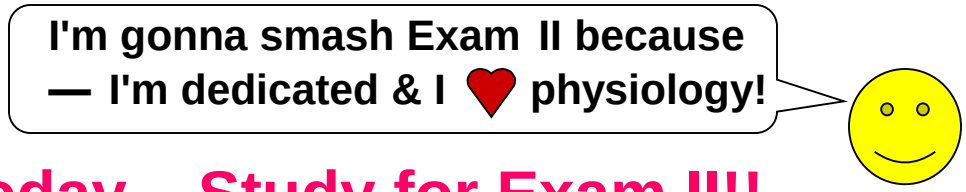


BI 121 Lecture 13

I. ***Announcements*** **No lab today – Study for Exam II!!**
Optional Lab notebook check after last Lab 6, Mac pulmonary function testing (PFT) next Thursday. Q?

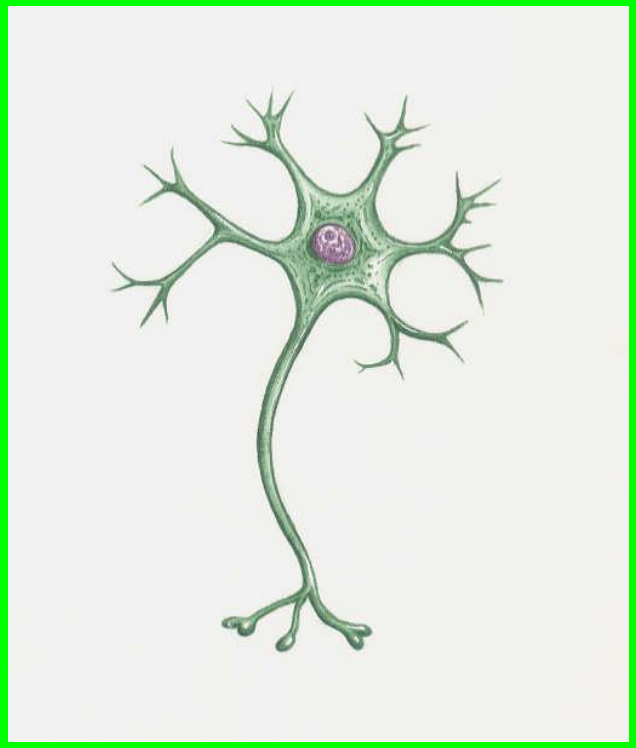
II. ***Peripheral Nervous System Connections***
LS sections of ch 3, 4, & 7

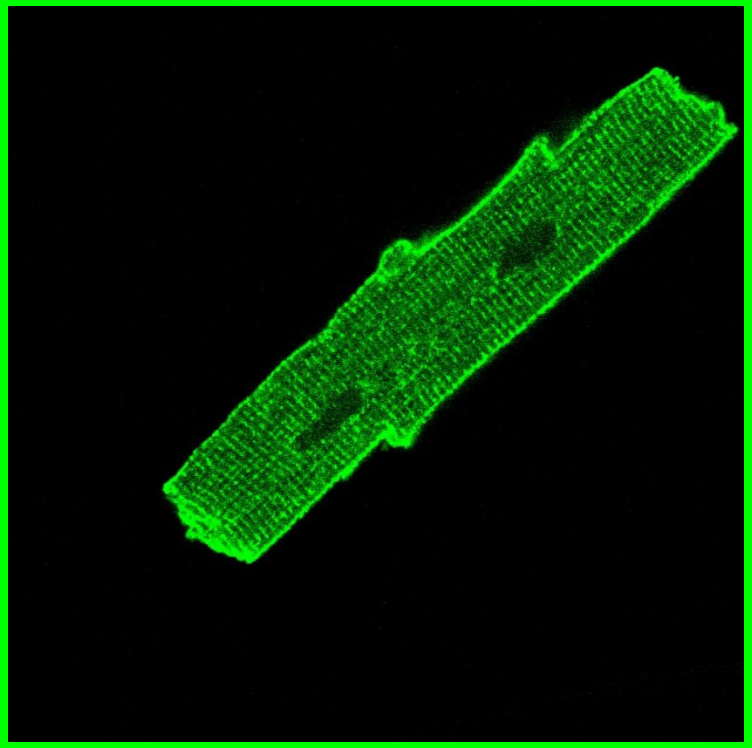
A. How do excitable cells signal? ch 3 pp 62-7;ch 4 pp 74-83
B. How does the signal cross the nerve-muscle gap? ch 7 p 185-92 fig 7-5 p 190
   1. Ca^{2+} bones!…but what else? p 190
   2. What do black widow spider venom, botulism, curare & nerve gas have in common? Botox pp 189-92

III. ***Muscle Structure + Function*** LS ch 8 + DC Module 12

A. Muscle types: cardiac, smooth, skeletal LS fig8-1pp194-6
B. How is skeletal muscle organized? LS fig 8-2, DC fig 12-2
C. What do thick filaments look like? LS fig 8-4, DC fig 12-4
D. Thin filaments? Banding pattern LS fig 8-5, 8-3, 8-7
E. How do muscles contract? LS fig 8-6, 8-10
F. What's a cross-bridge cycle? LS fig 8-11 +…

Why are nerve & muscle unique?





They are excitable!!

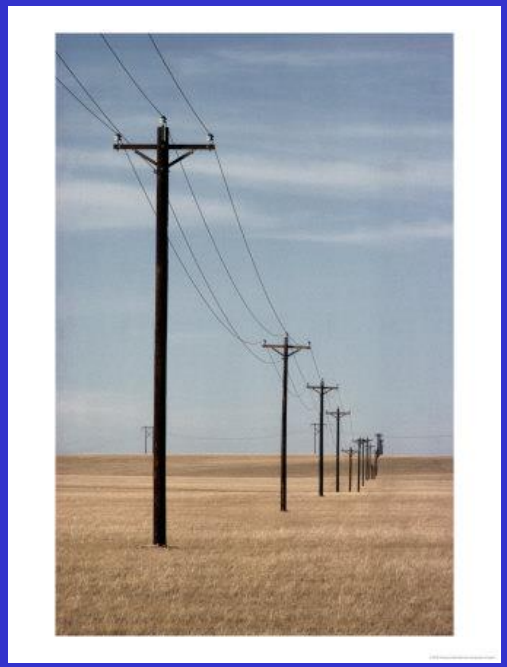
Action Potentials ≡ Spikes ≡ Impulses

Ultra-short reversal of membrane potential

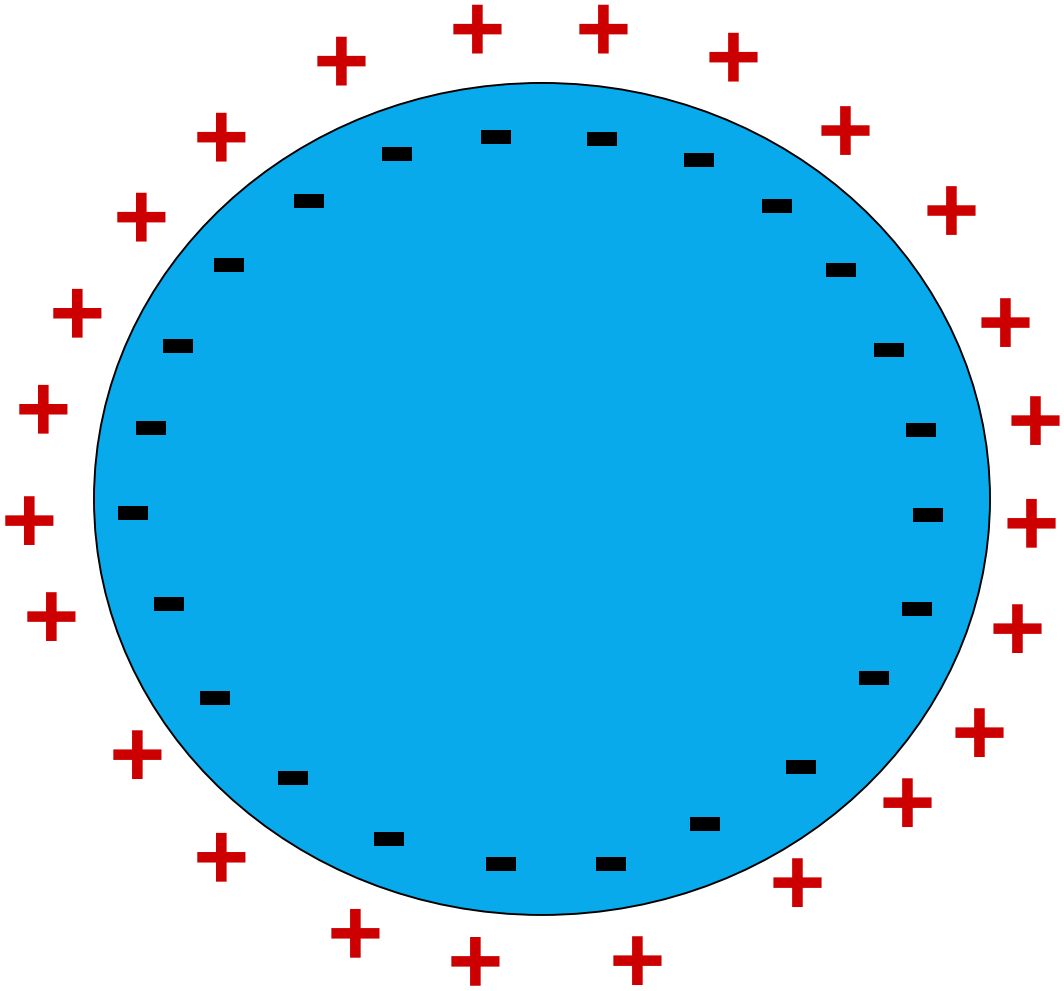
Only in nerve and muscle cells

Maintains strength over distance

Primary way nerves & muscles communicate!



"Resting"/Membrane Potential?

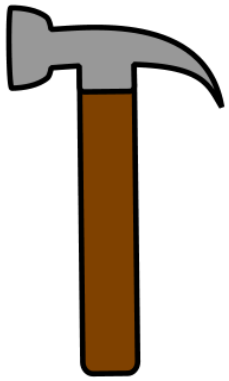


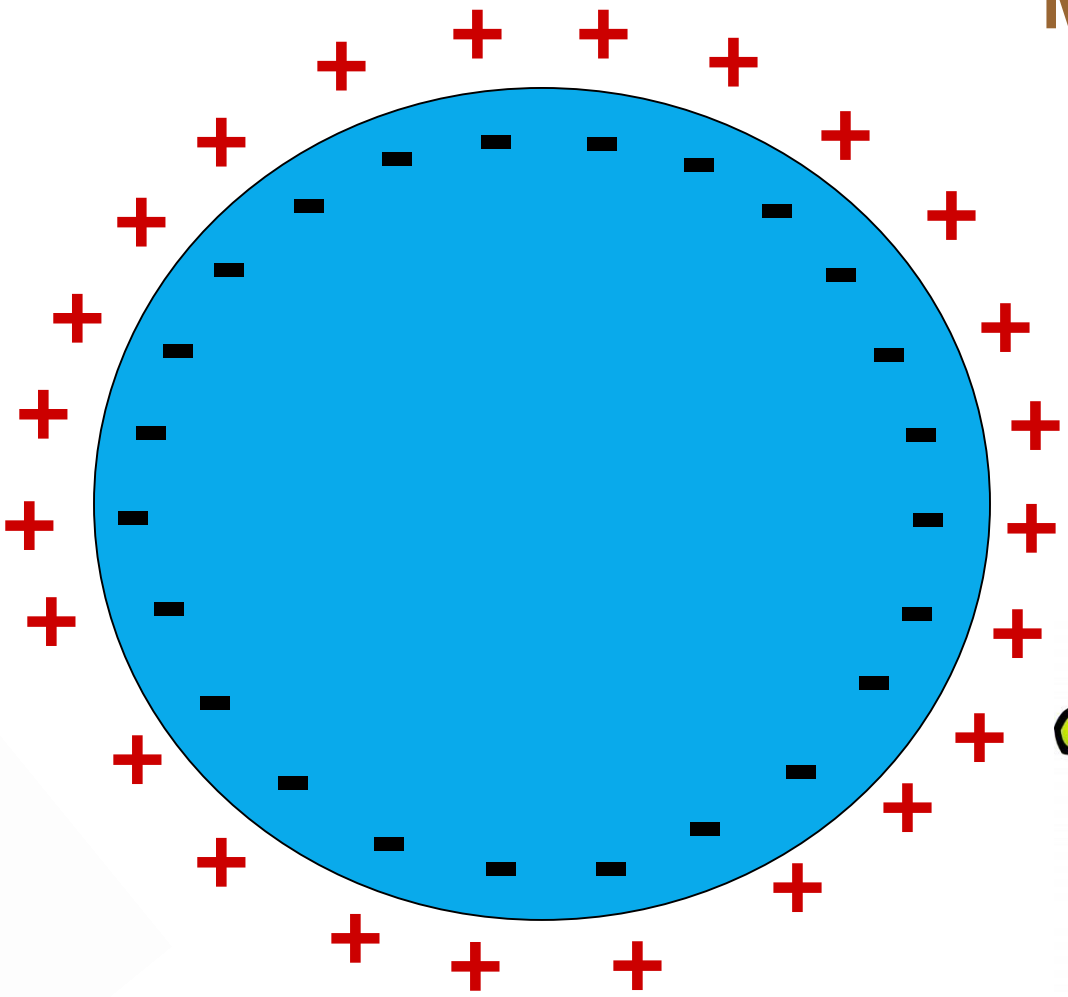
Cells are slightly negative inside!

Stimulate Cell @ Rest

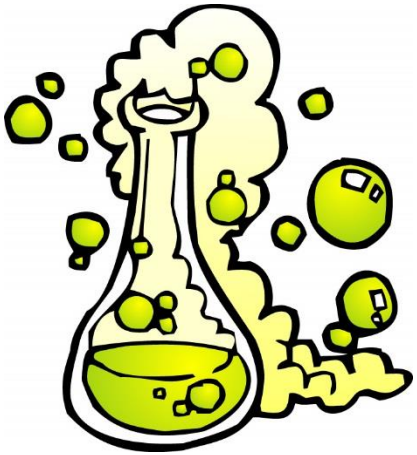
Thermal

Mechanical



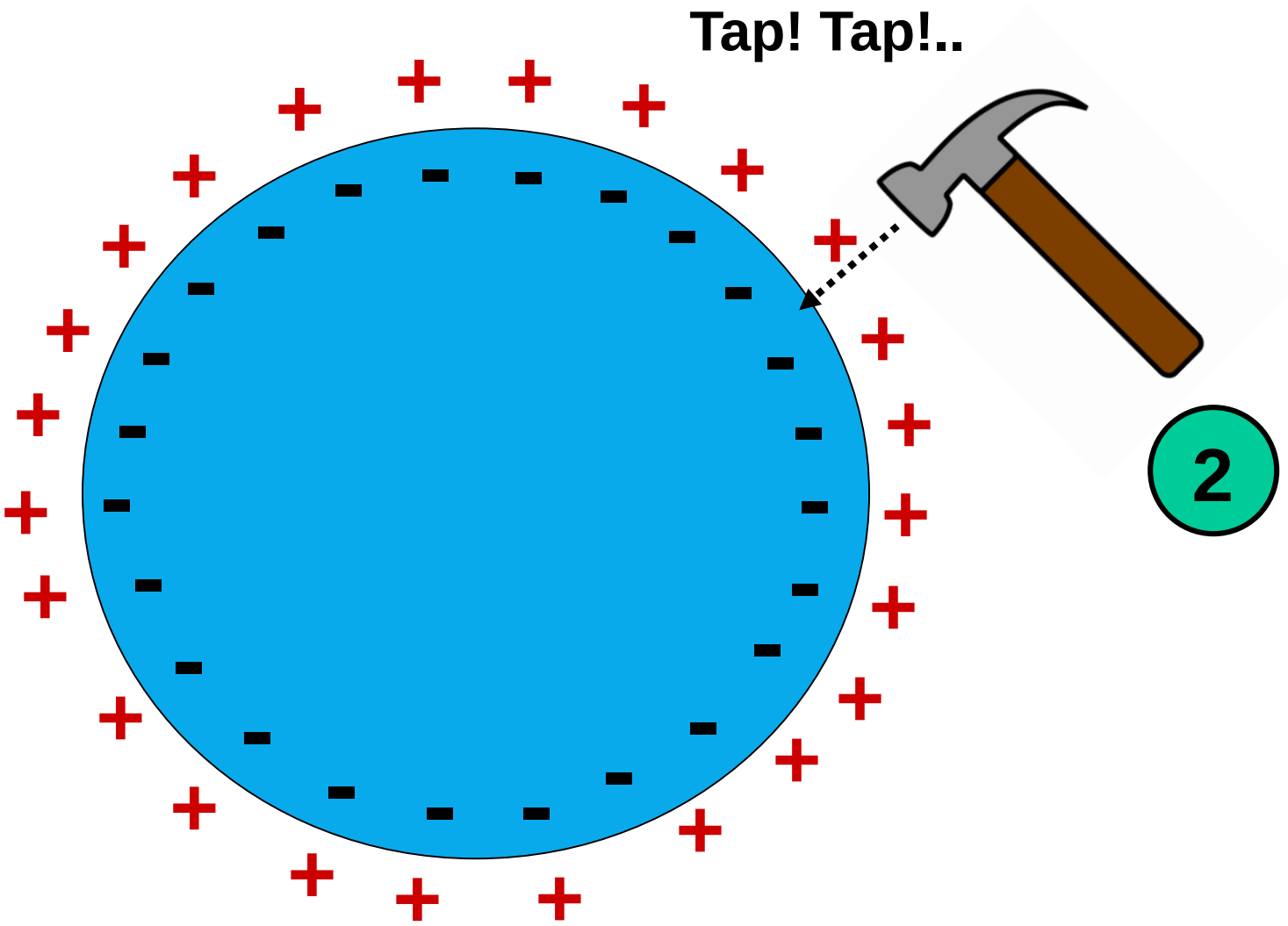


1

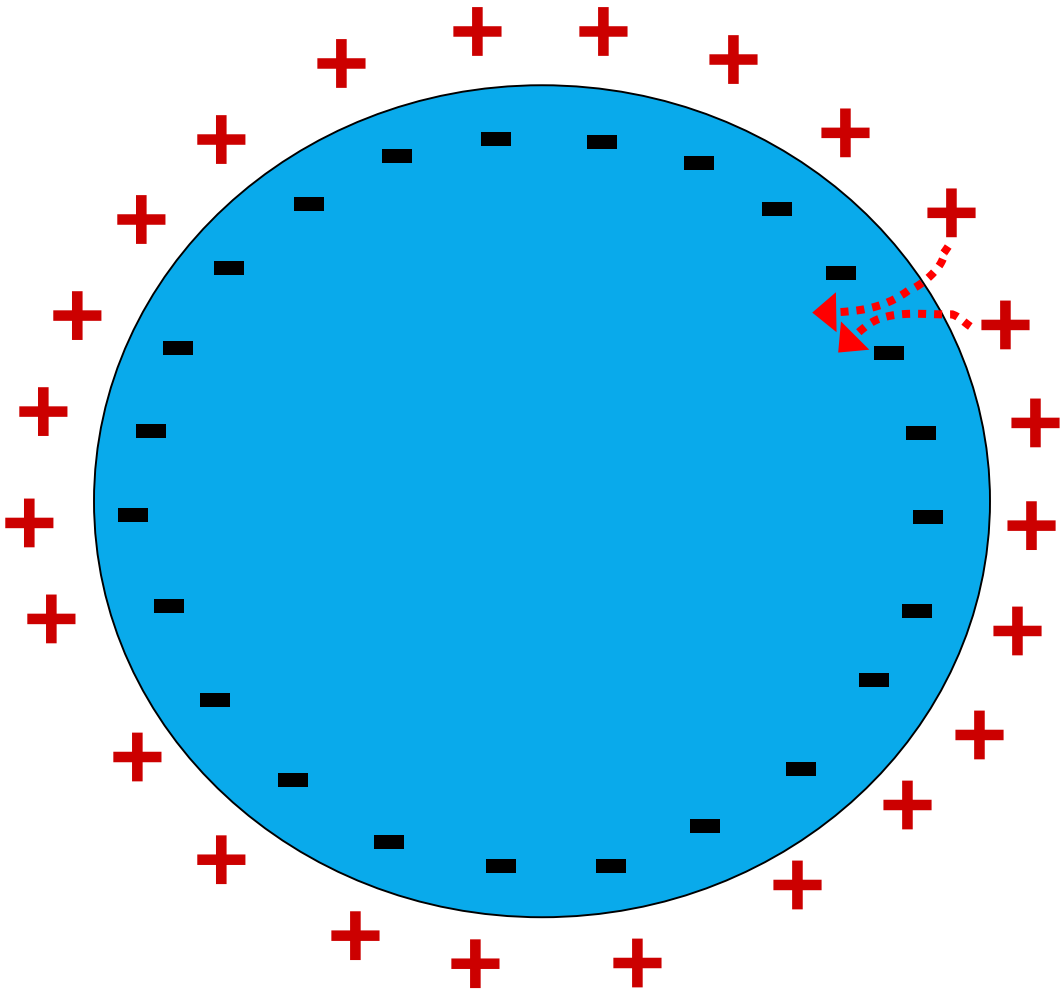


Electrical

Chemical

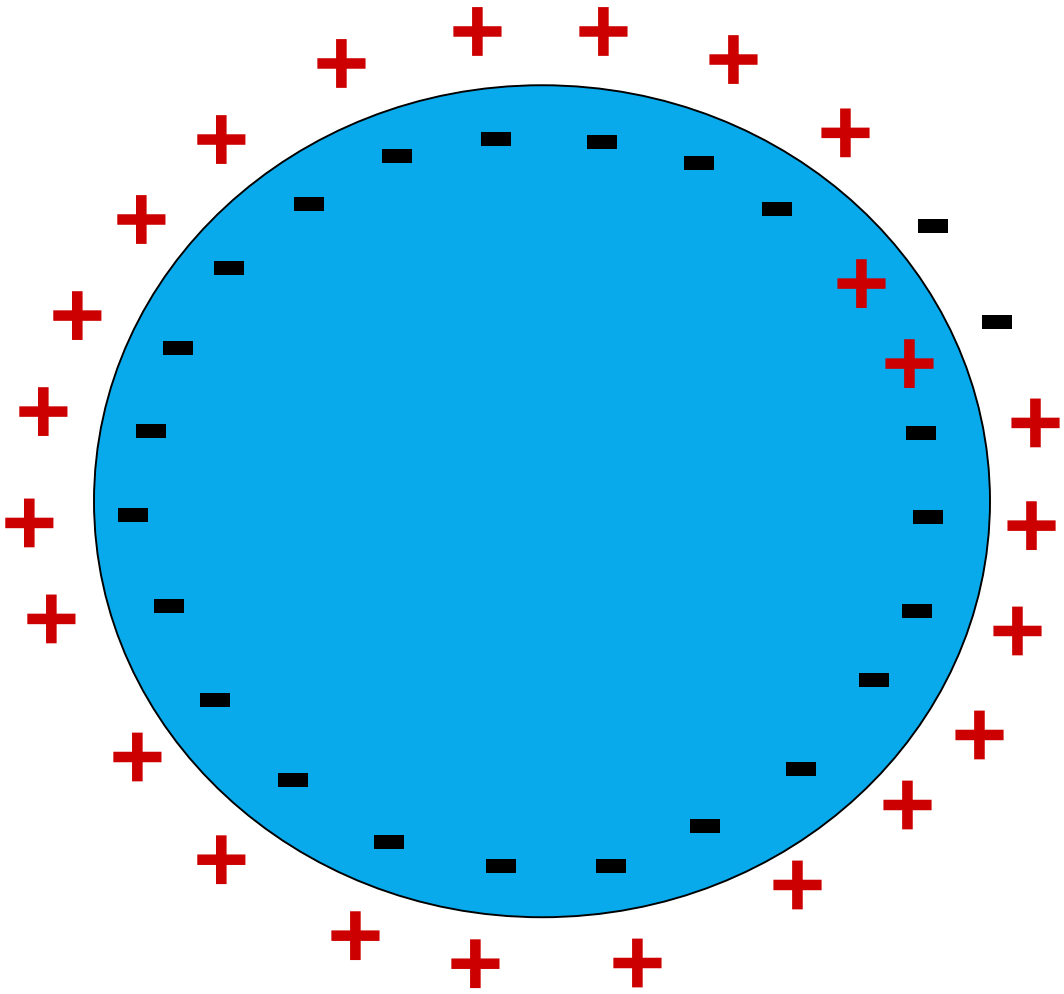

Tap! Tap!..
2

Changes Cell Membrane Permeability to Sodium/Na+!



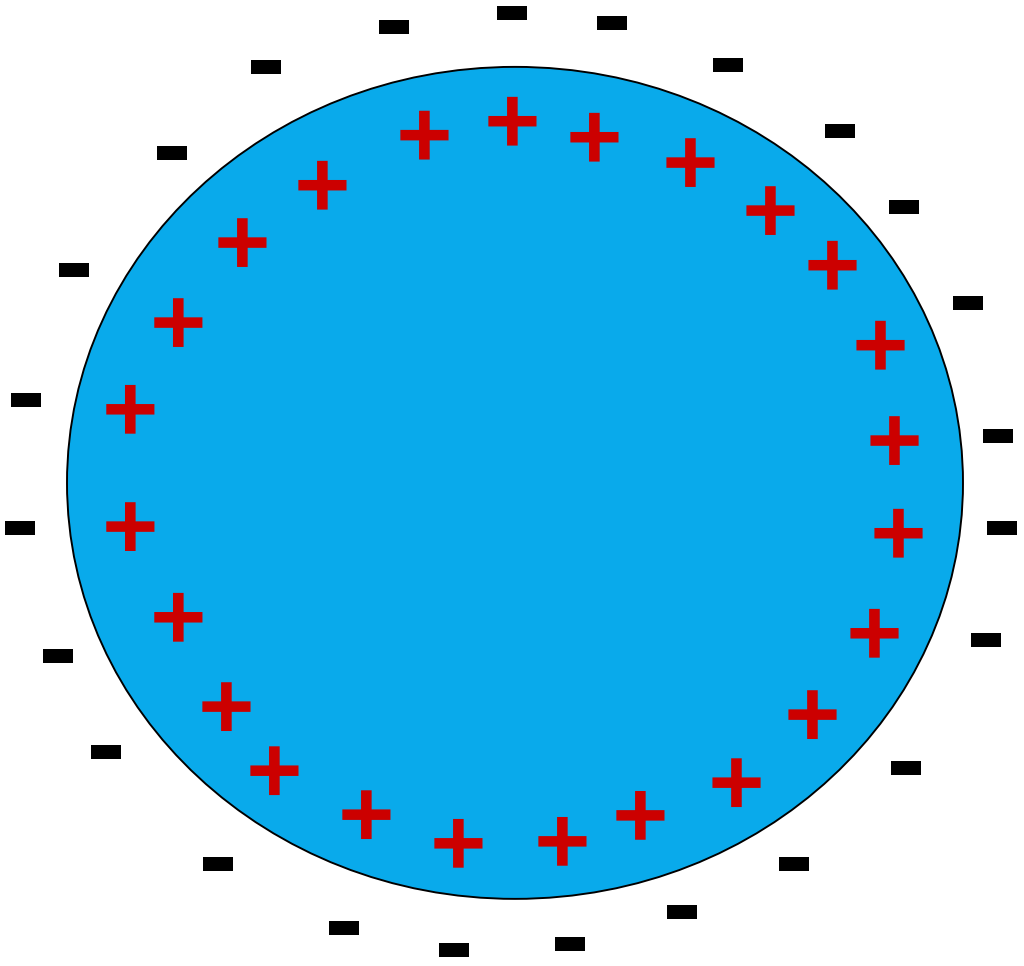
3

+ Charges/Na+ Rushes In!



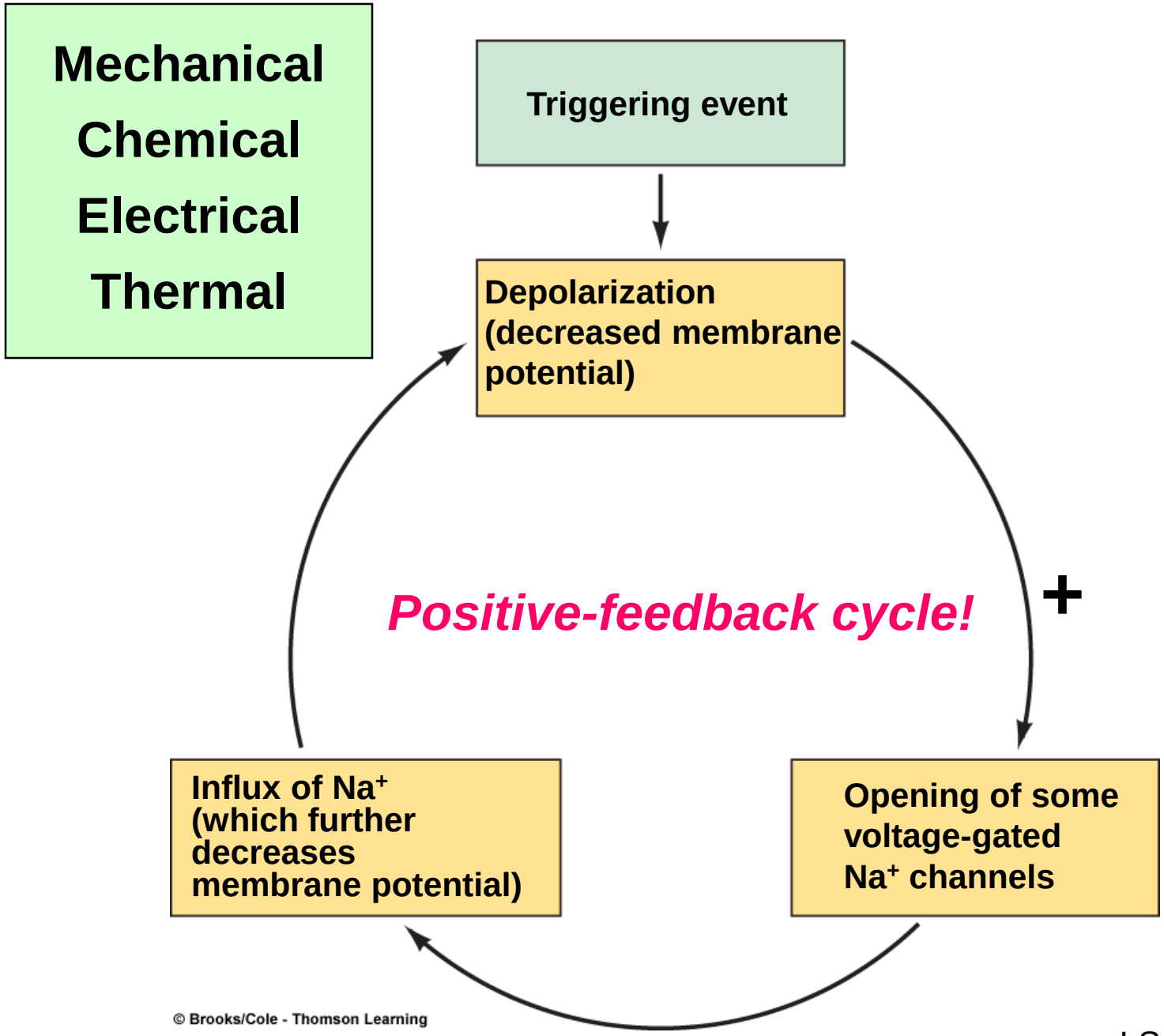
4

Action Potential has occurred!

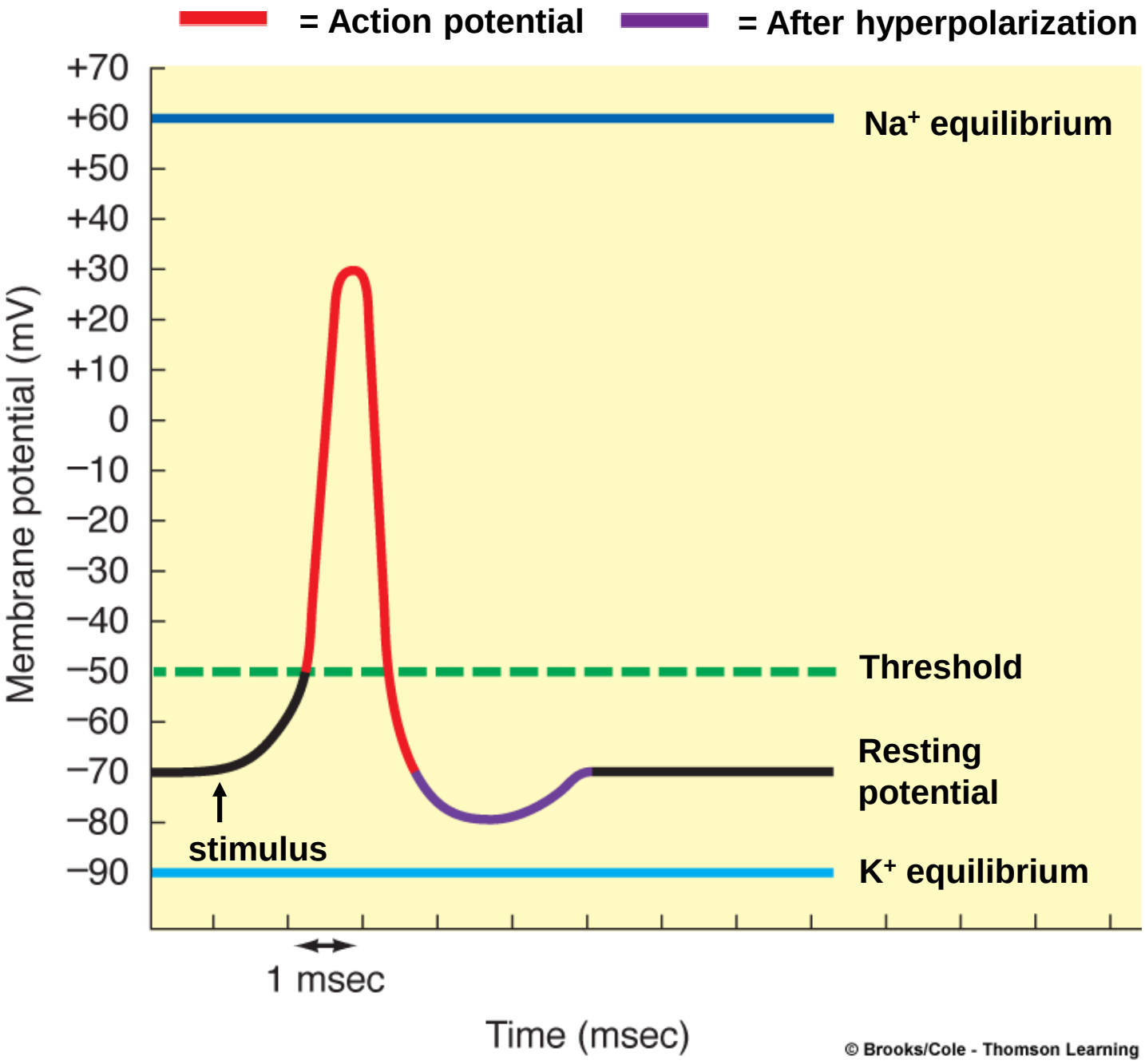


5

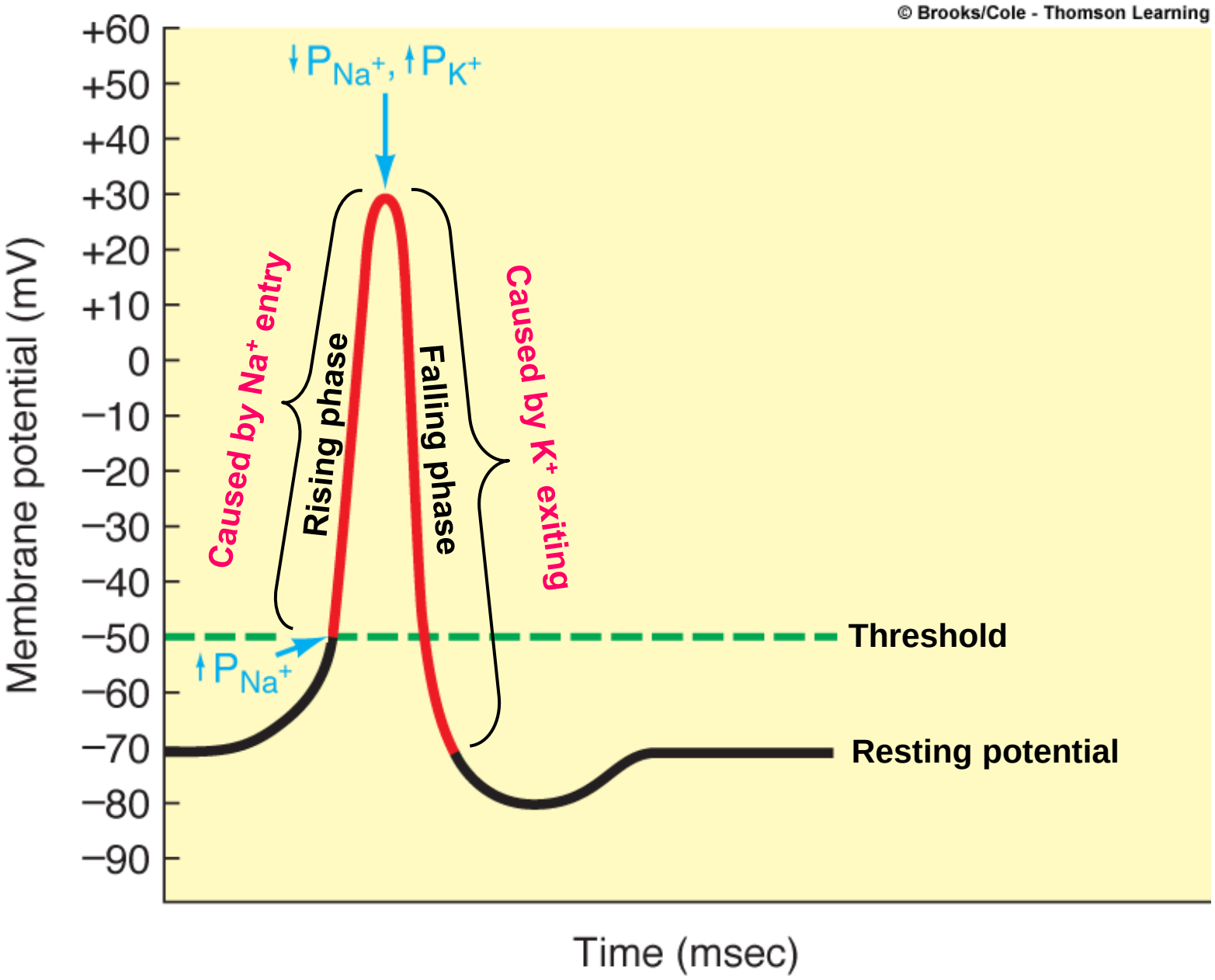
Brief (1-2 ms) reversal to + inside cell!



LS 2012 fig 4-7

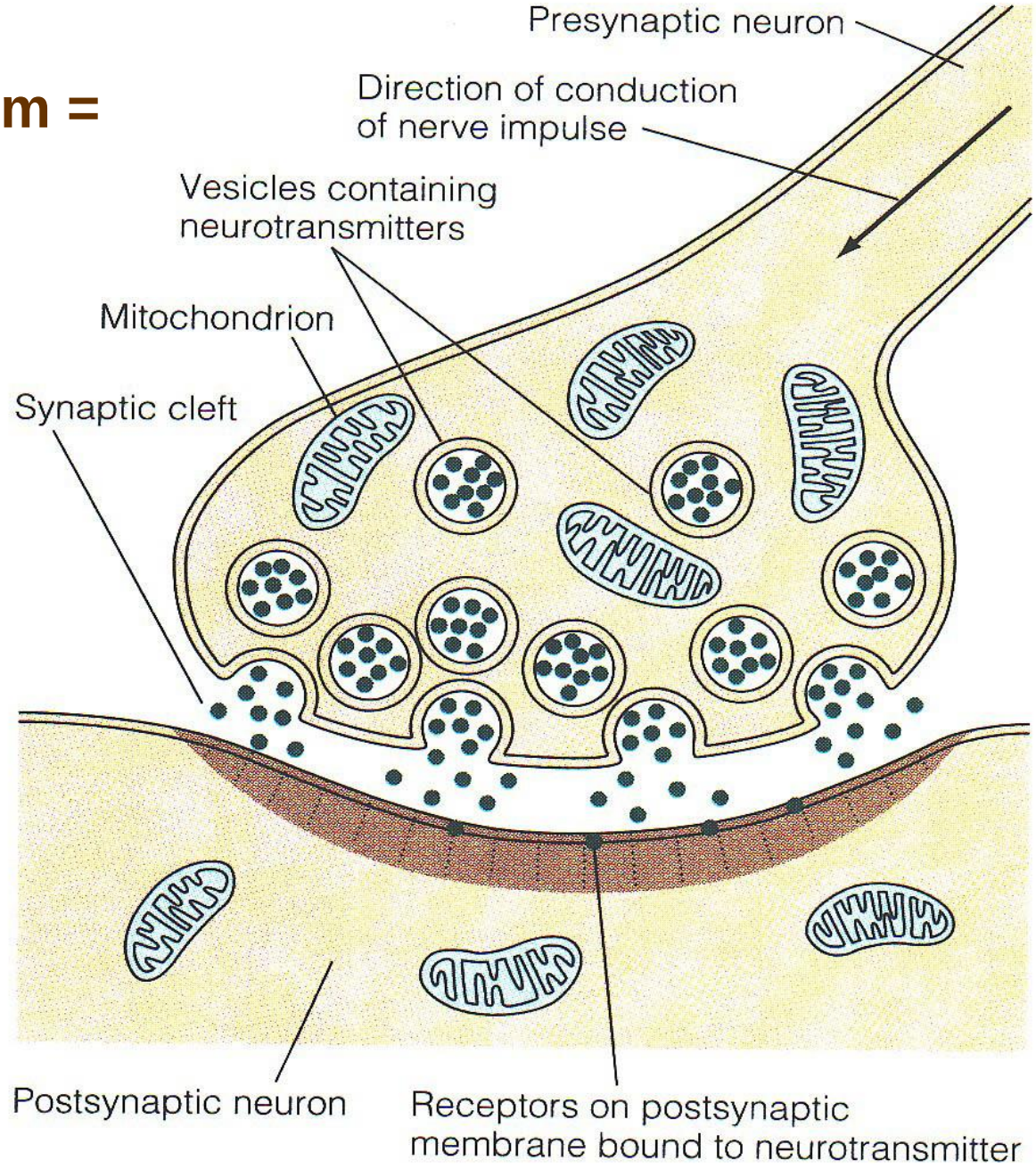


LS 2012 fig 4-5

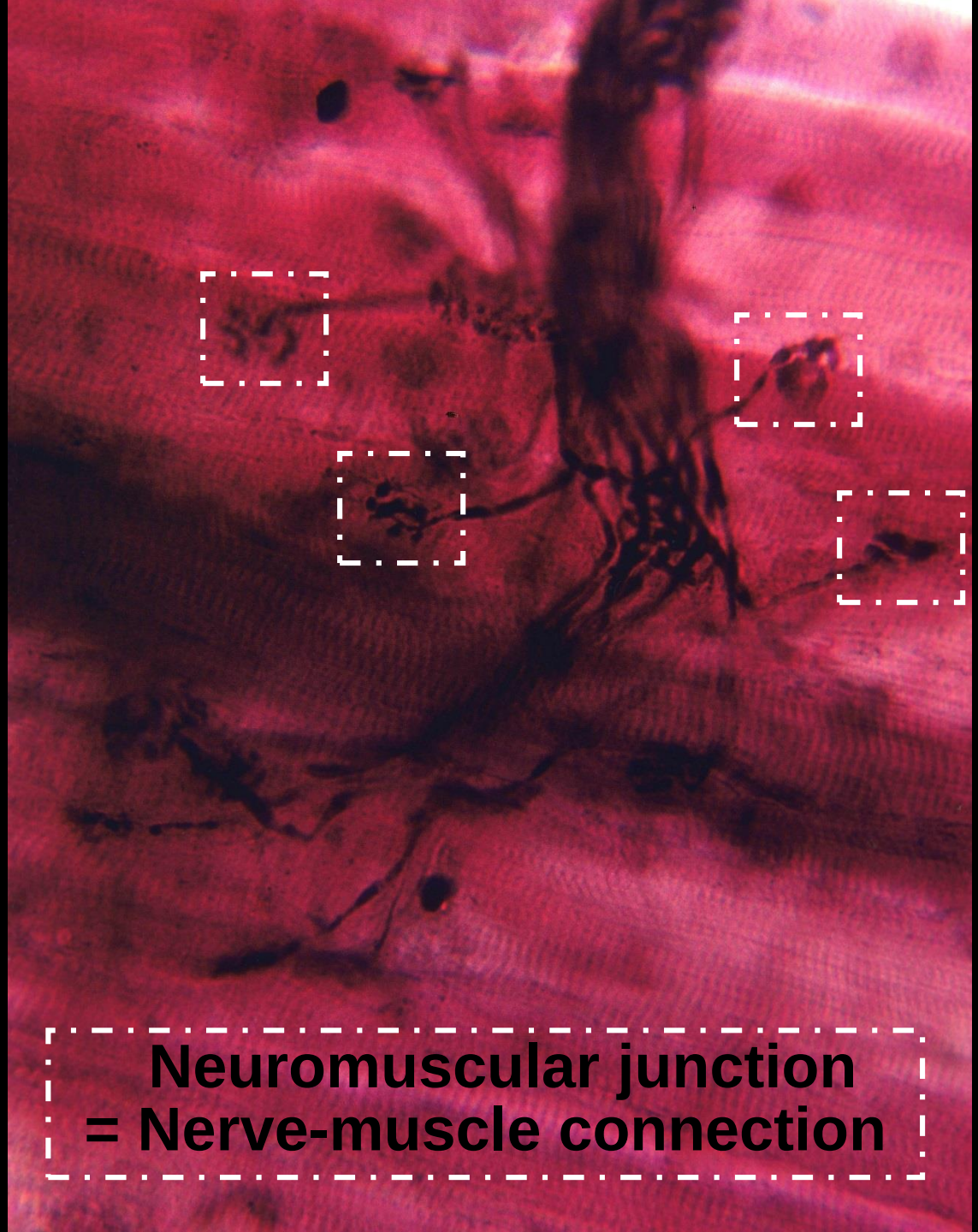


LS 2012 fig 4-8

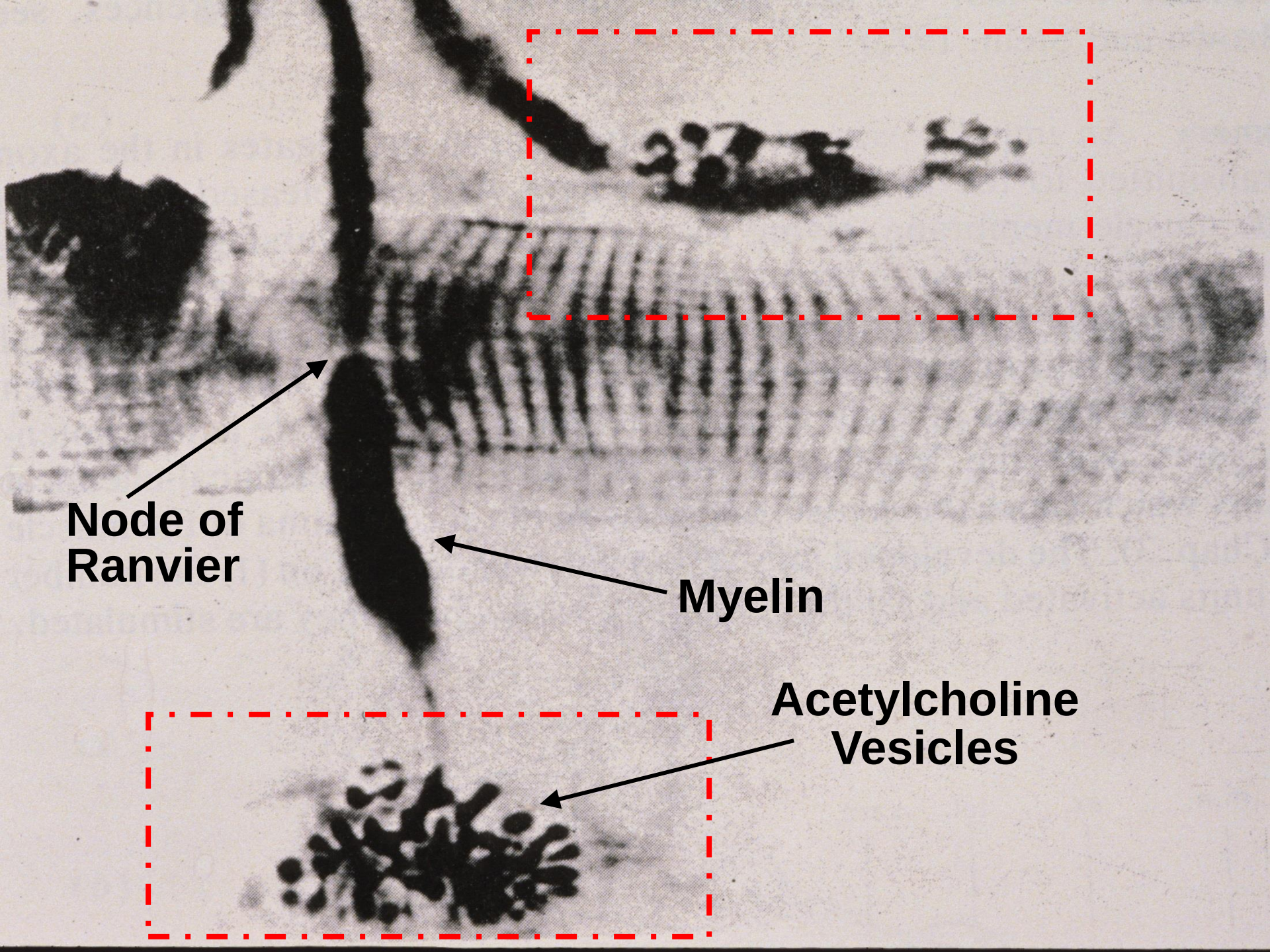
Synapse =
Generic term = connection between excitable cells!



DC 2003

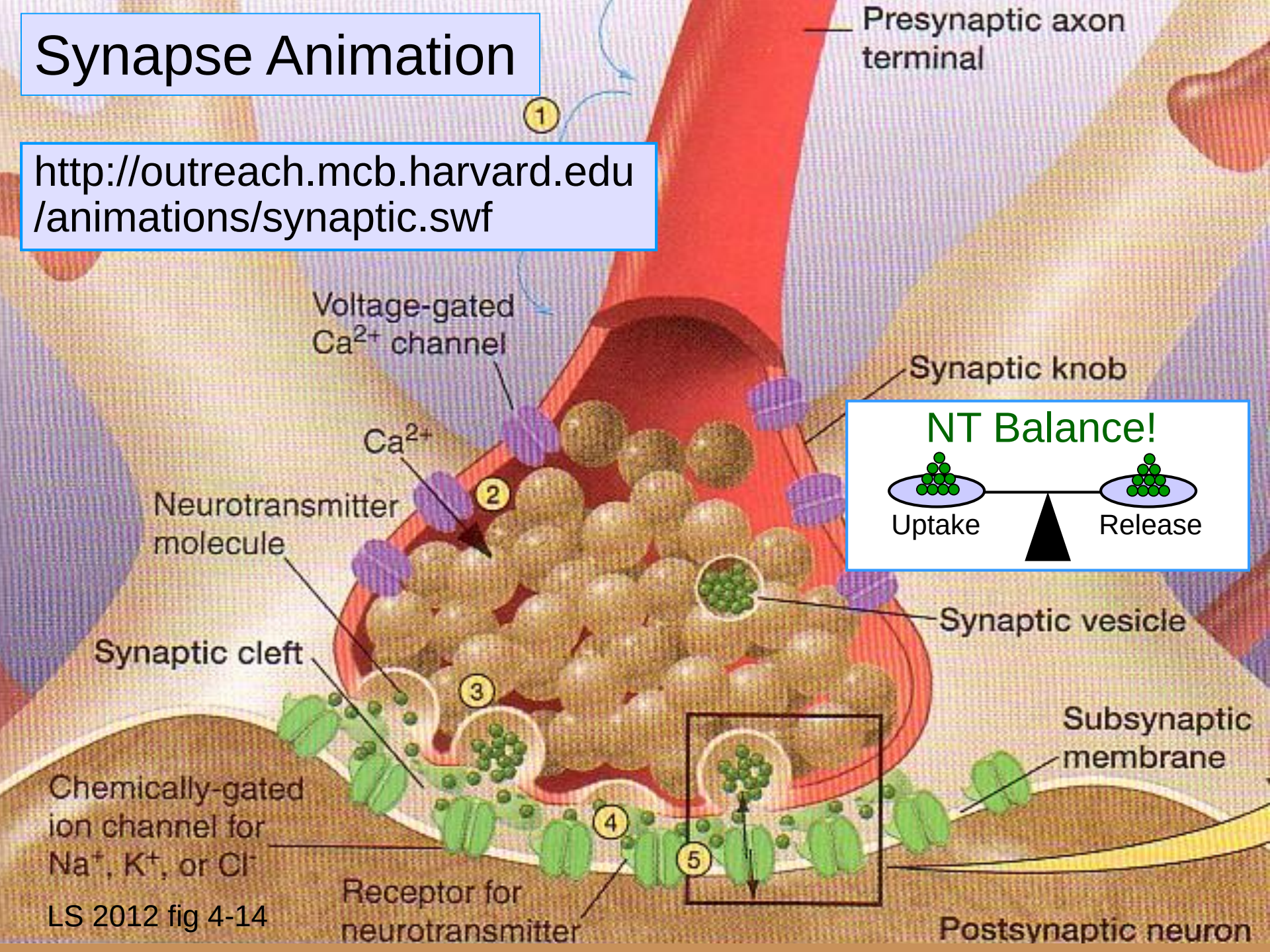


H Howard 1980


Node of
Ranvier
Myelin
Acetylcholine
Vesicles

Synapse Animation

http://outreach.mcb.harvard.edu/animations/synaptic.swf



NT Balance!

LS 2012 fig 4-14

Other Links That May Be Helpful!

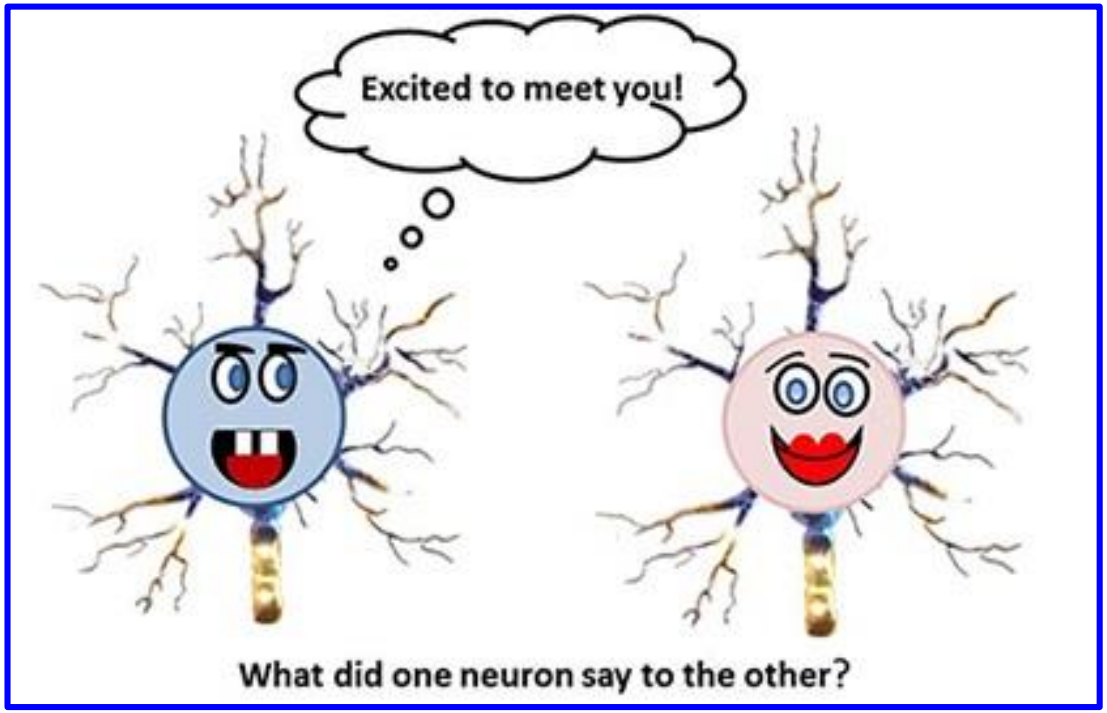
https://www.youtube.com/watch?v=6RbPIOq0O3w

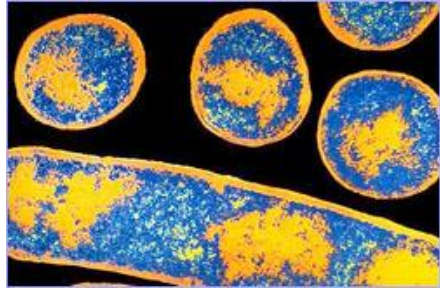
https://www.youtube.com/watch?v=mItV4rC57kM

https://www.youtube.com/watch?v=WhowH0kb7n0

http://sites.sinauer.com/psychopharm2e/animation03.01.html

https://www.youtube.com/watch?v=VitFvNvRIIY



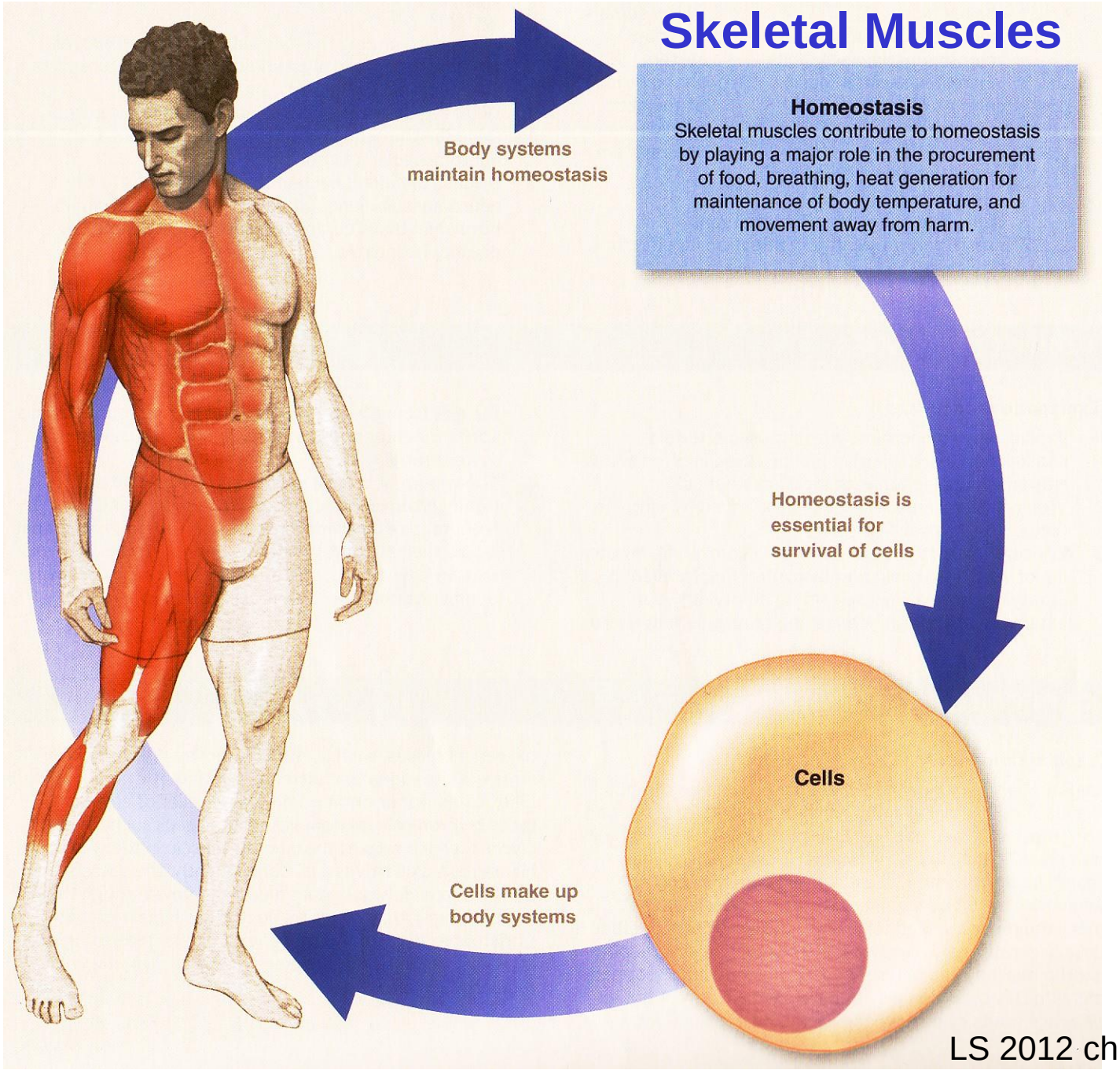



Campbell's
CLASSICS
BEAN
BACON

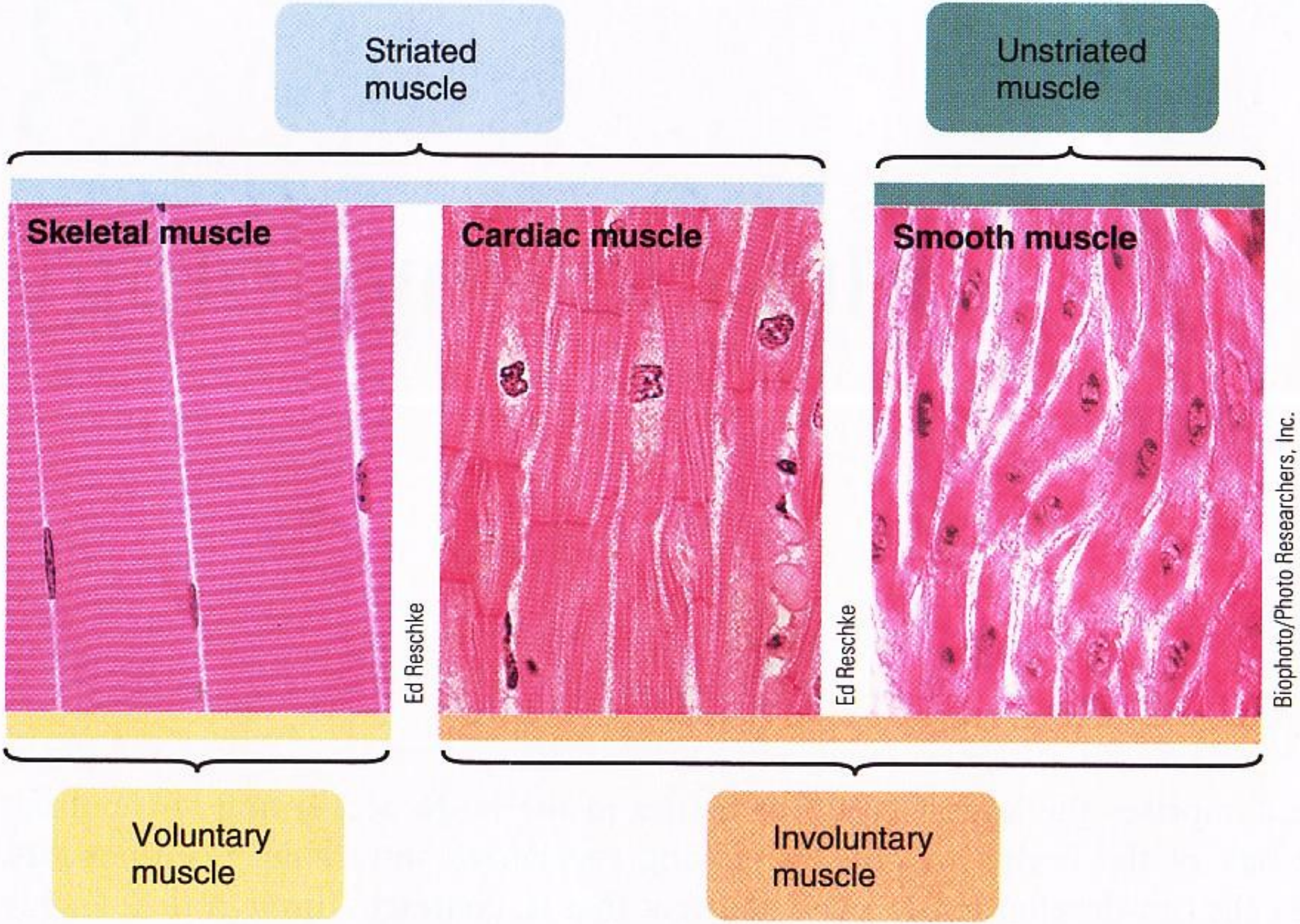
Axon of motor neuron
Myelin sheath
Action potential propagation in motor neuron
1
Axon terminal
Terminal button
Ca2+
Calcium channel
Vesicle of acetylcholine
2
Action potential propagation in muscle fiber
6
3
Muscle fiber
Plasma membrane of muscle fiber
4
K+
Acetylcholine receptor site
5
Na+
Cation channel
7
Local current flow between depolarized end plate and adjacent membrane
Acetylcholinesterase
Motor end plate
Contractile elements within muscle fiber

Time for a break! ☺

Skeletal Muscles

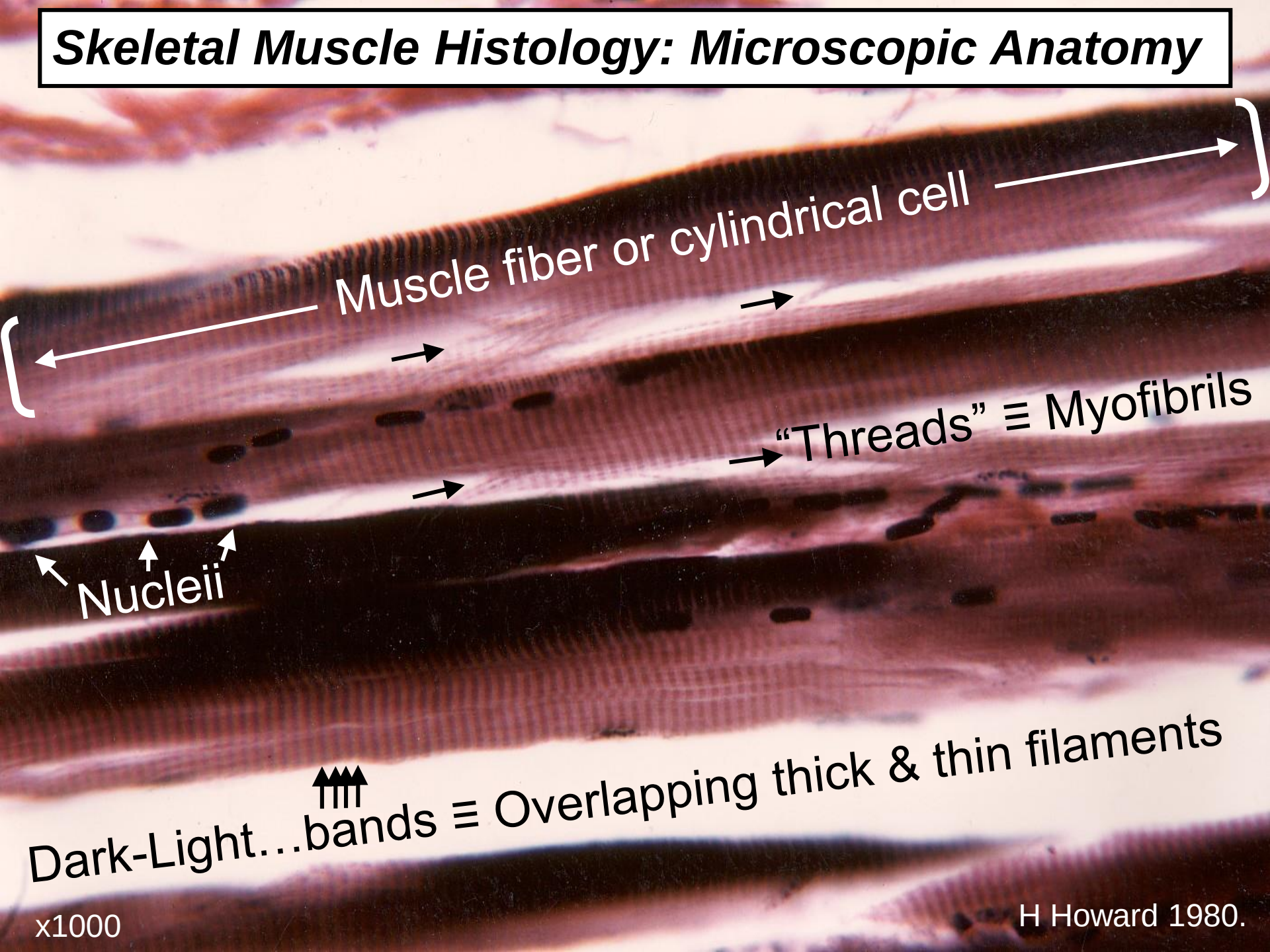


LS 2012 ch 8 vignette

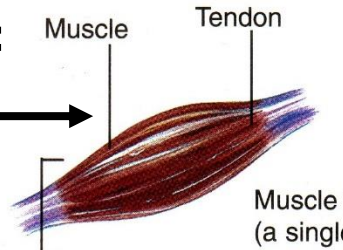


LS 2012 fig 8-1

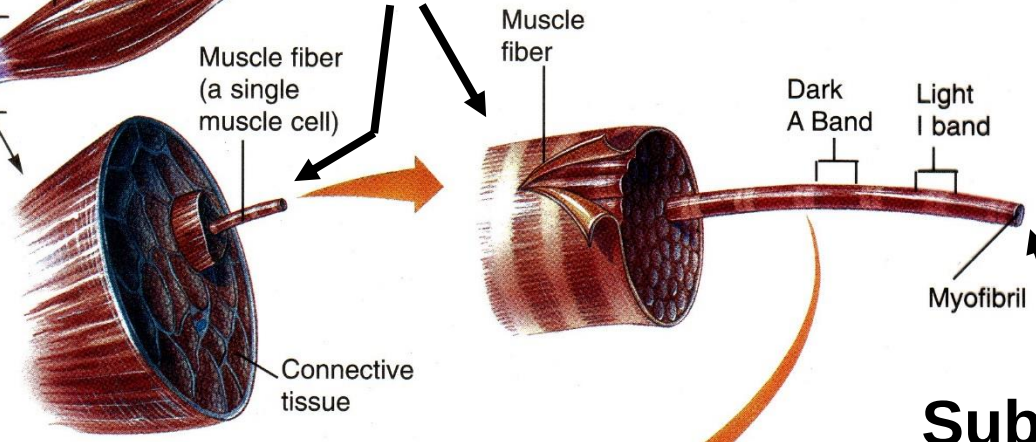
Skeletal Muscle Histology: Microscopic Anatomy



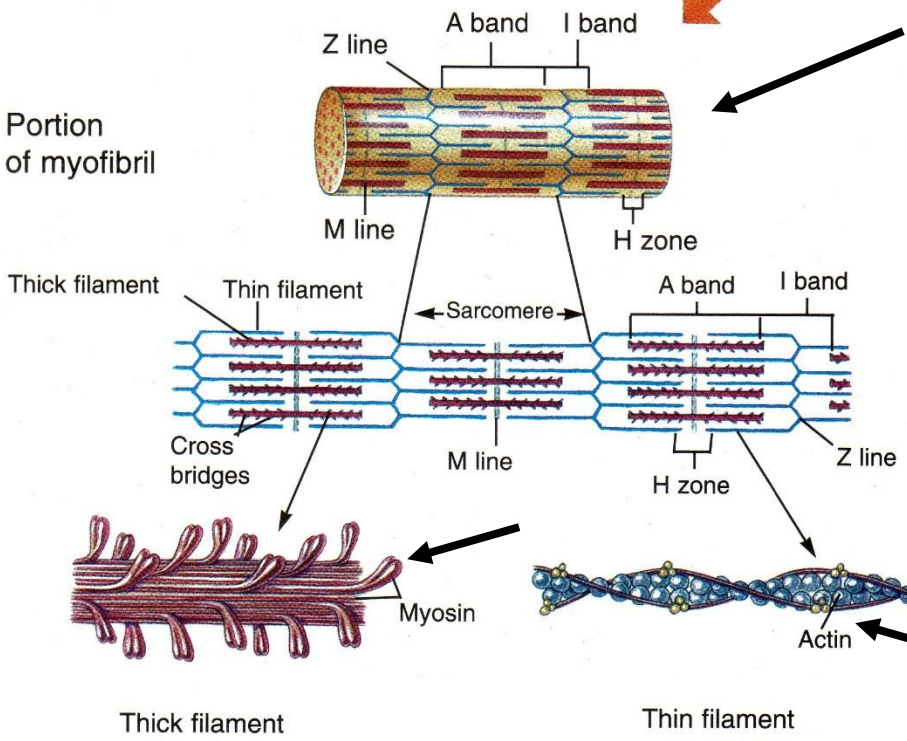
Organ = Muscle



Cell = Myocyte = Fiber



Subcellular = Cytoskeleton



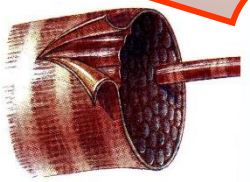
Molecules = Actin & Myosin

LS 2006, cf:
LS 2012 fig 8-2
DC 2013 fig 12-3

Whole Muscle

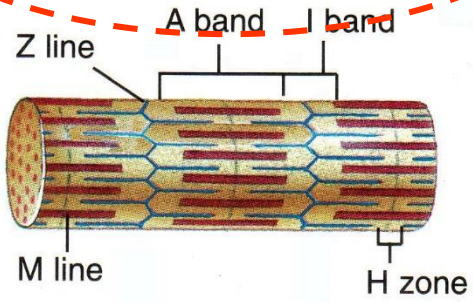
Organ

Myocyte or Muscle Fiber



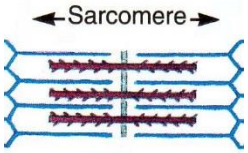
Cell

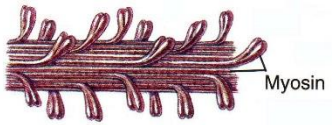
Myofibril



Cytoskeleton

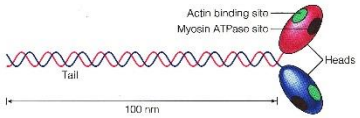
Thick & Thin Filaments

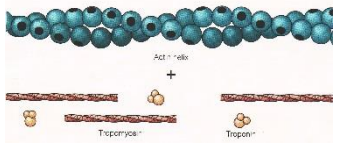


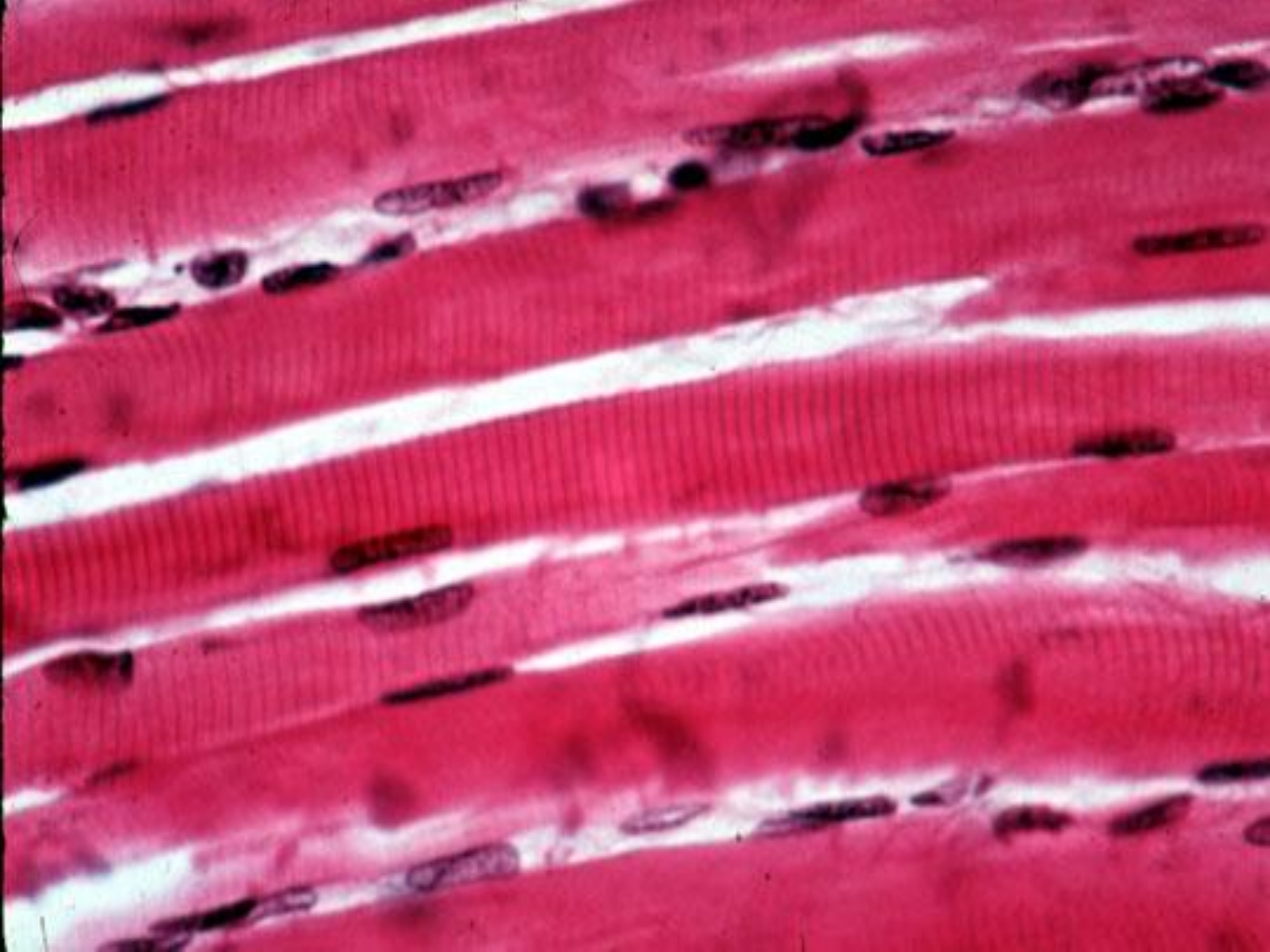


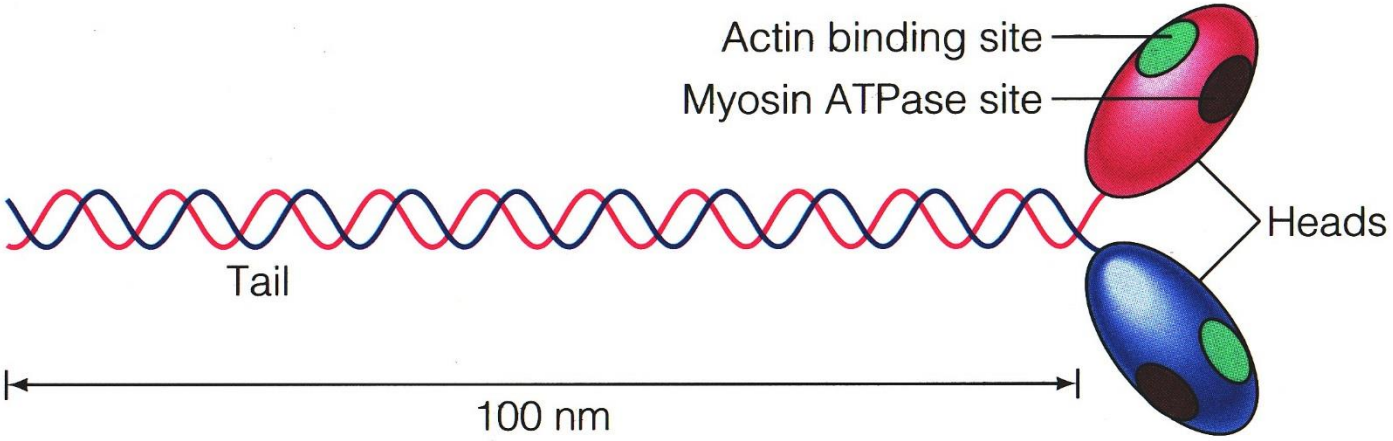
Myosin & Actin

Molecules



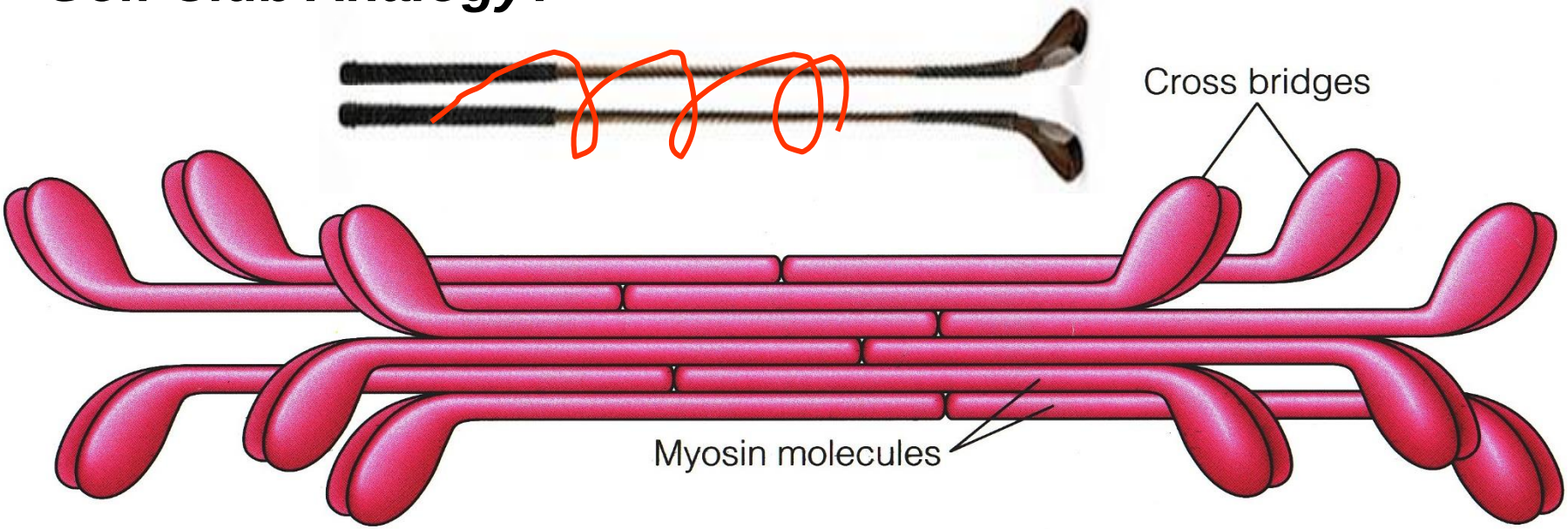






(a)

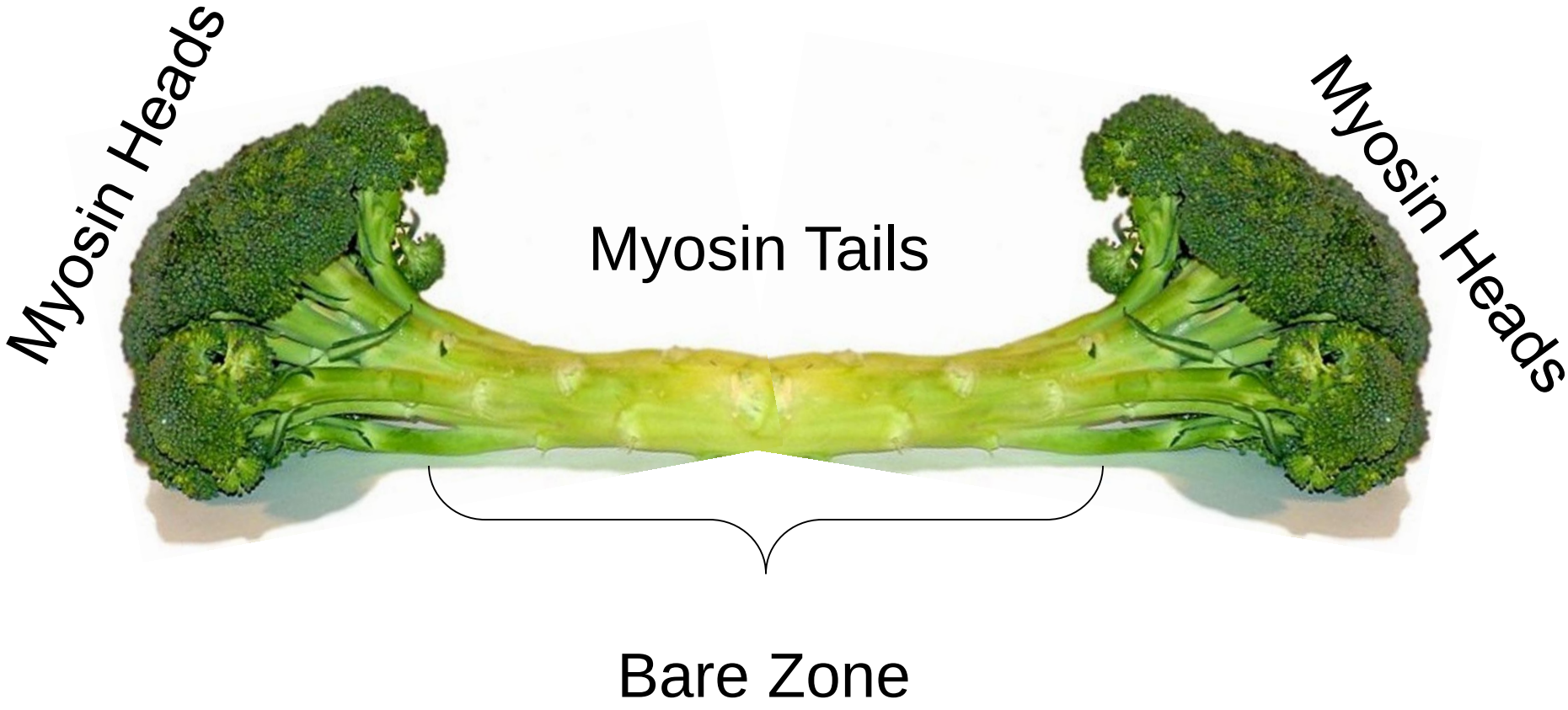
Golf Club Analogy?

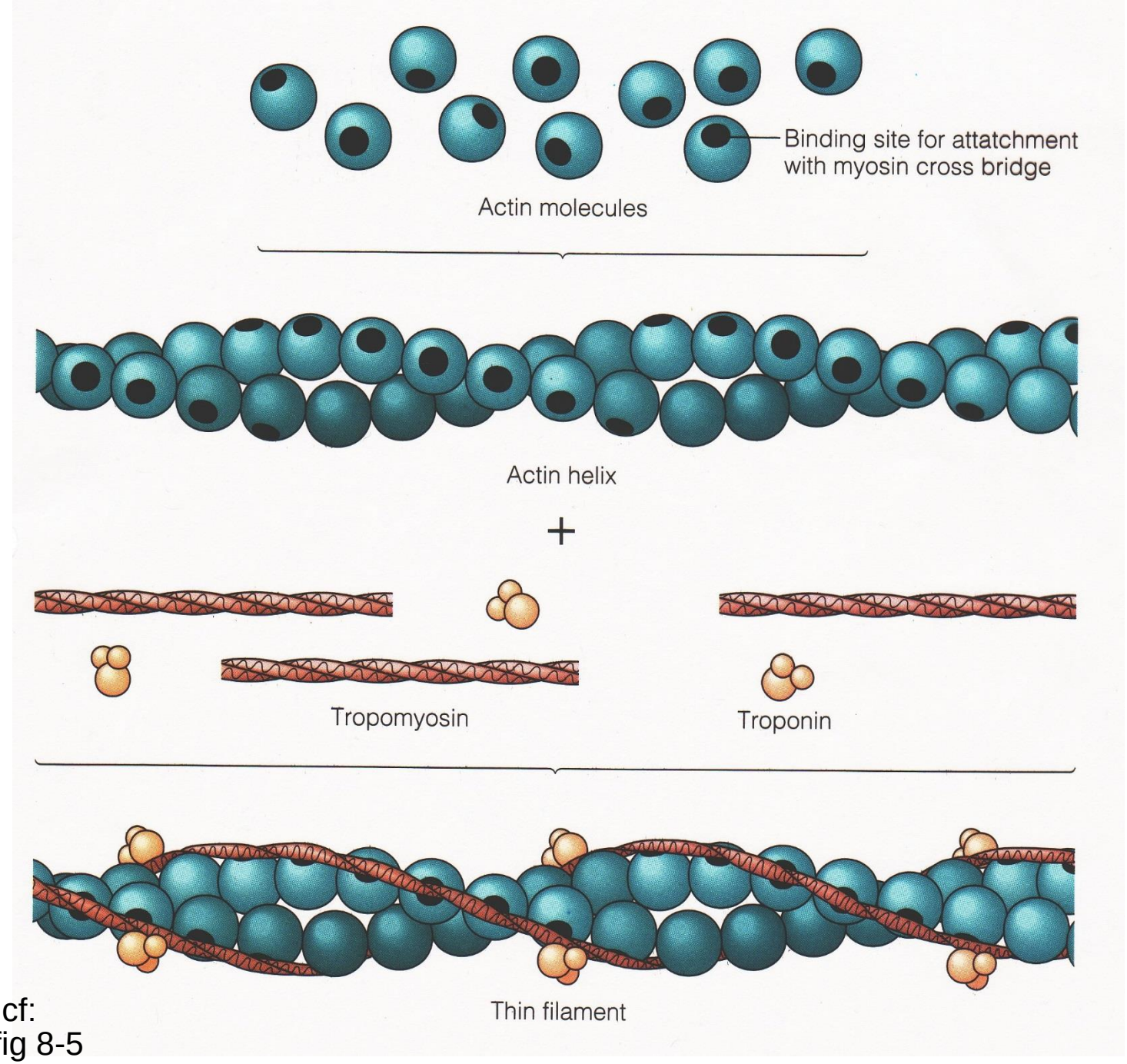


(b)

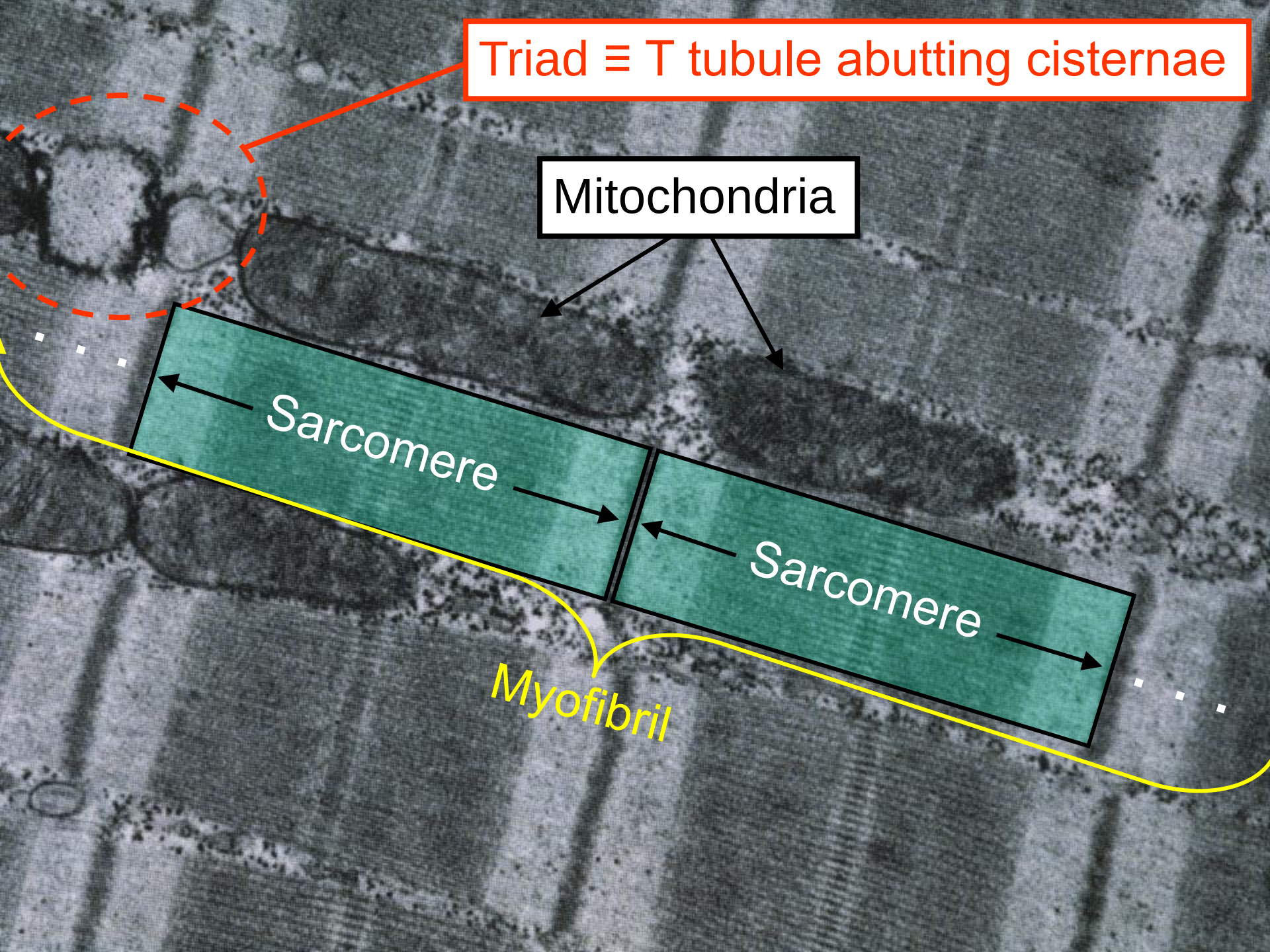
LS 2006, cf:
LS 2012 fig 8-4

Broccoli Analogy?



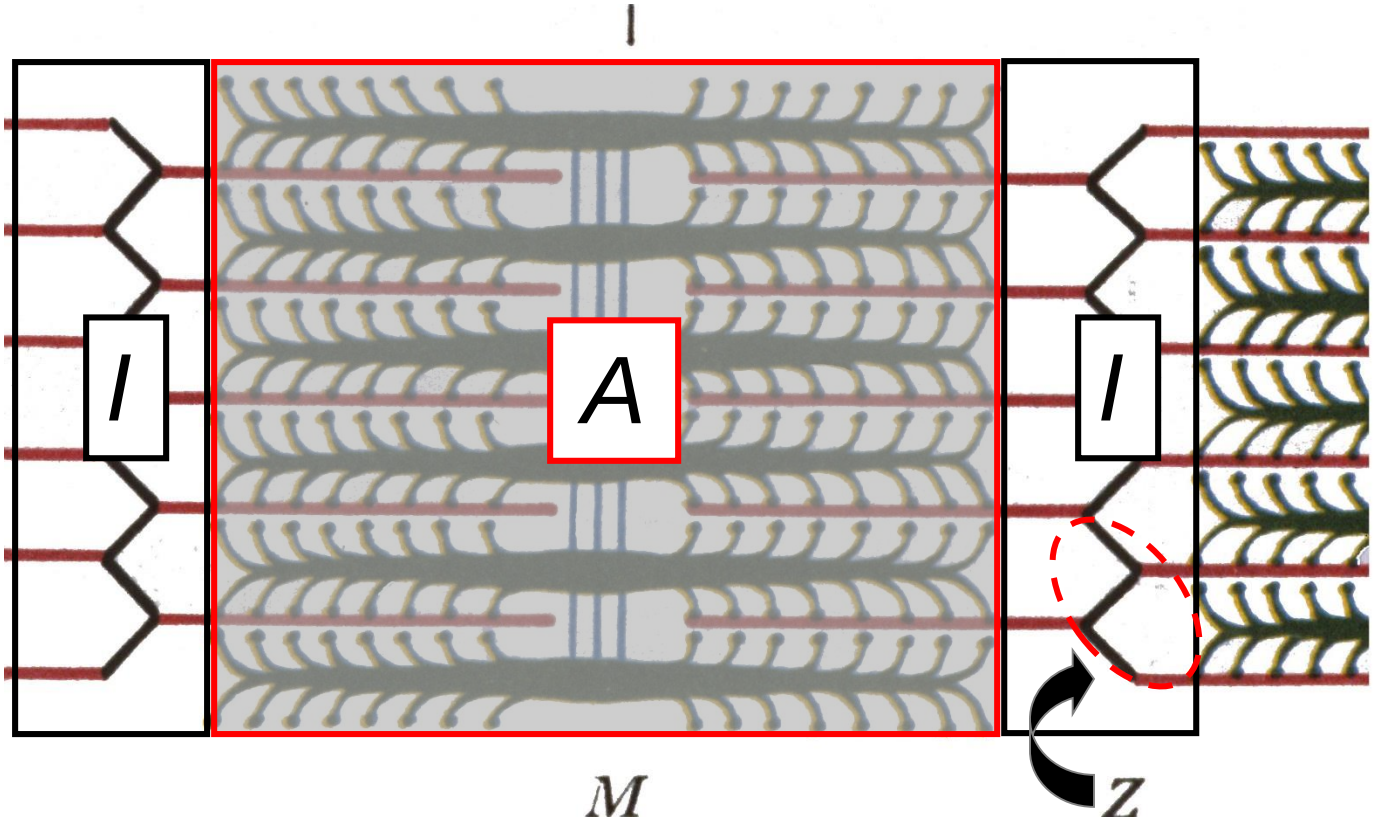


LS 2006, cf:
LS 2012 fig 8-5


Triad ≡ T tubule abutting cisternae
Mitochondria
Sarcomere
Sarcomere
Myofibril

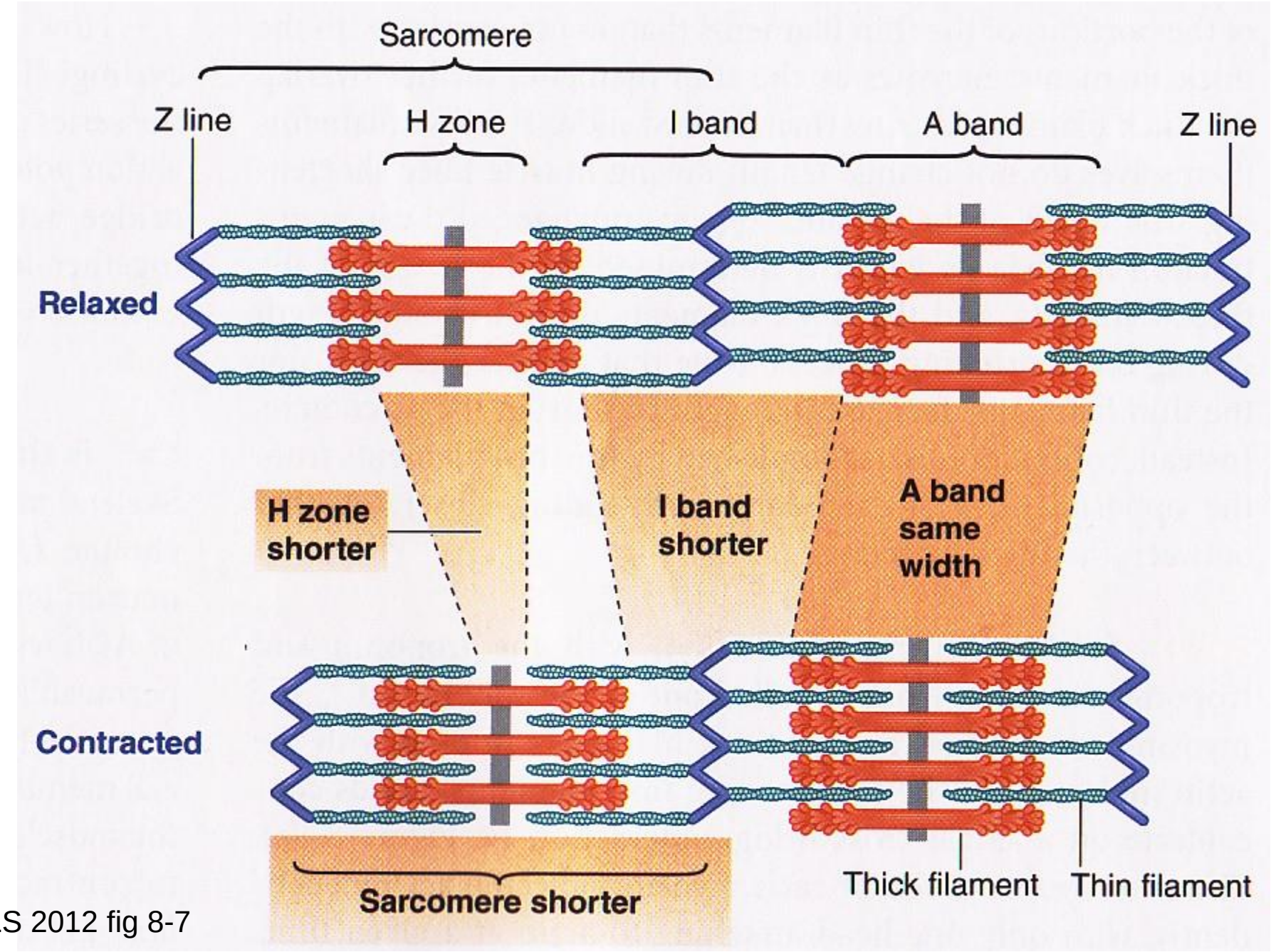
A Band = Dark Band

*A*nisotropic = Light Can't Shine Through



I Band = Light Band

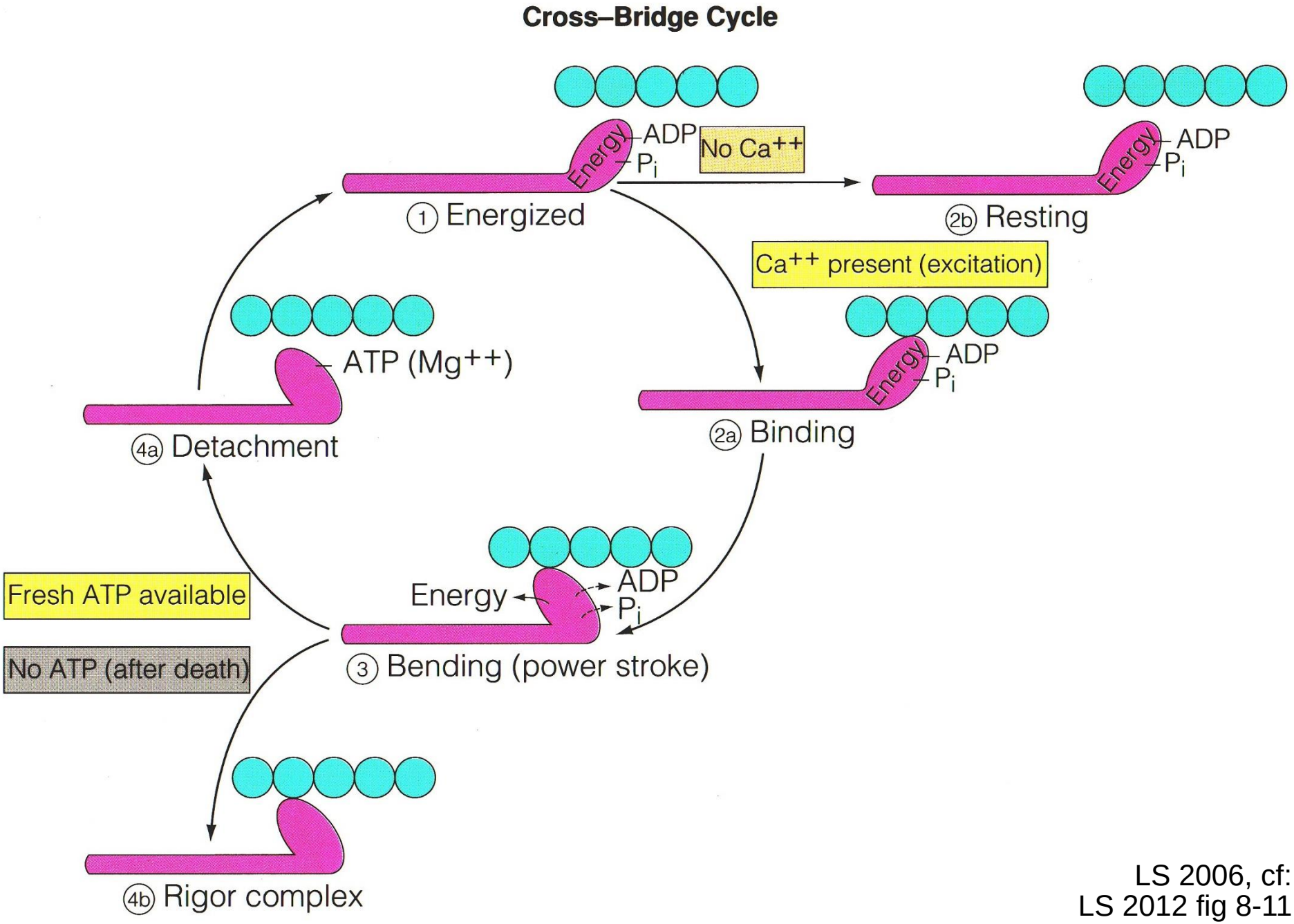
*I*sotropic = Light Can Shine Through



LS 2012 fig 8-7

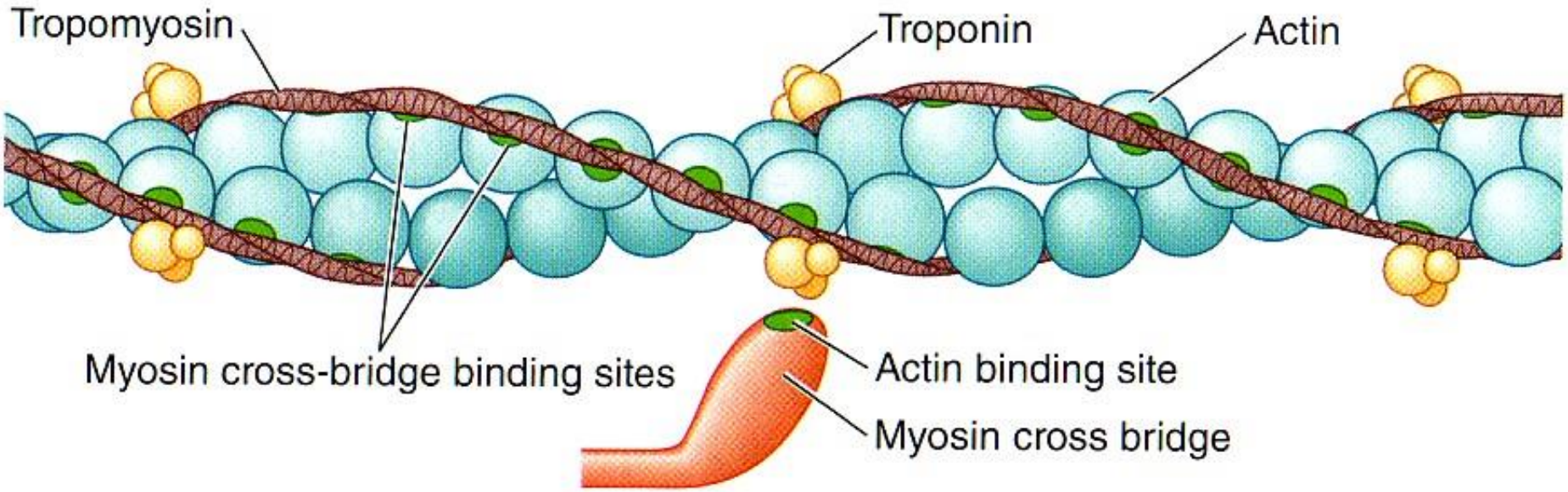
Discussion + Time for Questions!

What do we guess happens at the molecular level?



LS 2006, cf:
LS 2012 fig 8-11

Relaxed: No Cross-Bridge Binding



(a) Relaxed

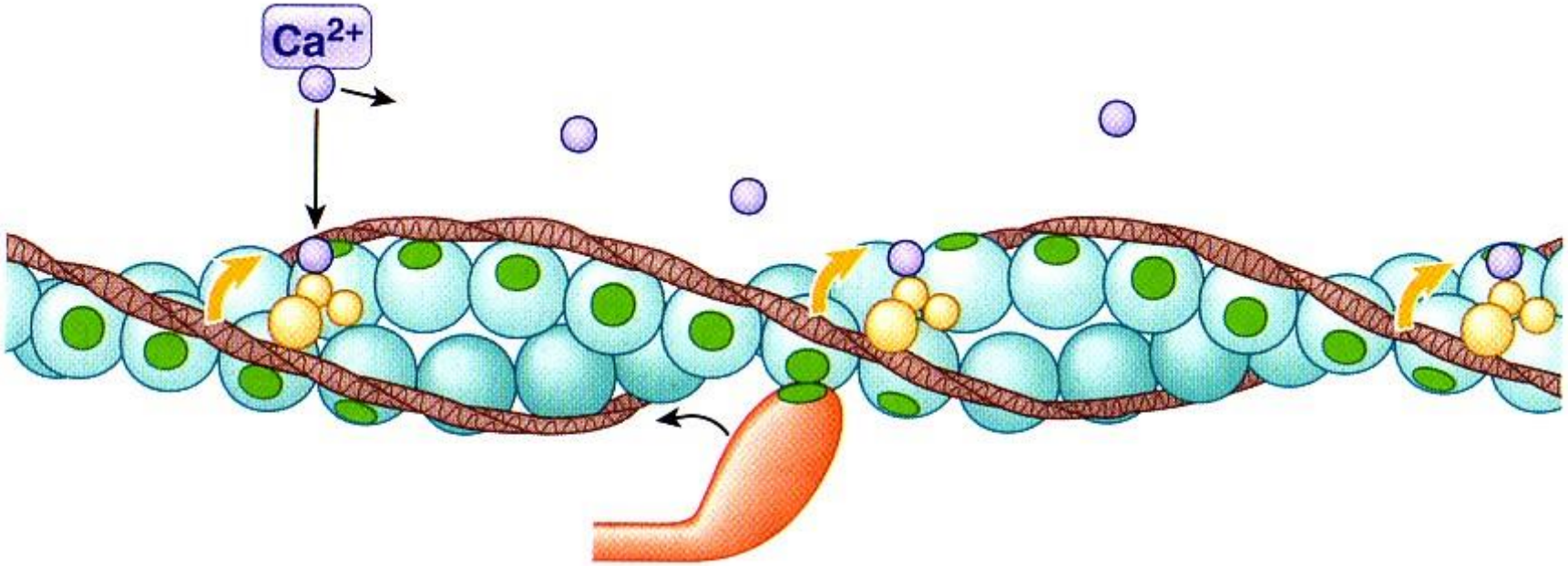
1. No excitation.

2. No cross-bridge binding because cross-bridge binding site on actin is physically covered by troponin–tropomyosin complex.

3. Muscle fiber is relaxed.

LS 2012 fig 8-6a

Excited: Calcium Triggers Cross-Bridge Binding



(b) Excited

1. Muscle fiber is excited and Ca^{2+} is released.

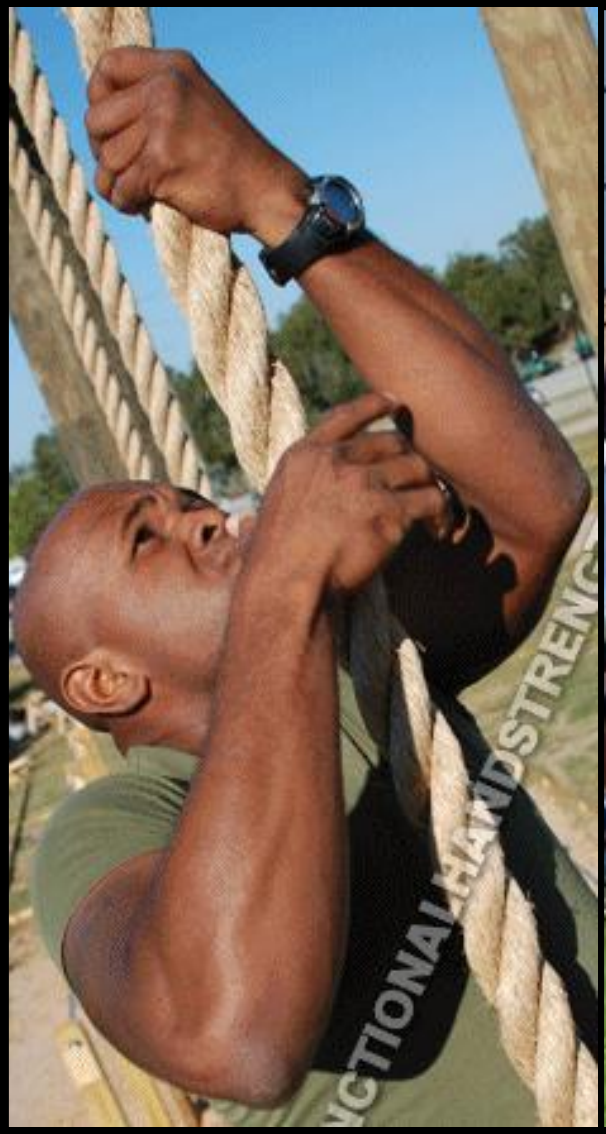
2. Released Ca^{2+} binds with troponin, pulling troponin–tropomyosin complex aside to expose cross-bridge binding site.

3. Cross-bridge binding occurs.

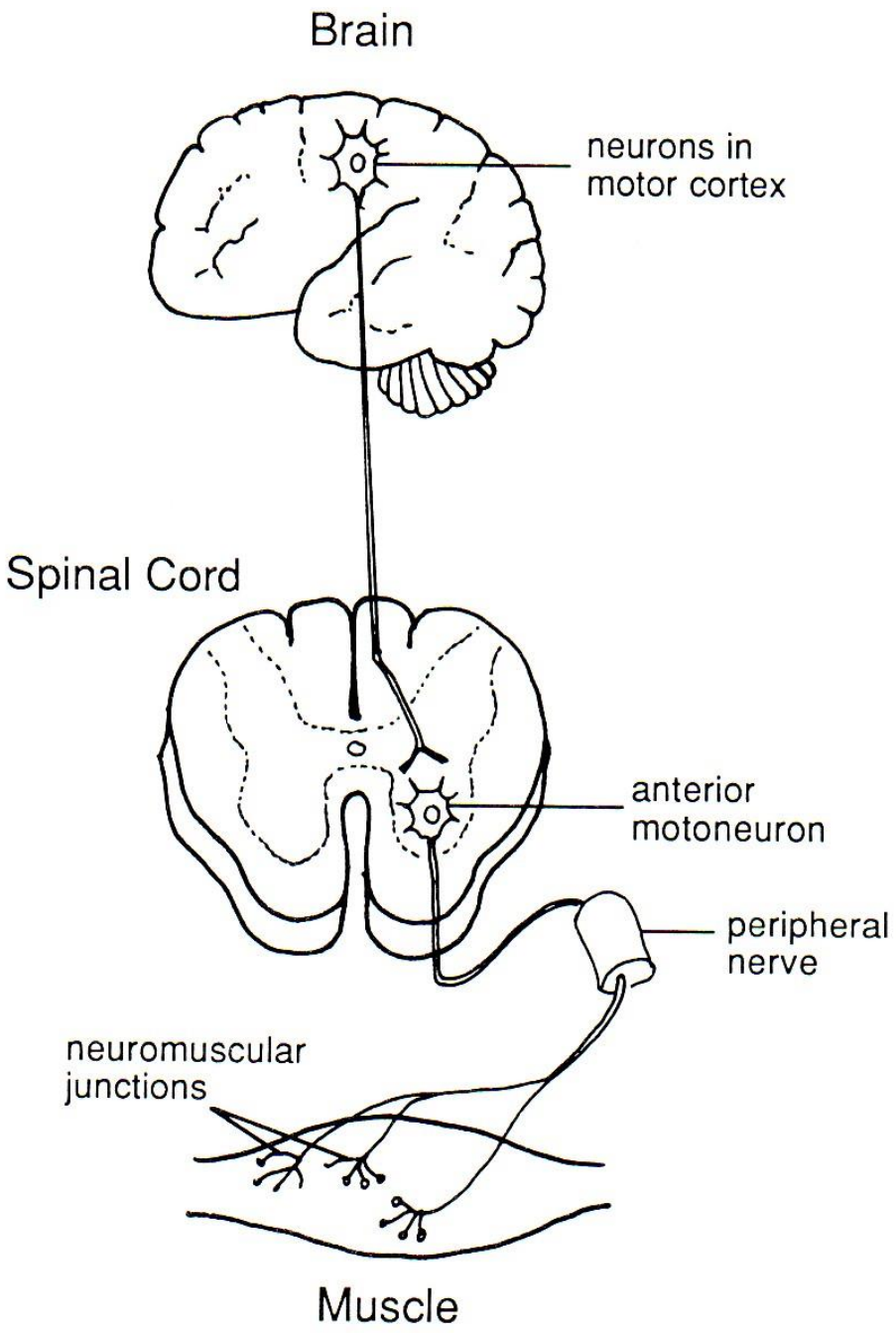
4. Binding of actin and myosin cross bridge triggers power stroke that pulls thin filament inward during contraction.

LS 2012 fig 8-6b

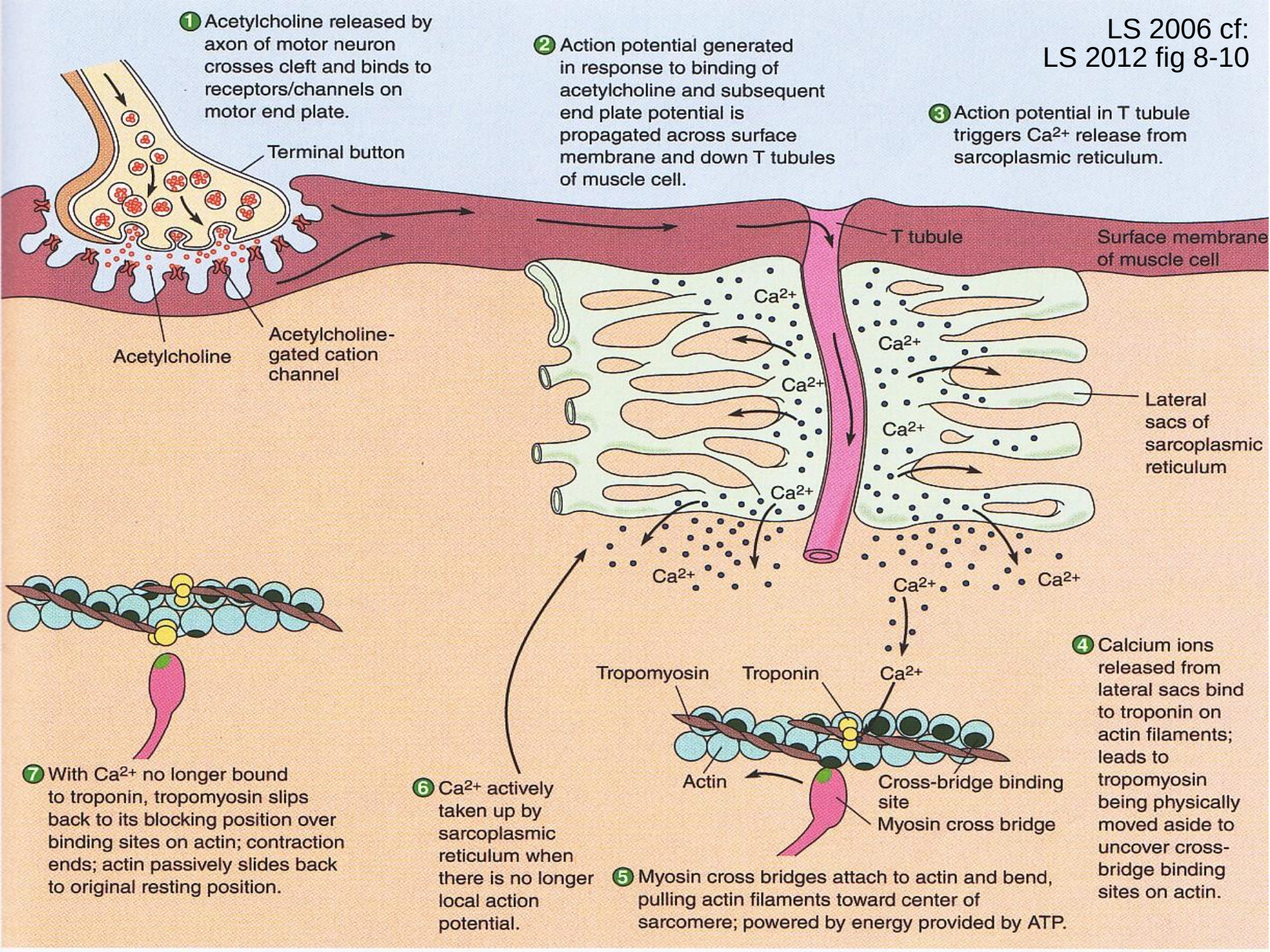
Rope Climb or Tug of War
Grasp, then Regrasp!



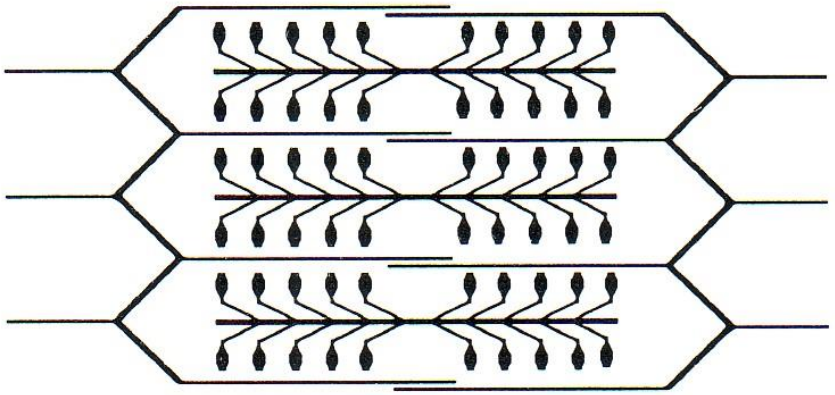

Summary
We are almost there!


Brain
neurons in
motor cortex
Spinal Cord
anterior
motoneuron
peripheral
nerve
neuromuscular
junctions
Muscle

LS 2006 cf:
LS 2012 fig 8-10

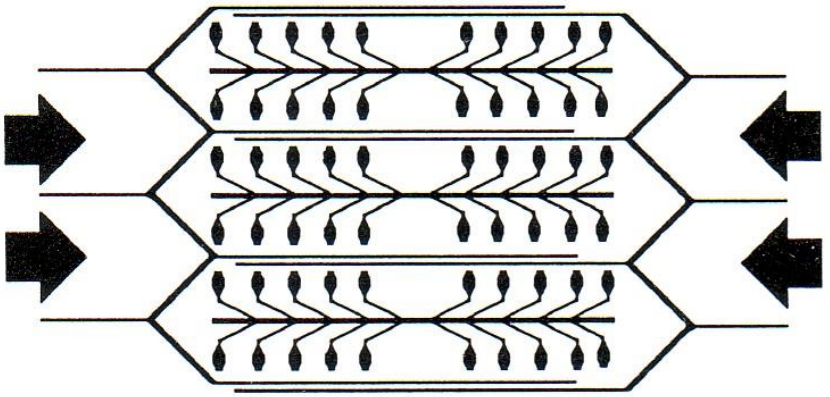


Relaxation Phase



1. Excitation by nerve fiber
2. Conduction by T-tubules
3. Ca^{2+} release by SR

Contractile Phase



D Liang & VP Lombardi 1989