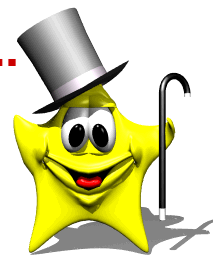


Work away! Thanks sincerely for making our poster sessions tops!...



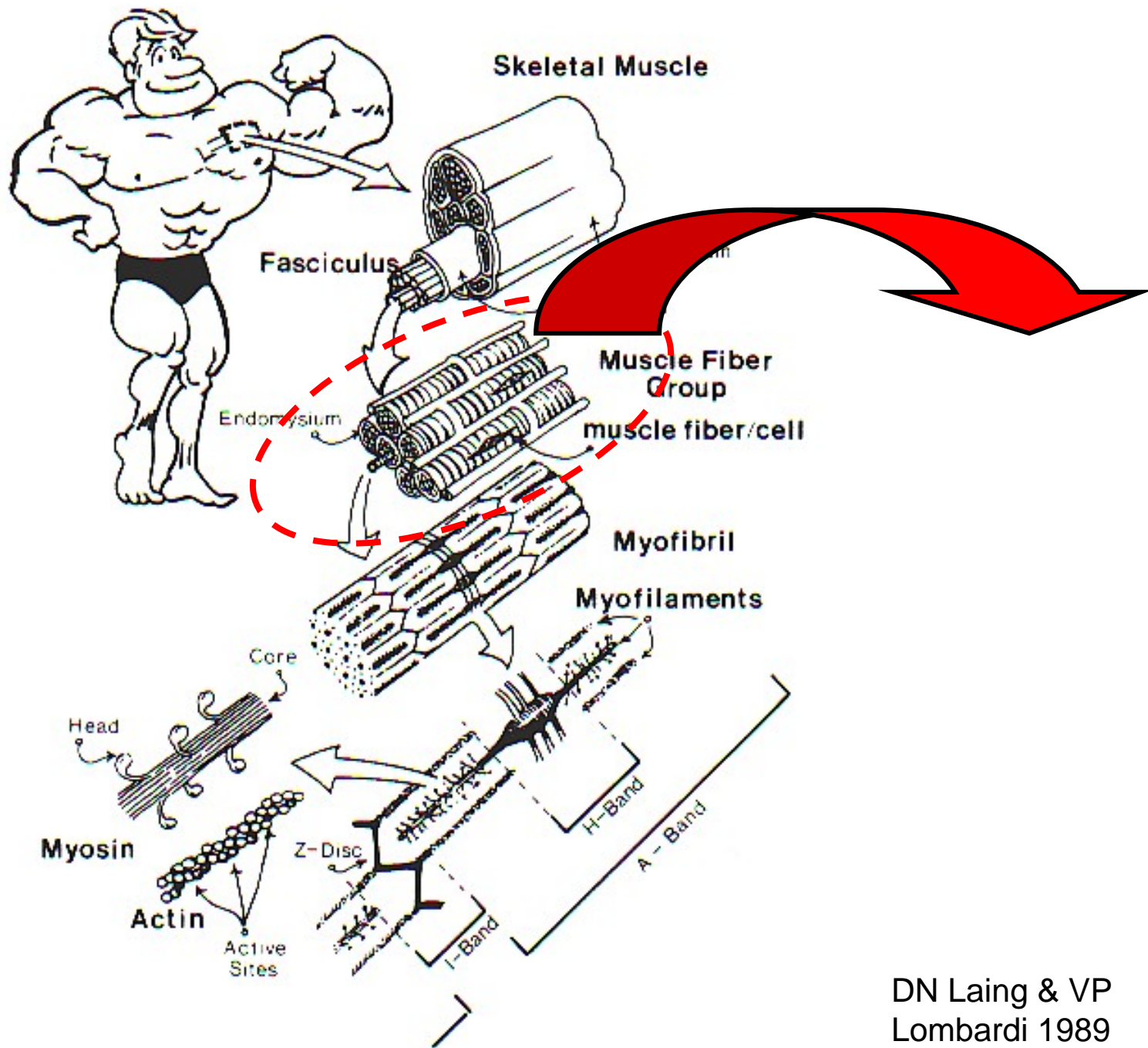
## **BI 199 APWT Discussion 14**

- I. Announcements** Poster Session Group 1 next Tuesday May 19! Q? No Discussion this Thursday designed for time to work on posters! Hooray!!
- II. Discussion** *NSCA Strength & Conditioning Journal*, Apr 2012, 34(2), 27-36.
  - A. Are deep squats a safe & viable exercise?
    - B Schoenfeld & M Williams.
    - B. Exploring the front squat. SP Bird & S Casey.
- III. How Skeletal Muscles Work & Adapt**  
Please see resources on reserve in Science Lib
  - A. What is muscle made of?
  - B. How is muscle organized?
  - C. What do thick filaments look like?
  - D. What do thin filaments look like?
  - E. How do muscles contract?
  - F. How do muscles adapt?  
Hypertrophy, atrophy, fiber types
- III. Questions/Discussion?**

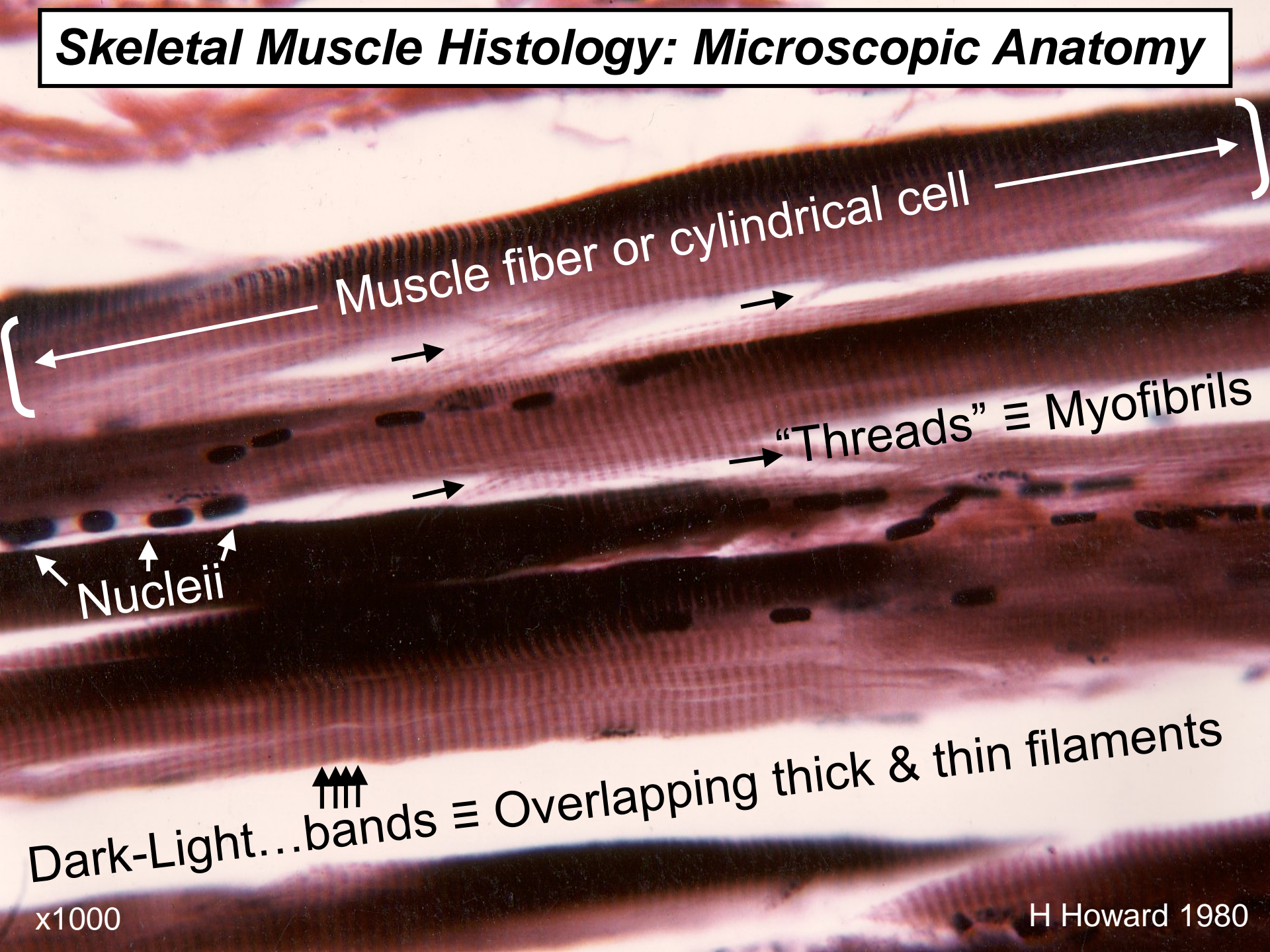
***Comments***

***Questions?***

***NSCA Articles***  
***Discussion***



# Skeletal Muscle Histology: Microscopic Anatomy



Muscle fiber or cylindrical cell

Nucleii

"Threads"  $\equiv$  Myofibrils

Dark-Light...bands  $\equiv$  Overlapping thick & thin filaments

x1000

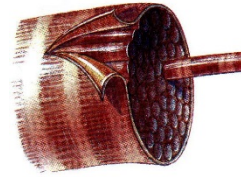
H Howard 1980

**Whole  
Muscle**



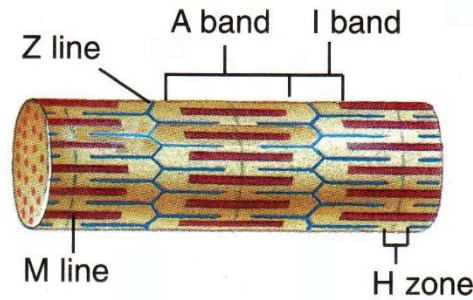
**Organ**

**Myocyte or  
Muscle Fiber**



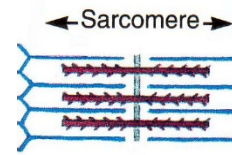
**Cell**

**Myofibril**

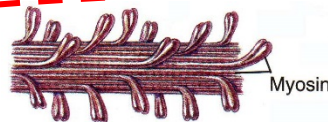


**Cytoskeleton**

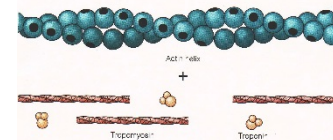
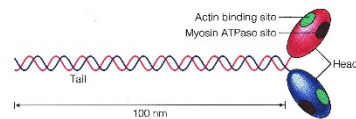
**Thick & Thin Filaments**

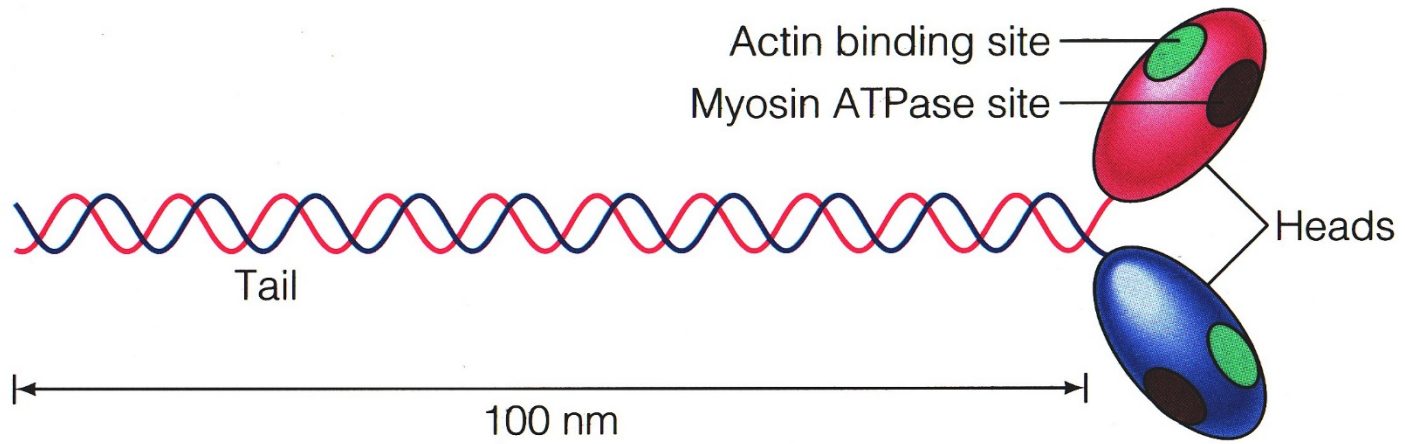


**Myosin & Actin**



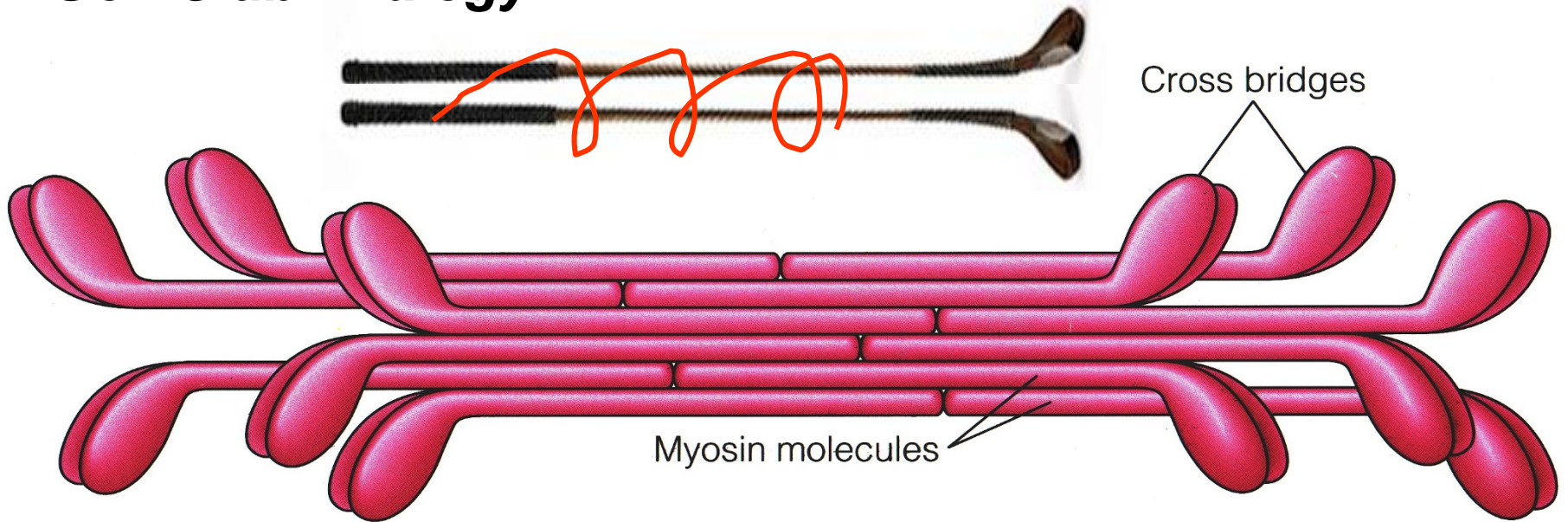
**Molecules**





(a)

## ***Golf Club Analogy?***



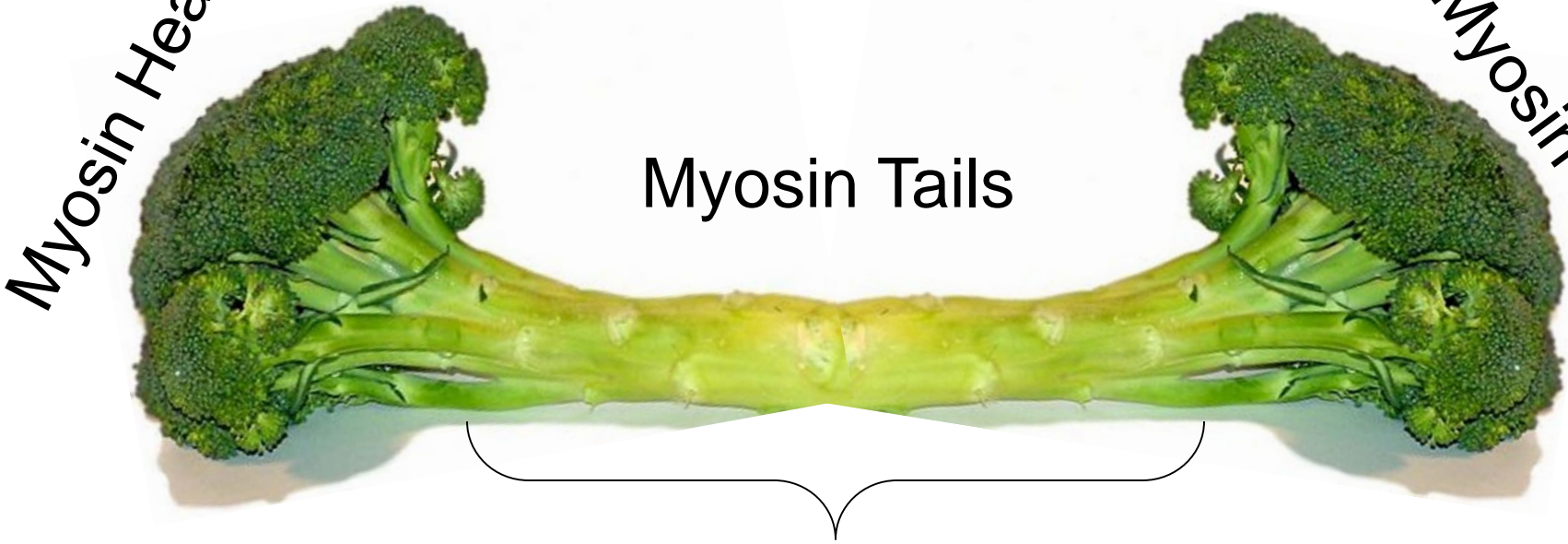
(b)

# ***Broccoli Analogy?***

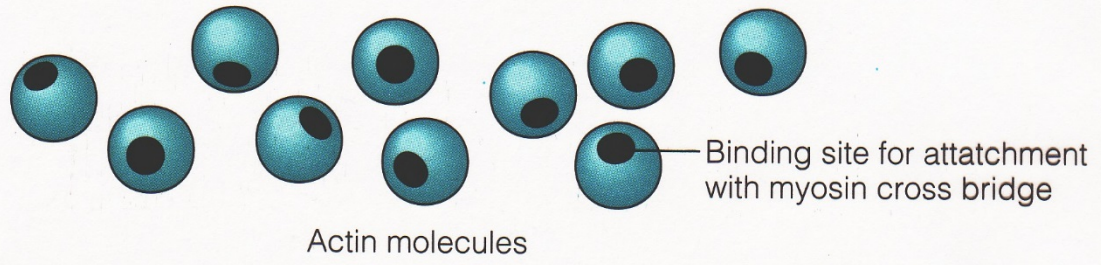
*Myosin Heads*

*Myosin Heads*

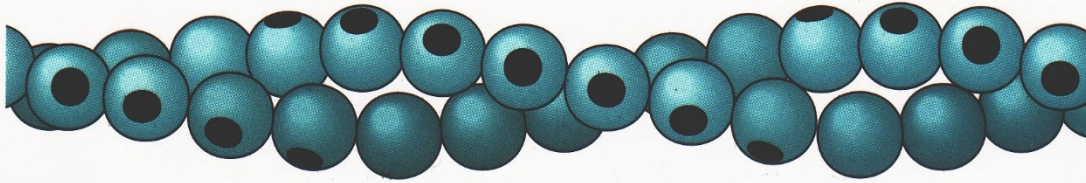
Myosin Tails



Bare Zone



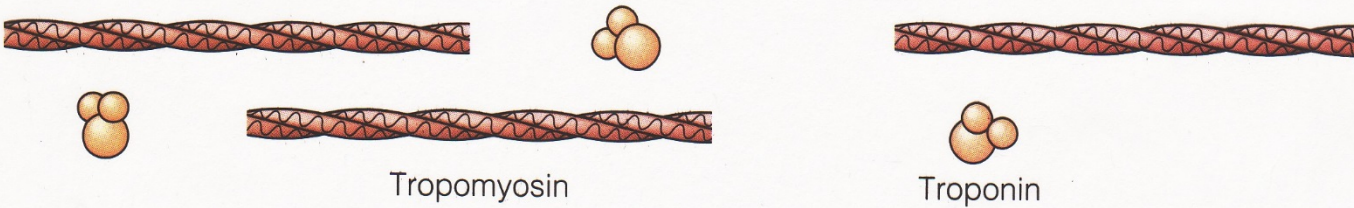
Actin molecules



Actin helix

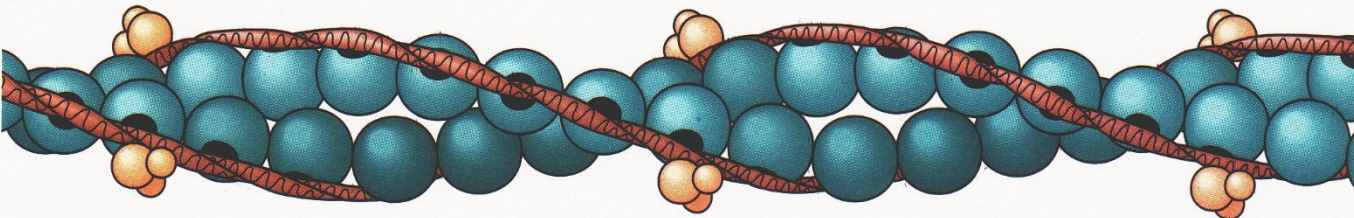


+



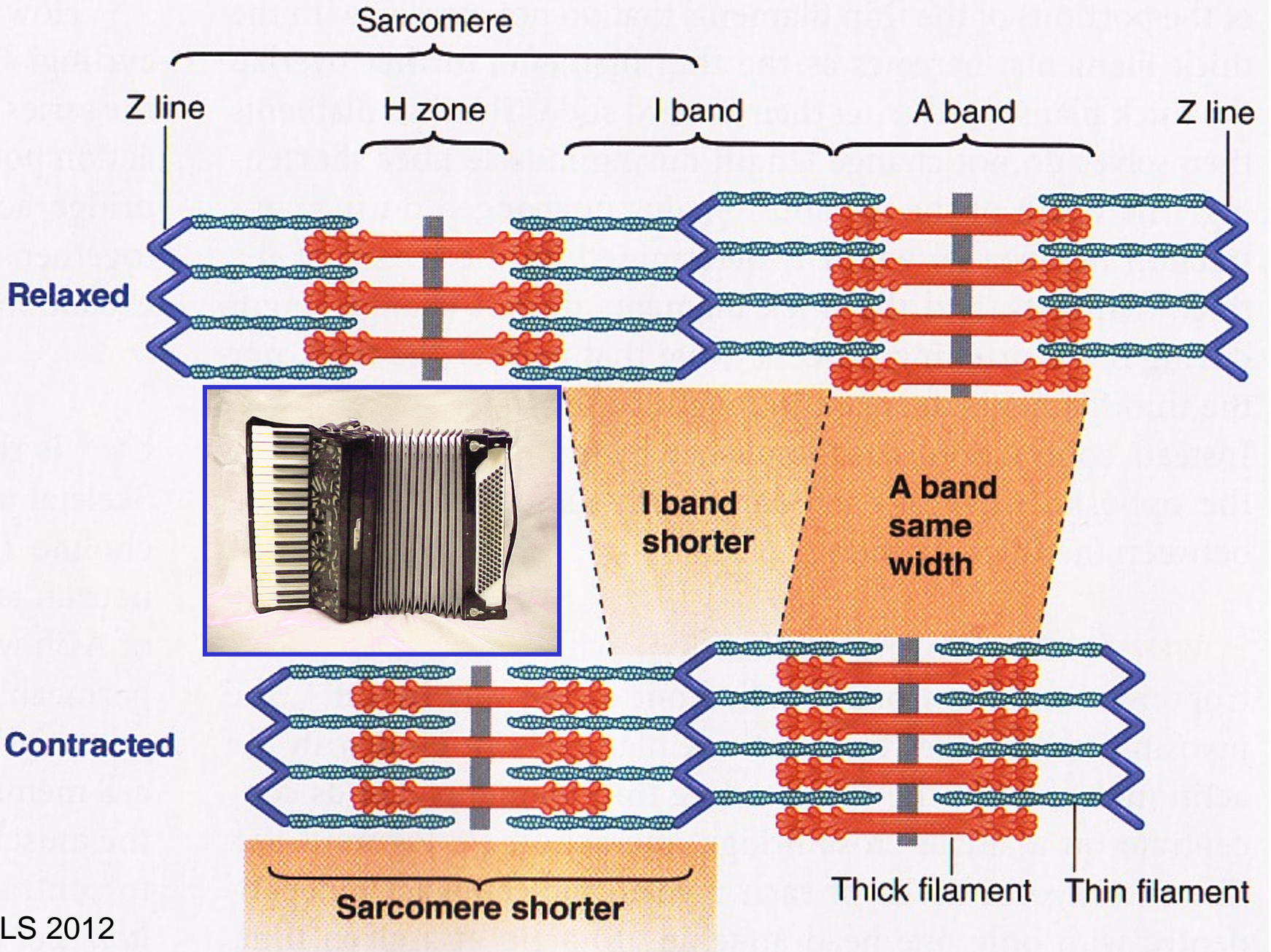
Tropomyosin

Troponin

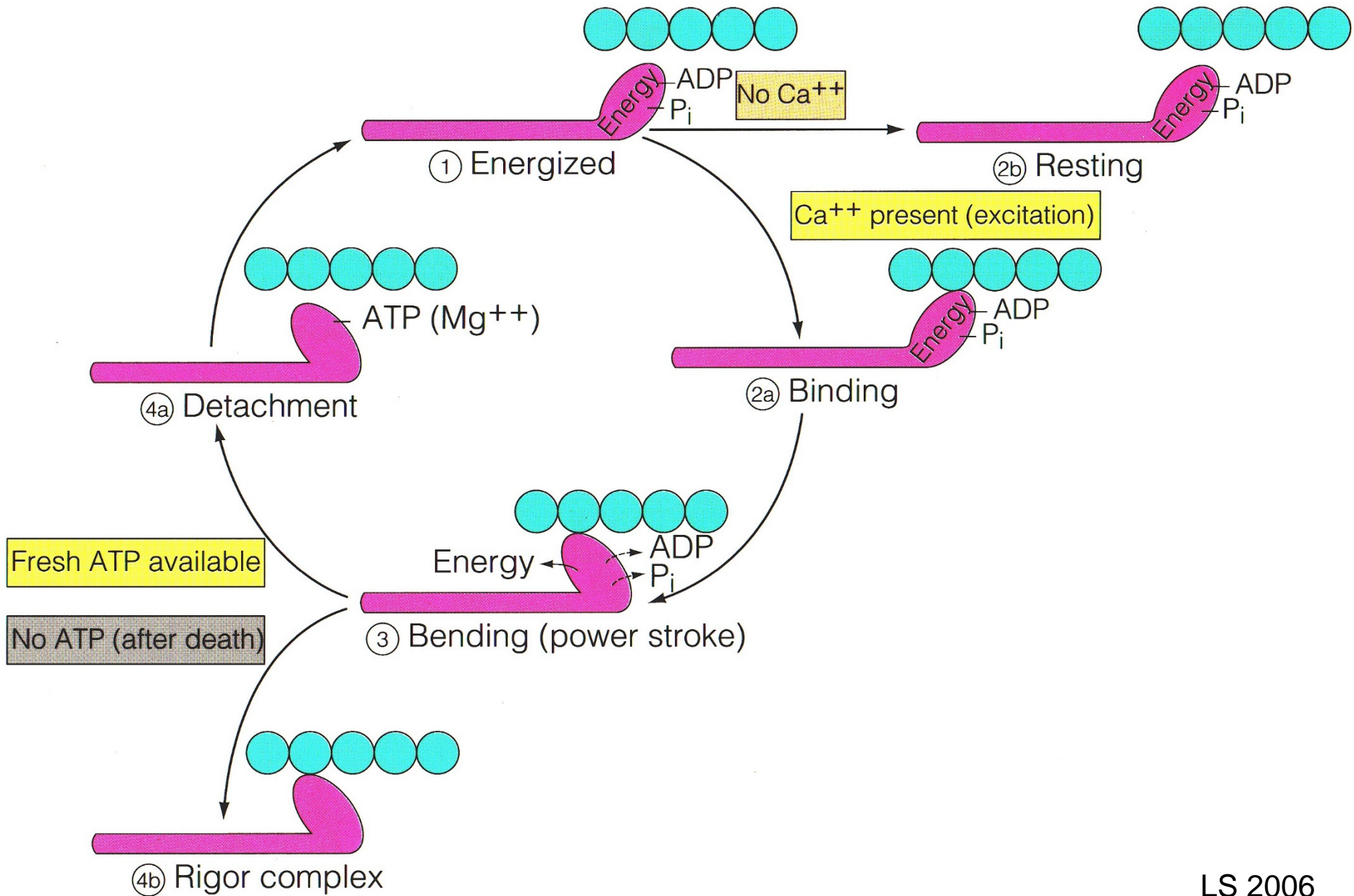


Thin filament





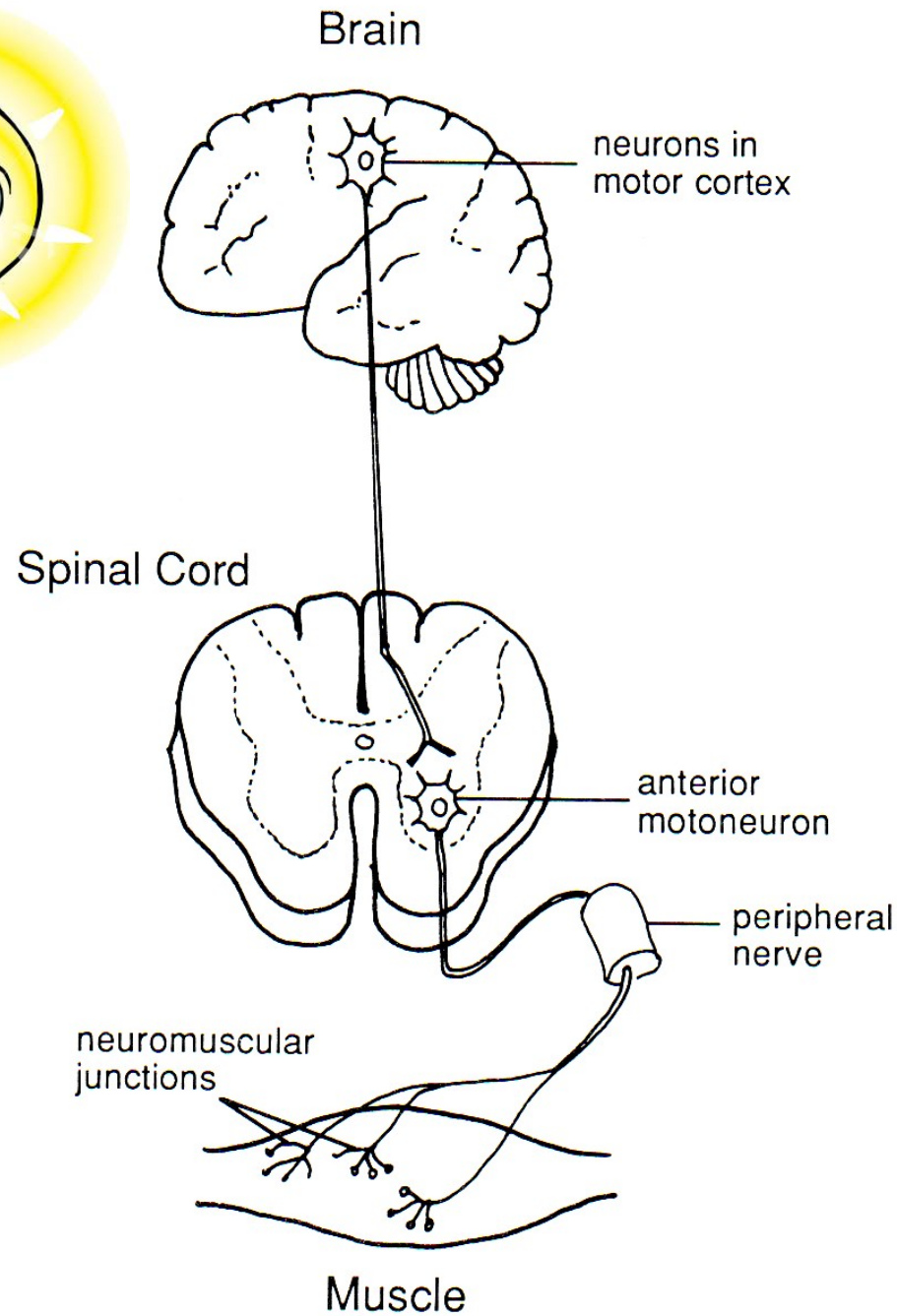
# Cross-Bridge Cycle



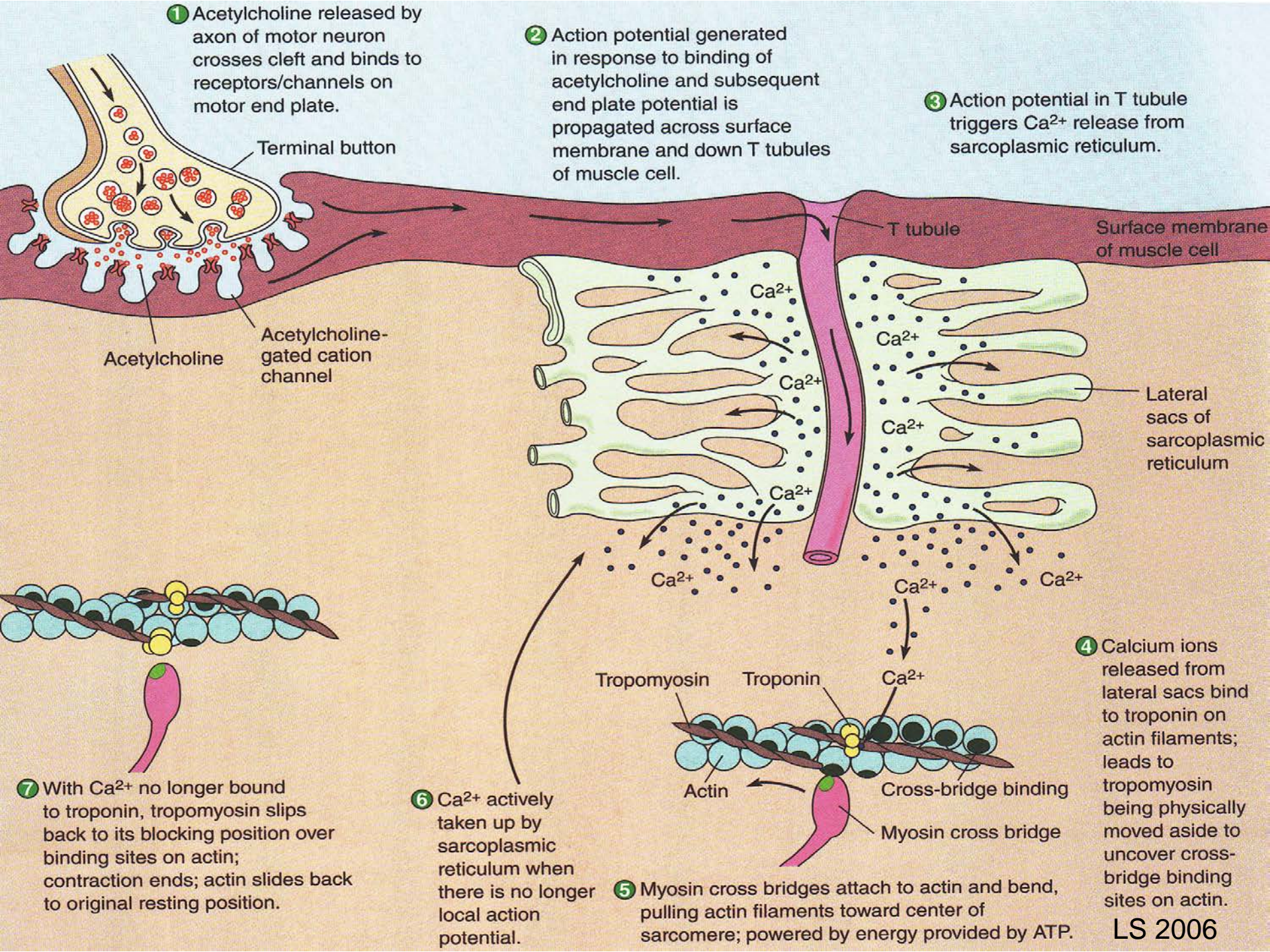
# *Rope Climb or Tug of War Grasp, then Regrasp!*



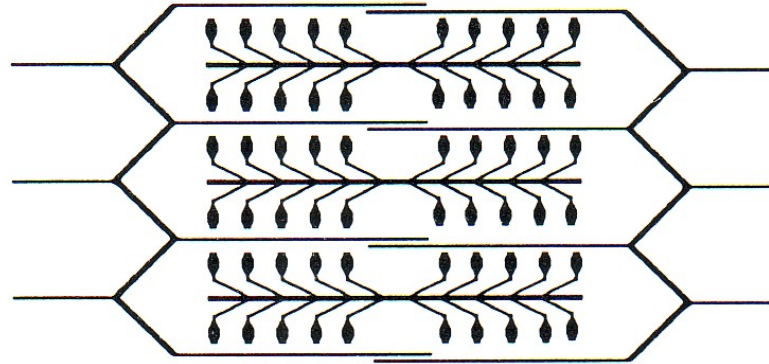
# *Summary*



DN Laing & VP Lombardi 1989

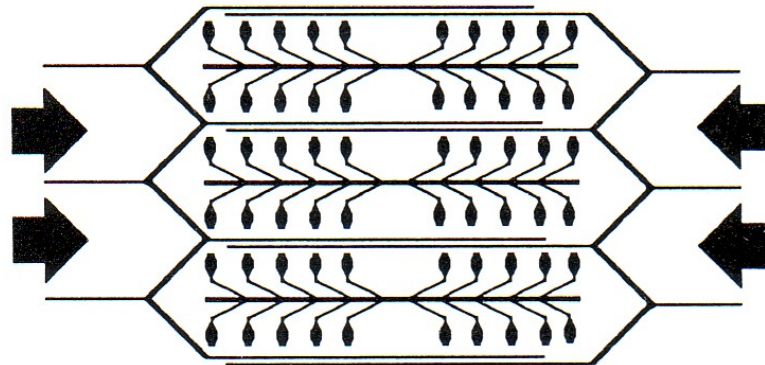


## Relaxation Phase



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

## Contractile Phase



***A. Malcolm Campbell***  
***Davidson College, Davidson, NC***

**<http://www.bio.davidson.edu/courses/movies.html>**



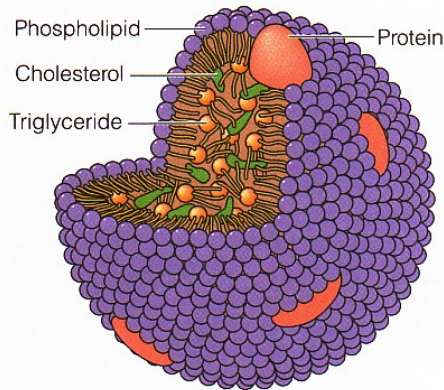
**Musclcp.mov**



# Adaptations to Exercise?

Body Levels of Organization?

Which Body System?

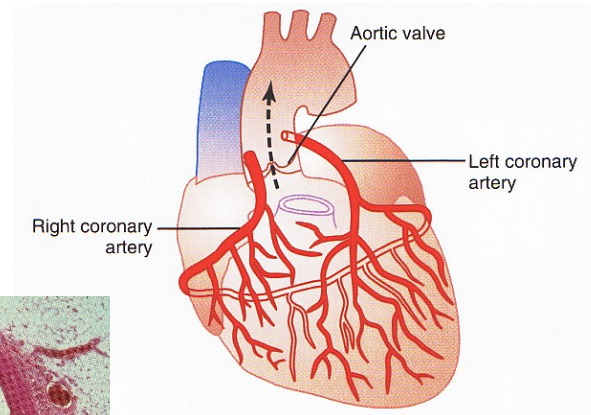


A typical lipoprotein

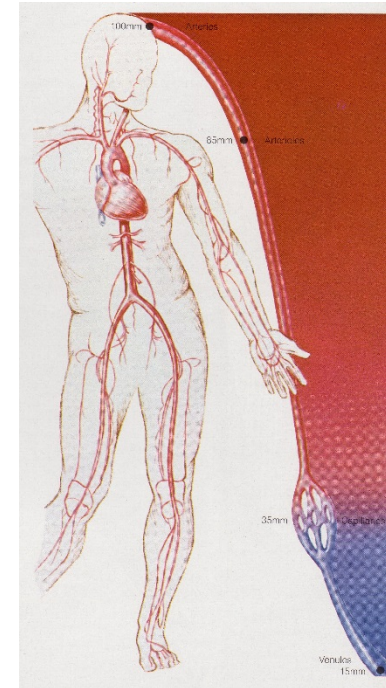
**Molecular**



**Cell/Tissue**



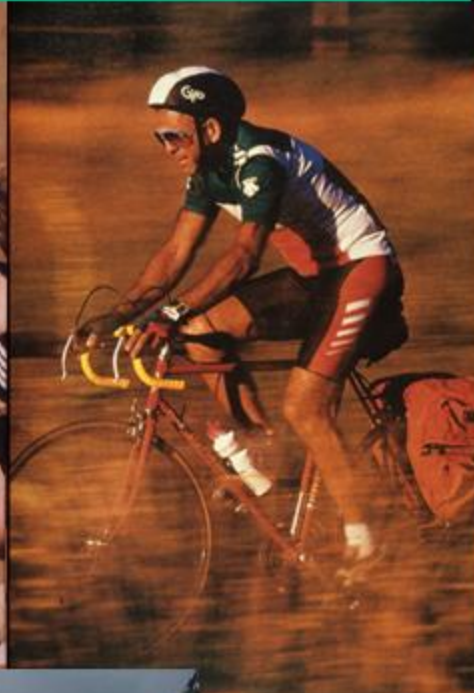
**Organ**



**Body System**

# Adaptations to Exercise?

Mode, Intensity, Duration, Frequency,  
Distribution of Training Sessions?  
Conditions of Environment? Individual?





**AEROBIC**

w/O<sub>2</sub>

PRIMARY FUEL

FAT,  
CARBOHYDRATE  
& PROTEIN  
(Small Amounts)

CARBOHYDRATE  
(Glucose & Glycogen)

ATP, ADP &  
Creatine  
Phosphate (CP)

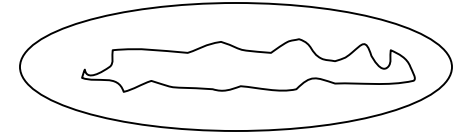
% AEROBIC  
(Oxidative  
Energy System)

% ANAEROBIC  
(Immediate & Non-Oxidative  
Energy Systems)

ACTIVITY

TIME (Min:Sec)

ACTIVITY	% AEROBIC (Oxidative Energy System)	% ANAEROBIC (Immediate & Non-Oxidative Energy Systems)	TIME (Min:Sec)
Marathon	100	0	135:00
Cross-Country Skiing	90	10	29:00
10-K Run	80	20	14:00
3-Mile Run	70	30	9:00
2-Mile Run	60	40	3:45
800-Meter Swim	50	50	3:45
1-Mile Run	40	60	3:45
Boxing	30	70	1:30
200-Meter Swim	20	80	0:50
Circuit Weight Training	10	90	0:20
Soccer	0	100	0:10
Lacrosse			
Tennis			
Basketball			
Volleyball			
200-Meter Dash			
Football			
Conventional Weight Training			

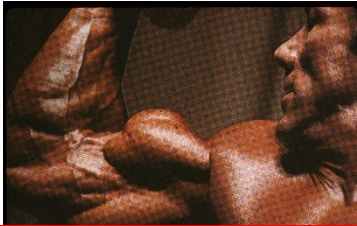


**MITOCHONDRIA**

**CYTOSOL**

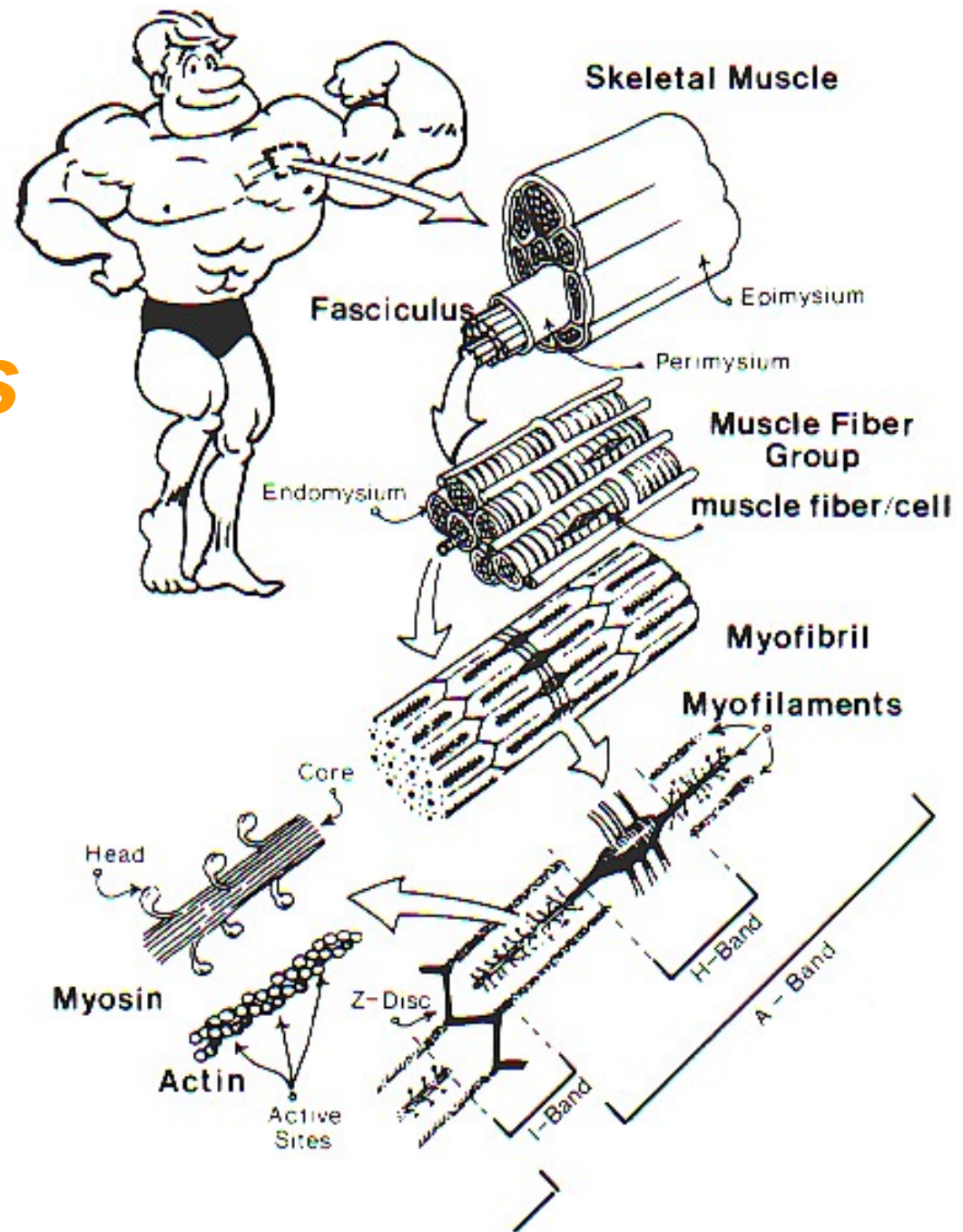
Glycolysis

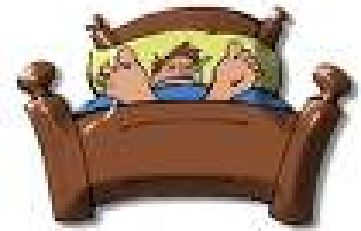
Immediate/ATP-PC



**ANAEROBIC**

# Adaptations to Skeletal Voluntary Muscle





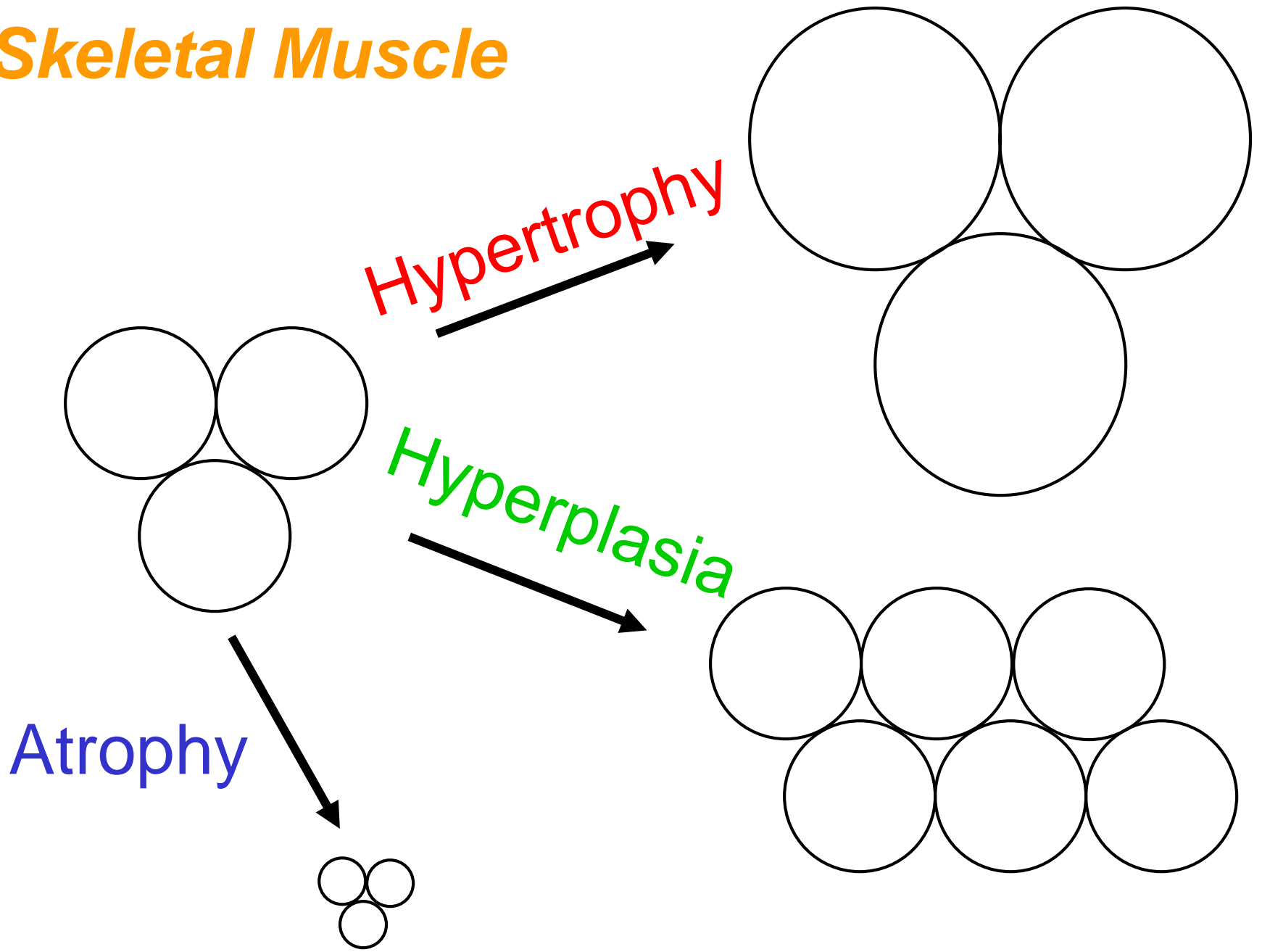
## Atrophy

*decrease in size  
& strength*

## Hypertrophy

*increase in size  
& strength*

# *Skeletal Muscle*



# *Women & Hypertrophy?*



***What happens in muscles at cellular & subcellular levels?***







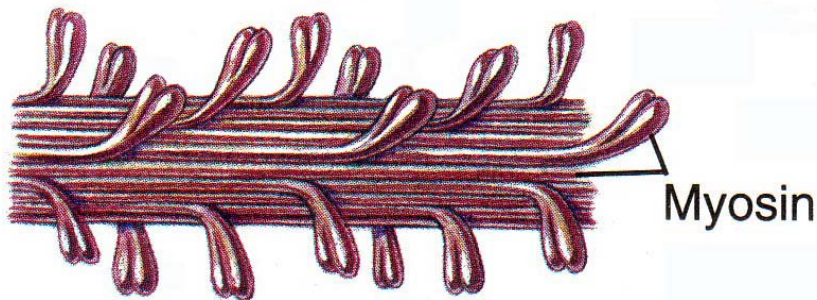
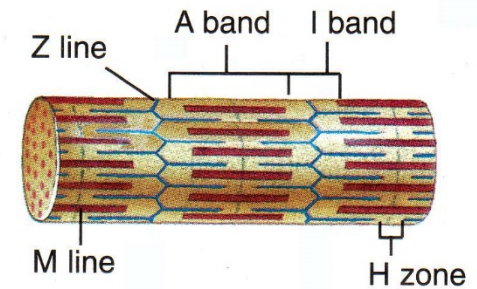
Myofibril

***Hypertrophy: Increased***

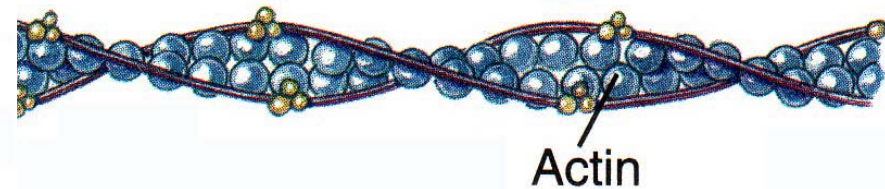
***Number of Myofibrils***

***Thick & Thin Filaments***

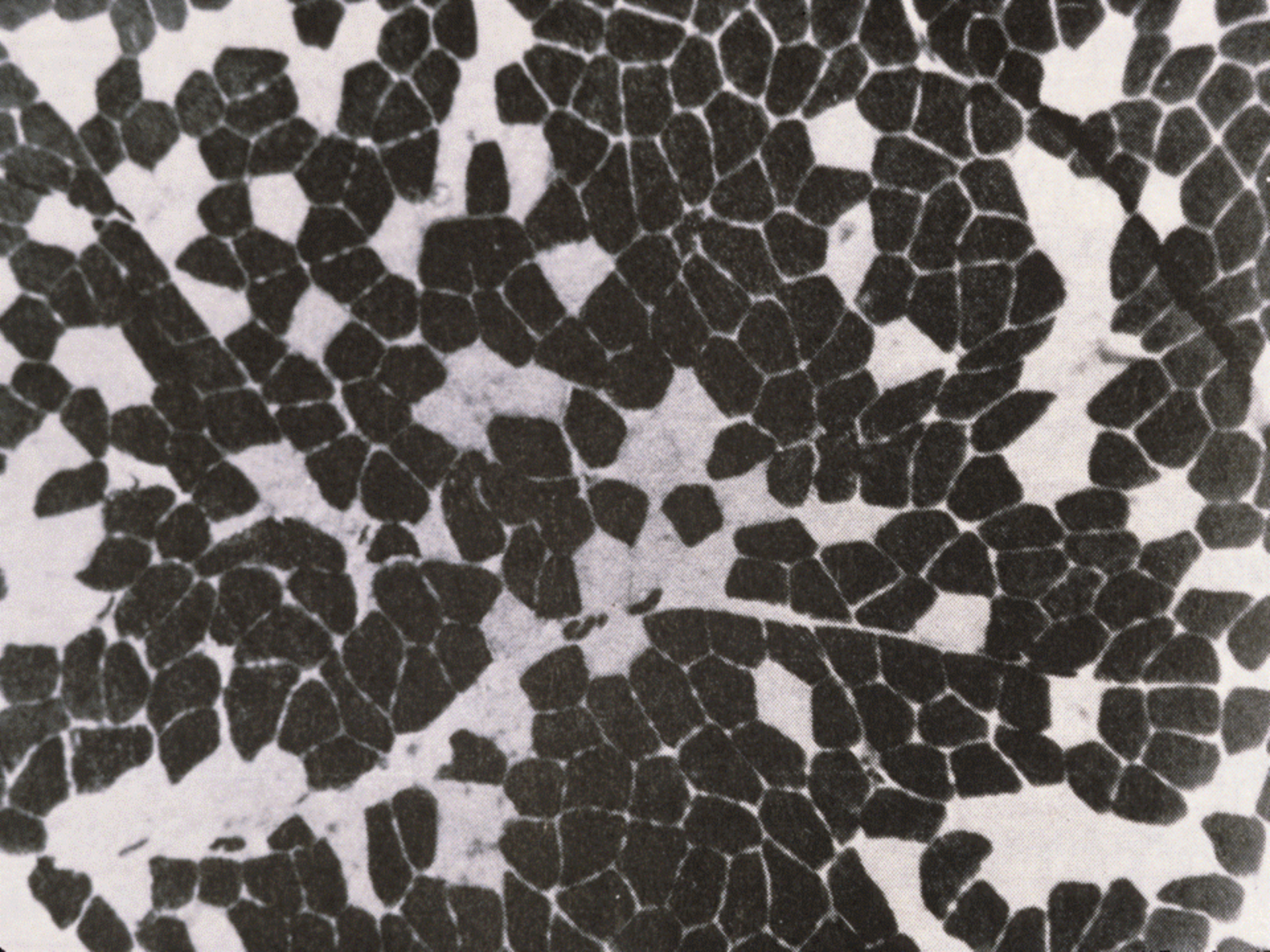
***Myosin & Actin Molecules***



Myosin



Actin



# Characteristics of Skeletal Muscle Fibers

Characteristic	TYPE OF FIBER		
	Slow Oxidative (Type I)	Fast Oxidative (Type IIa)	Fast Glycolytic (Type IIb)
Myosin-ATPase Activity	Low	High	High
Speed of Contraction	Slow	Fast	Fast
Resistance to Fatigue	High	Intermediate	Low
Aerobic Capacity	High	High	Low
Anaerobic Capacity	Low	Intermediate	High
Mitochondria	Many	Many	Few
Capillaries	Many	Many	Few
Myoglobin Content	High	High	Low
Color of Fibers	Red	Red	White
Glycogen Content	Low	Intermediate	High

# *Changes in Muscle Due to Endurance Training*

- ↑ Mitochondria, # & size
- ↑ Mitochondrial (aerobic) enzymes including those specific for fat burning
- ↑ Vascularization of muscles (better blood flow)
- ↑ Stores of fat in muscles accompanied by
- ↓ Triglycerides/fats in bloodstream
- ↑ Enzymes: activation, transport, breakdown ( $\beta$ -oxidation) of fatty acids
- ↑ Myoglobin (enhances  $O_2$  transport)
- ↑ Resting energy levels which inhibit sugar breakdown
- ↑ Aerobic capacity of all three fiber types.

# *Changes in Muscle Due to Strength Training*

- ↑ Size of larger fast vs smaller slow fibers
- ↑ CP as well as creatine phosphokinase (CPK) which enhances short-term power output
- ↑ Key enzymes which help store and dissolve sugar including glycogen phosphorylase (GPP) & phosphofructokinase (PFK)
- ↓ Mitochondrial # relative to muscle tissue
- ↓ Vascularization relative to muscle tissue
- Splitting of fast fibers? Hyperplasia?
- With growth hormone (GH), androgenic-anabolic steroids (AAS)?

***Which end of  
continuum?***

**+**

***Which energy  
nutrient/s?***

# + *Which specific muscles?*





cf:





***Discussion***

***Comments***

***Questions?***