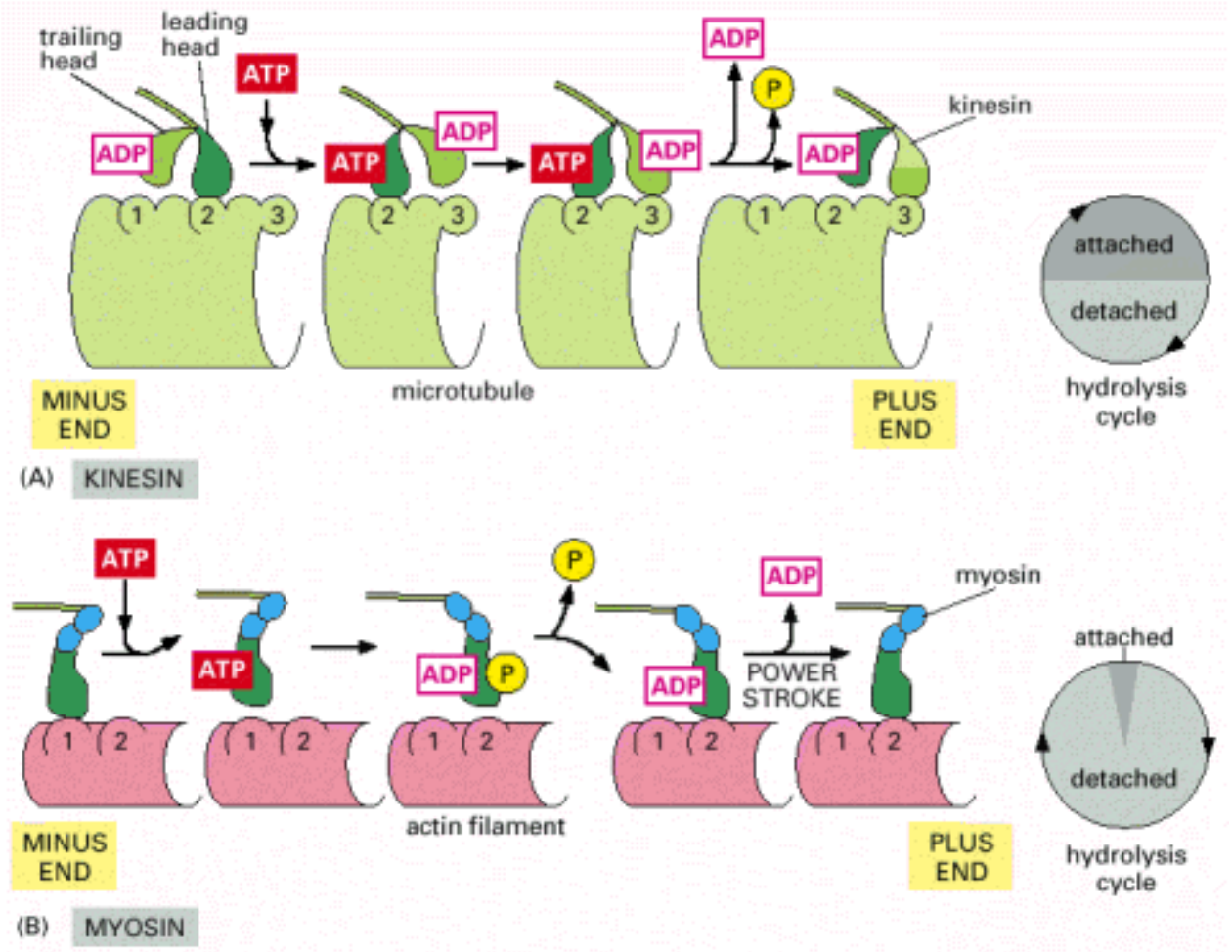
Cell Movements

UNIVERSITY OF WASHINGTON

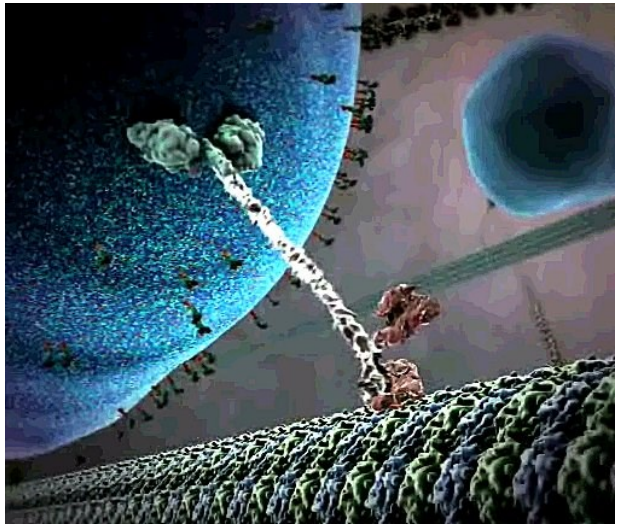
First Movements…

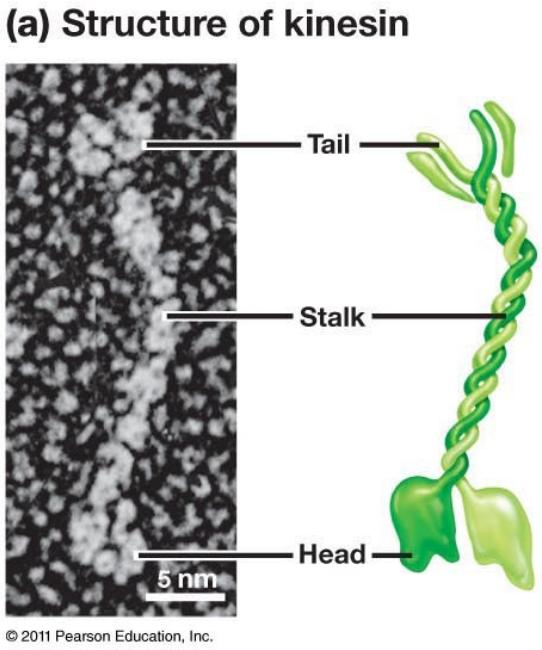


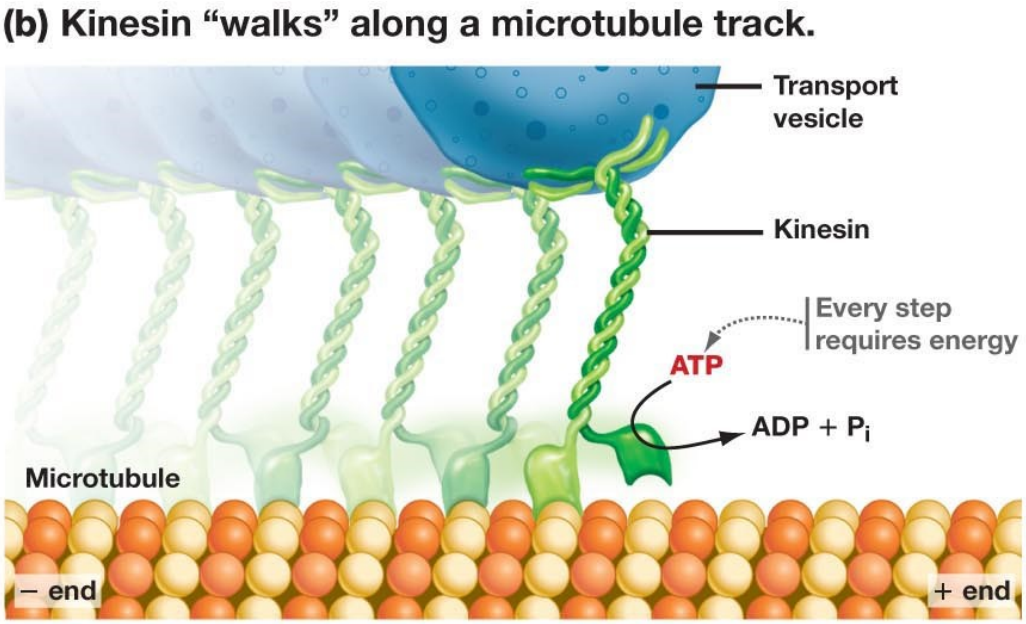
Molecular Motors



Kinesin

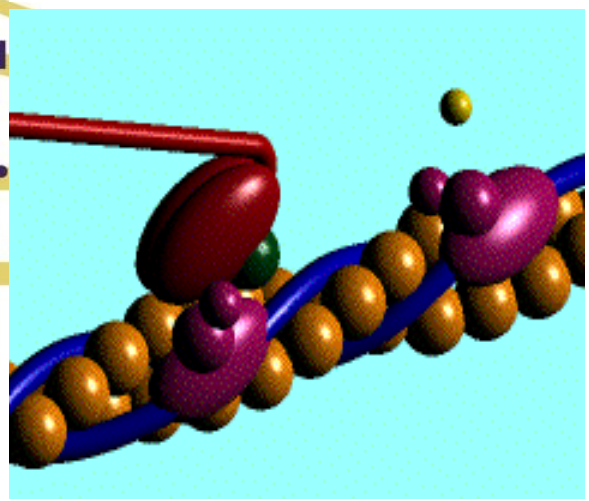


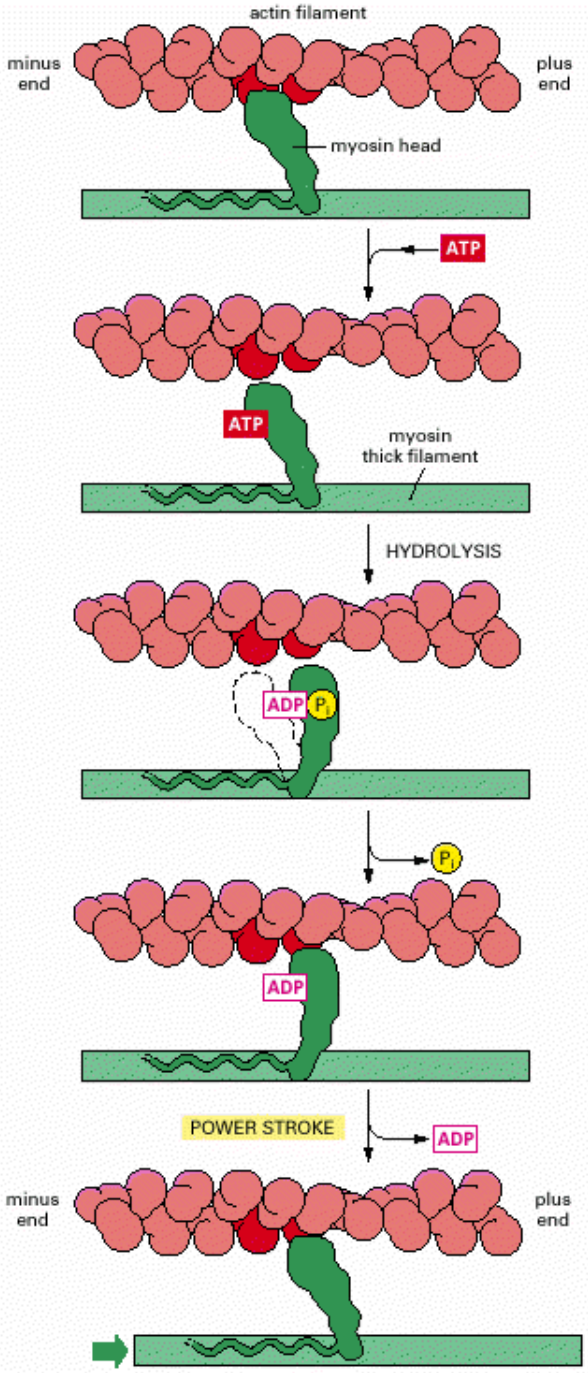

(a) Structure of kinesin
Tail
Stalk
Head
5 nm
© 2011 Pearson Education, Inc.


(b) Kinesin "walks" along a microtubule track.
Transport vesicle
Kinesin
Every step requires energy
ATP
ADP + Pi
Microtubule
– end
+ end

Biological Frameworks for Engineers

Myosin





ATTACHED At the start of the cycle shown in this figure, a myosin head lacking a bound nucleotide is locked tightly onto an actin filament in a *rigor* configuration (so named because it is responsible for *rigor mortis*, the rigidity of death). In an actively contracting muscle, this state is very short-lived, being rapidly terminated by the binding of a molecule of ATP.

RELEASED A molecule of ATP binds to the large cleft on the "back" of the head (that is, on the side furthest from the actin filament) and immediately causes a slight change in the conformation of the domains that make up the actin-binding site. This reduces the affinity of the head for actin and allows it to move along the filament. (The space drawn here between the head and actin emphasizes this change, although in reality the head probably remains very close to the actin.)

COCKED The cleft closes like a clam shell around the ATP molecule, triggering a large shape change that causes the head to be displaced along the filament by a distance of about 5 nm. Hydrolysis of ATP occurs, but the ADP and inorganic phosphate (P_i) produced remain tightly bound to the protein.

FORCE-GENERATING A weak binding of the myosin head to a new site on the actin filament causes release of the inorganic phosphate produced by ATP hydrolysis, concomitantly with the tight binding of the head to actin. This release triggers the power stroke—the force-generating change in shape during which the head regains its original conformation. In the course of the power stroke, the head loses its bound ADP, thereby returning to the start of a new cycle.

ATTACHED At the end of the cycle, the myosin head is again locked tightly to the actin filament in a rigor configuration. Note that the head has moved to a new position on the actin filament.

Important Movements

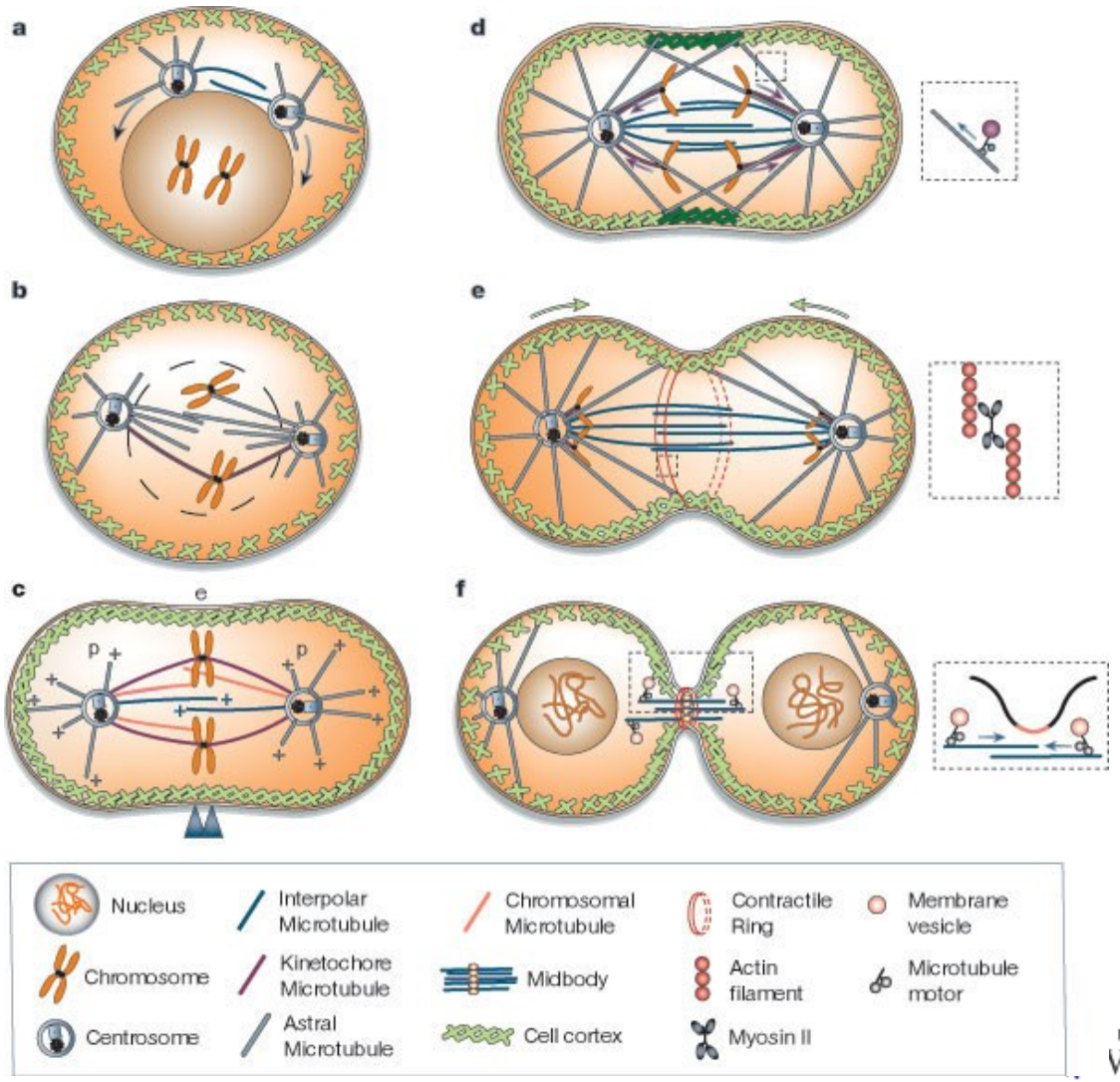
- Cytokinesis
- Migration of Cells
- Contraction of Cells

Cytokinesis

Frog Embryo Development

http://www.youtube.com/watch?v=dXpAbezdOho

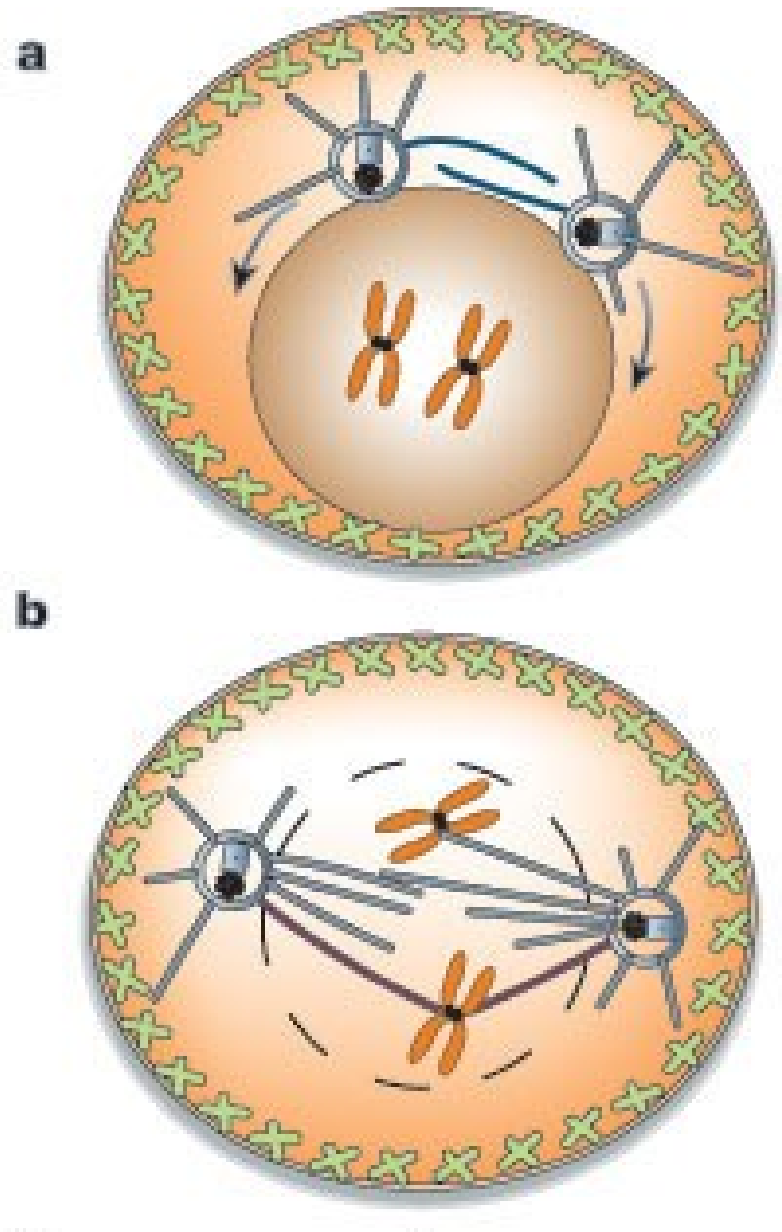
Cytokinesis



Cytokinesis

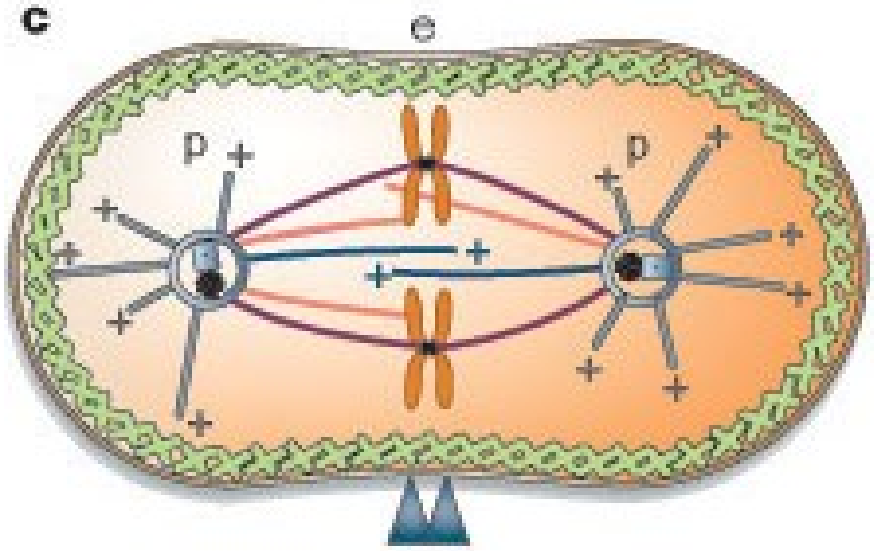
- Prophase

- Prometaphase



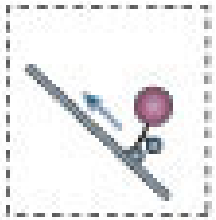
Cytokinesis

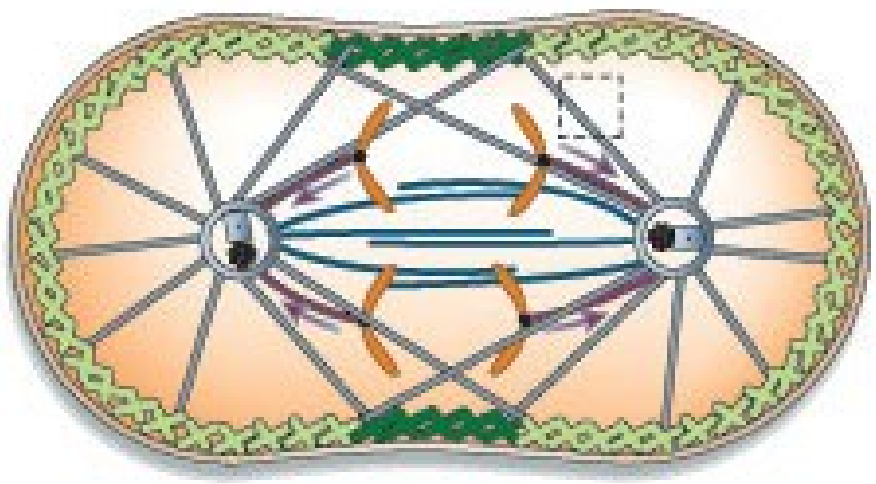
- Metaphase



- Anaphase A

kinesin

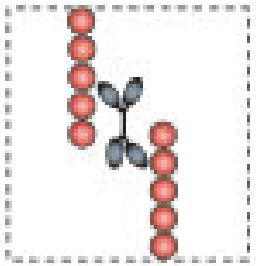




Cytokinesis

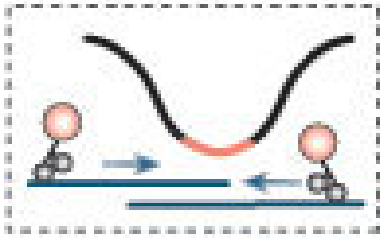
- Anaphase B

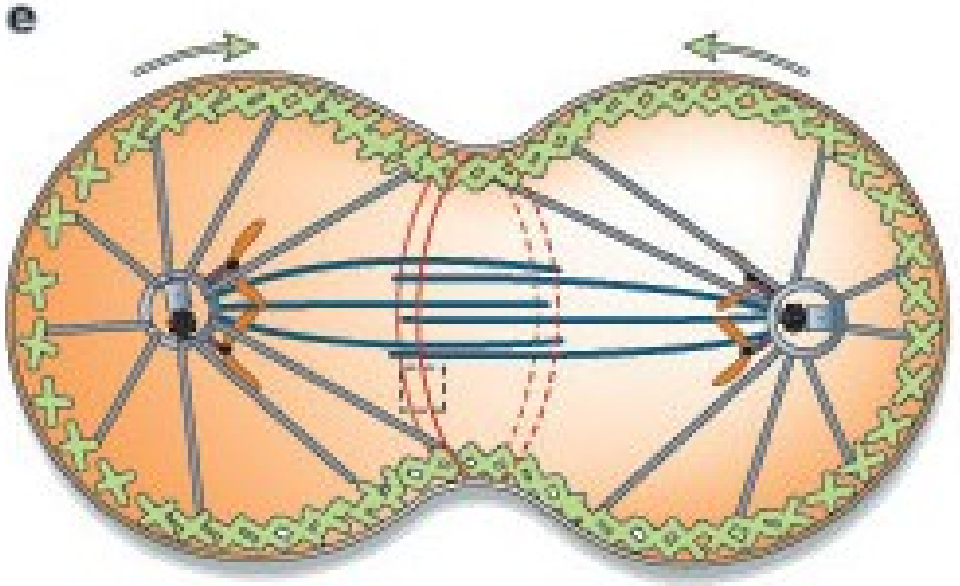
actin
myosin

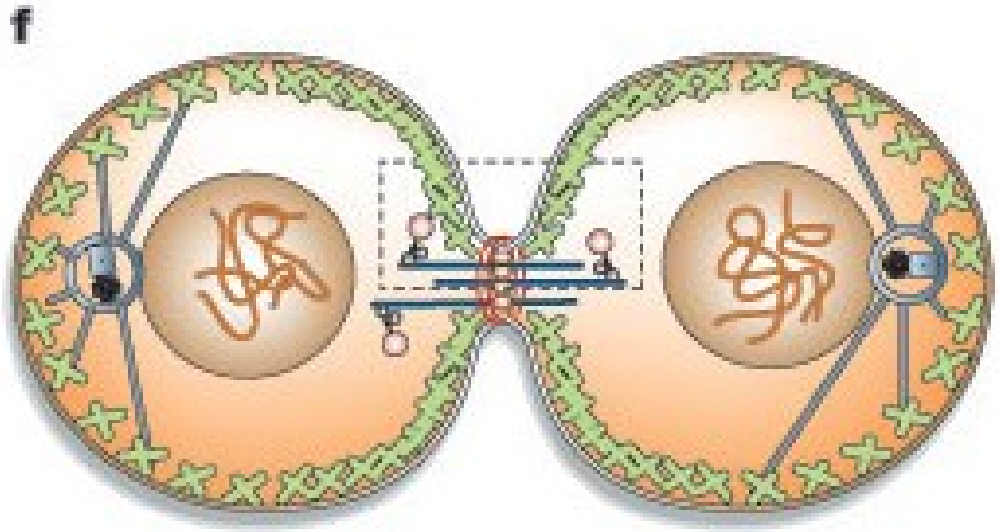


- Telophase

abscission



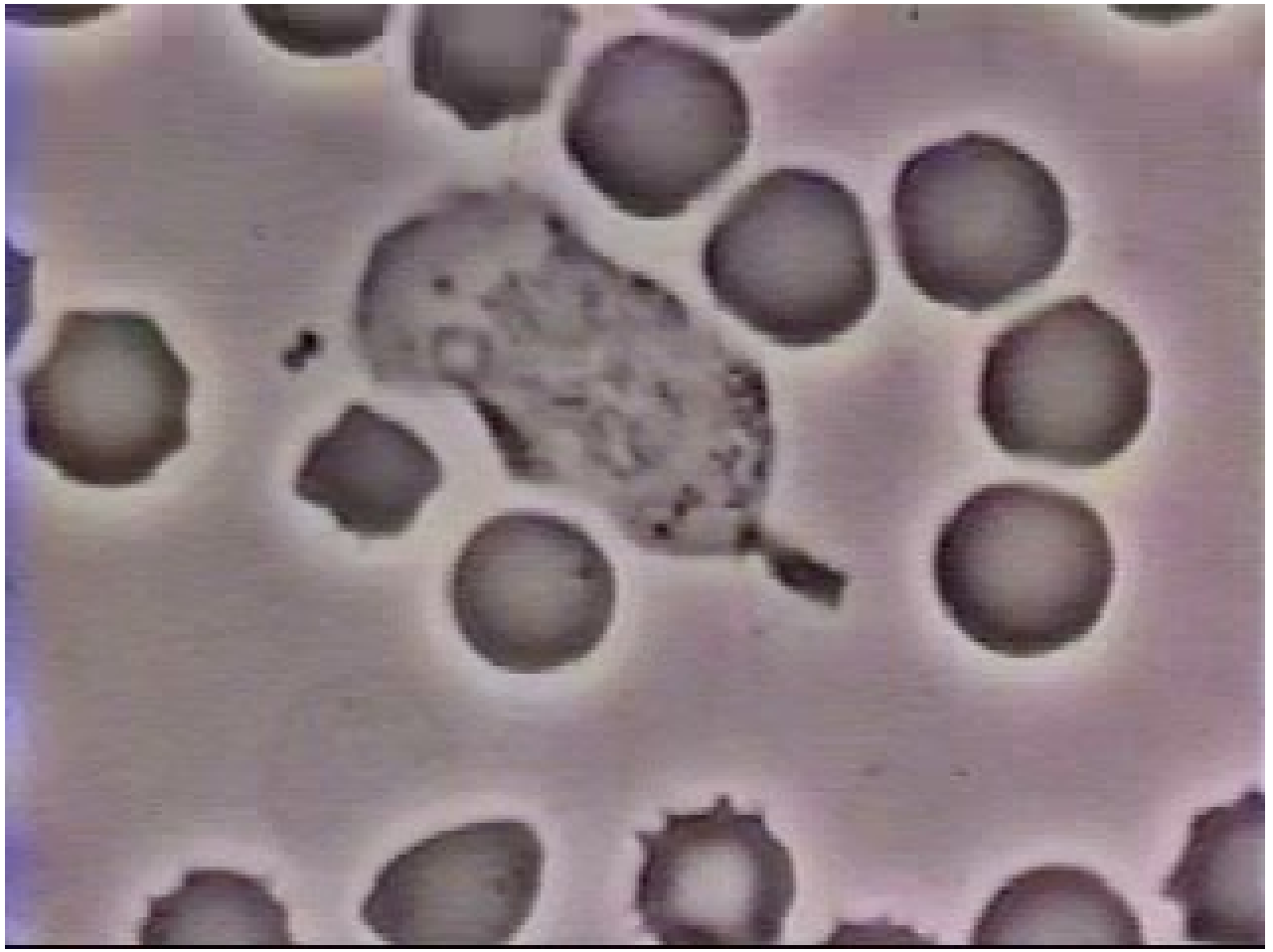




Cell Migration

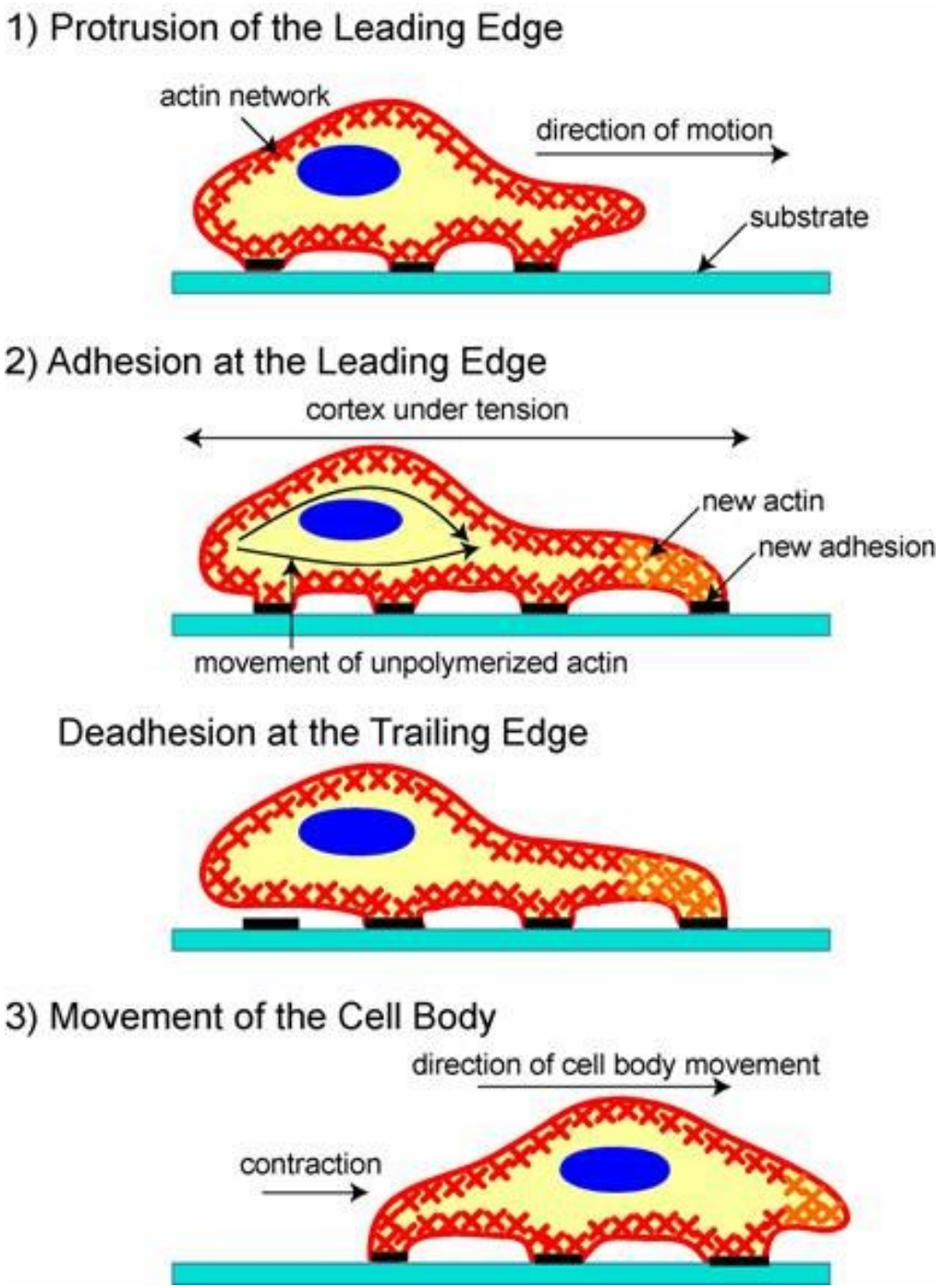
Cell Migration

Cell Migration

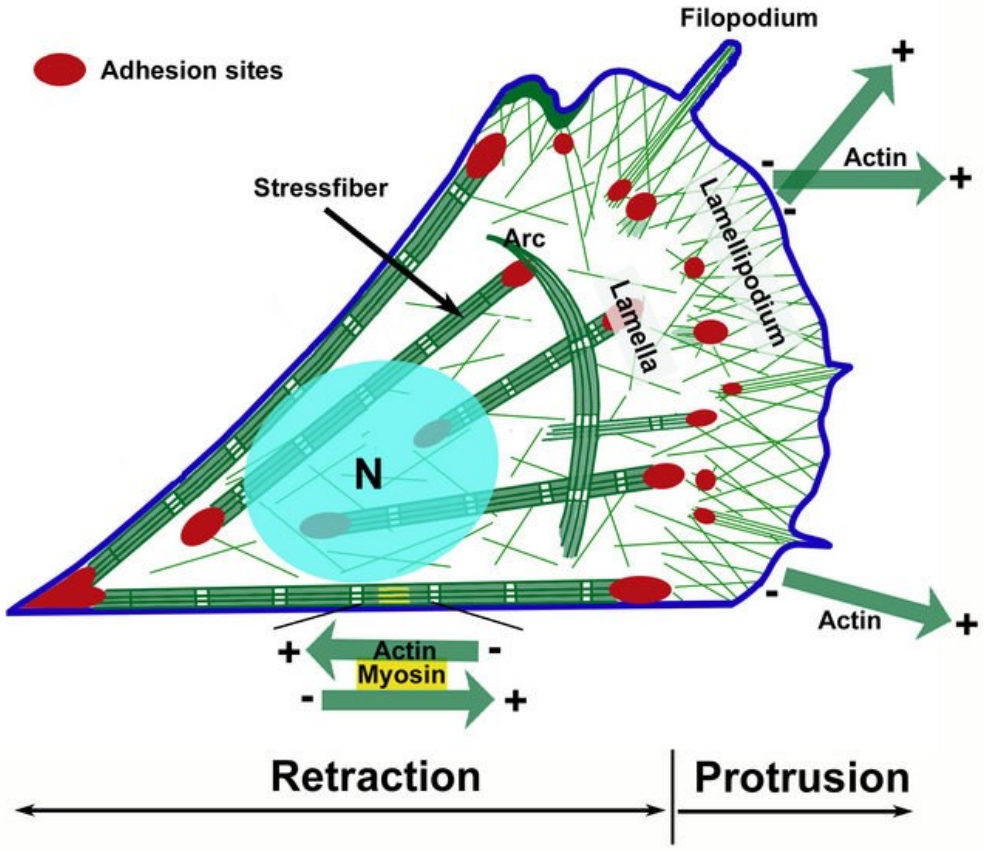


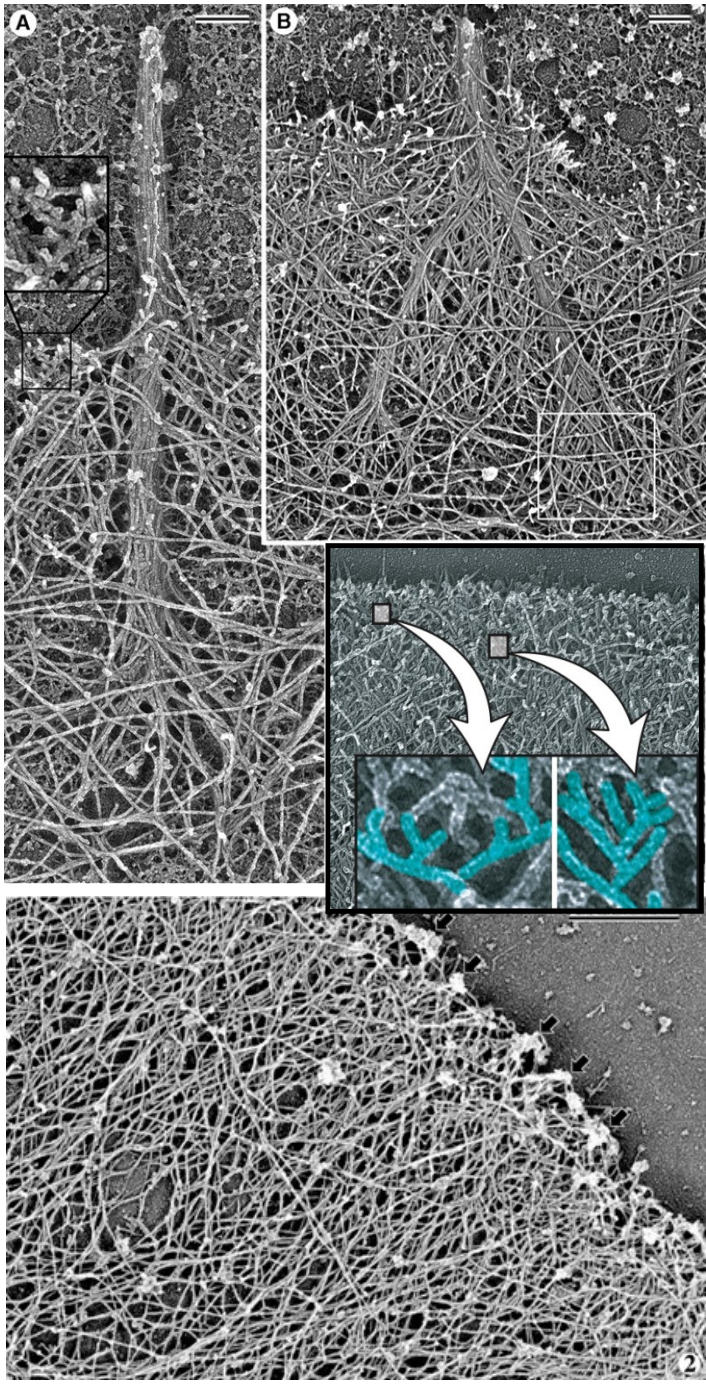
Neutrophil chasing a bacterium

Steps in Cell Migration

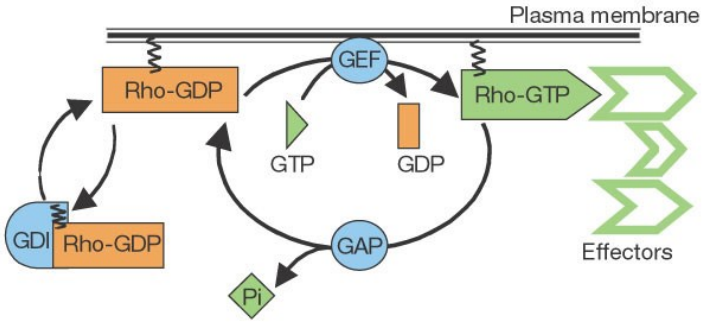


Lamellipodium & Filopodia

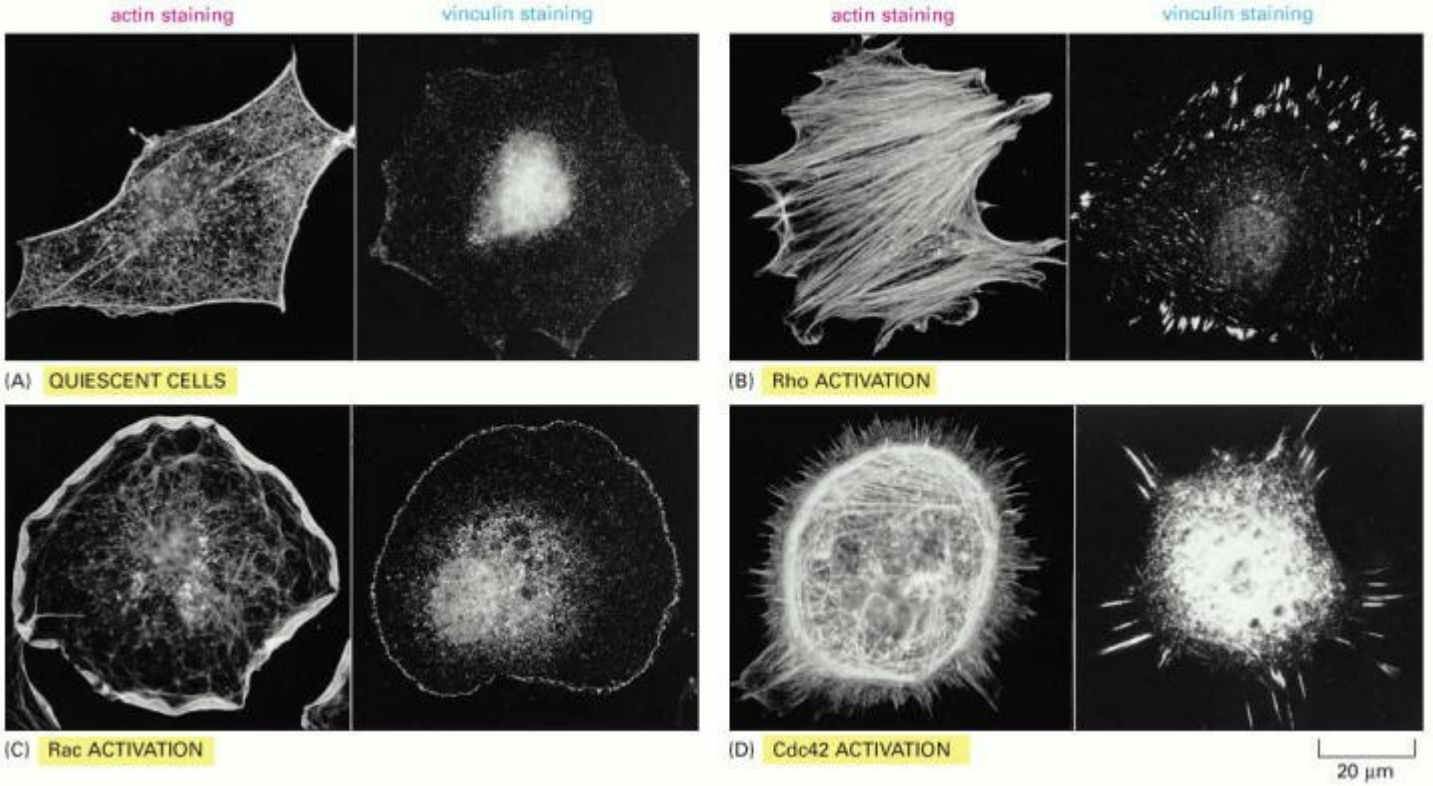




Rho Family GTPases

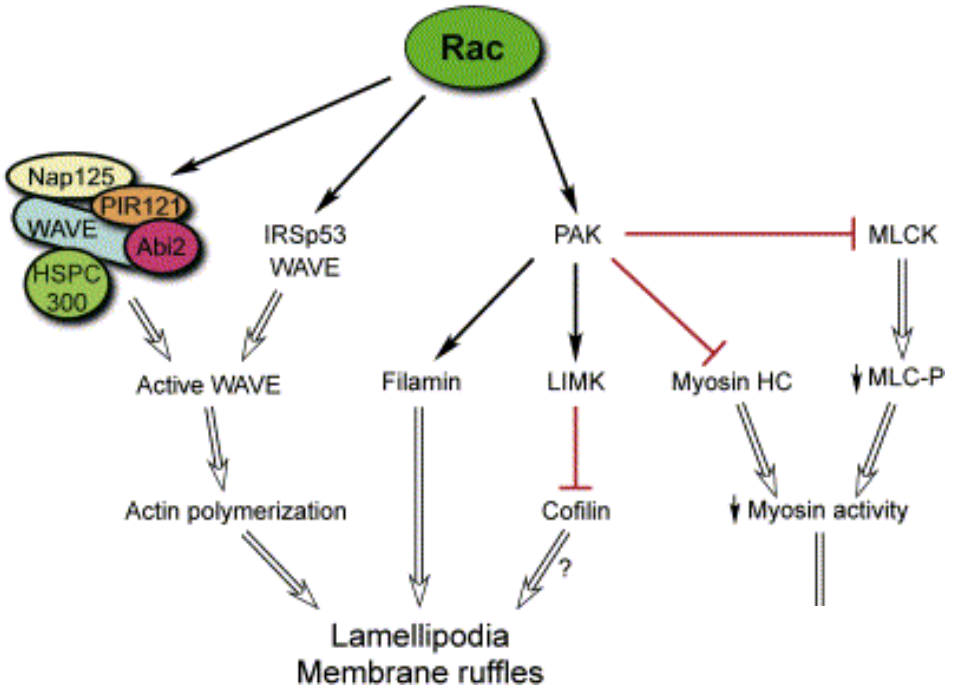


An interesting discovery by Anne Ridley and Alan Hall while studying the oncogene *ras*…



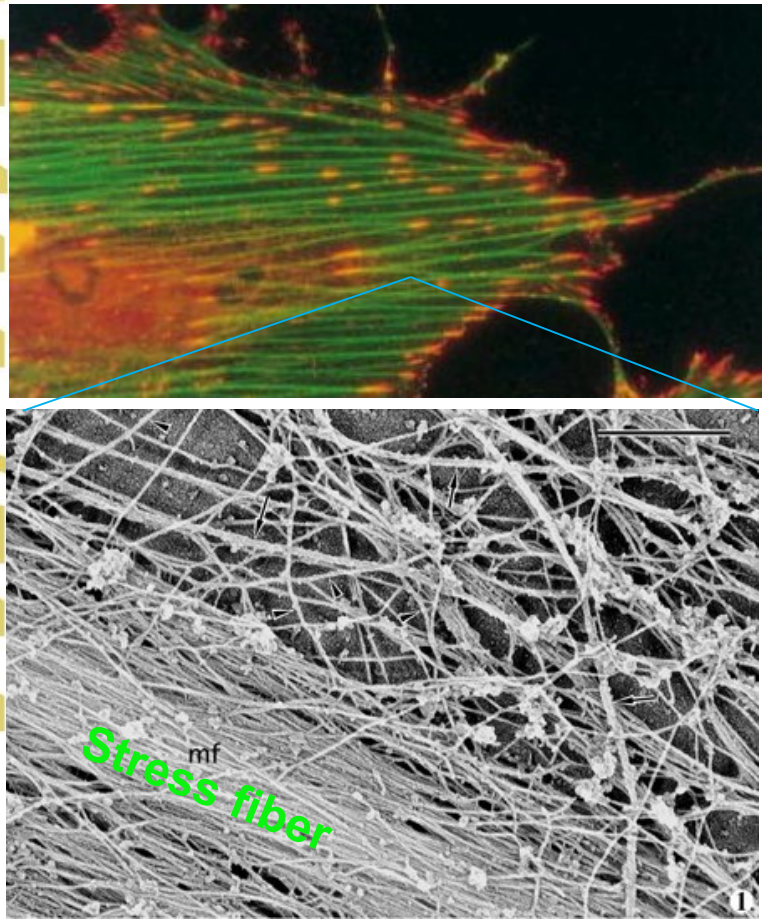
Rac Effectors

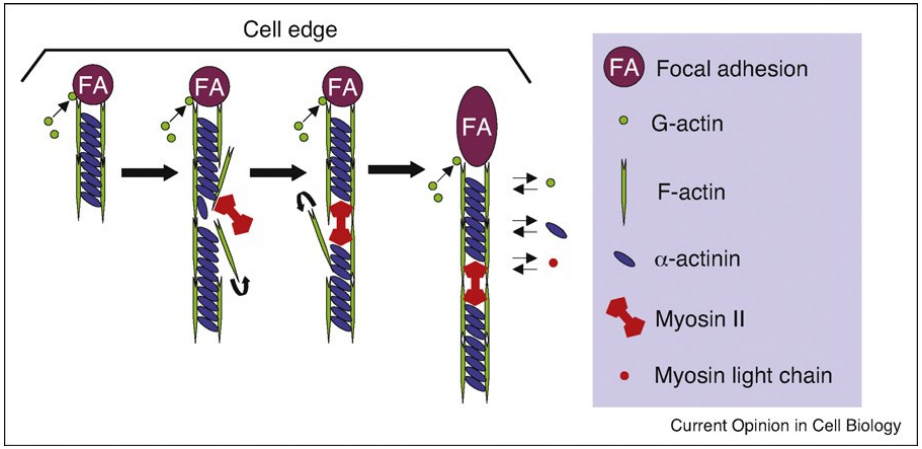
- Rac helps migration and cell elongation

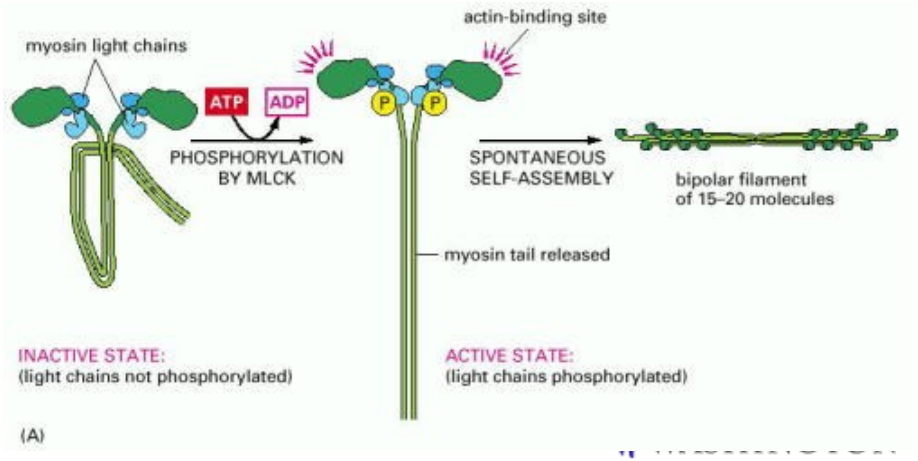


Stress Fibers

- Transient bundled structures

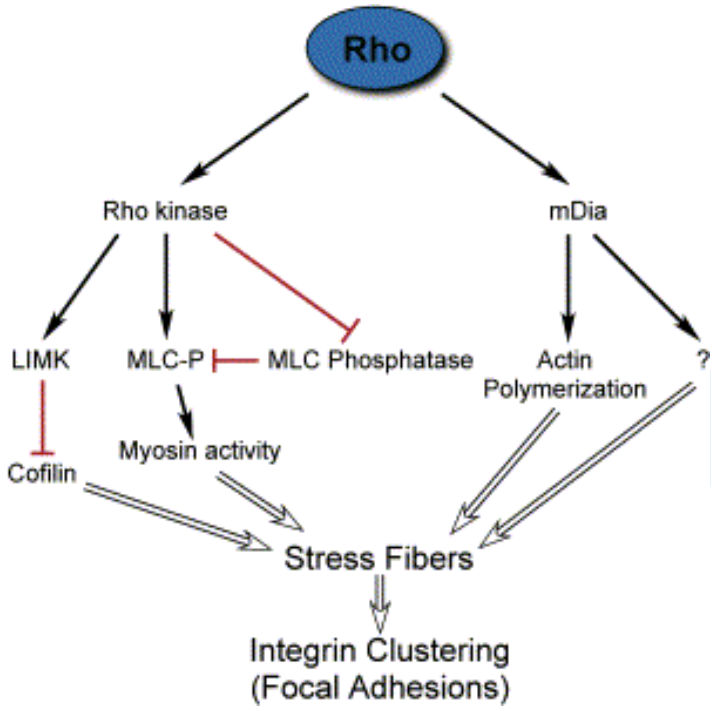


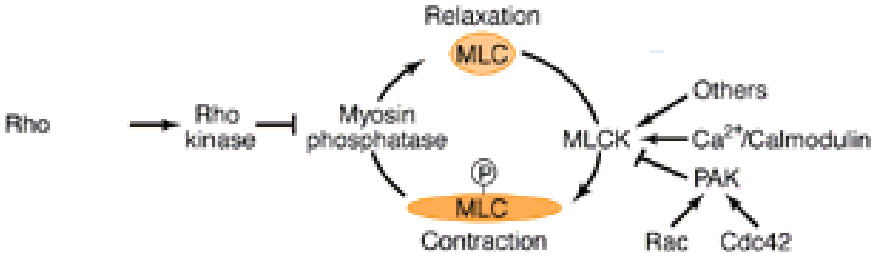




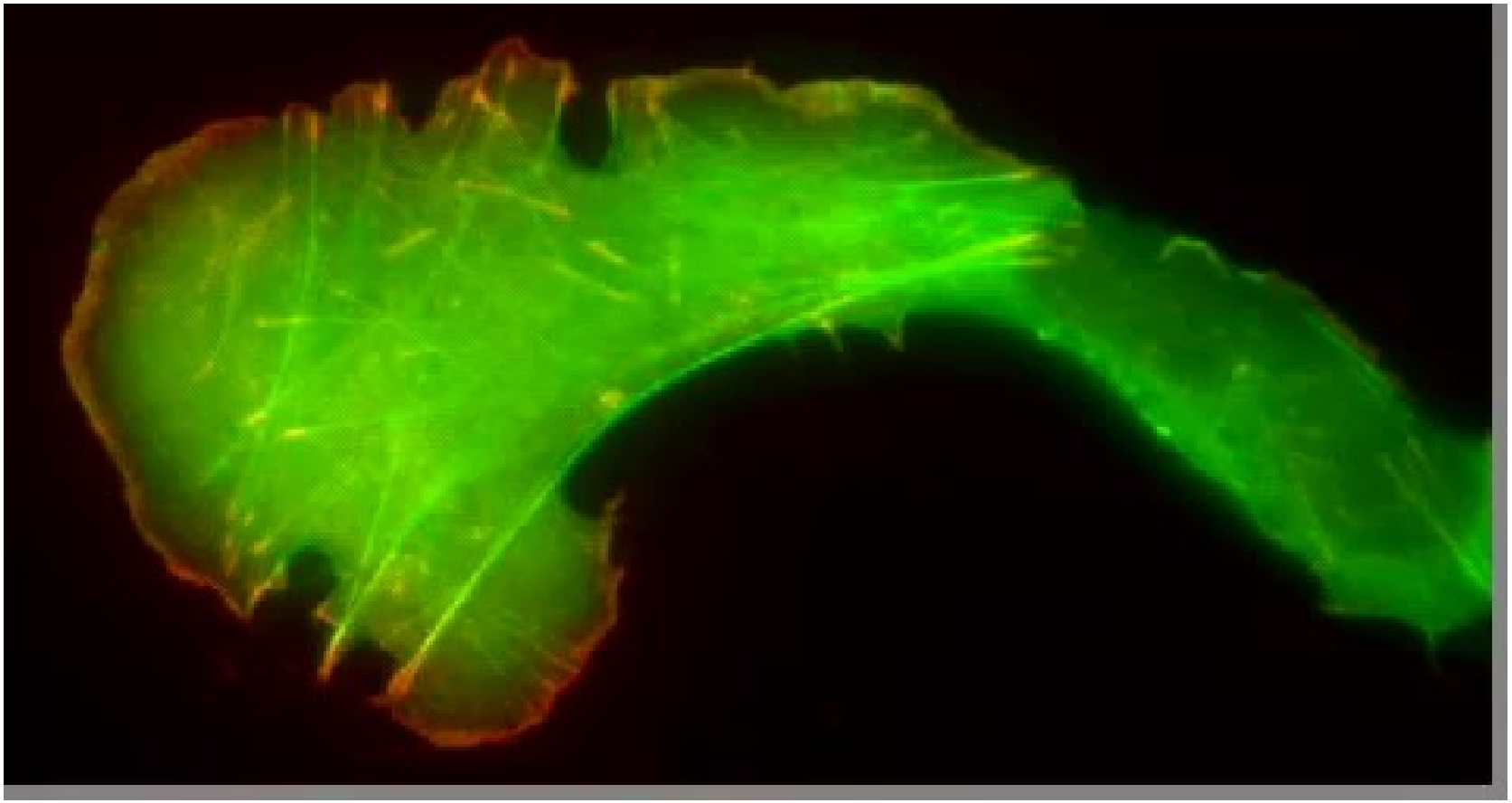
Rho Effectors

- Rho promotes actin-myosin tension and helps migration

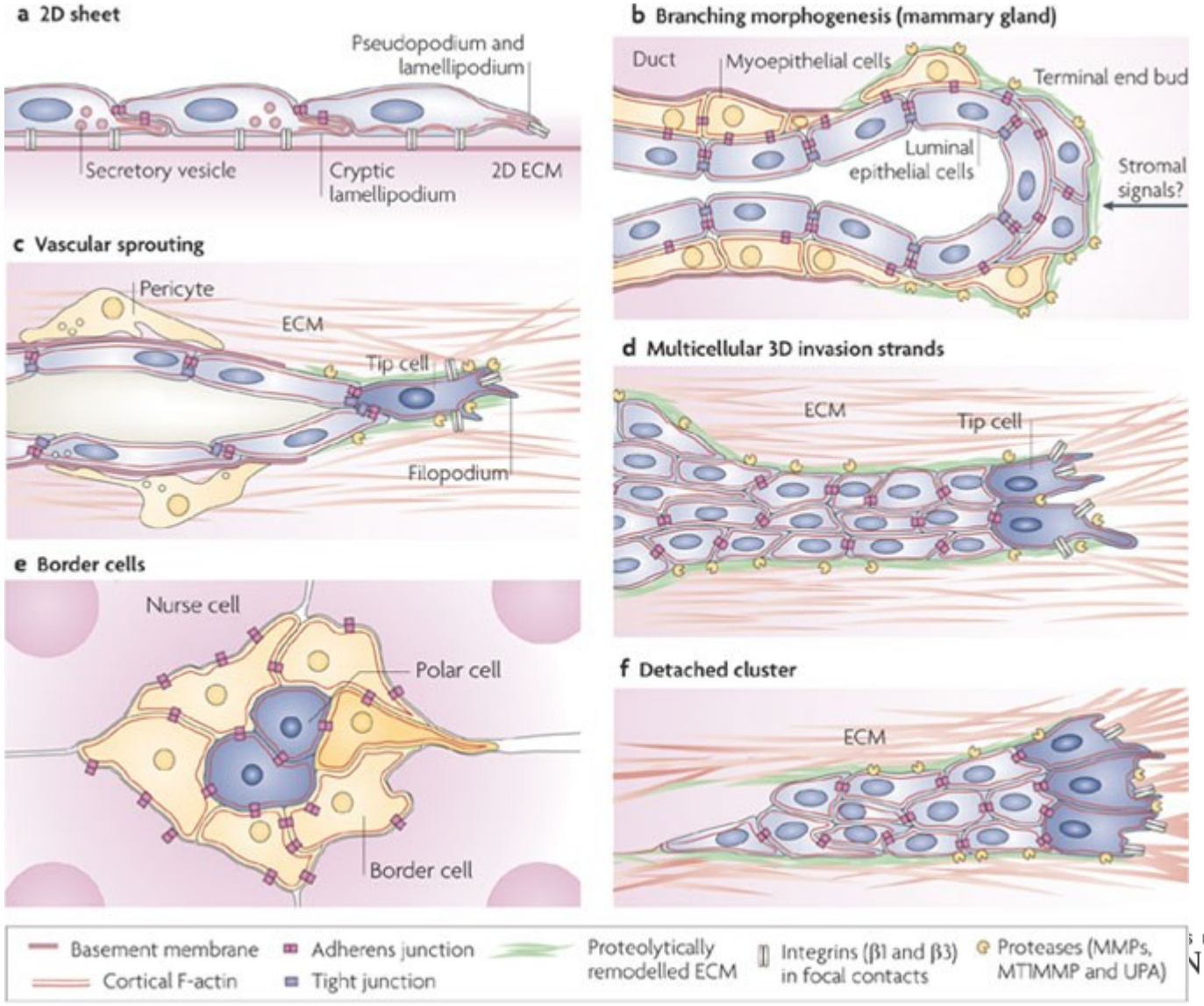




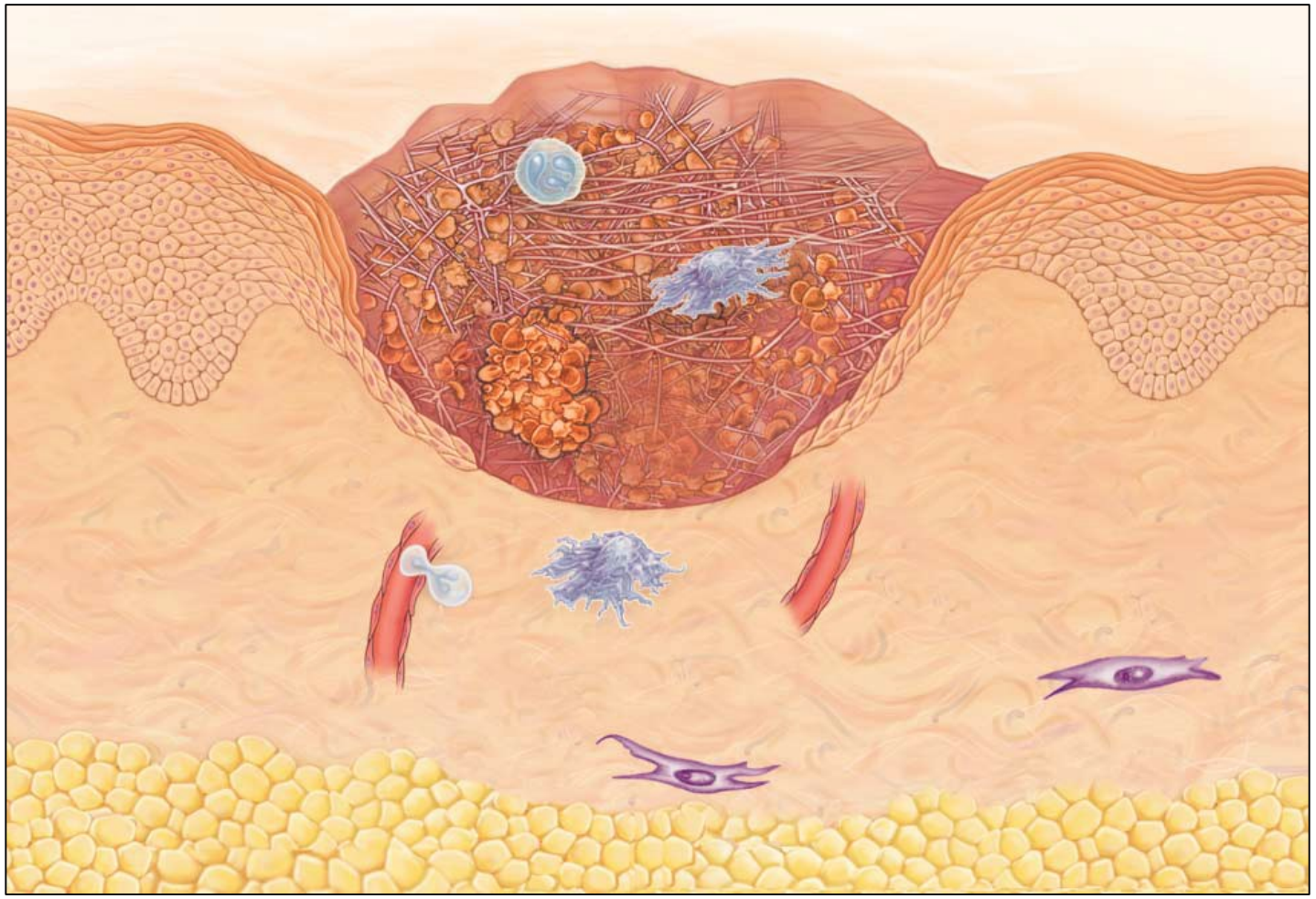
Cell Migration



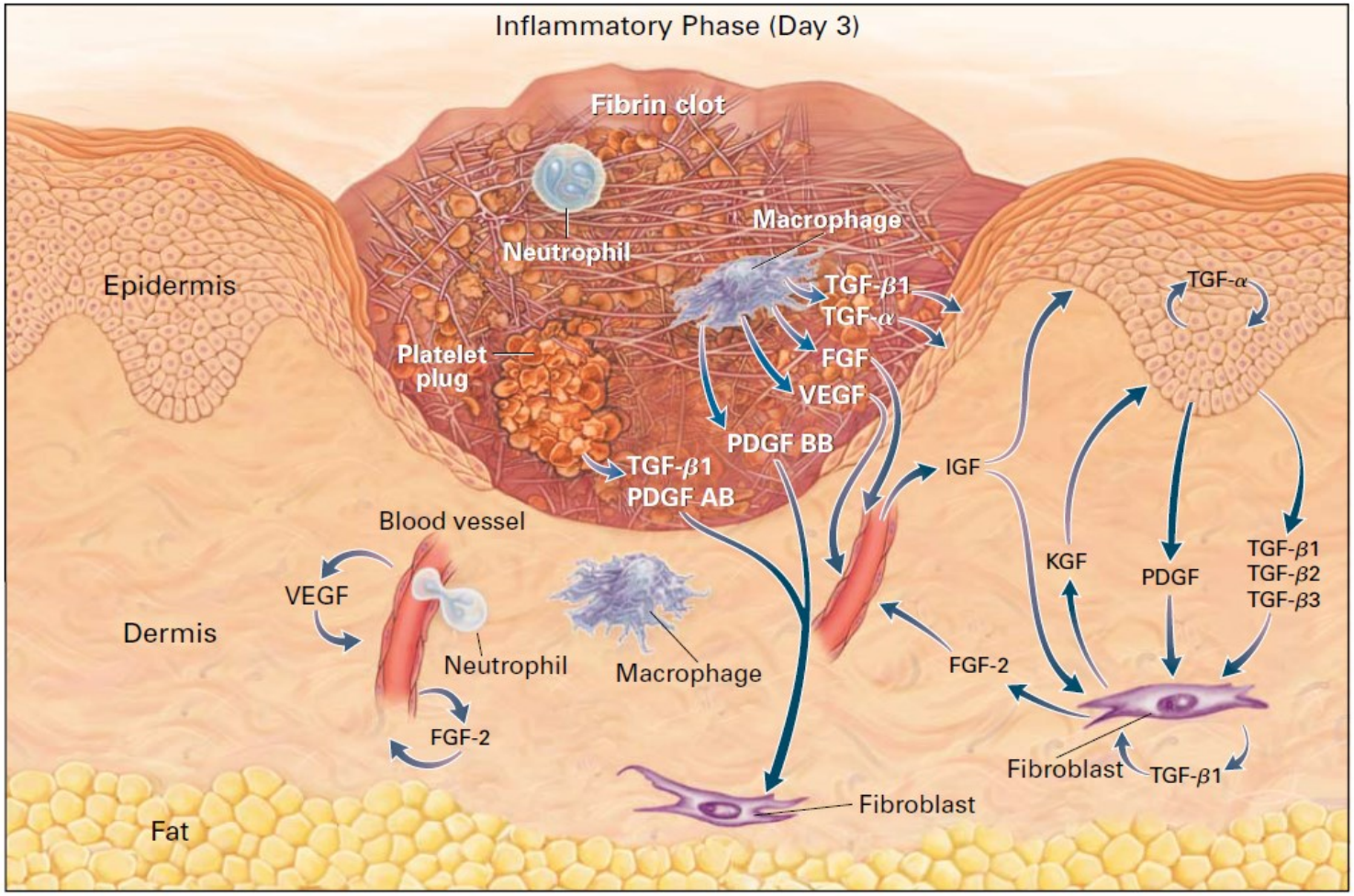
Multicellular Migration



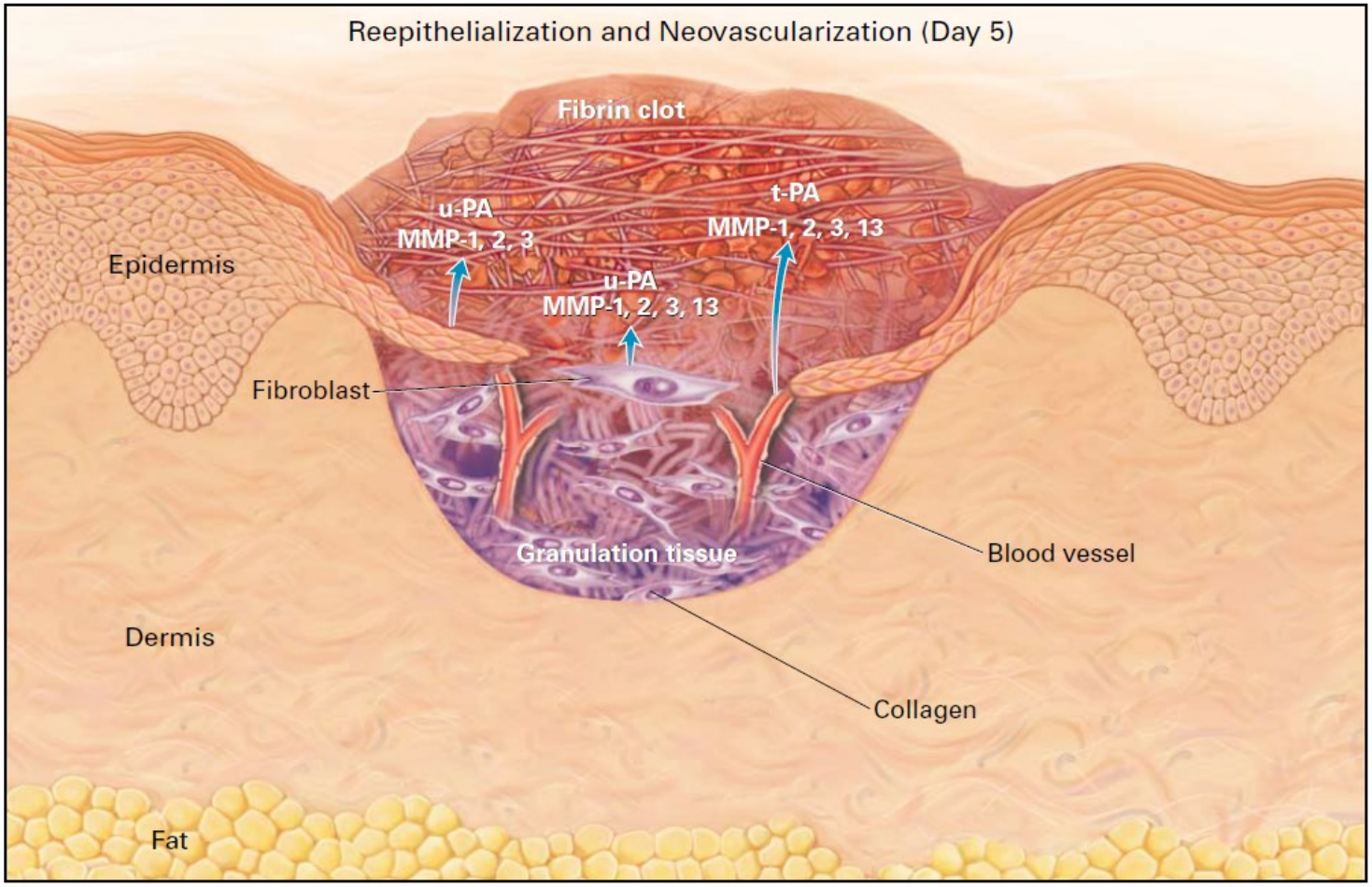
Wound Healing



Cell Migration & Secretion

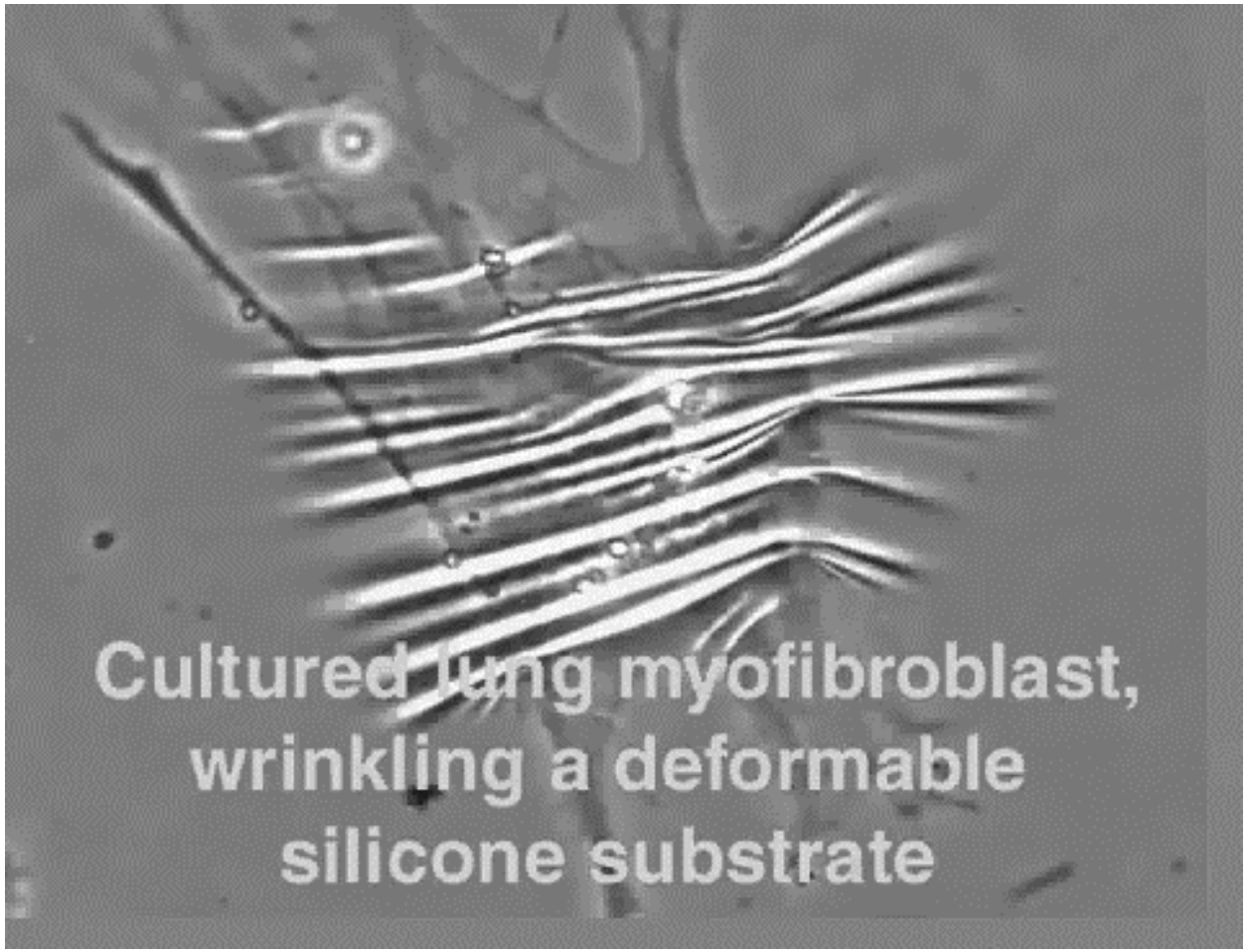


Healing and Scarring



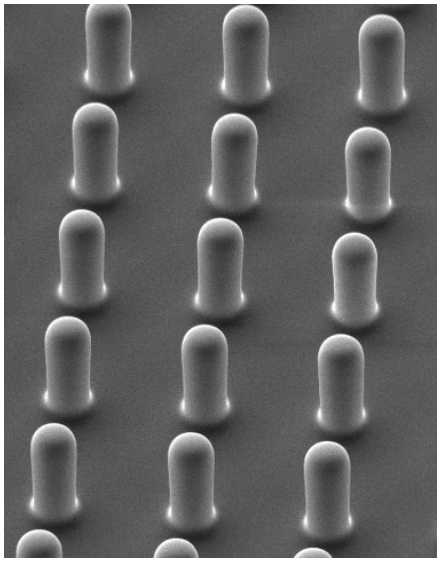
Cell Contraction

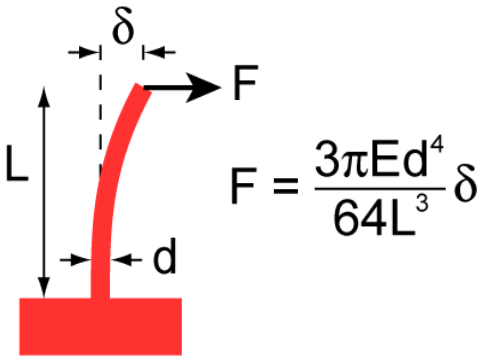
Wrinkling Membranes

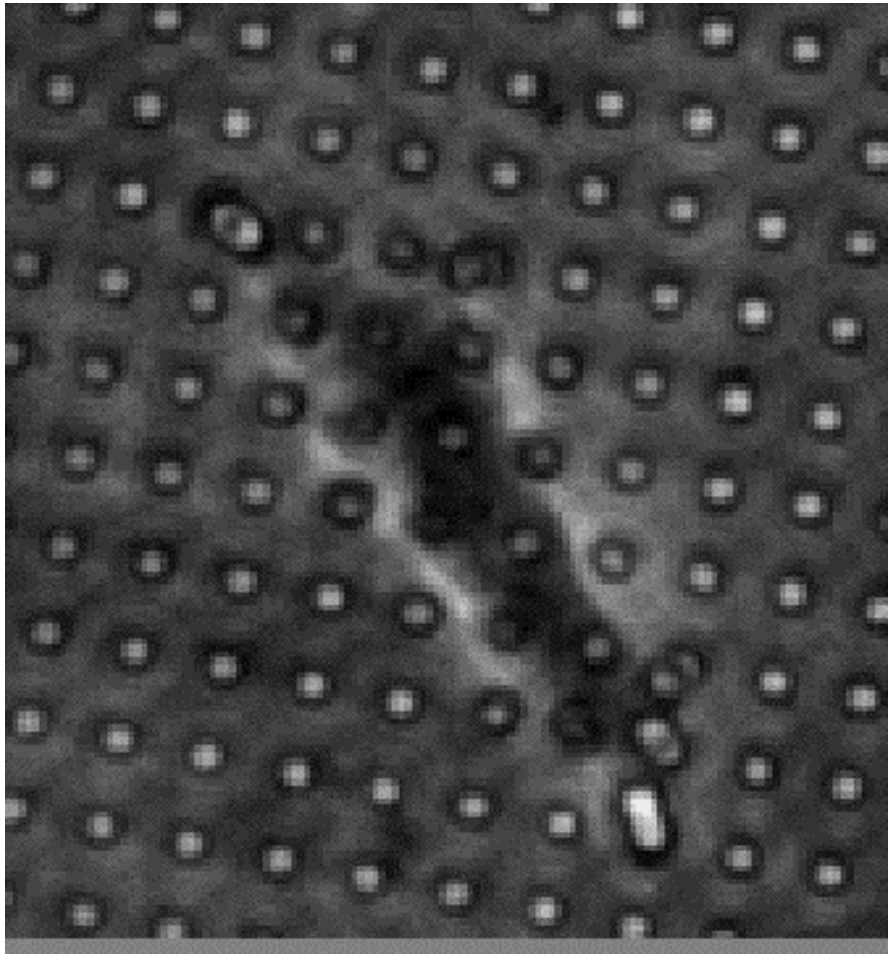


SMA-FP = NH_2-terminal peptide of α–smooth muscle actin inhibits force generation

Microposts



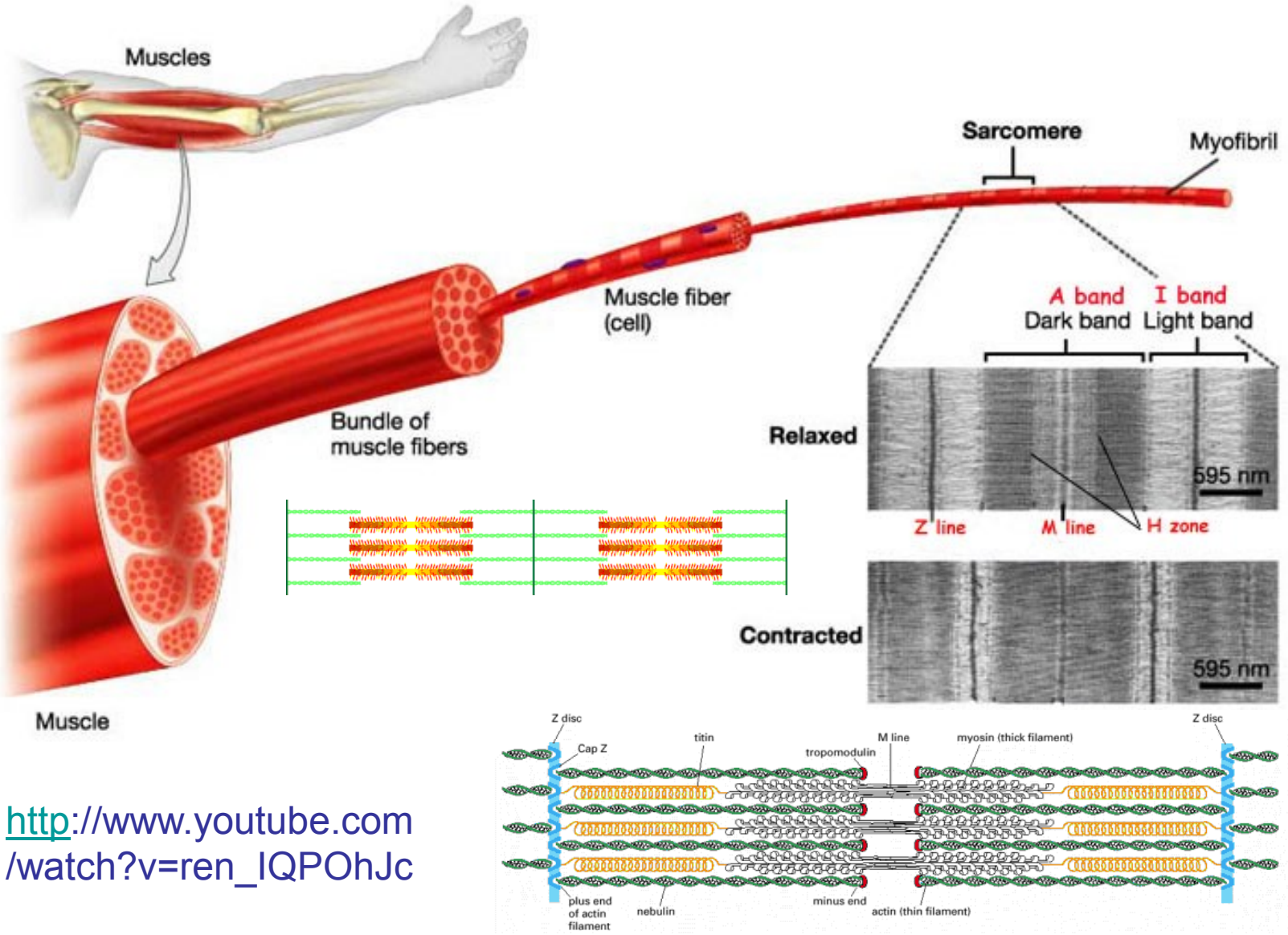




Muscle Cells

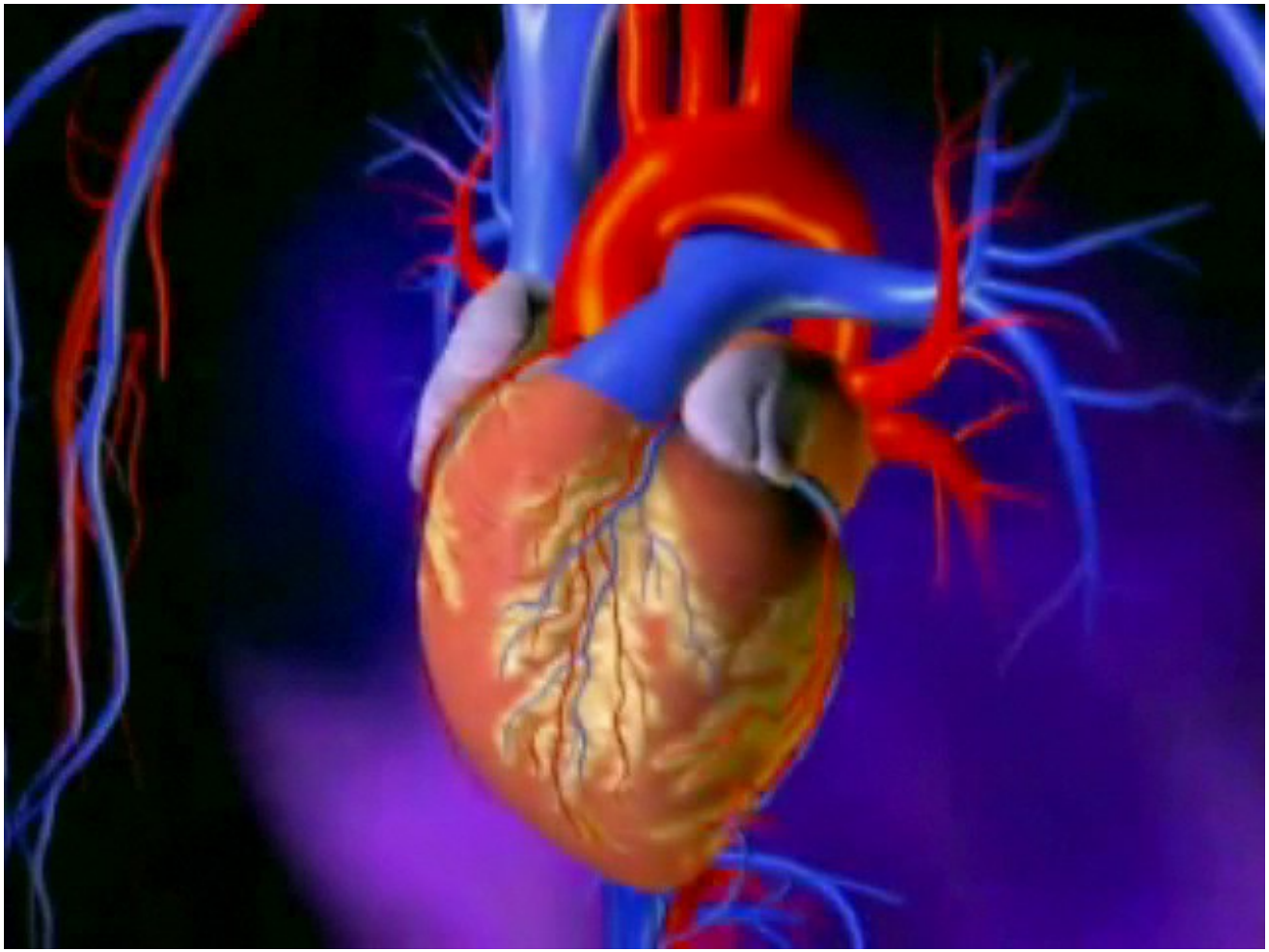
http://www.youtube.com/watch?v=4j3NW1qrR0k

Sarcomeres



http://www.youtube.com/watch?v=ren_IQPOhJc

Cardiac Contraction



Questions?