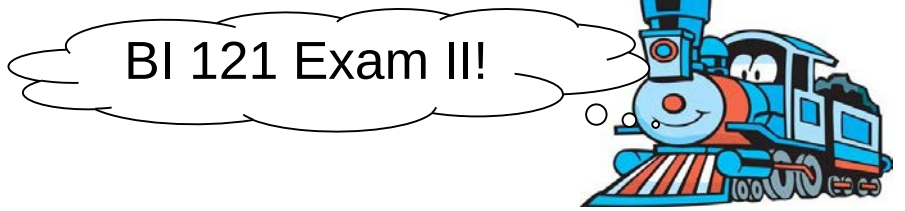
Exam II is coming! I'll be ready!!...



BI 121 Lecture 14

I. ***Announcements*** **Last Lab 6, Pulmonary Function Testing + optional notebook ✓ this Thurs. Exam II Tues, Dec 8, 8 am Q?**

II. ***Nervous System Connections*** **LS 7**

- A. **Autonomic NS: Branches, neurotransmitters, receptors, actions, fight-or-flight stories ch 7 pp 179-85**
- B. **Why are nerve & muscle unique? ch 4 p 71**
- C. **How do excitable cells signal? ch 3 pp 62-7;ch 4 pp 74-83**
- D. **How does the signal cross the nerve-muscle gap? ch 7 p 185-92 fig 7-5 p 190**
- E. **What do black widow spider venom, botulism/Botox?, curare & nerve gas have in common? LS fig 7-5 p 190**

III. ***Muscle Structure-Function & Adaptation*** **LS ch 8 + DC Mod 12**

- A. **Muscle types: cardiac, smooth, skeletal LS fig 8-1 pp194-6**
- 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 +…**

Hormonal Adrenaline Surge Reinforces Nervous Outflow & Accesses Tissues Not Directly Innervated!!

80% Epinephrine/Adrenaline (E)

20% Norepinephrine (NE)

Output *to blood*

Adrenals = Paired organs above kidneys

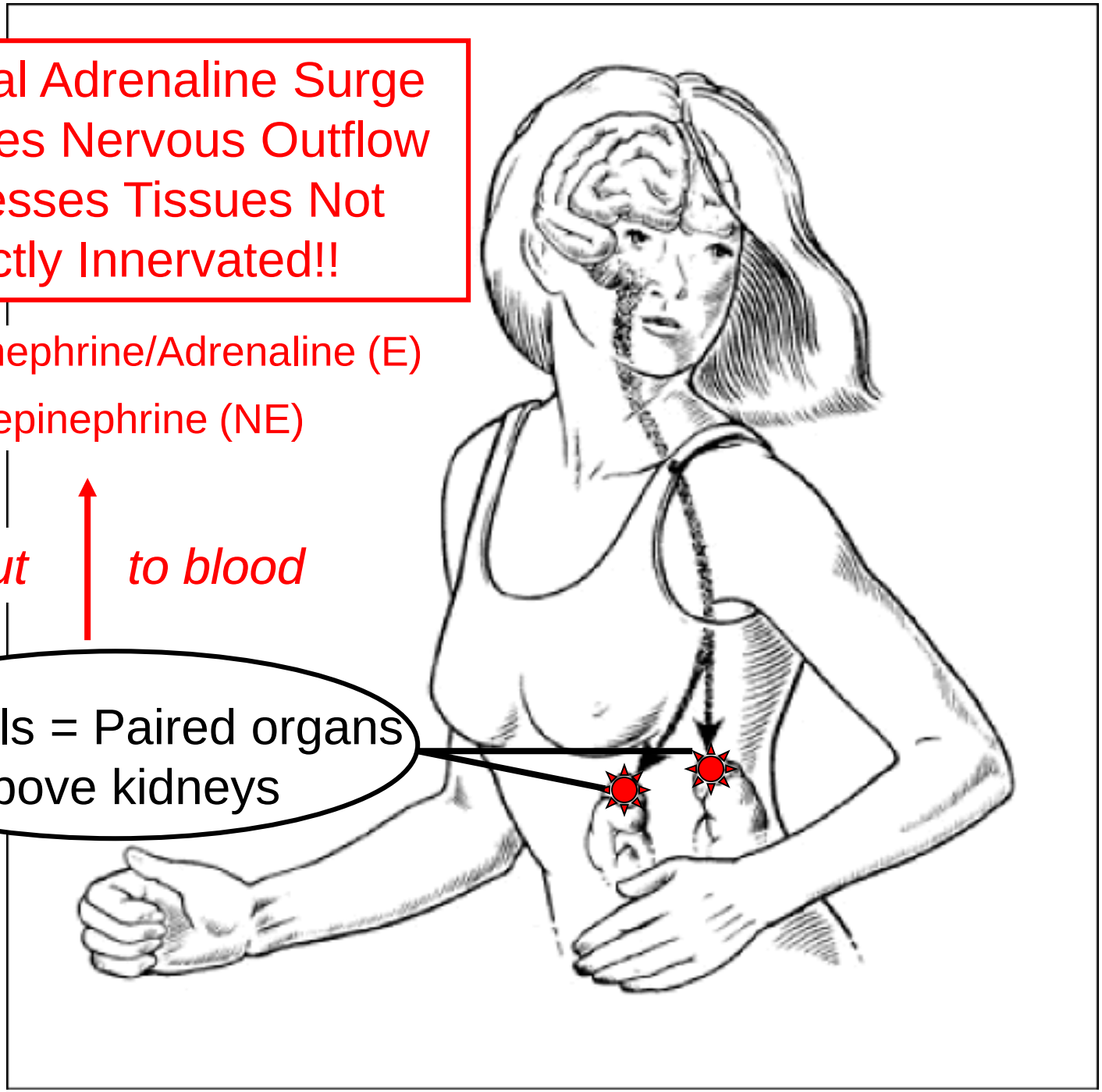
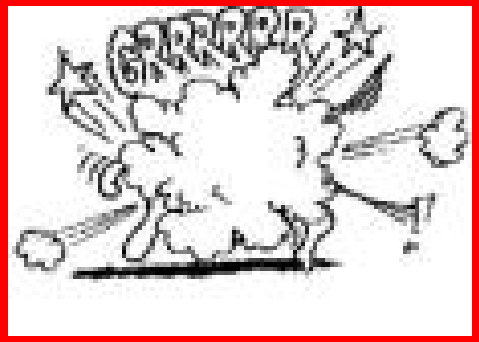


Table 7-1 Effects of Autonomic Nervous System on Various Organs

Organ	Effect of Sympathetic Stimulation	Effect of Parasympathetic Stimulation
Heart	Increases heart rate and increases force of contraction of the whole heart	Decreases heart rate and decreases force of contraction of the atria only
Blood Vessels	Constricts	Dilates vessels supplying the penis and the clitoris only
Lungs	Dilates the bronchioles (airways)	Constricts the bronchioles
Digestive Tract	Decreases motility (movement)	Increases motility
	Contracts sphincters (to prevent forward movement of tract contents)	Relaxes sphincters (to permit forward movement of tract contents)
	Inhibits digestive secretions	Stimulates digestive secretions
Urinary Bladder	Relaxes	Contracts (emptying)
Eye	Dilates the pupil	Constricts the pupil
	Adjusts the eye for far vision	Adjusts the eye for near vision
Liver (glycogen stores)	Glycogenolysis (glucose is released)	None
Adipose Cells (fat stores)	Lipolysis (fatty acids are released)	None
Exocrine Glands		
Exocrine pancreas	Inhibits pancreatic exocrine secretion	Stimulates pancreatic exocrine secretion (important for digestion)
Sweat glands	Stimulates secretion by sweat glands important in cooling the body	Stimulates secretion by specialized sweat glands in the armpits and genital area
Salivary glands	Stimulates a small volume of thick saliva rich in mucus	Stimulates a large volume of watery saliva rich in enzymes
Endocrine Glands		
Adrenal medulla	Stimulates epinephrine and norepinephrine secretion	None
Endocrine pancreas	Inhibits insulin secretion	Stimulates insulin secretion
Genitals	Controls ejaculation (males) and orgasm contractions (both sexes)	Controls erection (penis in males and clitoris in females)
Brain Activity	Increases alertness	None

Fight-or-Flight Stories!

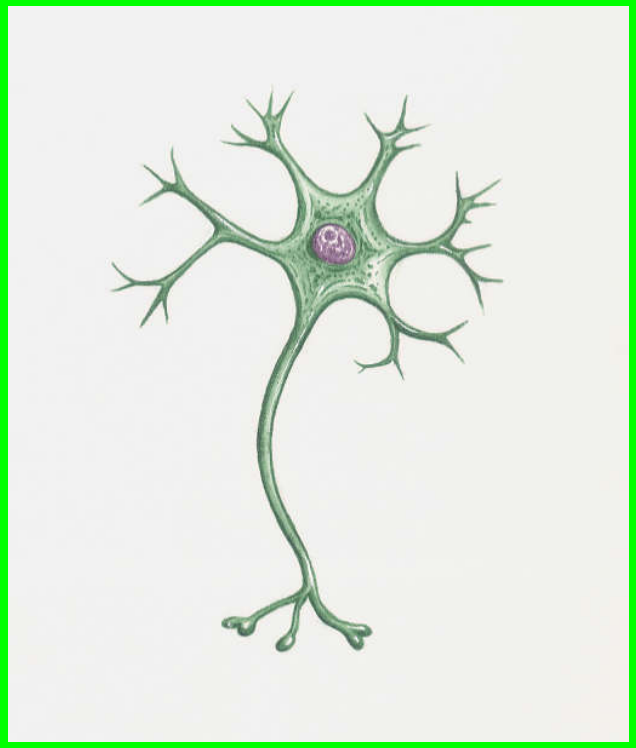


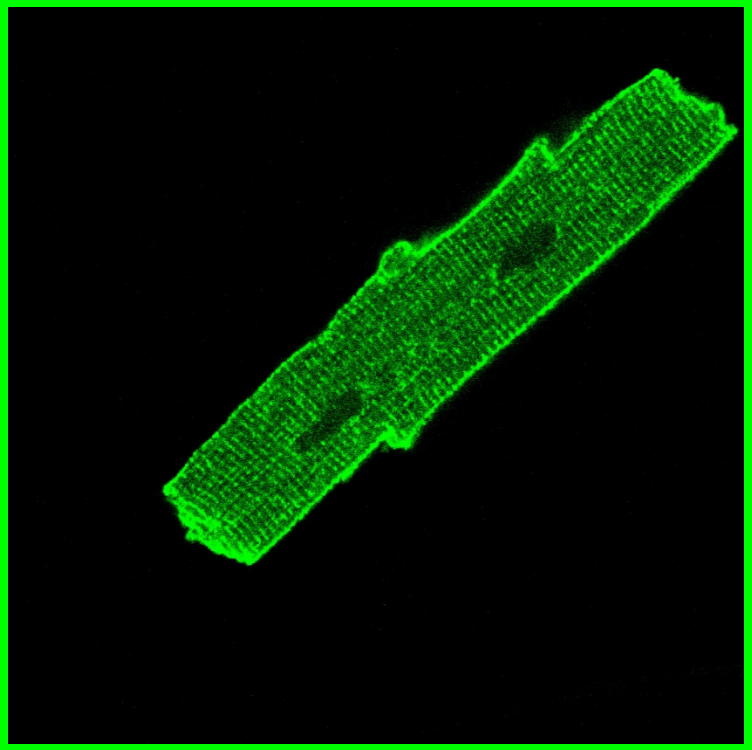
or

…choose this!!

Time for a break! ☺

Why are nerve & muscle unique?





They are excitable!!

Action Potentials ≡ Spikes ≡ Impulses

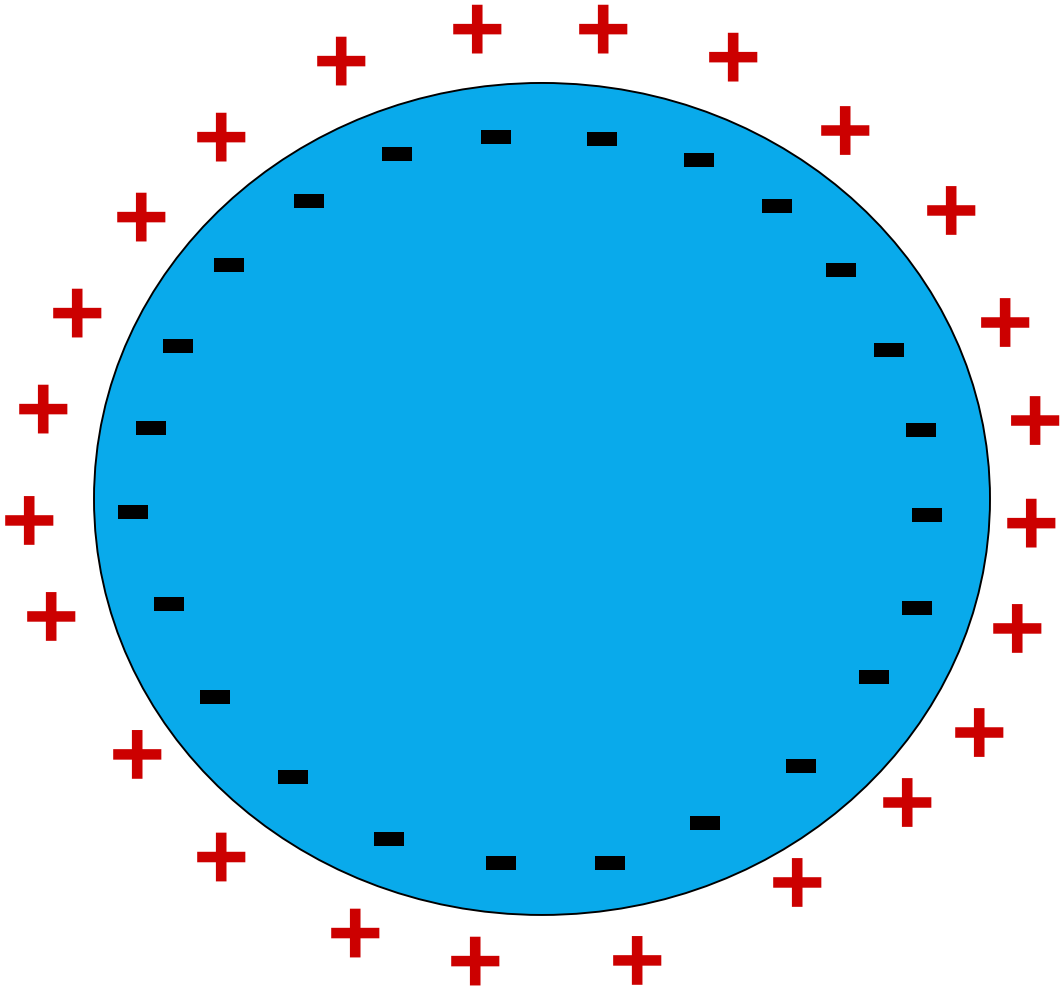
Ultra-short reversal of membrane potential

Only in nerve and muscle cells

Maintains strength over distance

Primary way nerves & muscles communicate!

"Resting"/Membrane Potential?

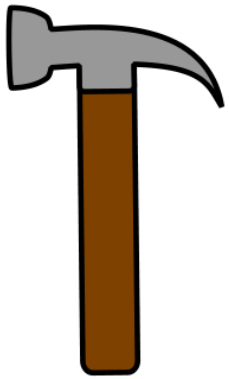


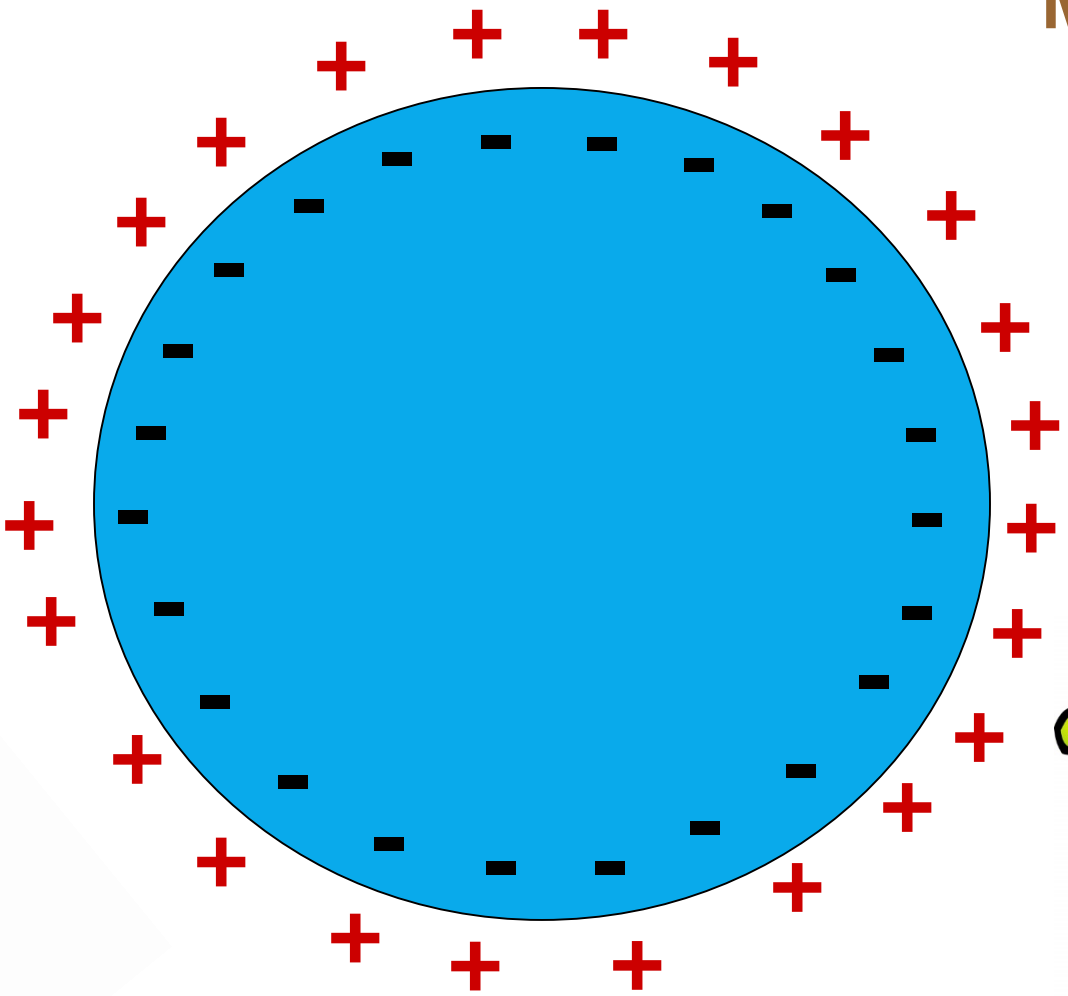
Cells are slightly negative inside!

Stimulate Cell @ Rest

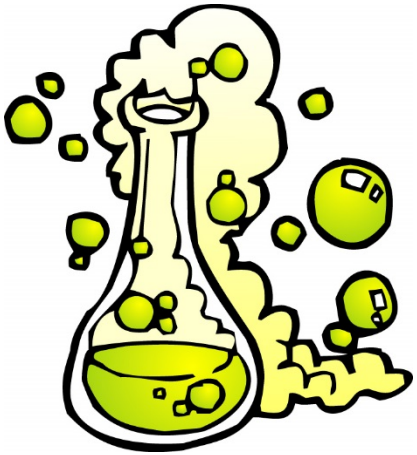
Thermal

Mechanical



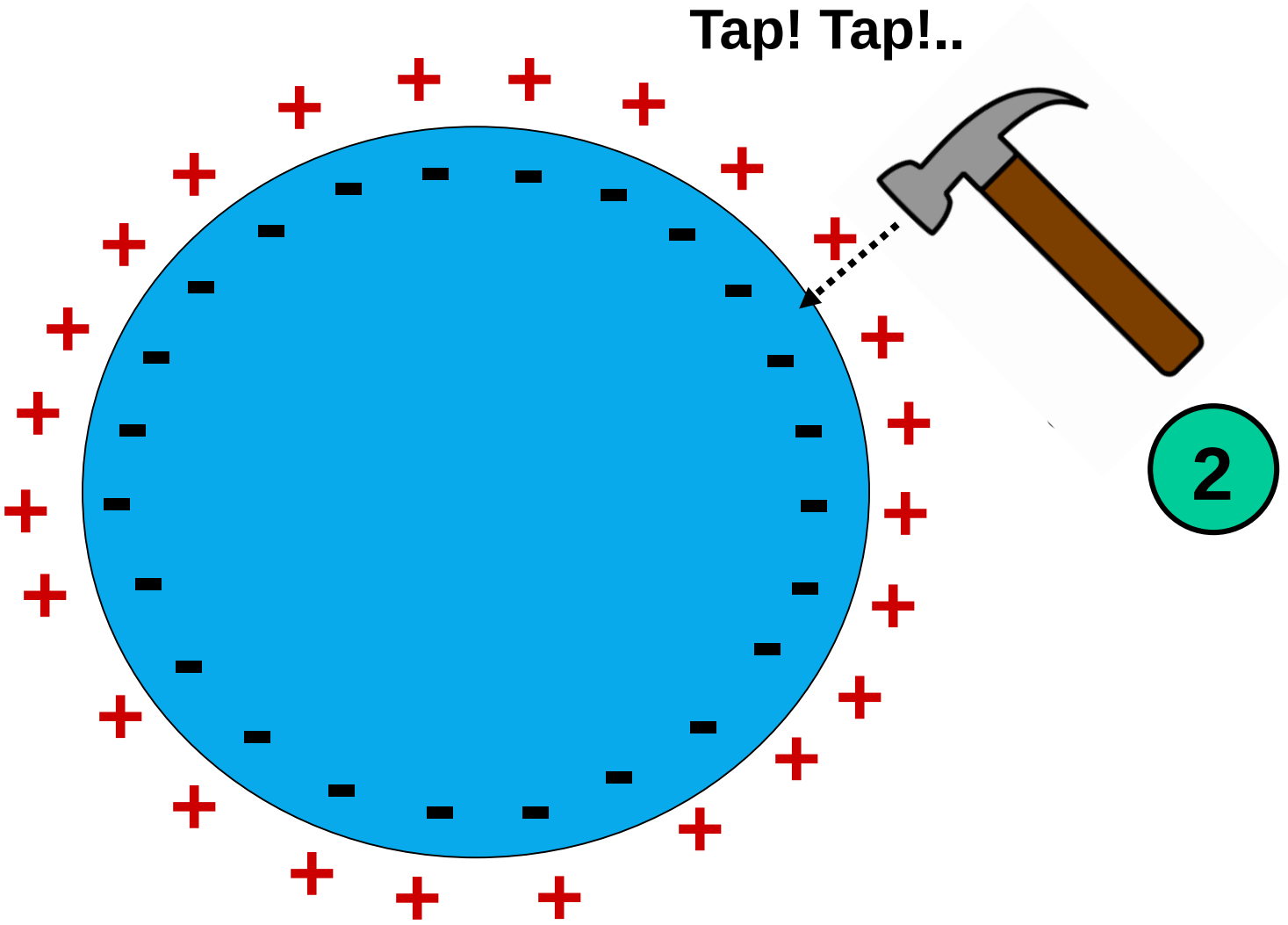


1

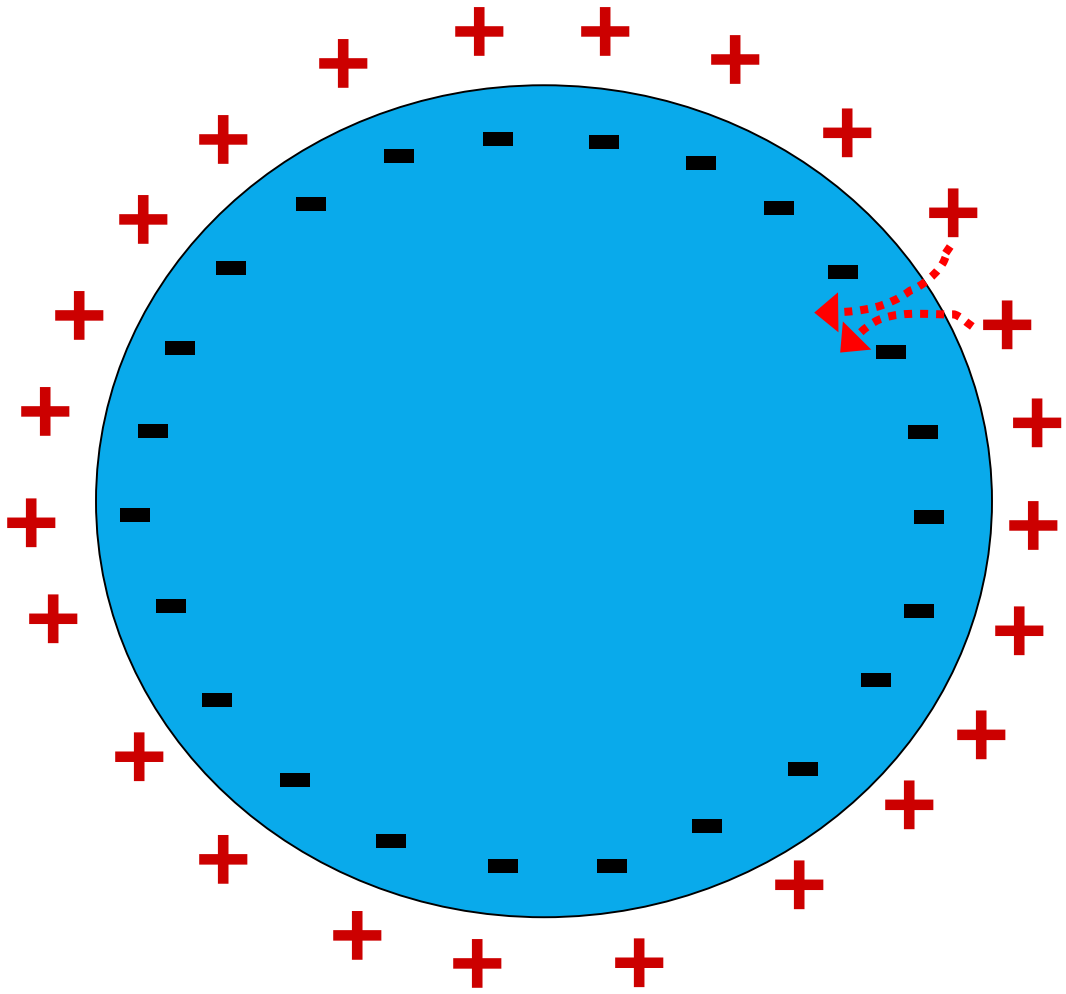


Electrical

Chemical

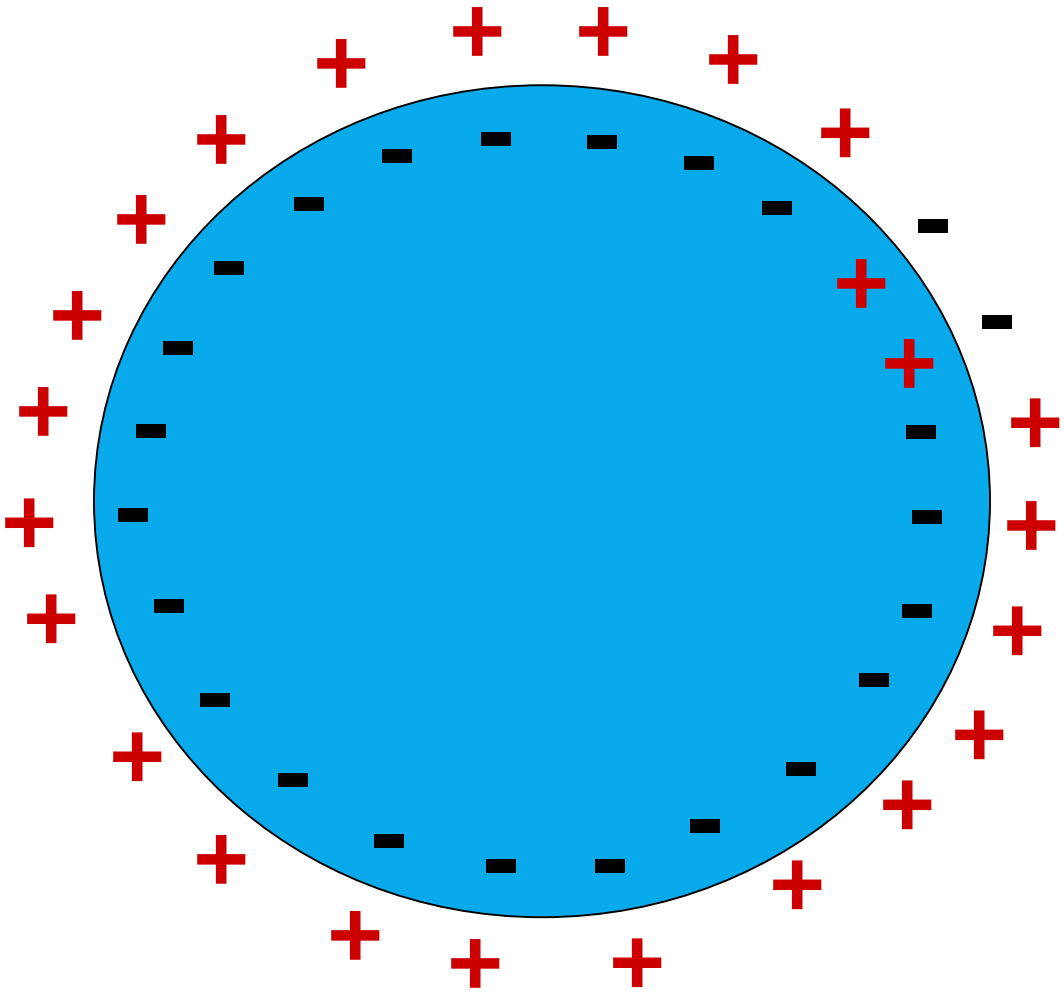

Tap! Tap!..
2

Changes Cell Membrane Permeability to Sodium/Na+!



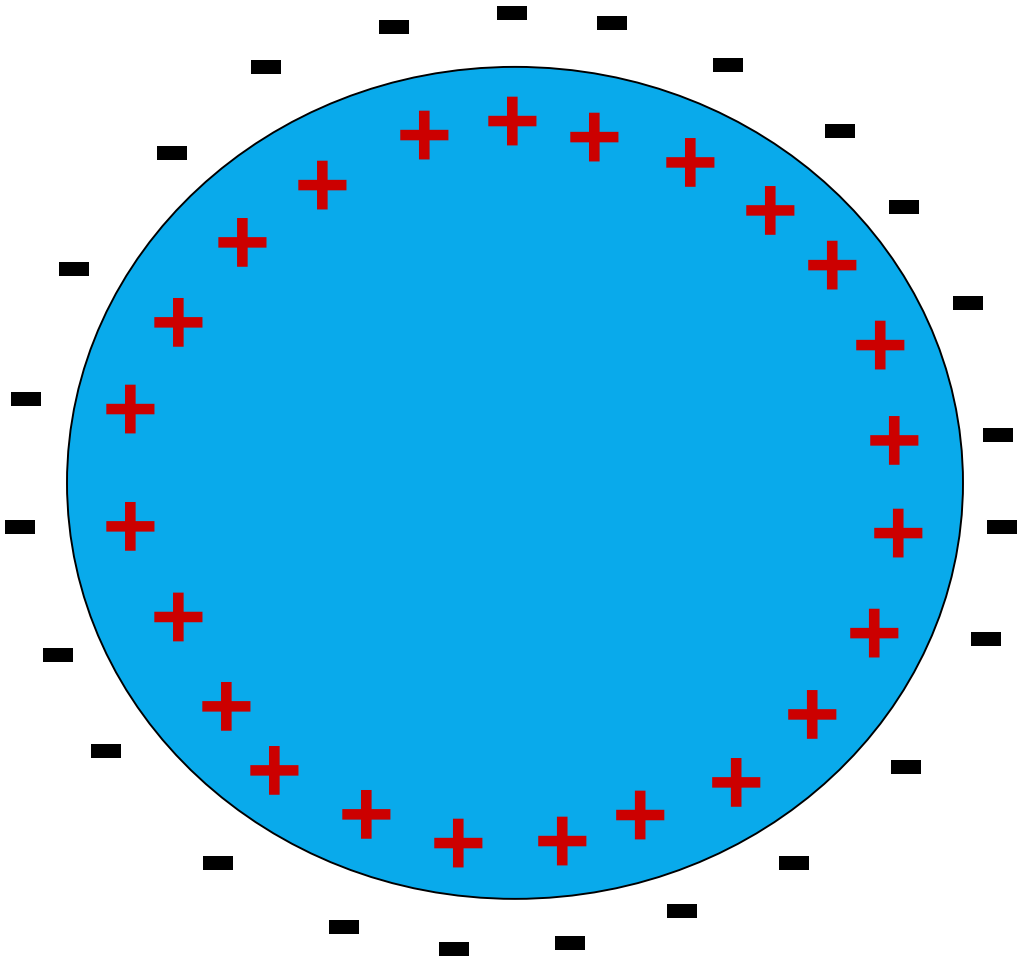
3

+ Charges/Na+ Rushes In!



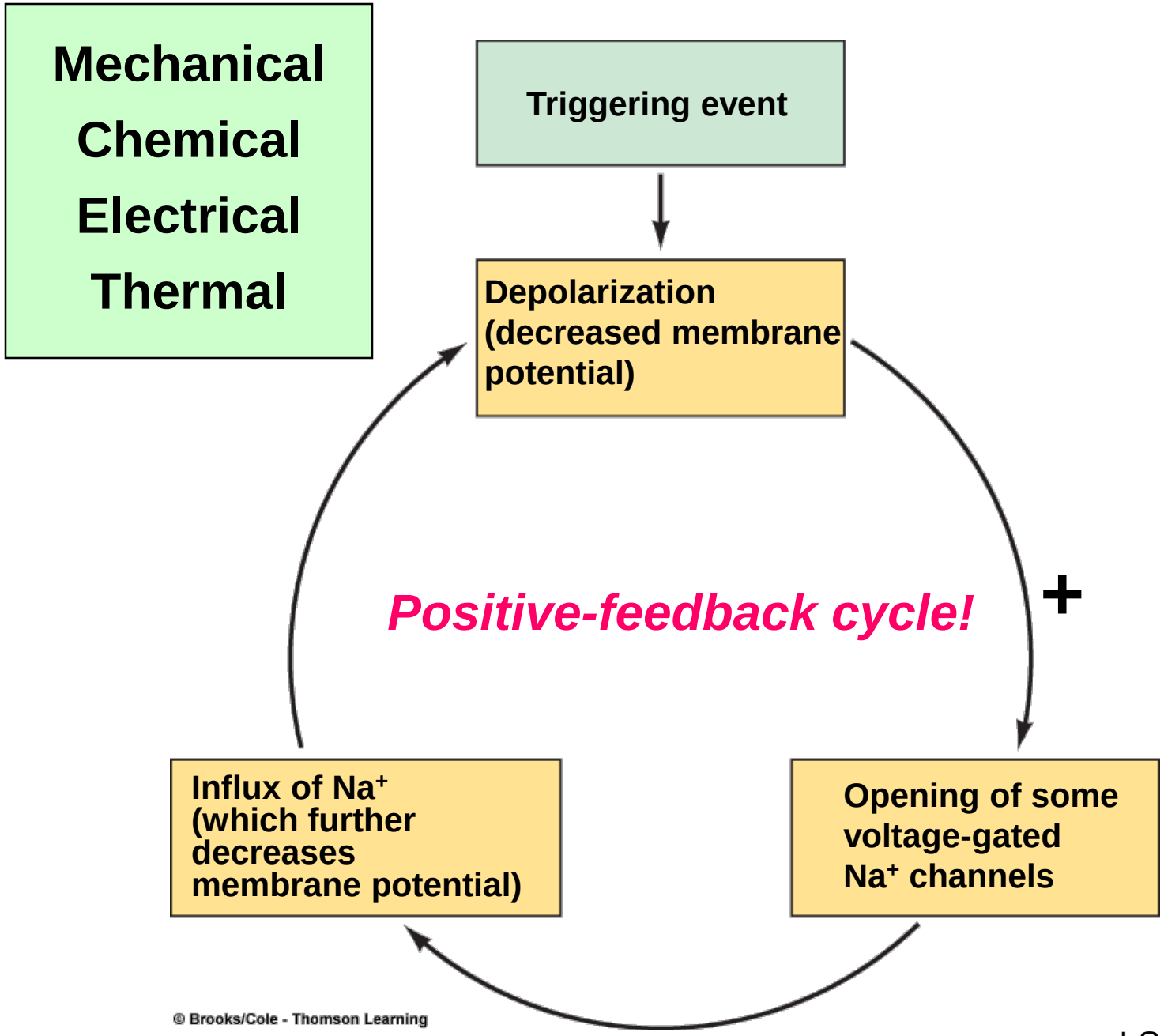
4

Action Potential has occurred!

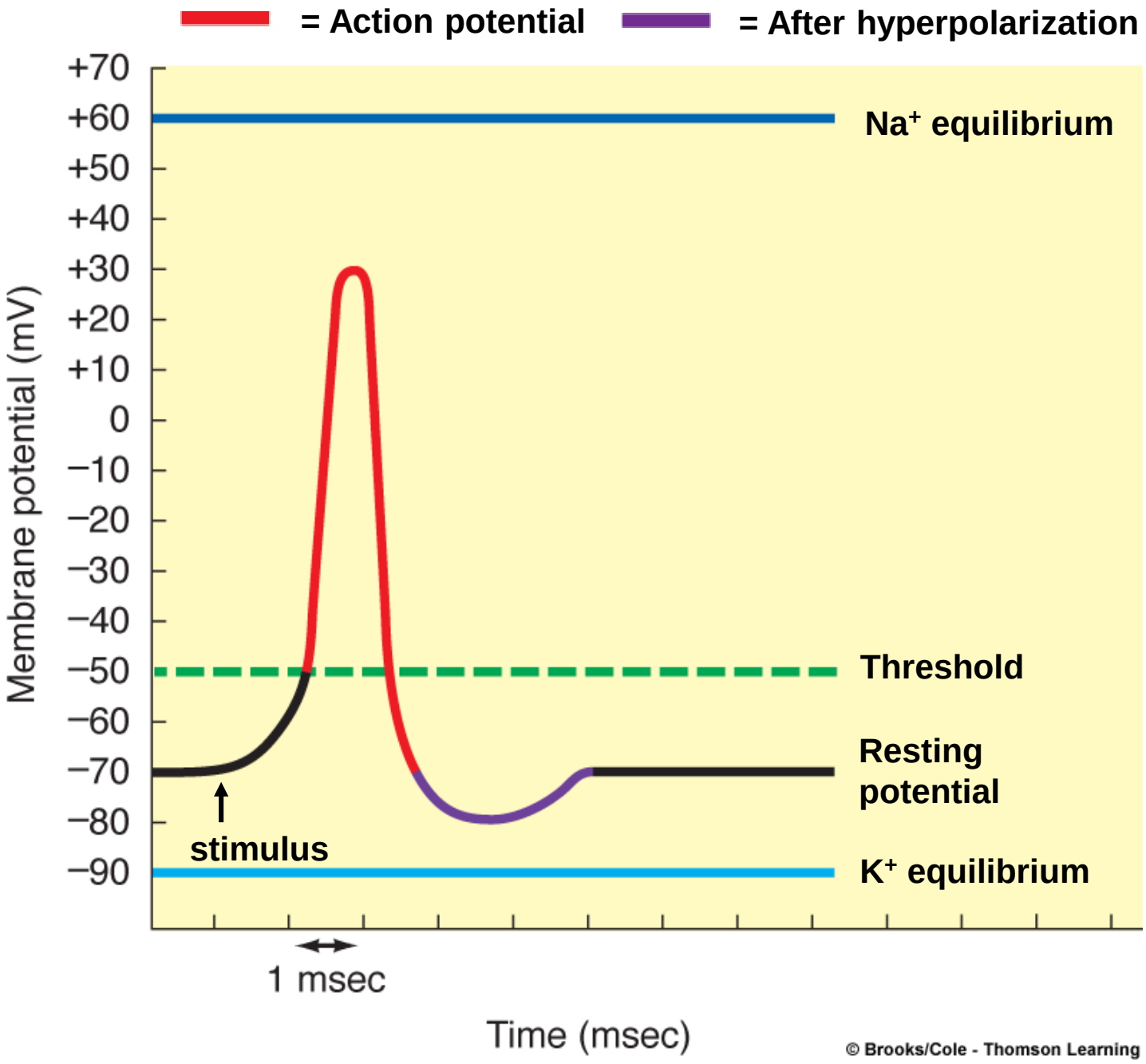


5

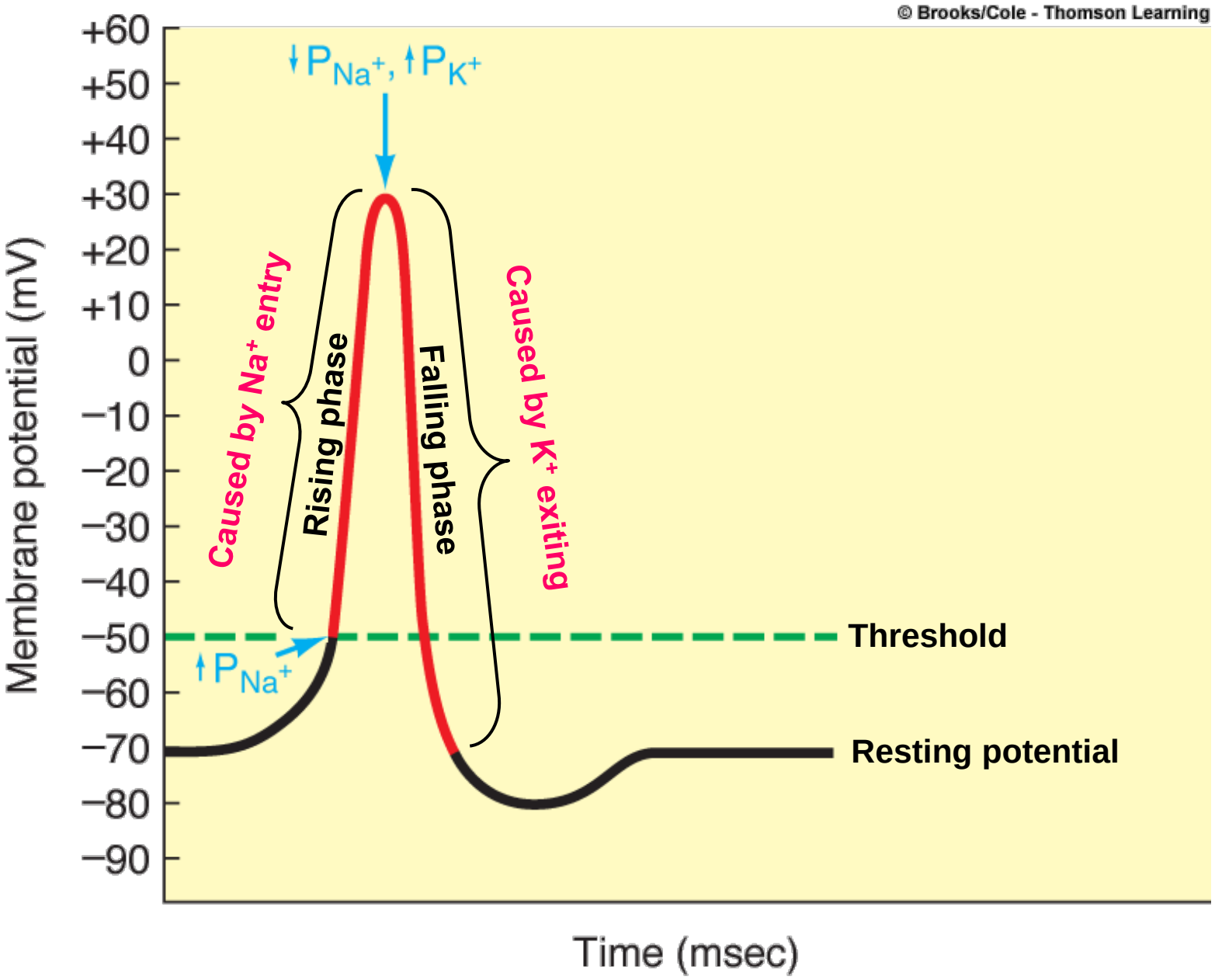
Brief (1-2 ms) reversal to + inside cell!



LS 2012 fig 4-7

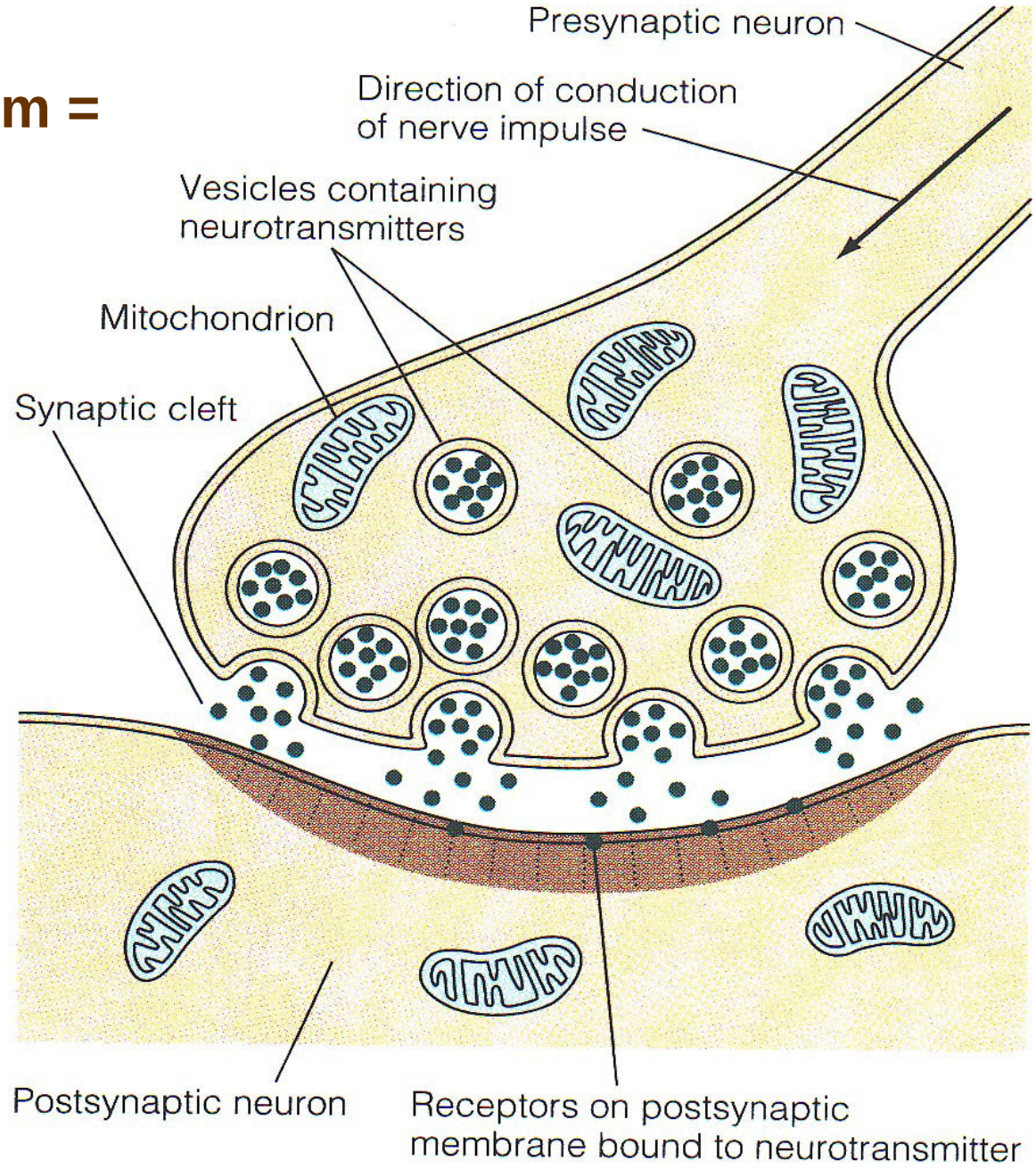


LS 2012 fig 4-5

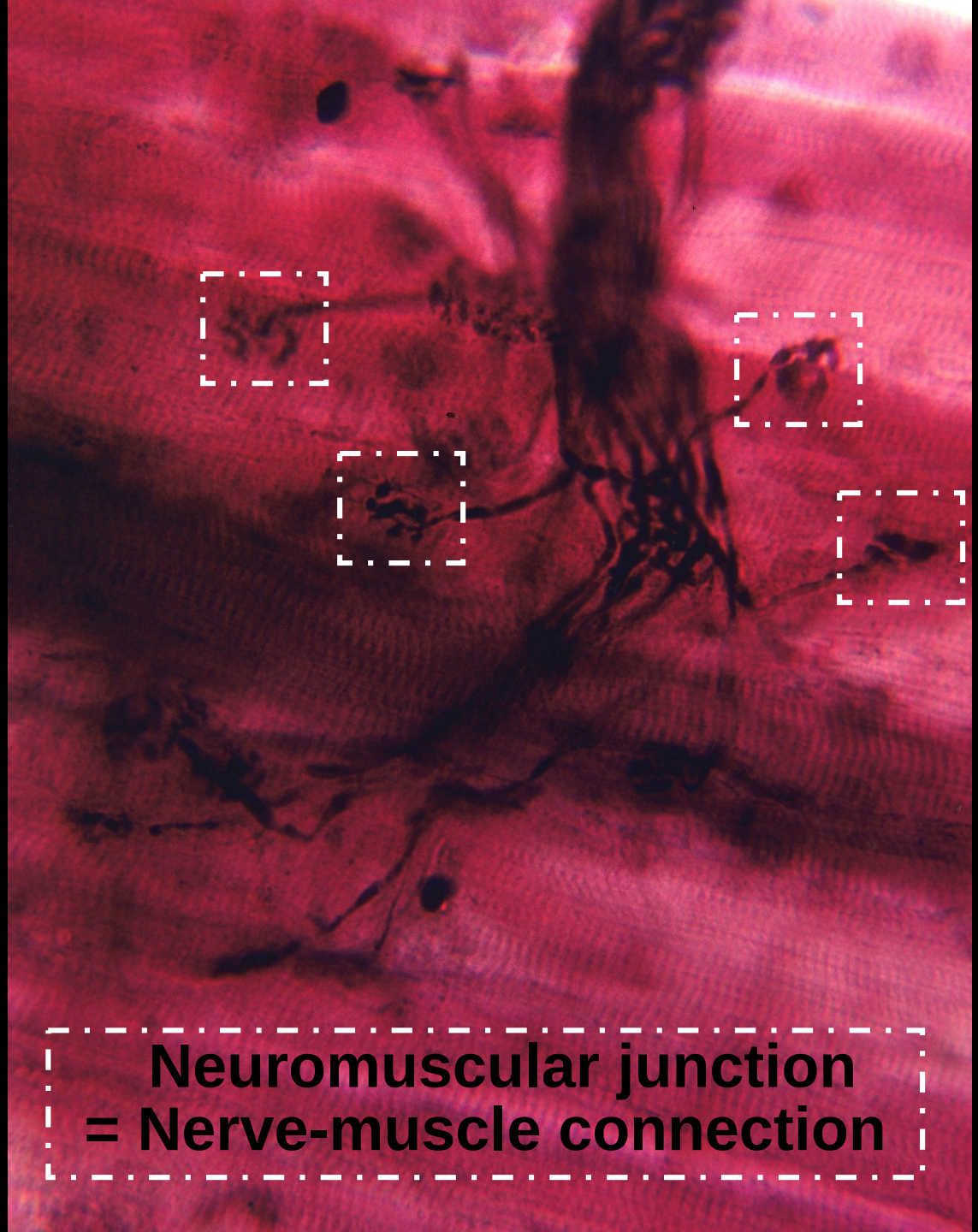


LS 2012 fig 4-8

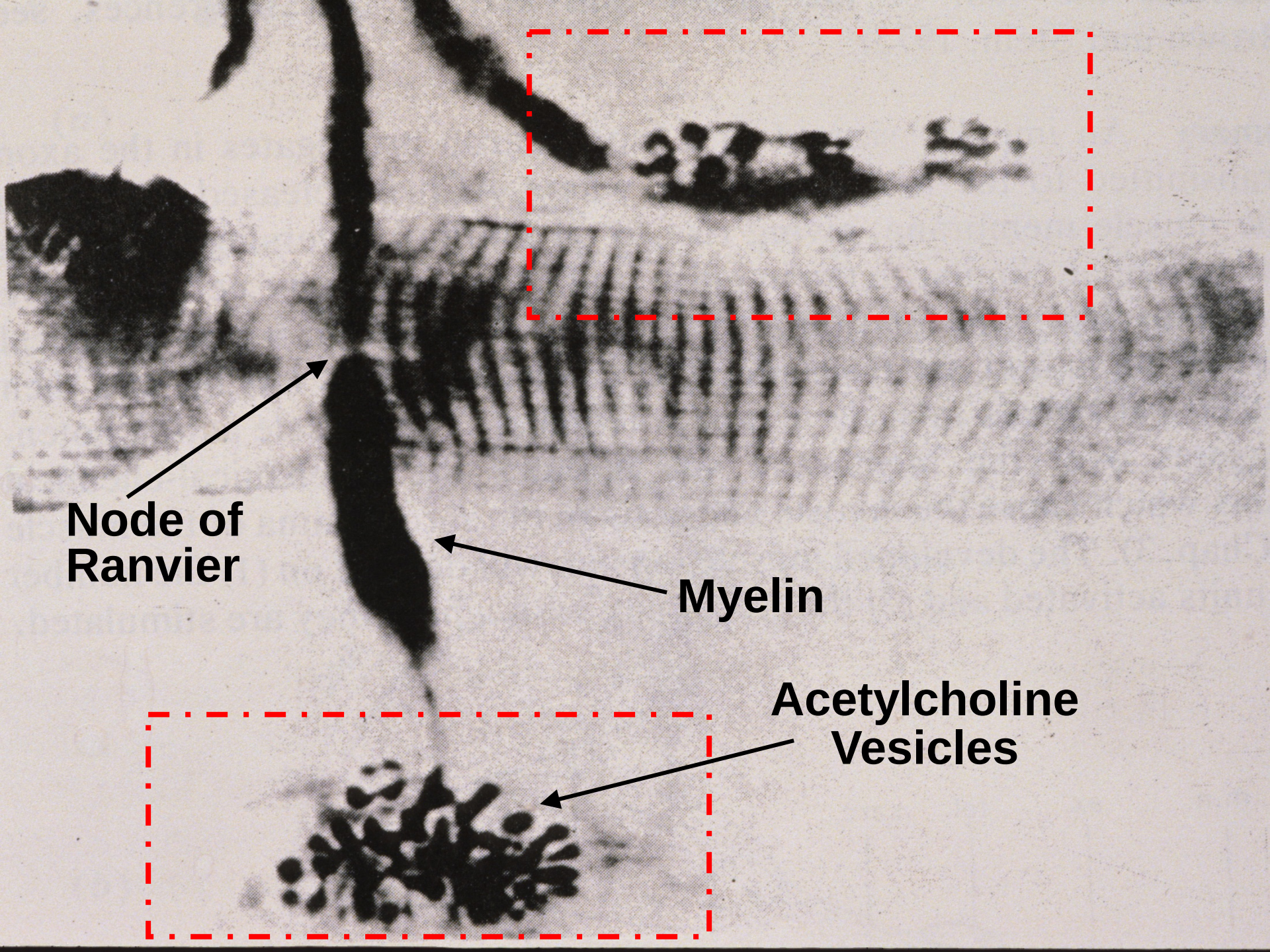
Synapse **=**
Generic term = connection between excitable cells!



DC 2003

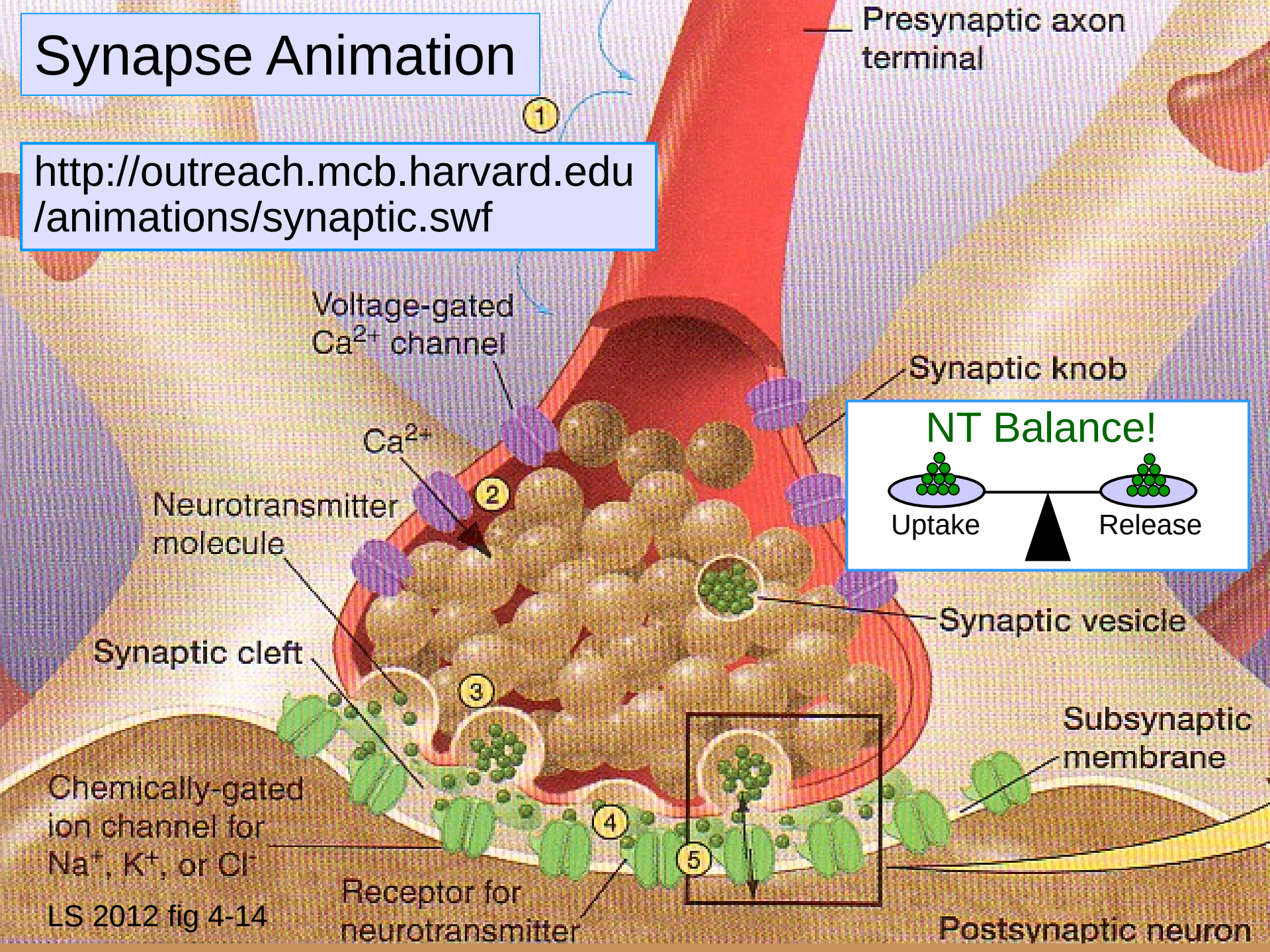


H Howard 1980


Node of
Ranvier
Myelin
Acetylcholine
Vesicles

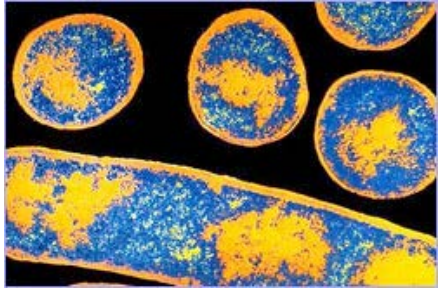
Synapse Animation

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



NT Balance!

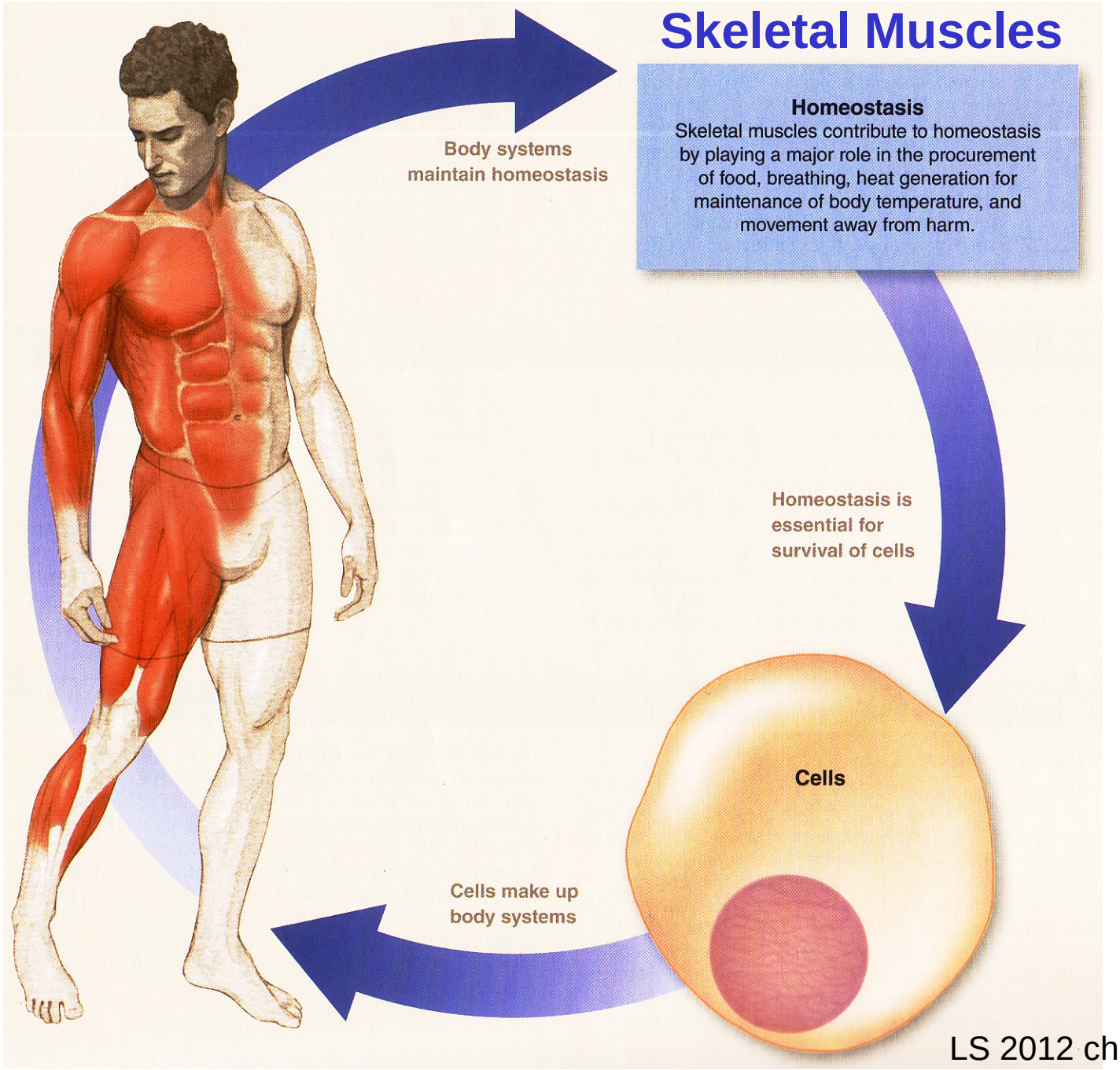
LS 2012 fig 4-14



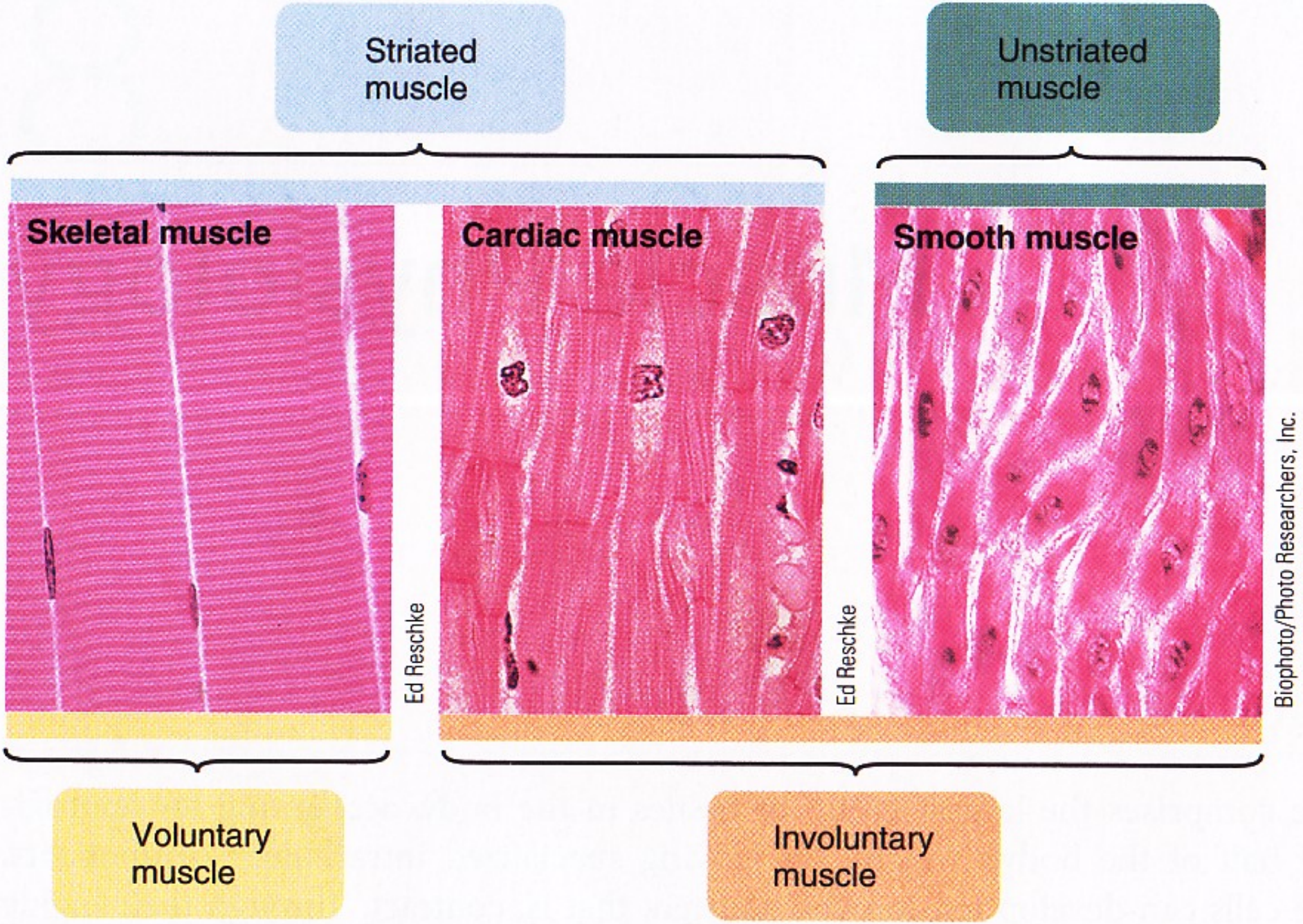

Campbell's
CLASSICS
BEAN
BACON

Axon of motor neuron
Myelin sheath
Action potential propagation in motor neuron
1
Axon terminal
Terminal button
Vesicle of acetylcholine
Ca2+
Calcium channel
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
Acetylcholinesterase
Local current flow between depolarized end plate and adjacent membrane
Motor end plate
Contractile elements within muscle fiber

Skeletal Muscles

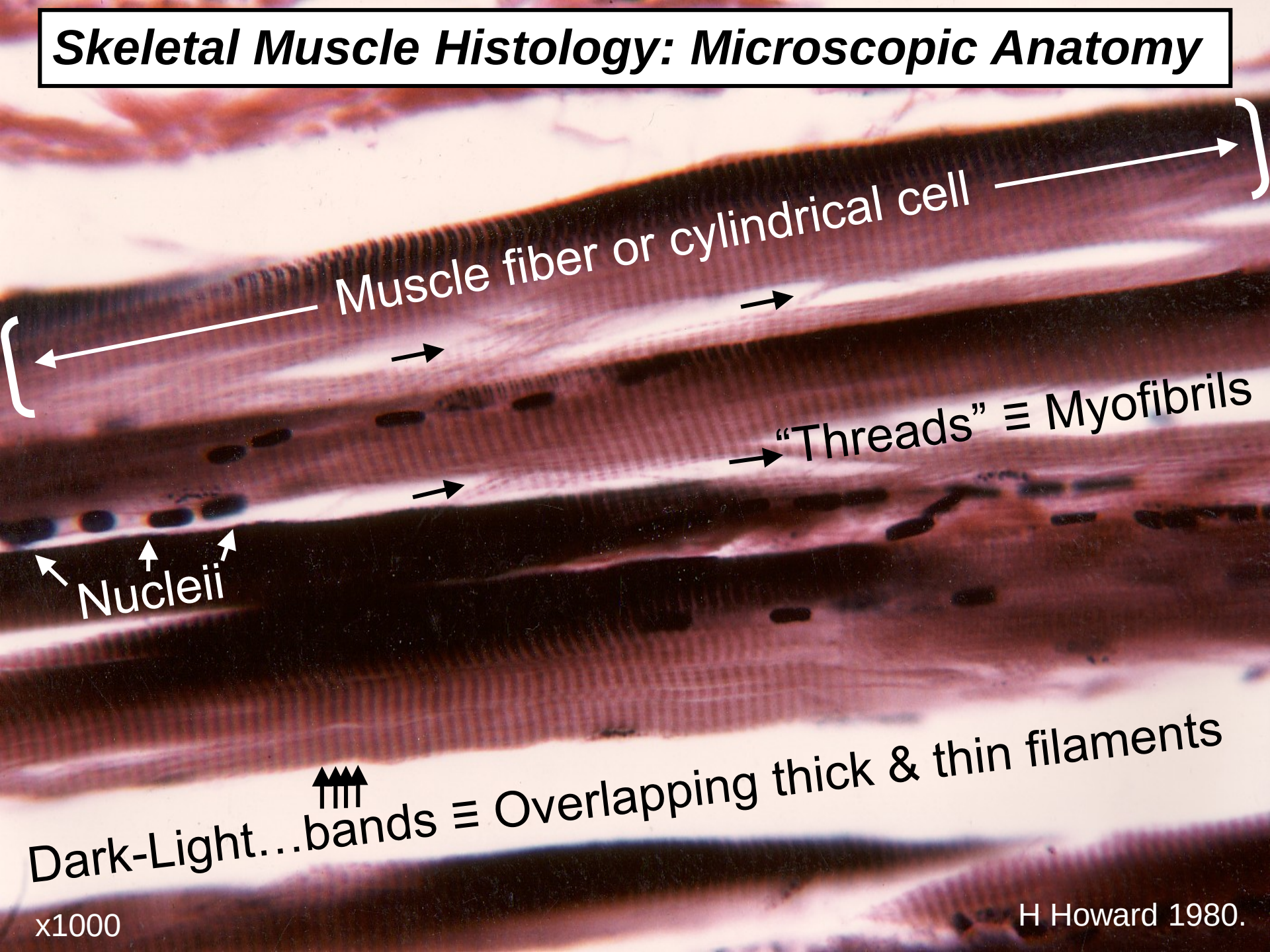


LS 2012 ch 8 vignette

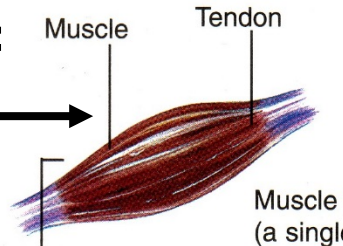


LS 2012 fig 8-1

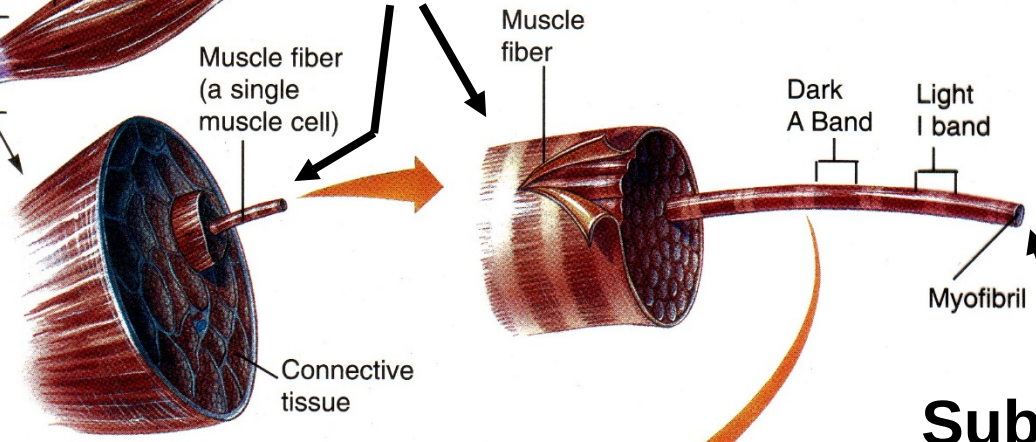
Skeletal Muscle Histology: Microscopic Anatomy



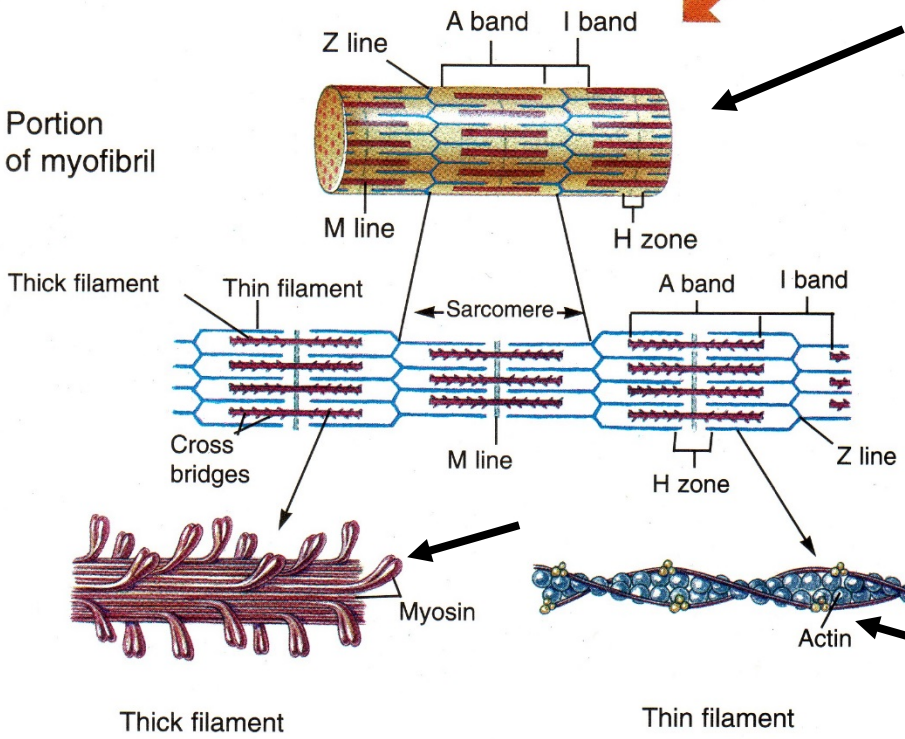
Organ = Muscle



Cell = Myocyte = Fiber



Subcellular = Cytoskeleton



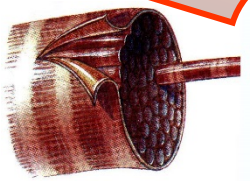
Molecules = Actin & Myosin

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

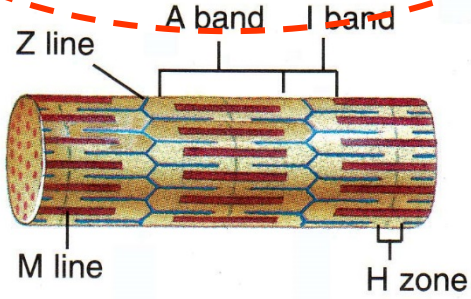
Whole Muscle

Organ

Myocyte or Muscle Fiber

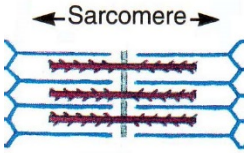


Cell

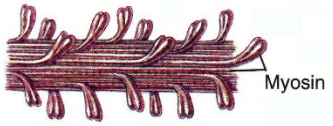


Myofibril

Cytoskeleton

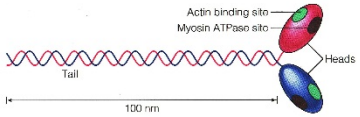


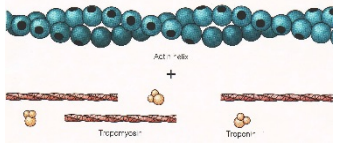
Thick & Thin Filaments

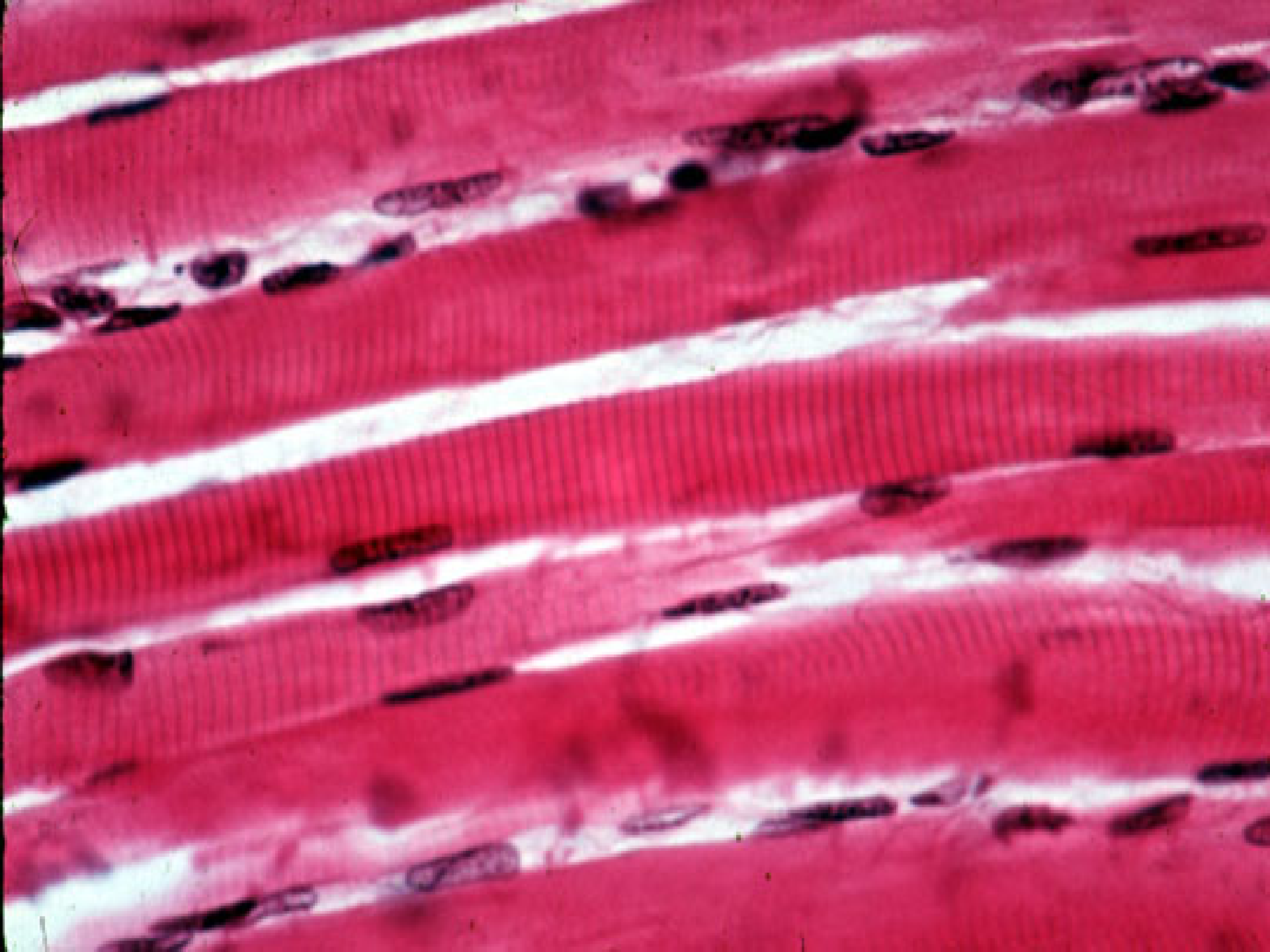


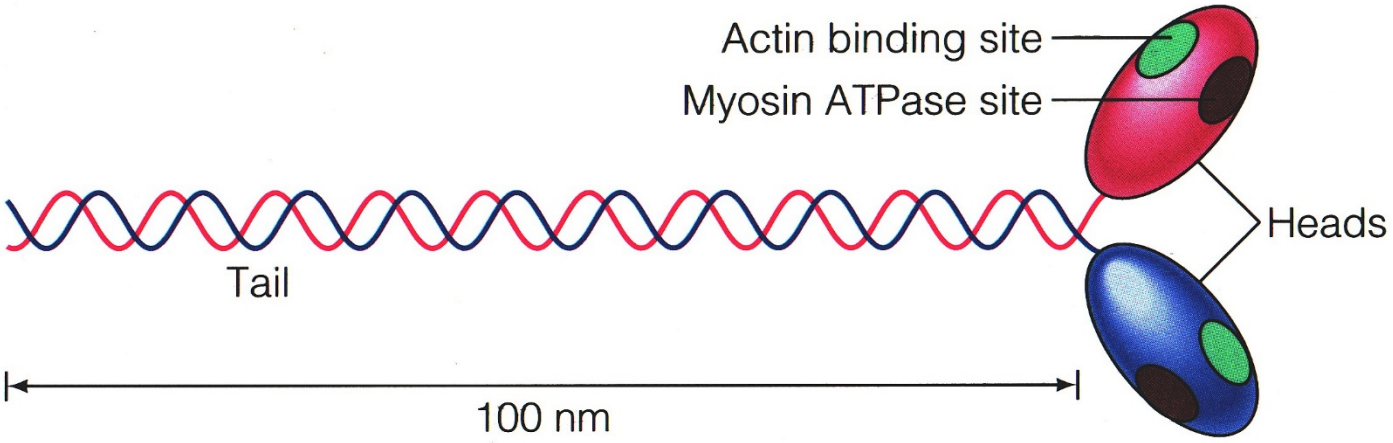
Myosin & Actin

Molecules



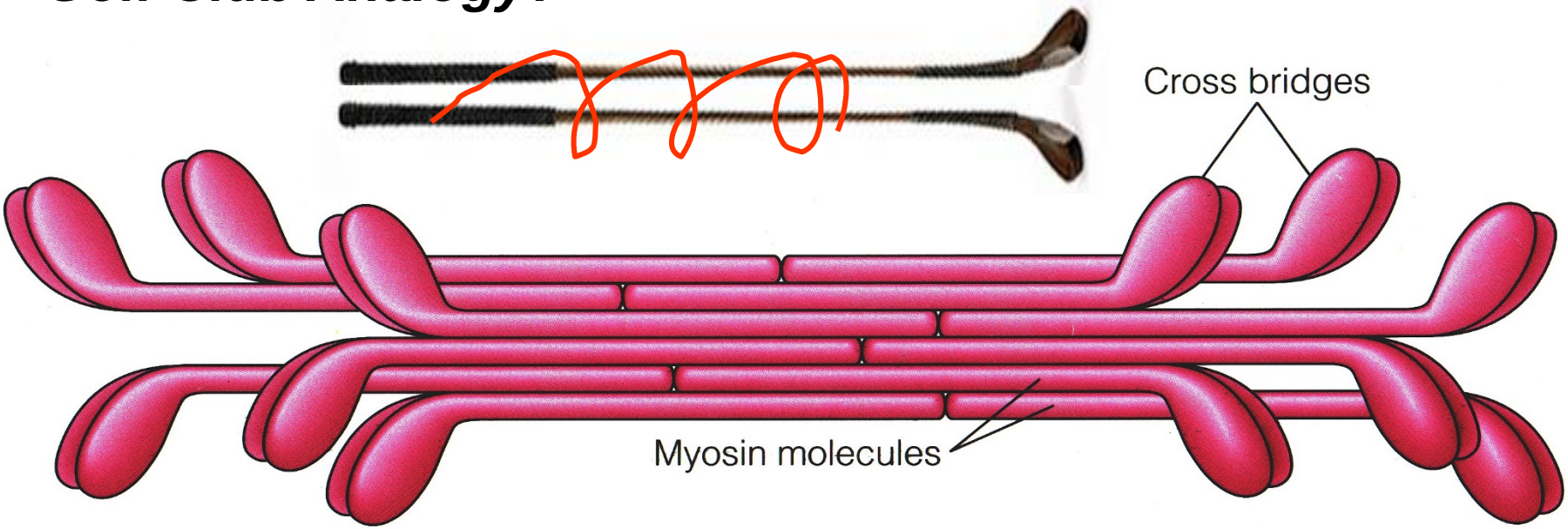






(a)

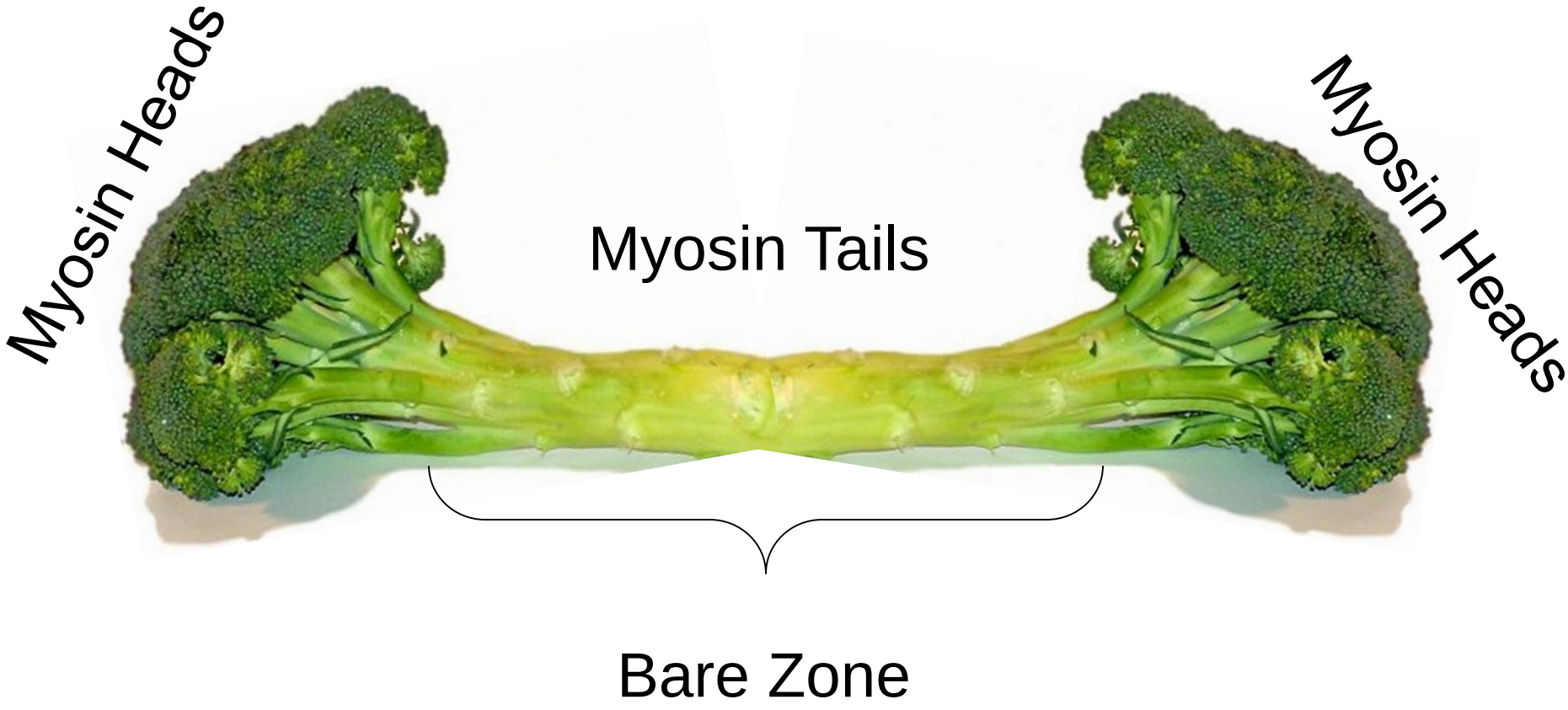
Golf Club Analogy?

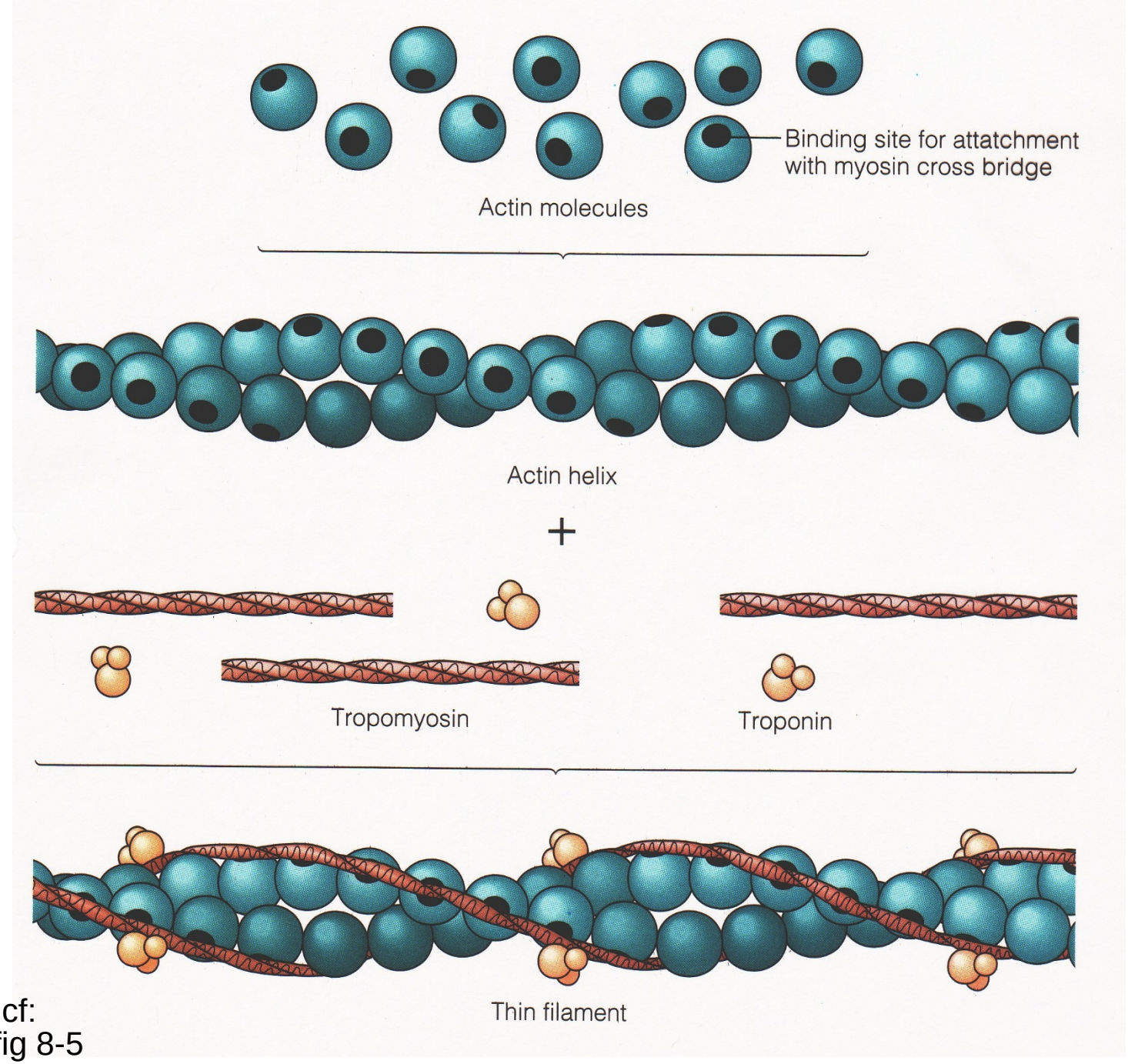


(b)

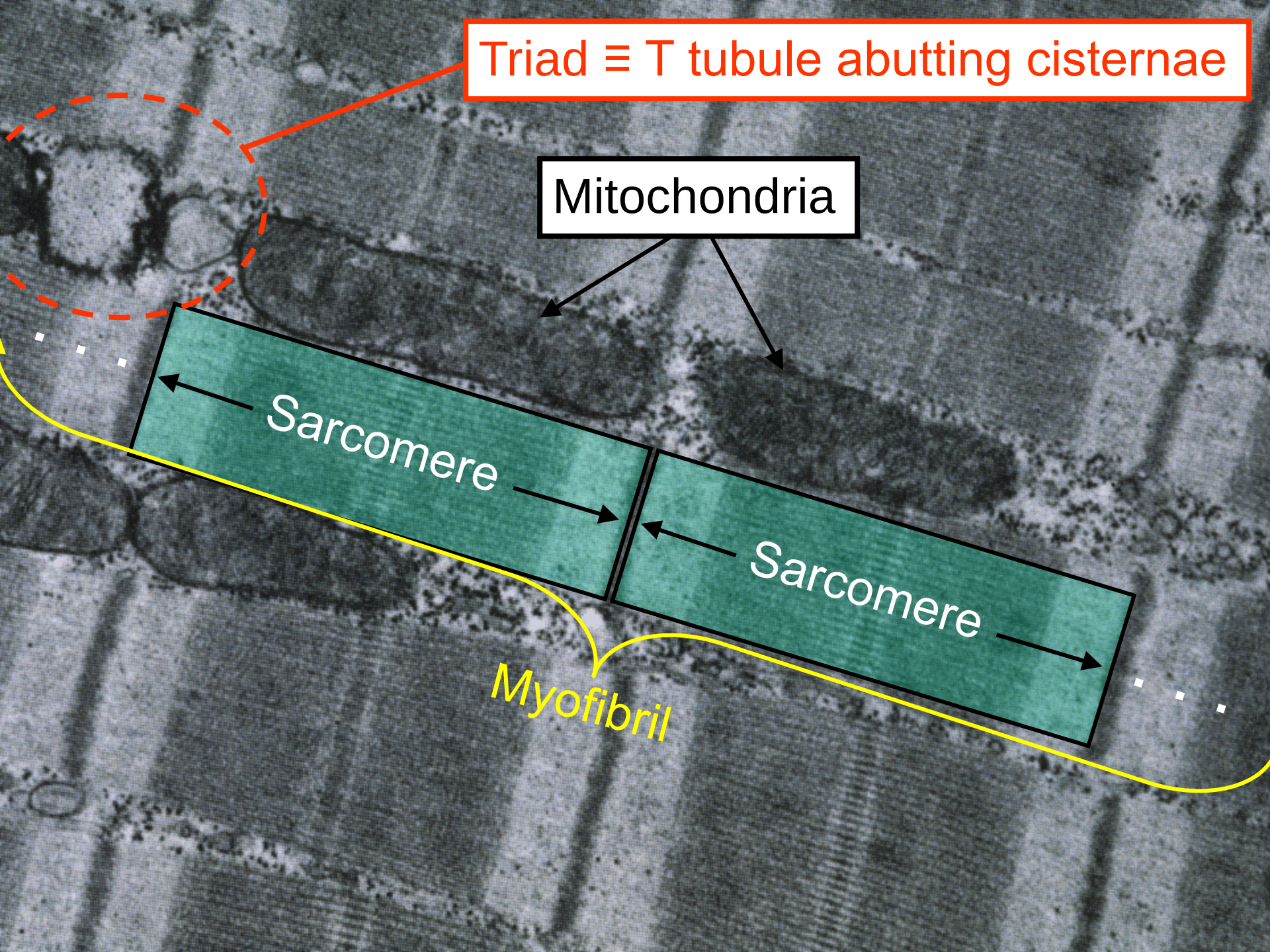
LS 2006, cf:
LS 2012 fig 8-4

Broccoli Analogy?



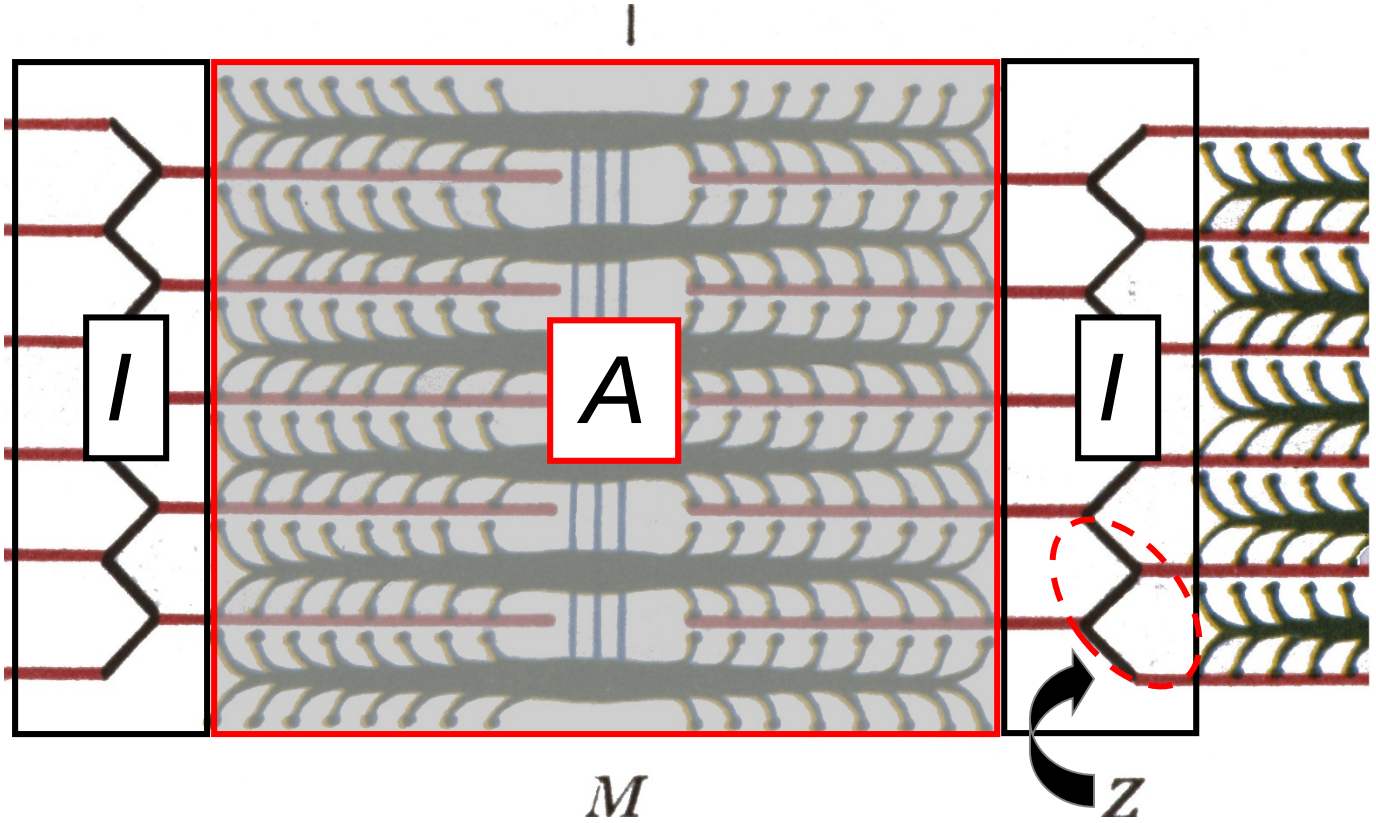


LS 2006, cf:
LS 2012 fig 8-5


Triad ≡ T tubule abutting cisternae
Mitochondria
Sarcomere
Sarcomere
Myofibril

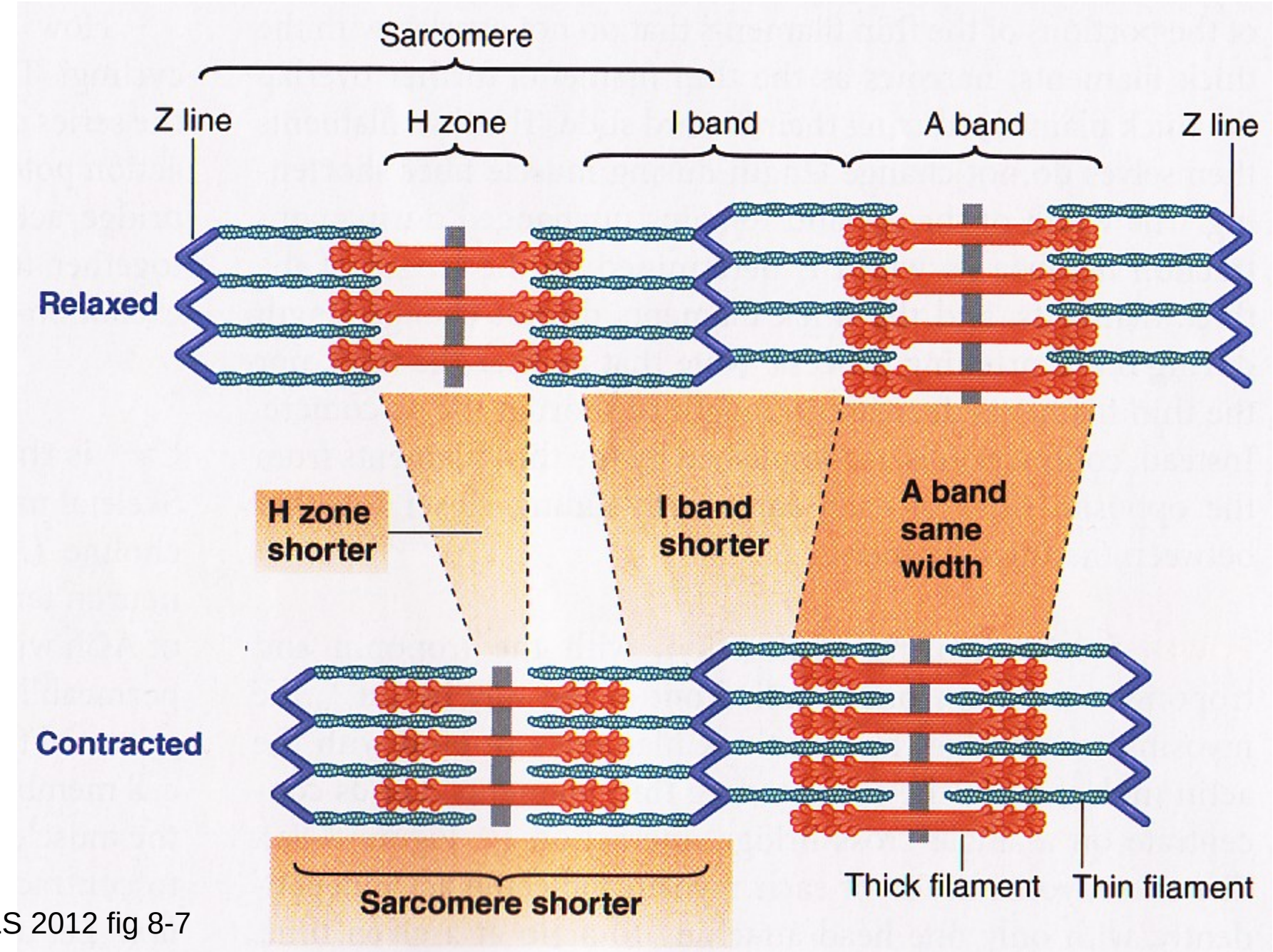
A Band = Dark Band

*A*nisotropic = Light Can't Shine Through



I Band = Light Band

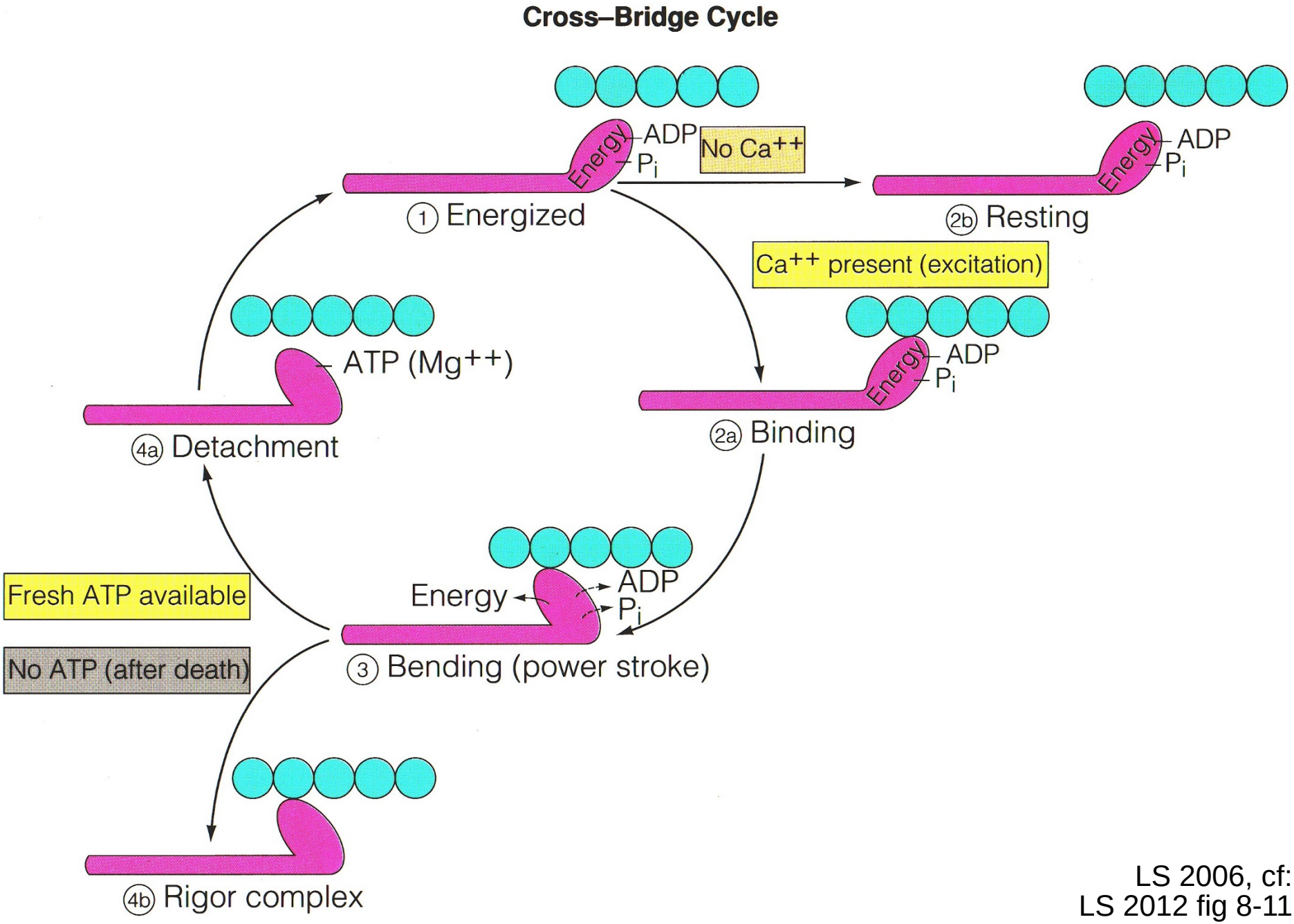
*I*sotropic = Light Can Shine Through



LS 2012 fig 8-7

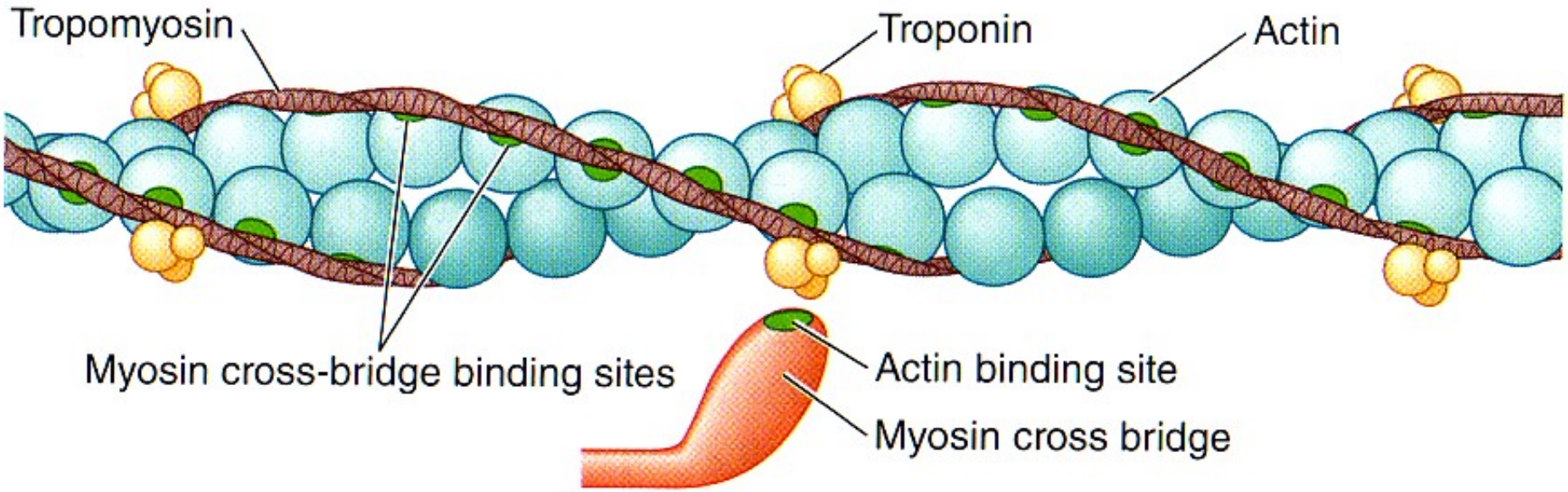
Discussion + Time for Questions!

What do we guess happens at the molecular level?



LS 2006, cf:
LS 2012 fig 8-11

Relaxed: No Cross-Bridge Binding



(a) Relaxed

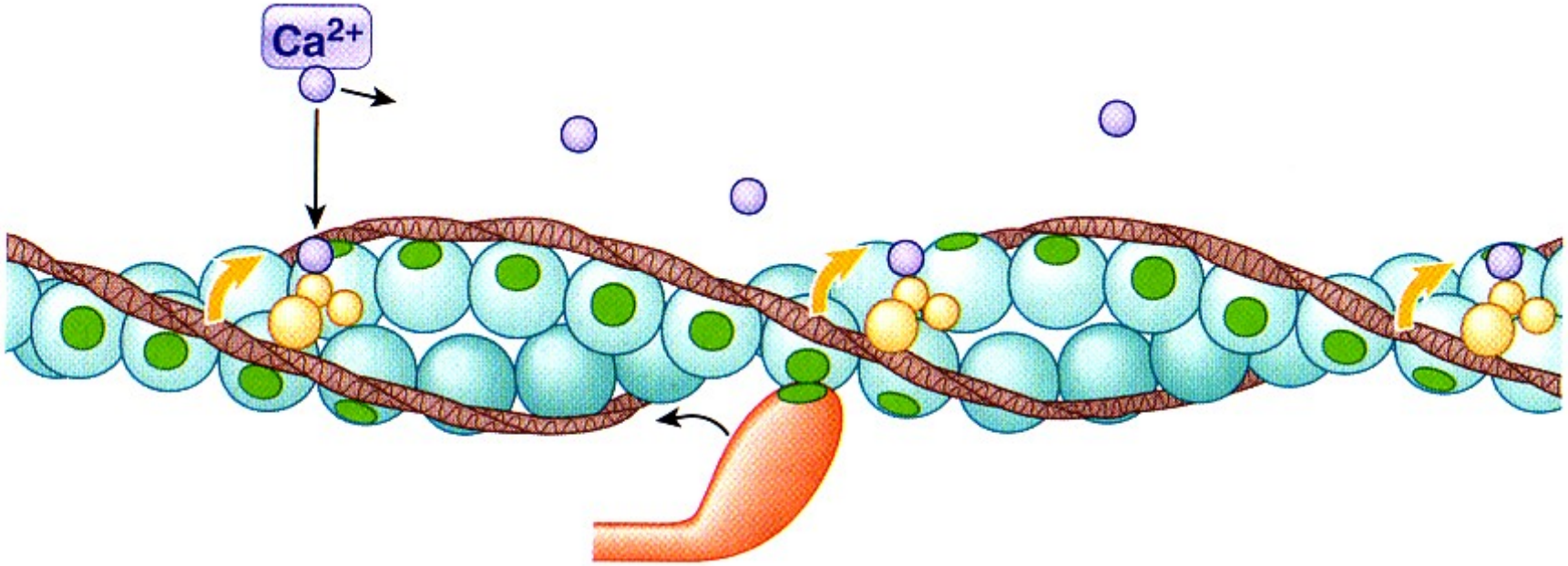
1. No excitation.

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.

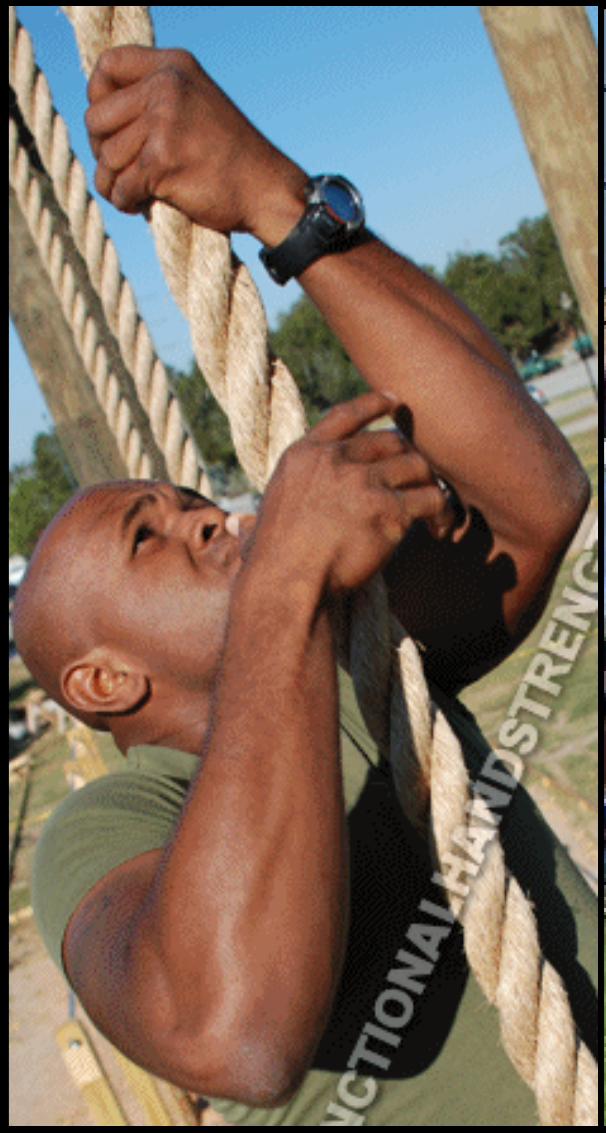
2. Released Ca^{2+} binds with troponin, pulling troponin–tropomyosin complex aside to expose cross-bridge binding site.

3. Cross-bridge binding occurs.

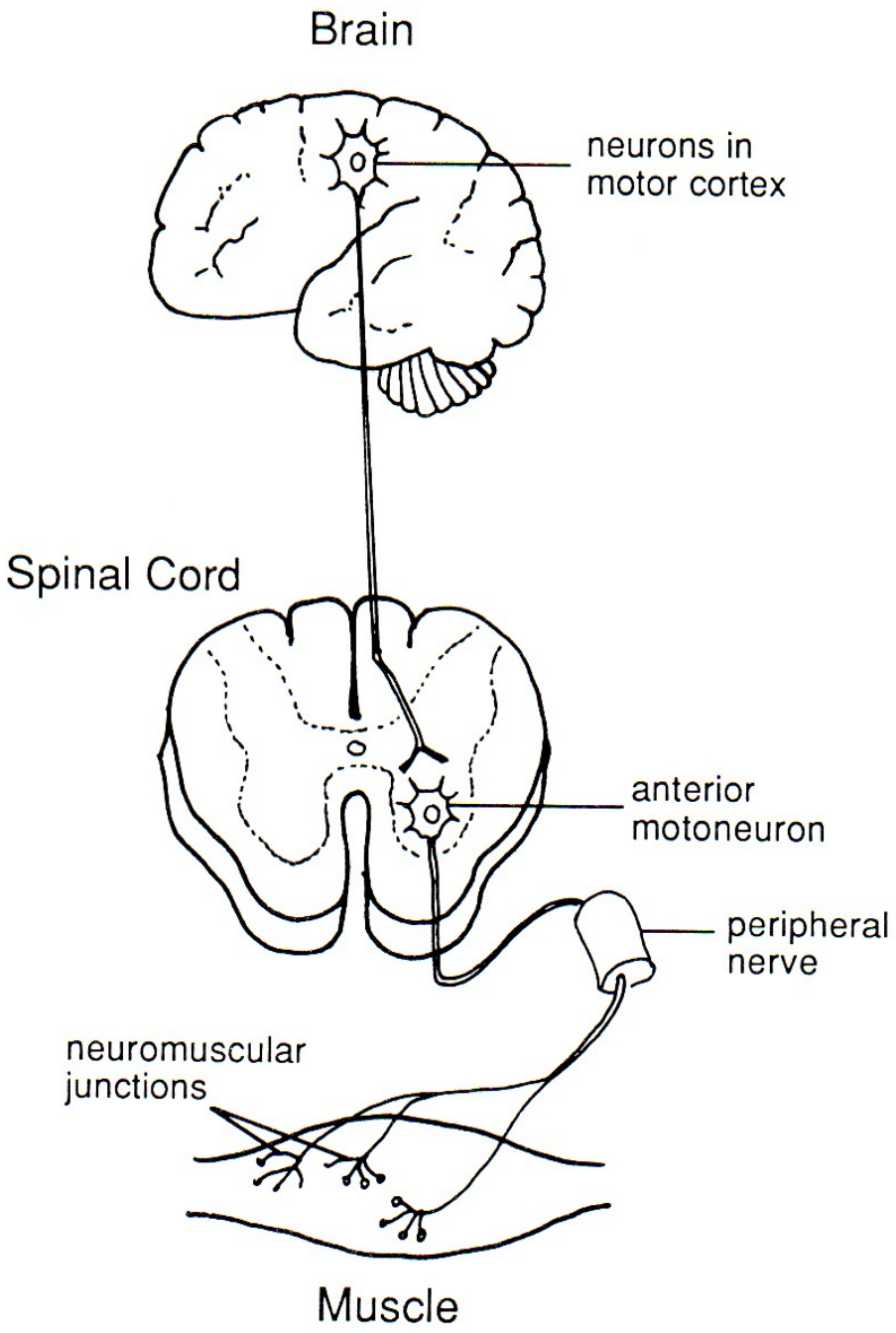
4. Binding of actin and myosin cross bridge triggers power stroke that pulls thin filament inward during contraction.

LS 2012 fig 8-6b

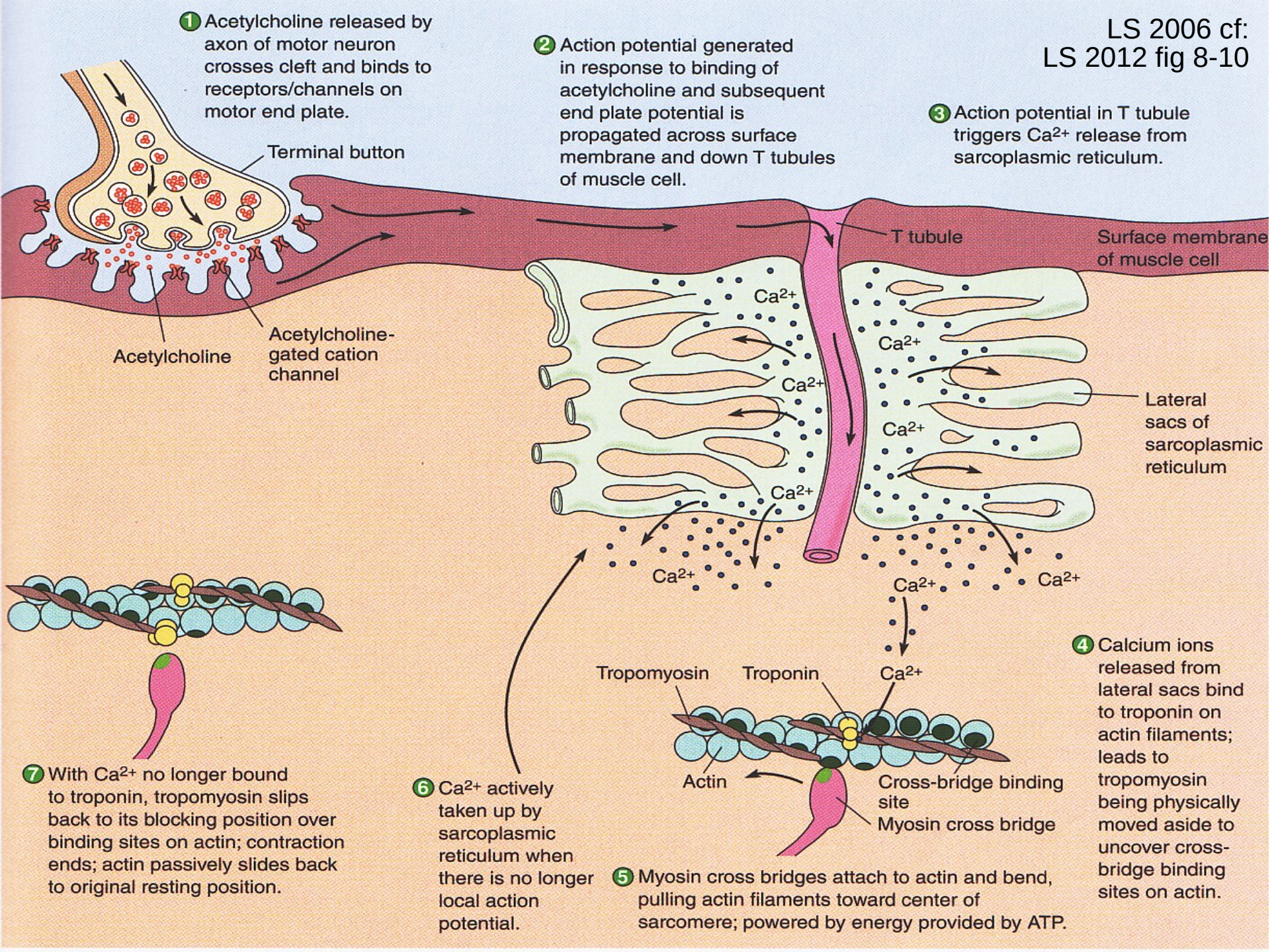
Rope Climb or Tug of War
Grasp, then Regrasp!



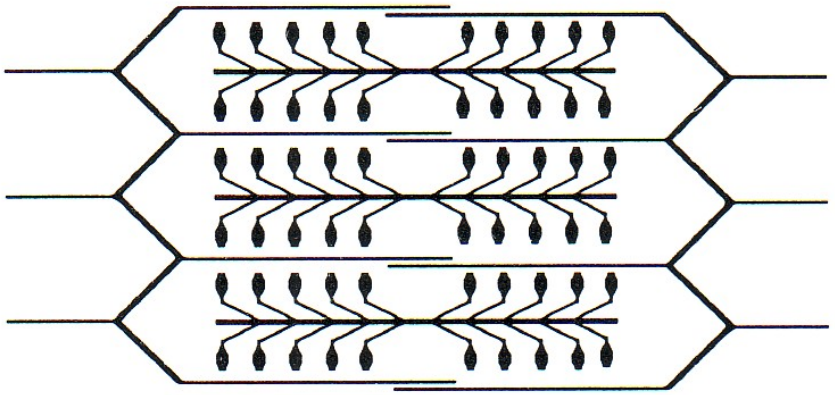

Summary
We are almost
there!


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

LS 2006 cf:
LS 2012 fig 8-10

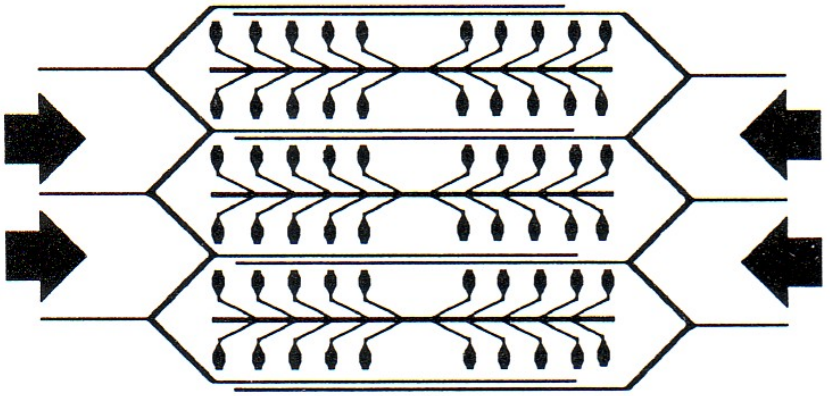


Relaxation Phase



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

Contractile Phase



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