BI 121 Lecture 16

We're on a roll! Bring on Exam II!

I. ***Announcements*** Notebooks? **Exam II, Dec 7th Friday 8 am.** Review session in class next Thurs. Q?

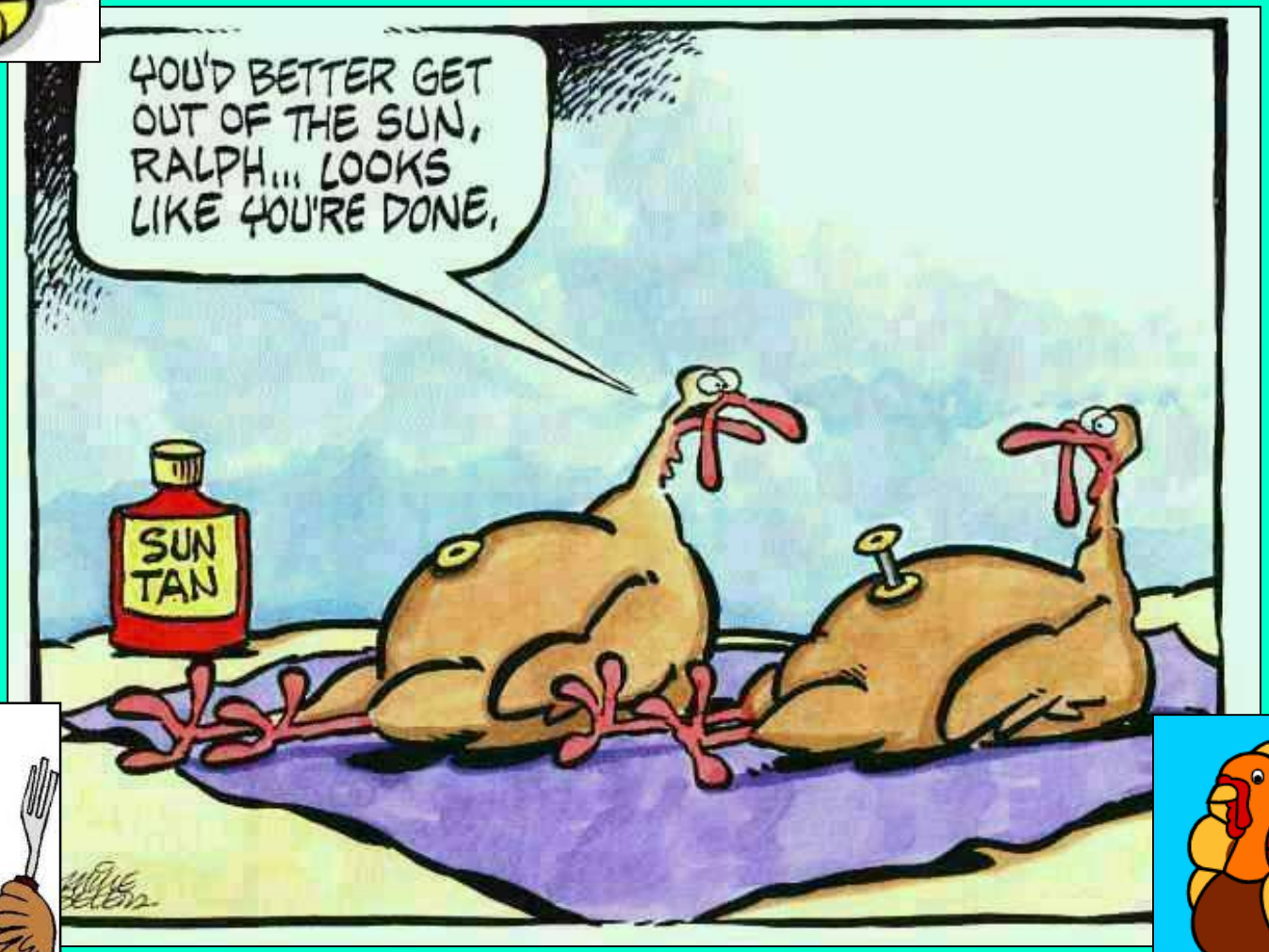
II. ***Muscle Contraction & Adaptation*** LS ch 8, DC Mod 12

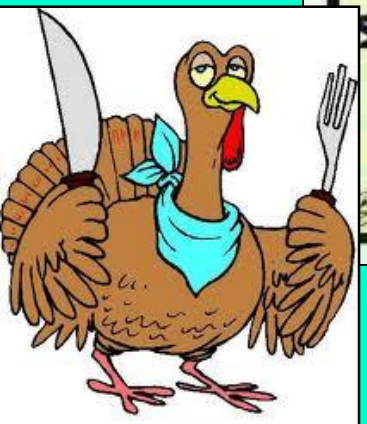
- A. Banding pattern? LS fig 8-3, fig 8-7
- B. How do muscles contract? LS fig 8-6, 8-10
- C. What's a cross-bridge cycle? LS fig 8-11 +…
- D. Summary of skeletal muscle contraction
- E. Exercise adaptation variables: ***mode***, ***intensity***, ***duration***, ***frequency***, ***distribution***, ***individual*** & environmental char...?
- F. Endurance *vs.* strength training continuum? fiber types...

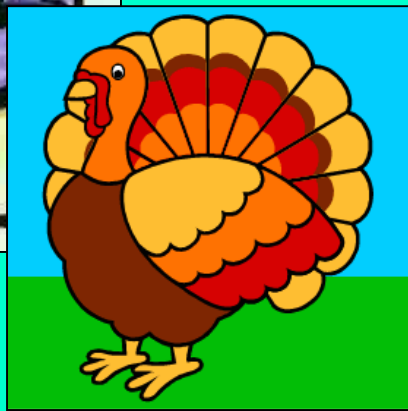
III. ***Respiratory System*** LS ch 12, DC Module 7, Fox +...

- A. Steps of respiration? External *vs.* cellular/internal? LS fig 12-1 pp 345-347
- B. Respiratory anatomy LS fig 12-2 p 347, DC, Fox +...
- C. Histology LS fig 12- 4 pp 347-349, DC
- D. How do we breathe? LS fig 12-12, fig 12-25 pp 349-356, pp 373-378

Be safe in travel! Peace!
Have a Happy Turkey Day!!!

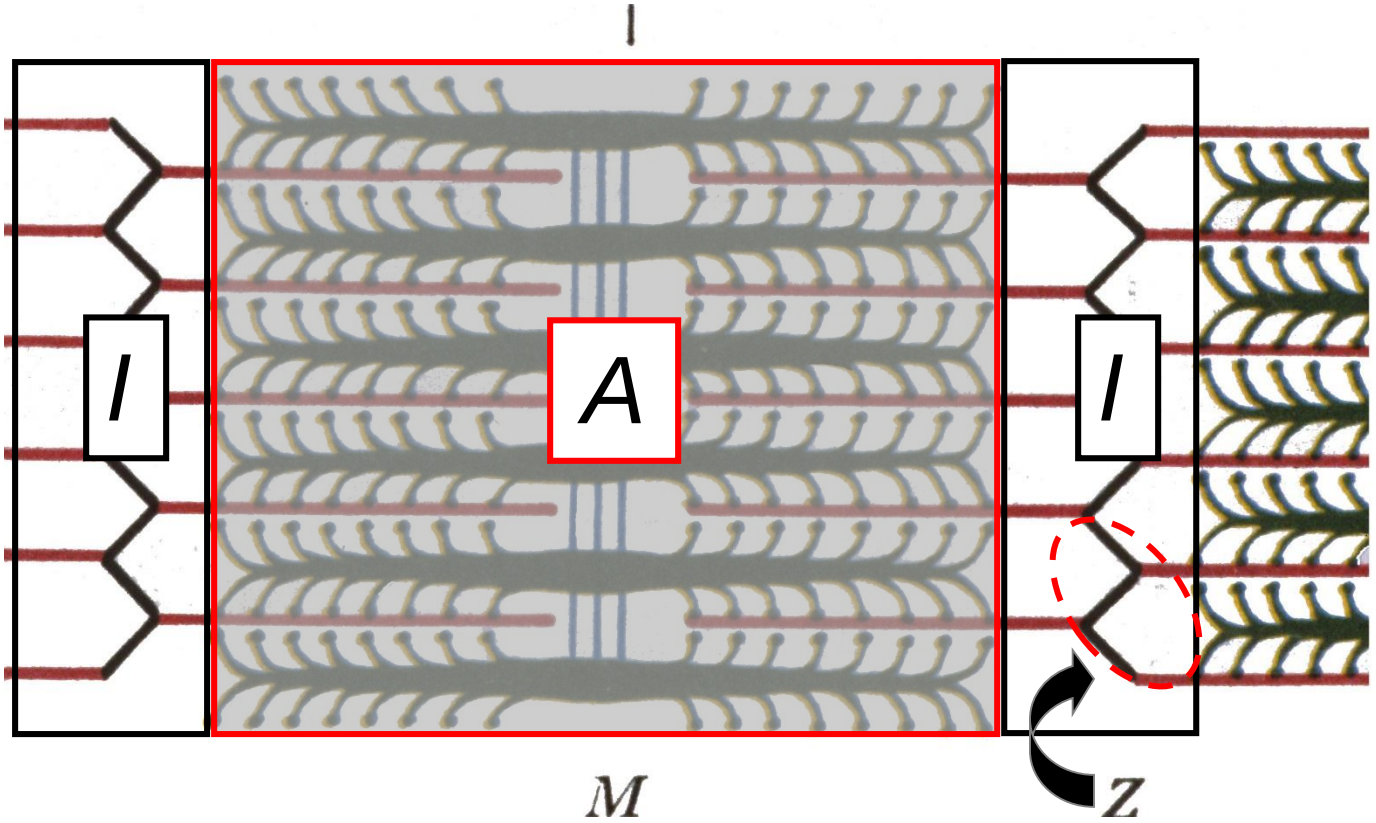






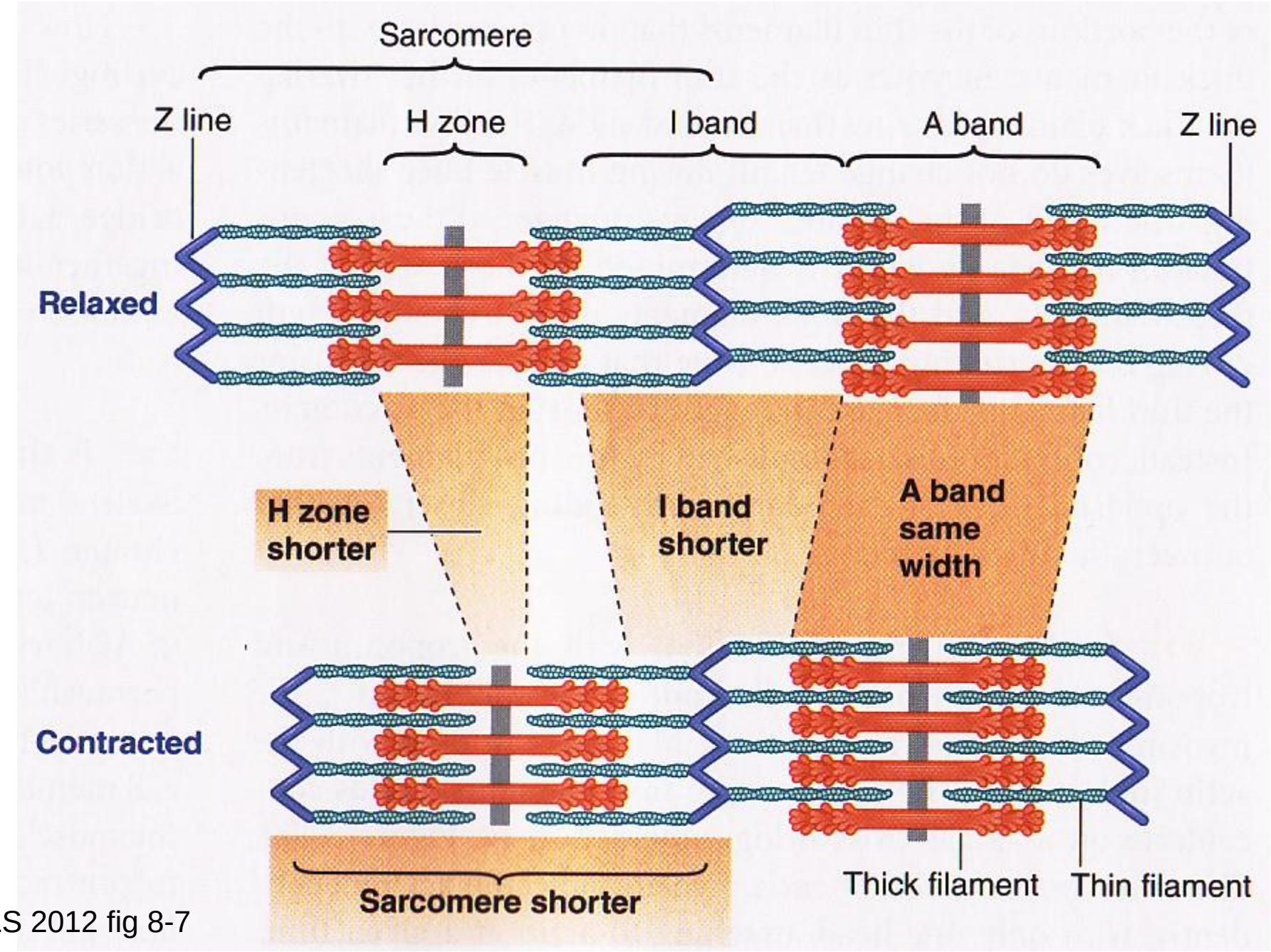
A Band = Dark Band

*A*nisotropic = Light Can't Shine Through



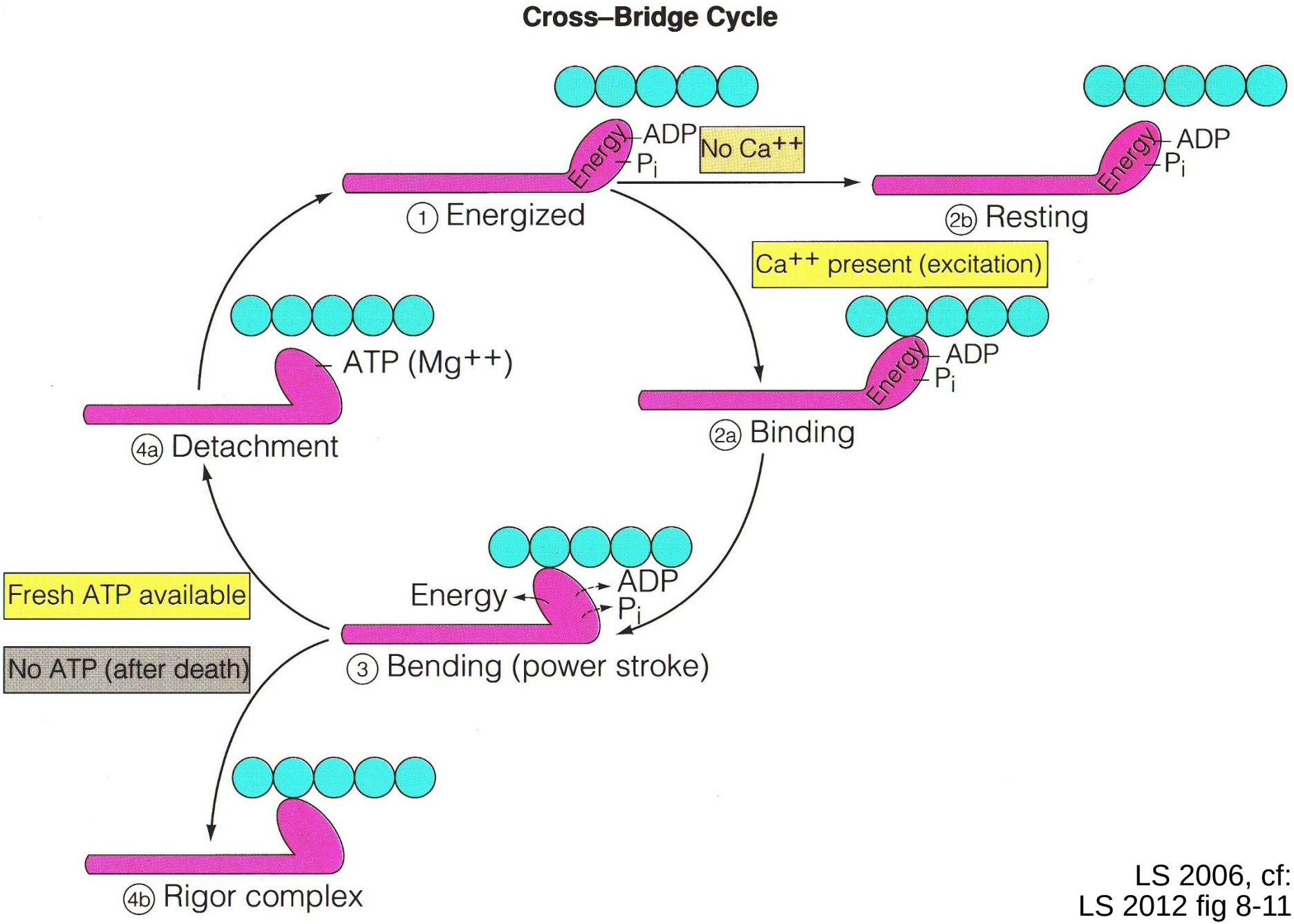
I Band = Light Band

*I*sotropic = Light Can Shine Through



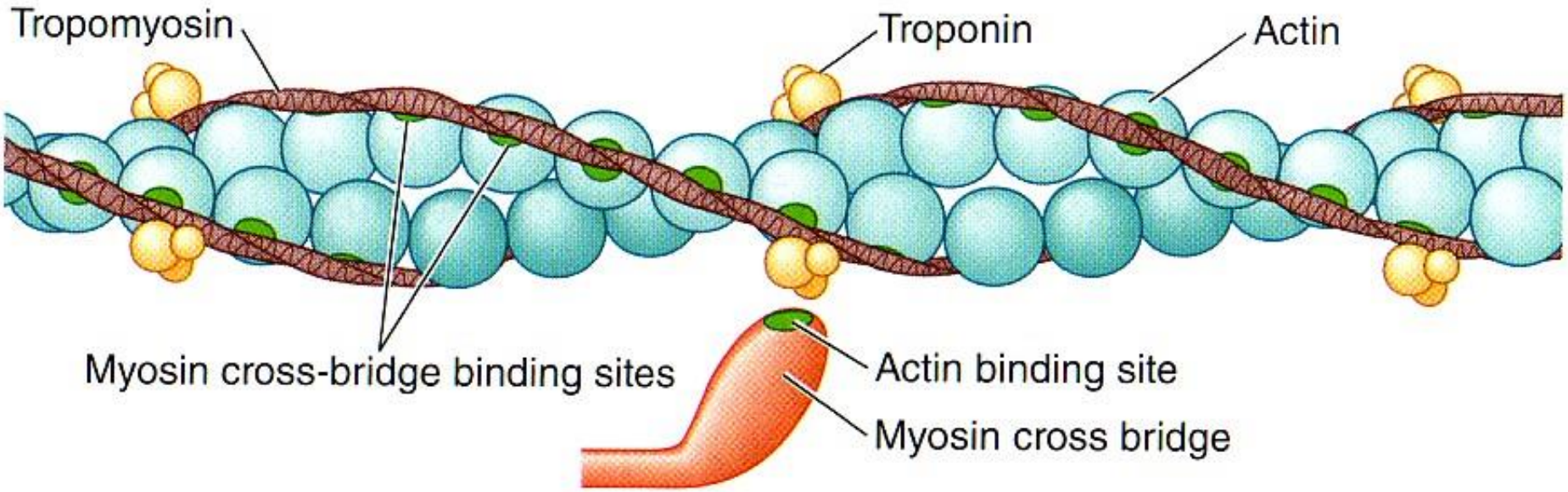
LS 2012 fig 8-7

What do we guess happens at the molecular level?



LS 2006, cf:
LS 2012 fig 8-11

Relaxed: No Cross-Bridge Binding



(a) Relaxed

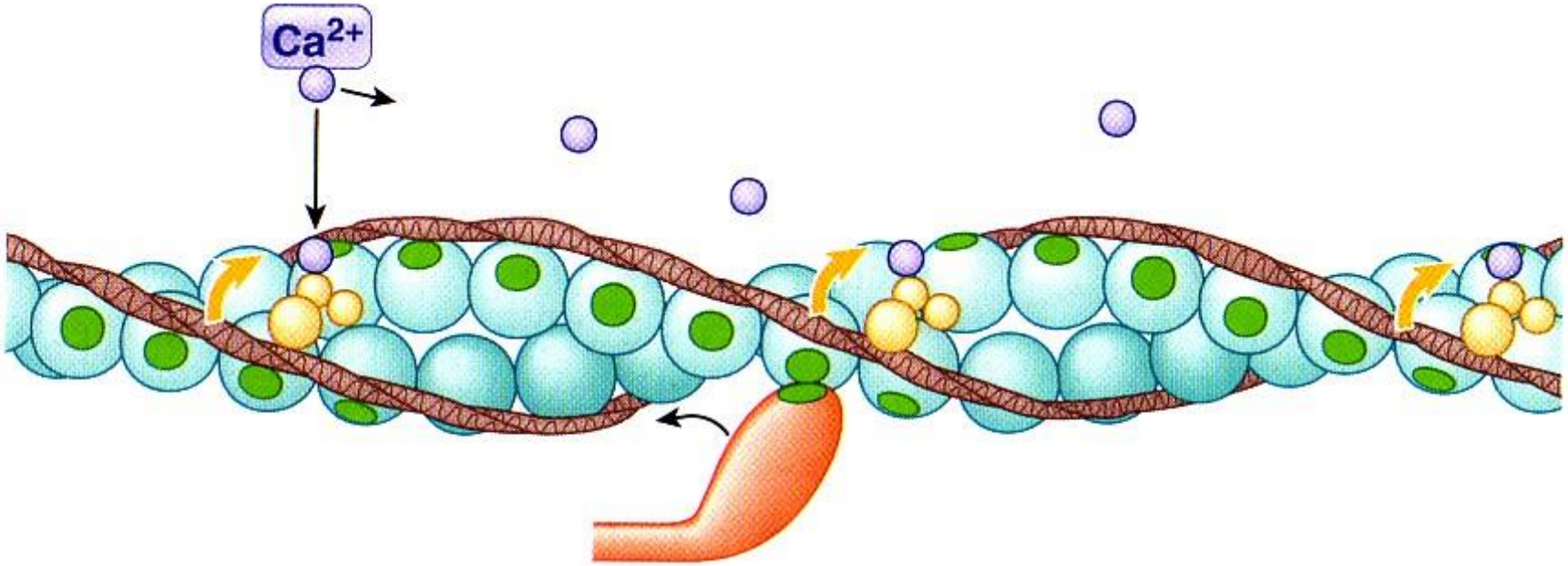
1. No excitation.

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.

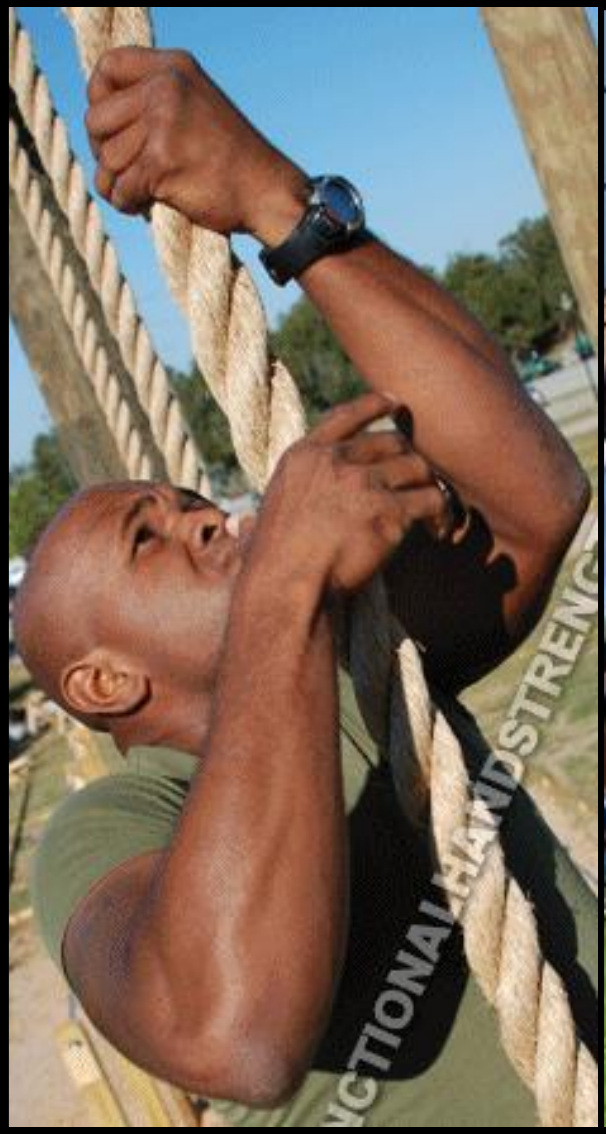
2. Released Ca^{2+} binds with troponin, pulling troponin–tropomyosin complex aside to expose cross-bridge binding site.

3. Cross-bridge binding occurs.

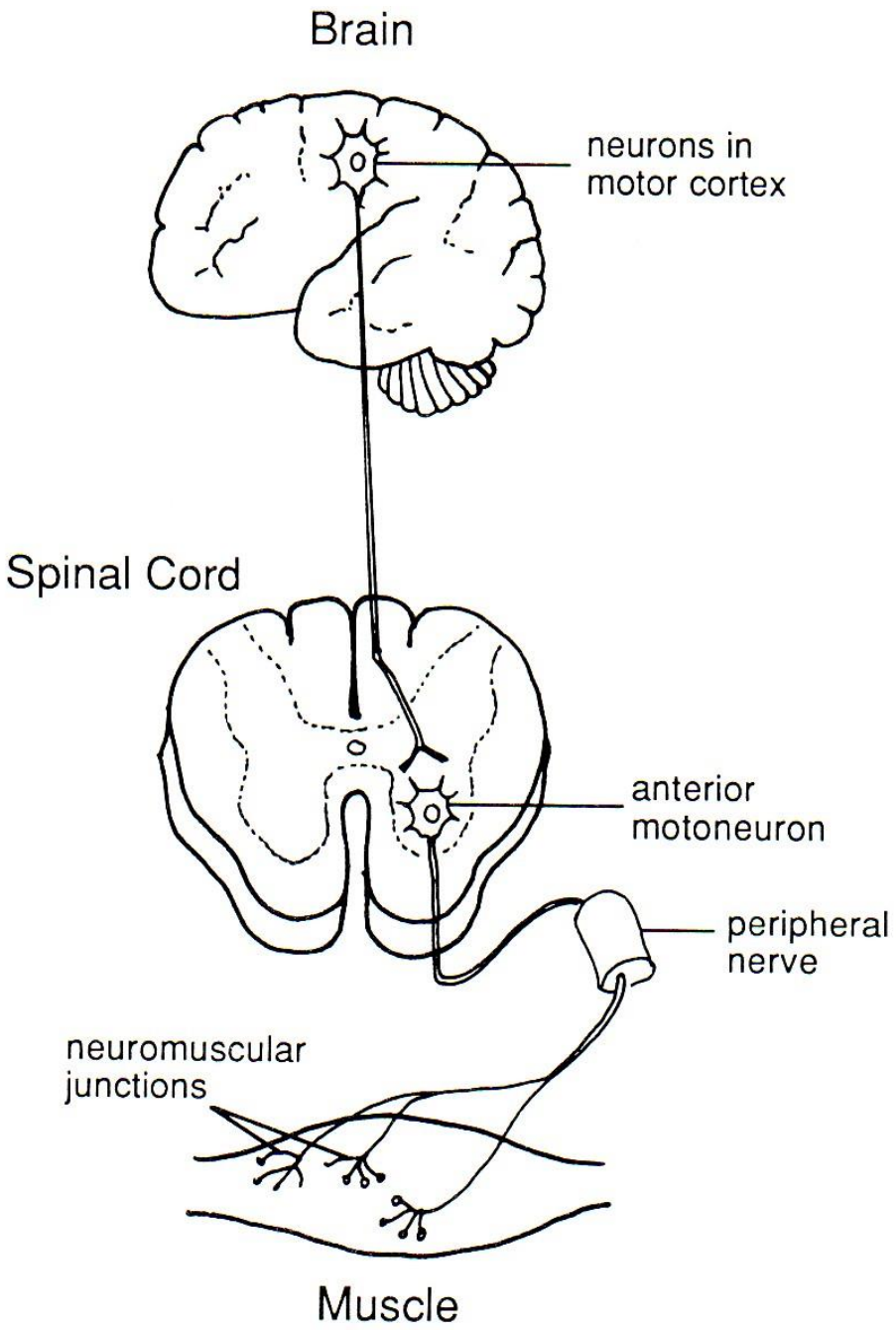
4. Binding of actin and myosin cross bridge triggers power stroke that pulls thin filament inward during contraction.

LS 2012 fig 8-6b

Rope Climb or Tug of War
Grasp, then Regrasp!

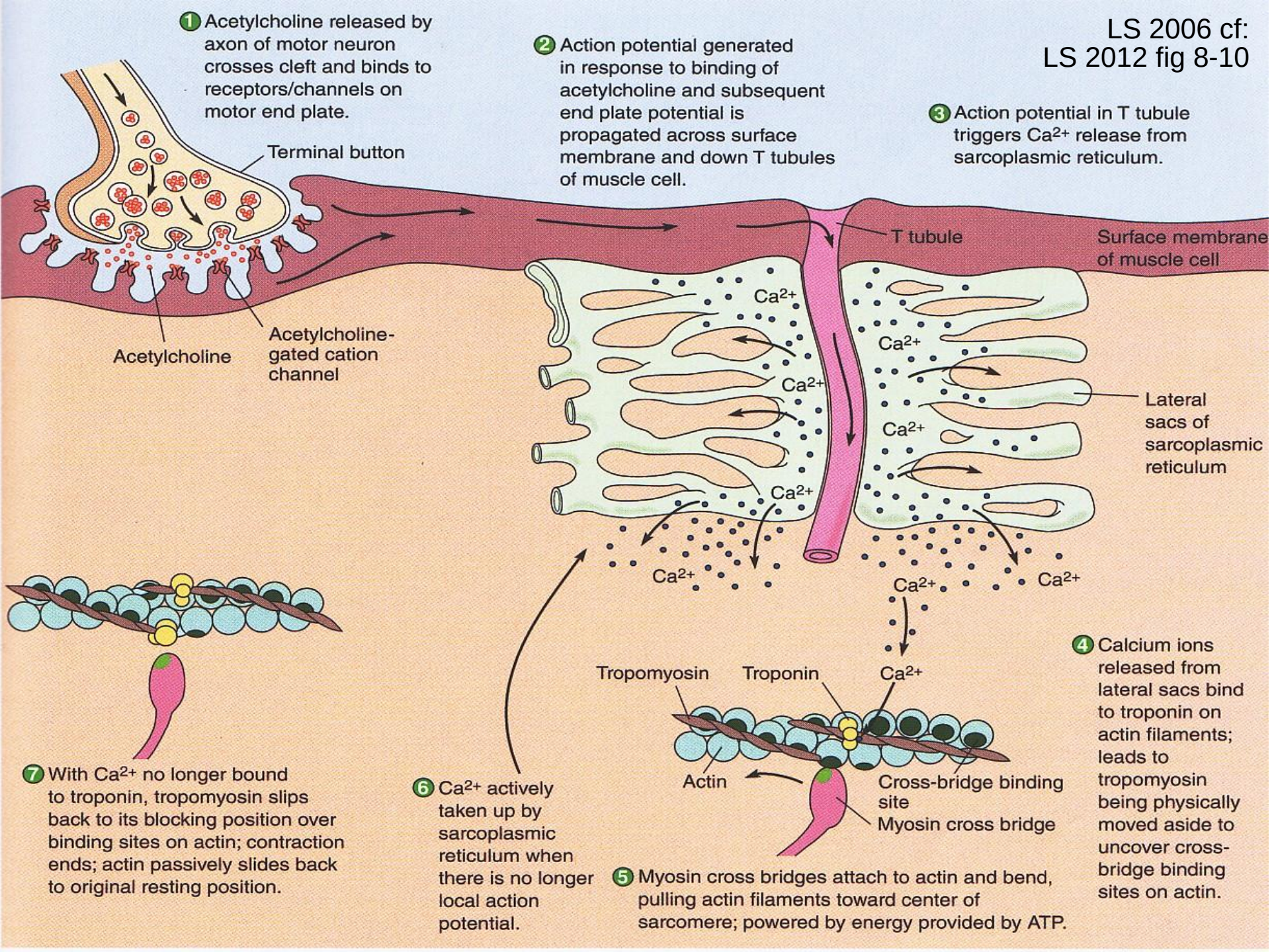


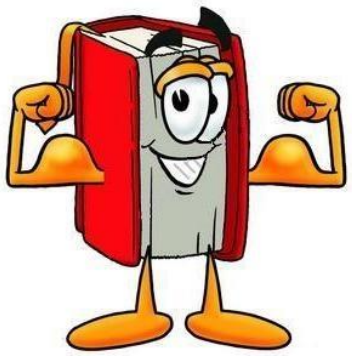
https://www.youtube.com/watch?v=Ktv-CaOt6UQ



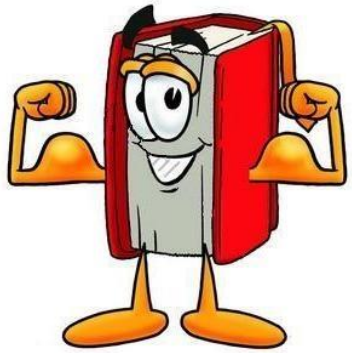
DN Laing & VP Lombardi, 1989

LS 2006 cf:
LS 2012 fig 8-10





Muscle Contraction Resources



https://ed.ted.com/lessons/how-your-muscular-system-works-emma-bryce

https://ed.ted.com/on/s3Zzdm8u

https://ed.ted.com/lessons/what-makes-muscles-grow-jeffrey-siegel

https://www.ncbi.nlm.nih.gov/books/NBK9961/

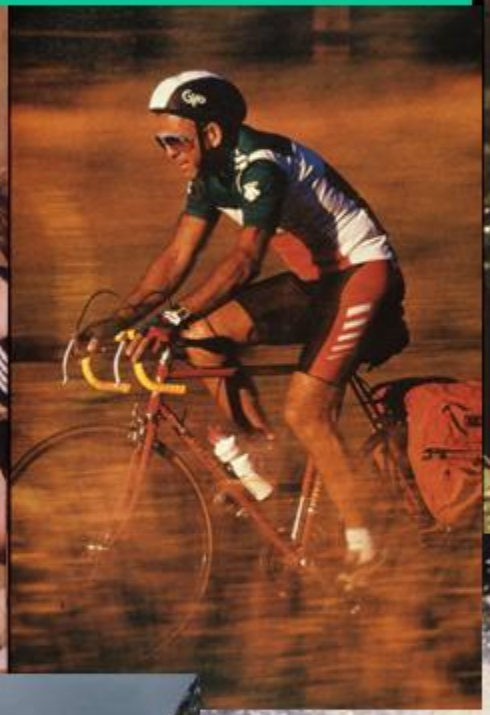
A. Malcolm Campbell
Davidson College, Davidson, NC
www.bio.davidson.edu/courses/movies.html

David Bolinsky, XVIVO
Rocky Hill, CT
http://www.xvivo.net/

Discussion + Time for Questions!

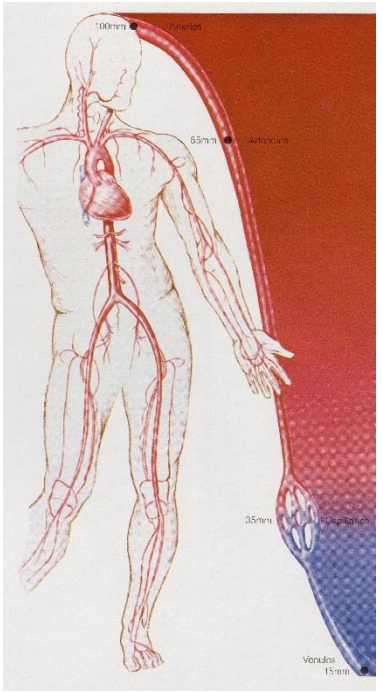
Adaptations to Exercise?

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

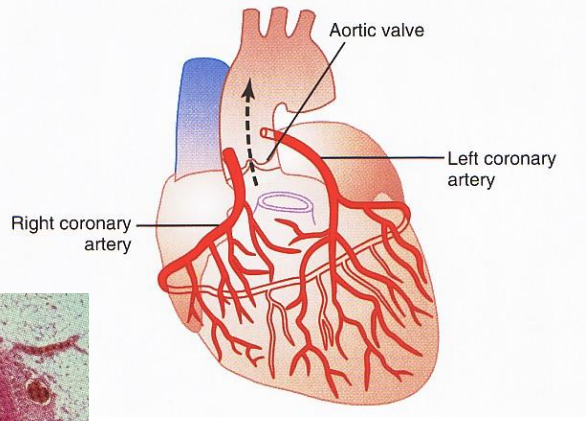


Adaptations to Exercise?

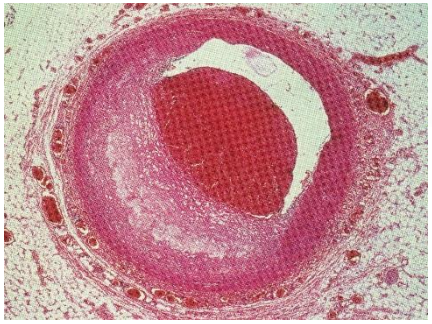
Body Levels of Organization?
Which Body System?



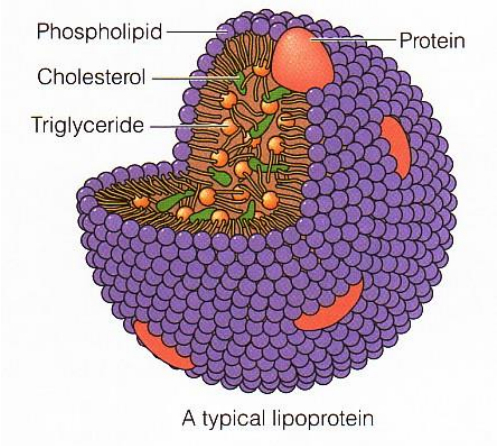
Body System



Organ

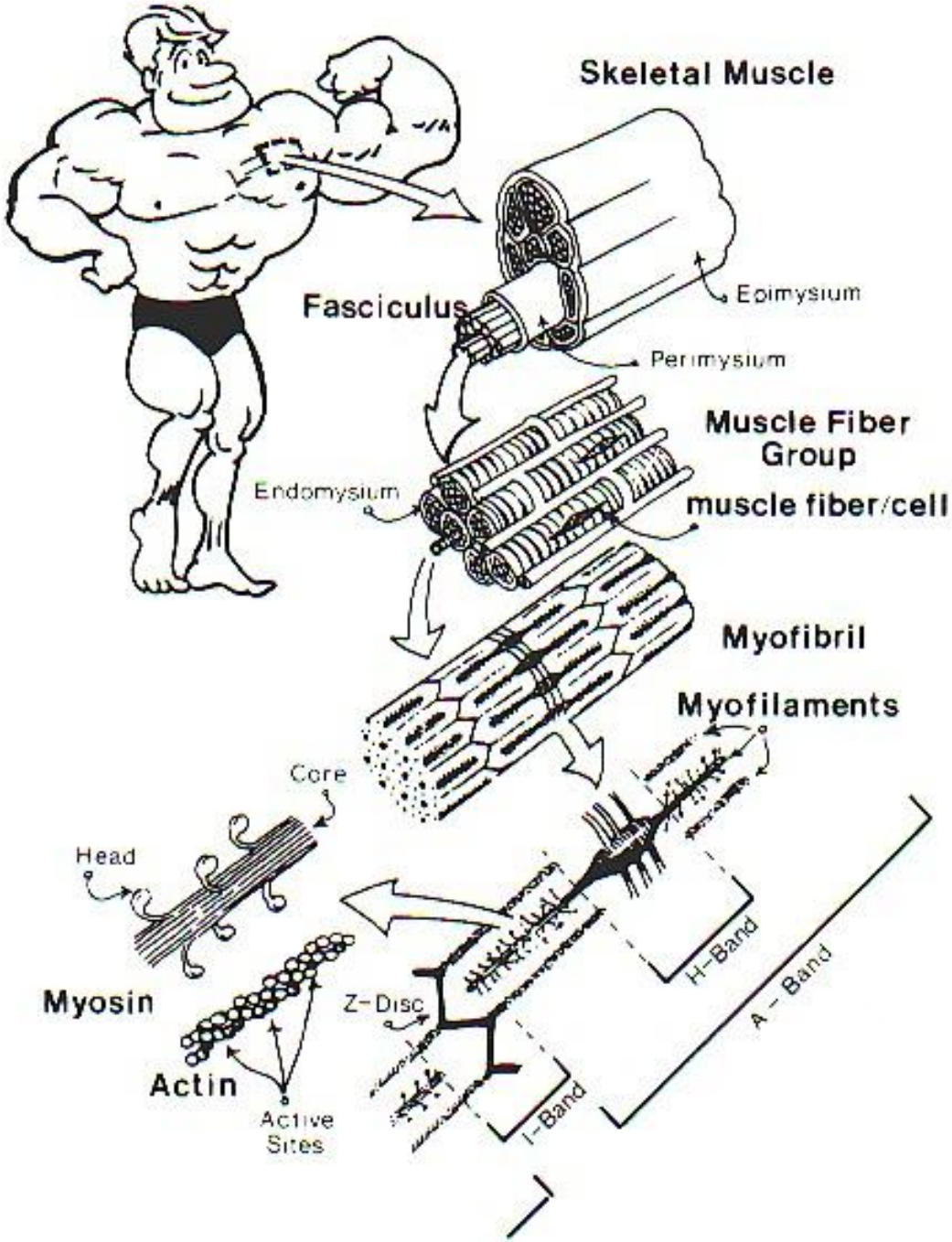


Cell/Tissue

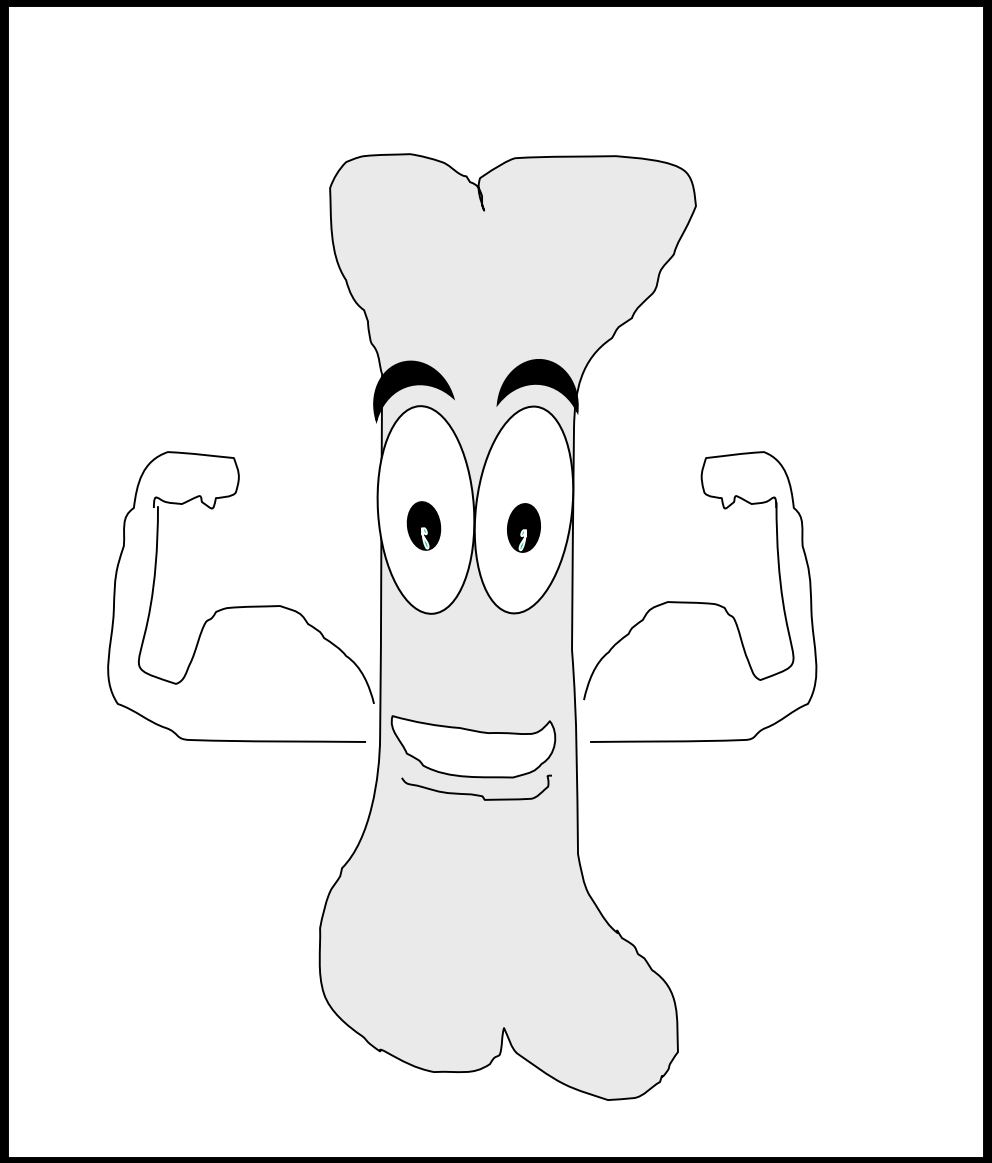


Molecular

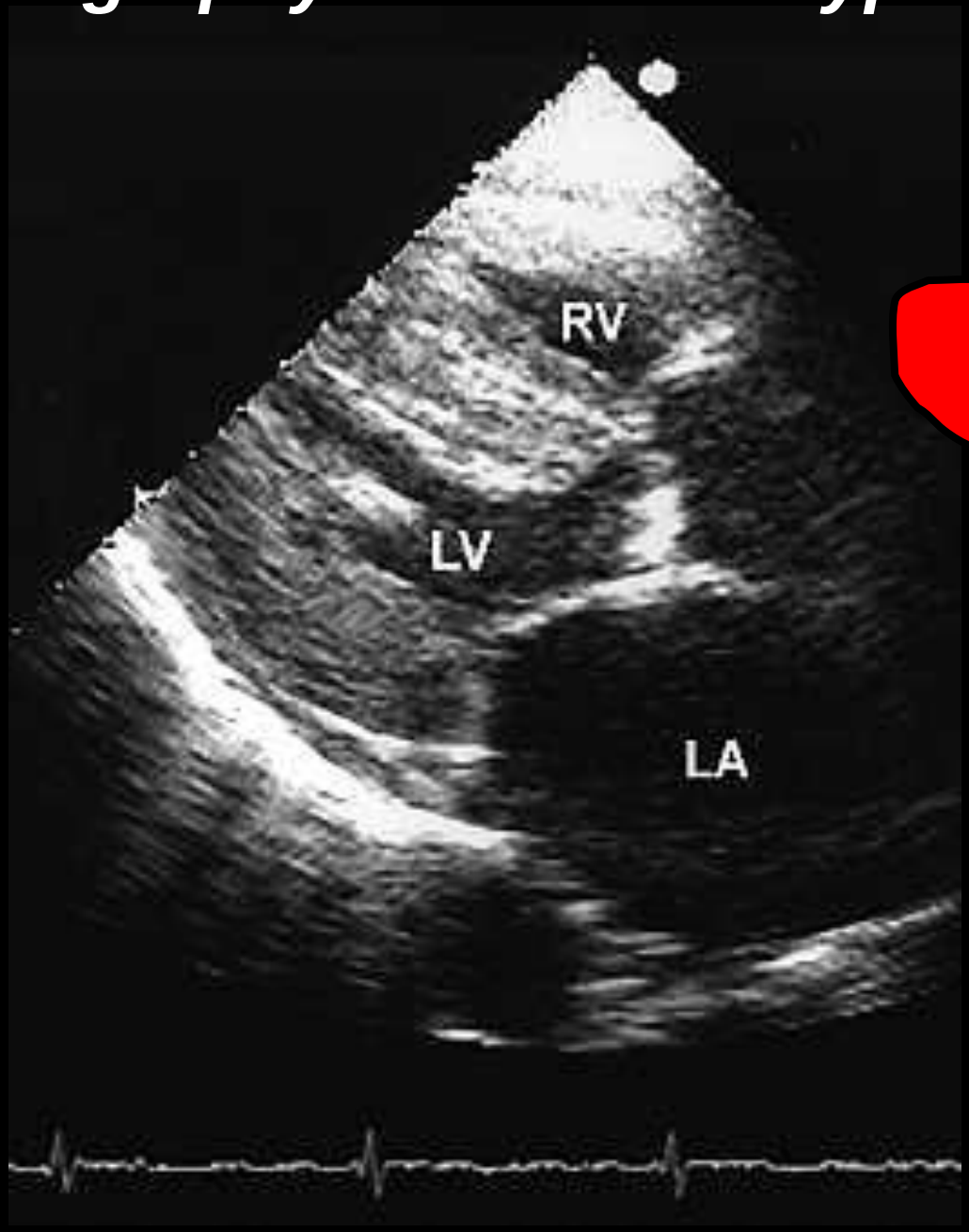
Muscle Adaptations to Exercise



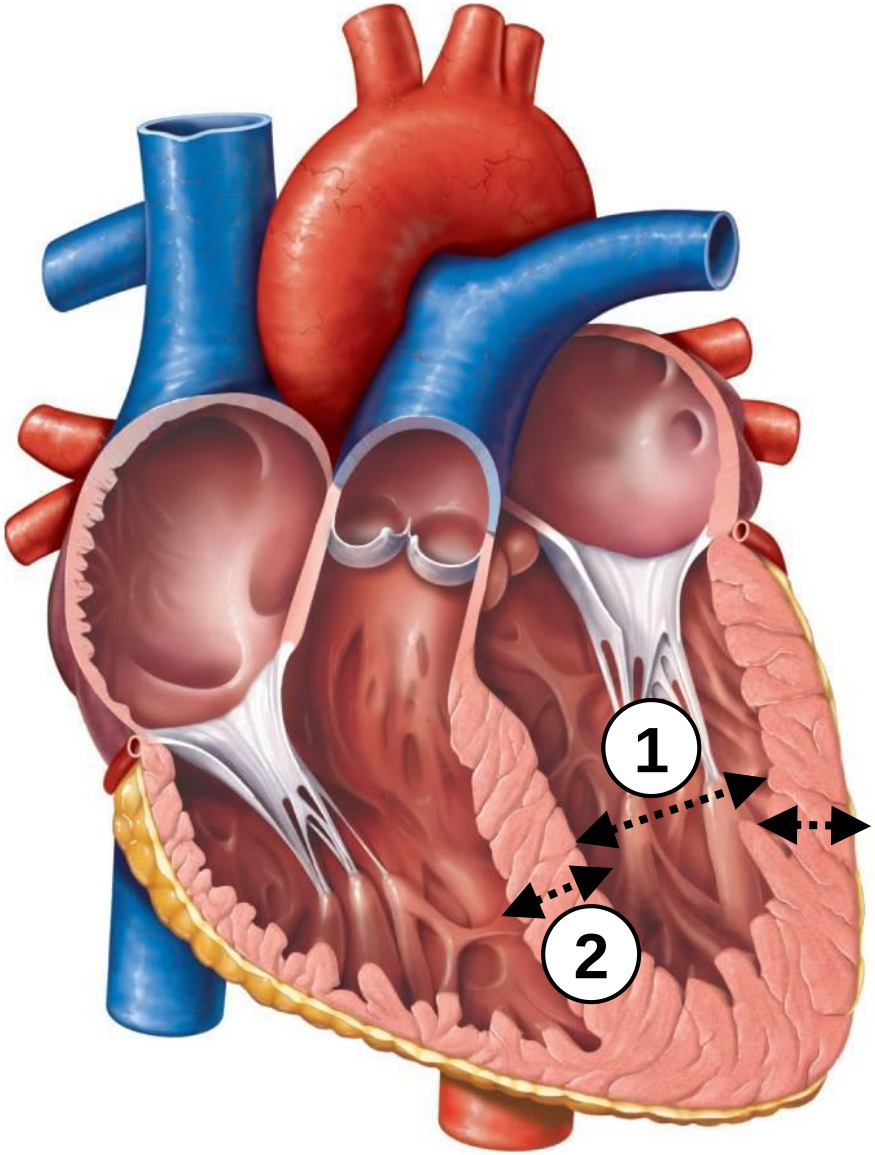
As muscles tug on bones, bones get stronger, too!...many systems adapt!!



Echocardiography documents hypertrophy...



Cardiac Adaptations to Exercise: ① Endurance vs. ② StrengthTraining



NB: ① > ↑ LBM

1 + 2

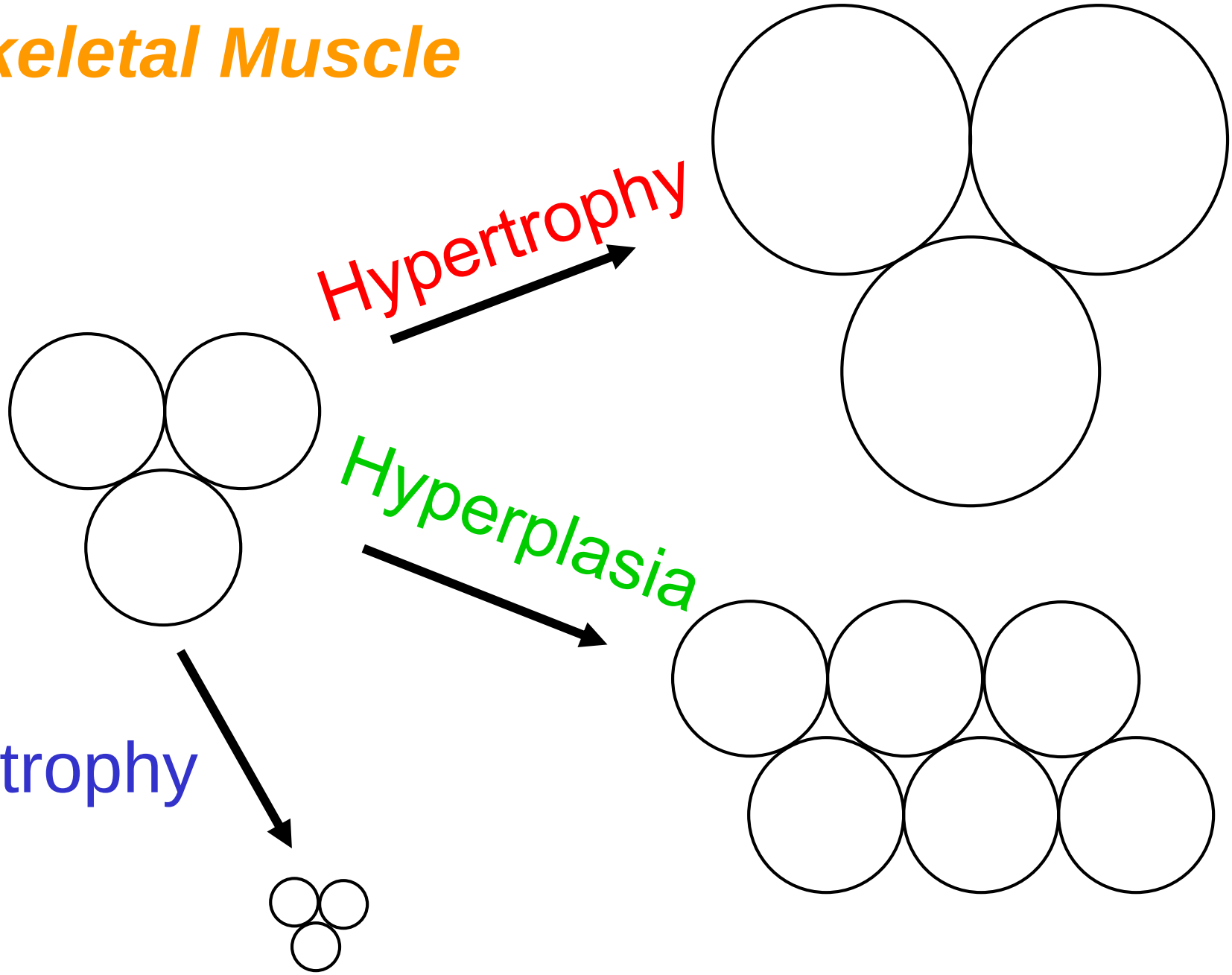
Atrophy

decrease in size & strength

Hypertrophy

increase in size & strength

Skeletal Muscle



Women & Hypertrophy?

What happens in muscles at cellular & subcellular levels?

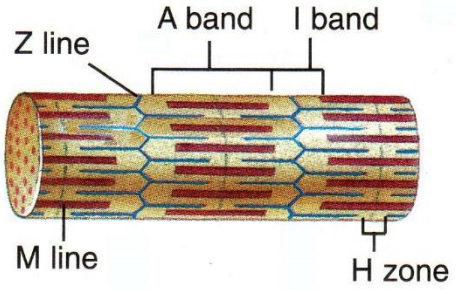
Myofibril

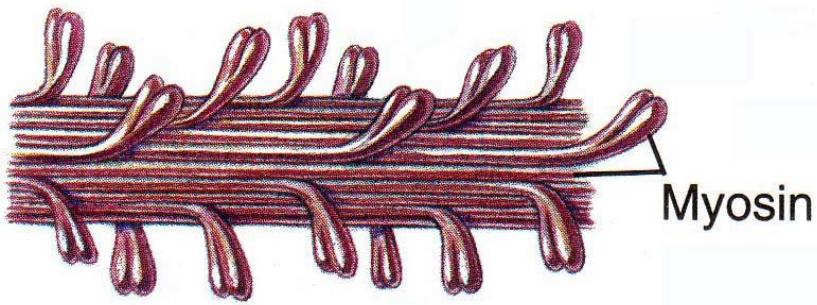
Hypertrophy: *Increased*

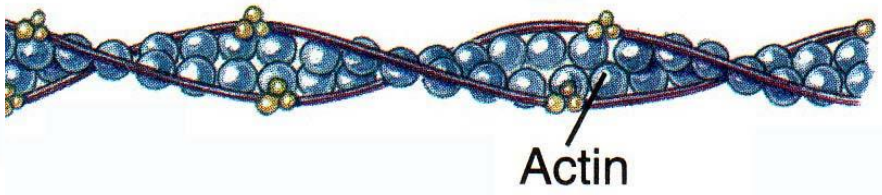
Number of Myofibrils

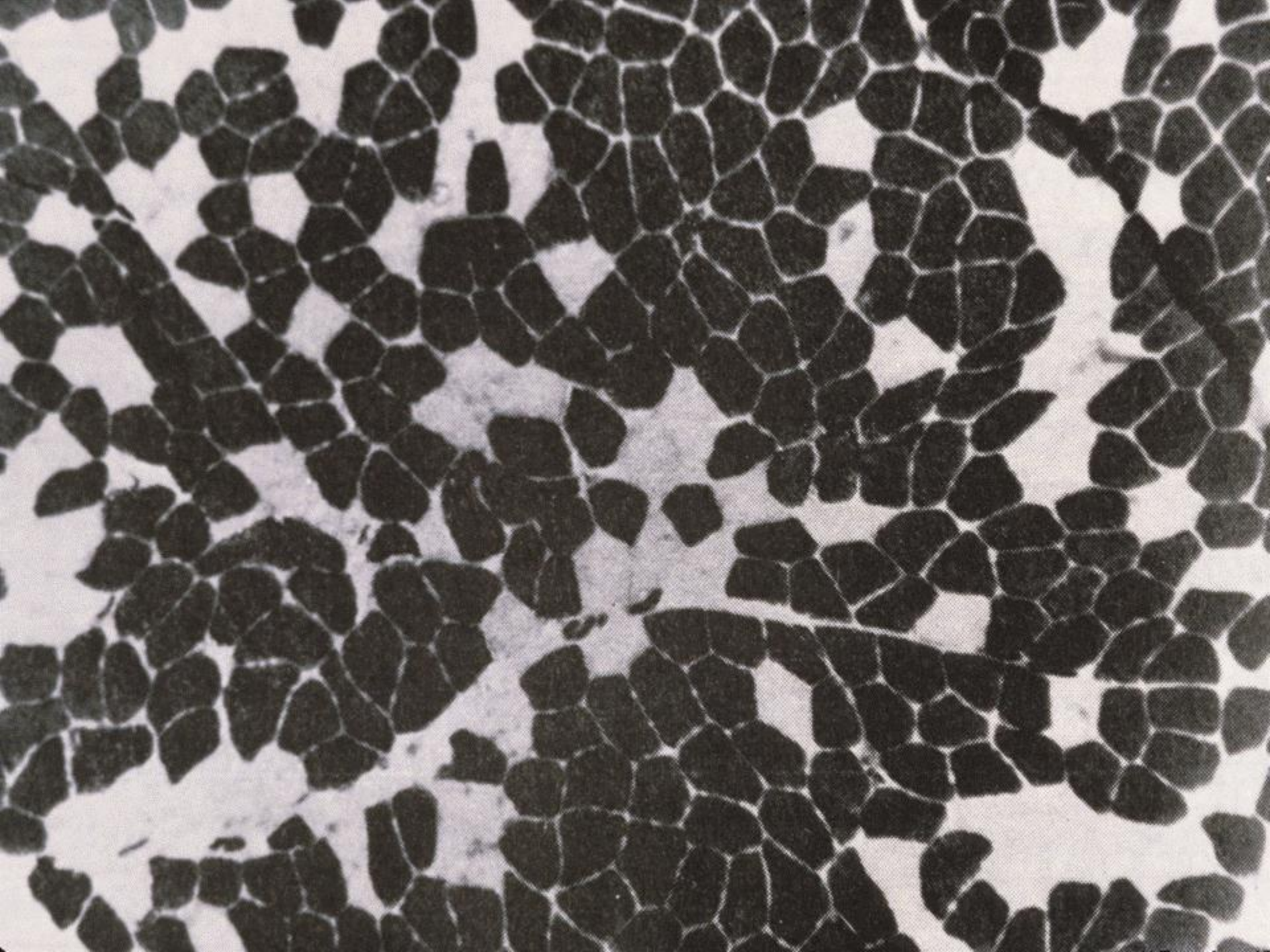
Thick & Thin Filaments

Myosin & Actin Molecules







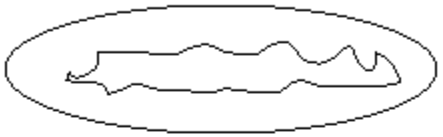


Characteristics of Skeletal Muscle Fibers

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

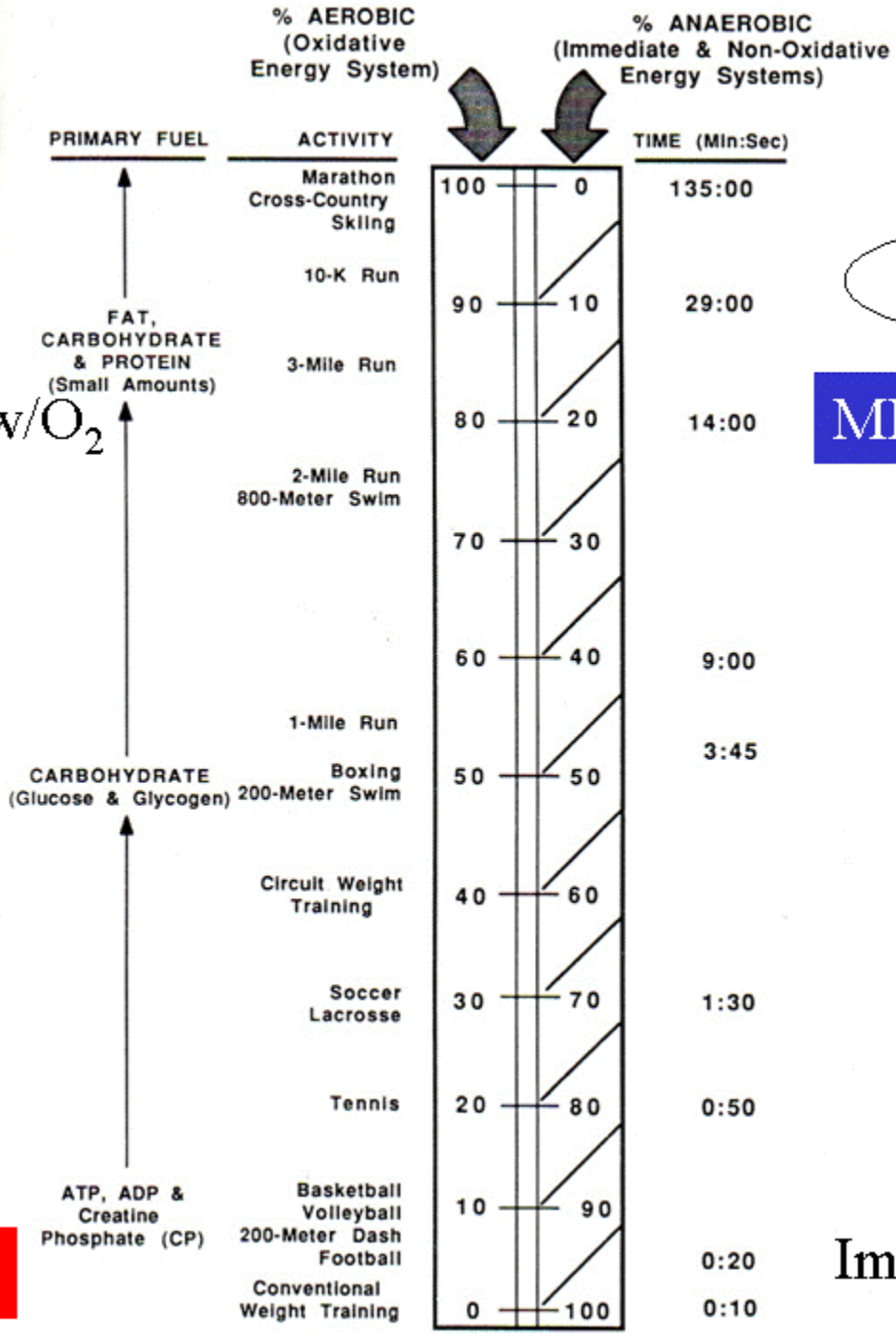
LS 2012 tab 8-1 modified
> VP Lombardi 1989

AEROBIC w/O_2



MITOCHONDRIA

ANAEROBIC



CYTOSOL

Glycolysis

Immediate/ATP-PC

Muscle Changes 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)?

Muscle Changes 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 (β-oxidation) of fatty acids
- ↑ Myoglobin (enhances O_2 transport)
- ↑ Resting energy levels which inhibit sugar breakdown
- ↑ Aerobic capacity of all three fiber types.

Which end of continuum?

+

Which energy nutrient/s?

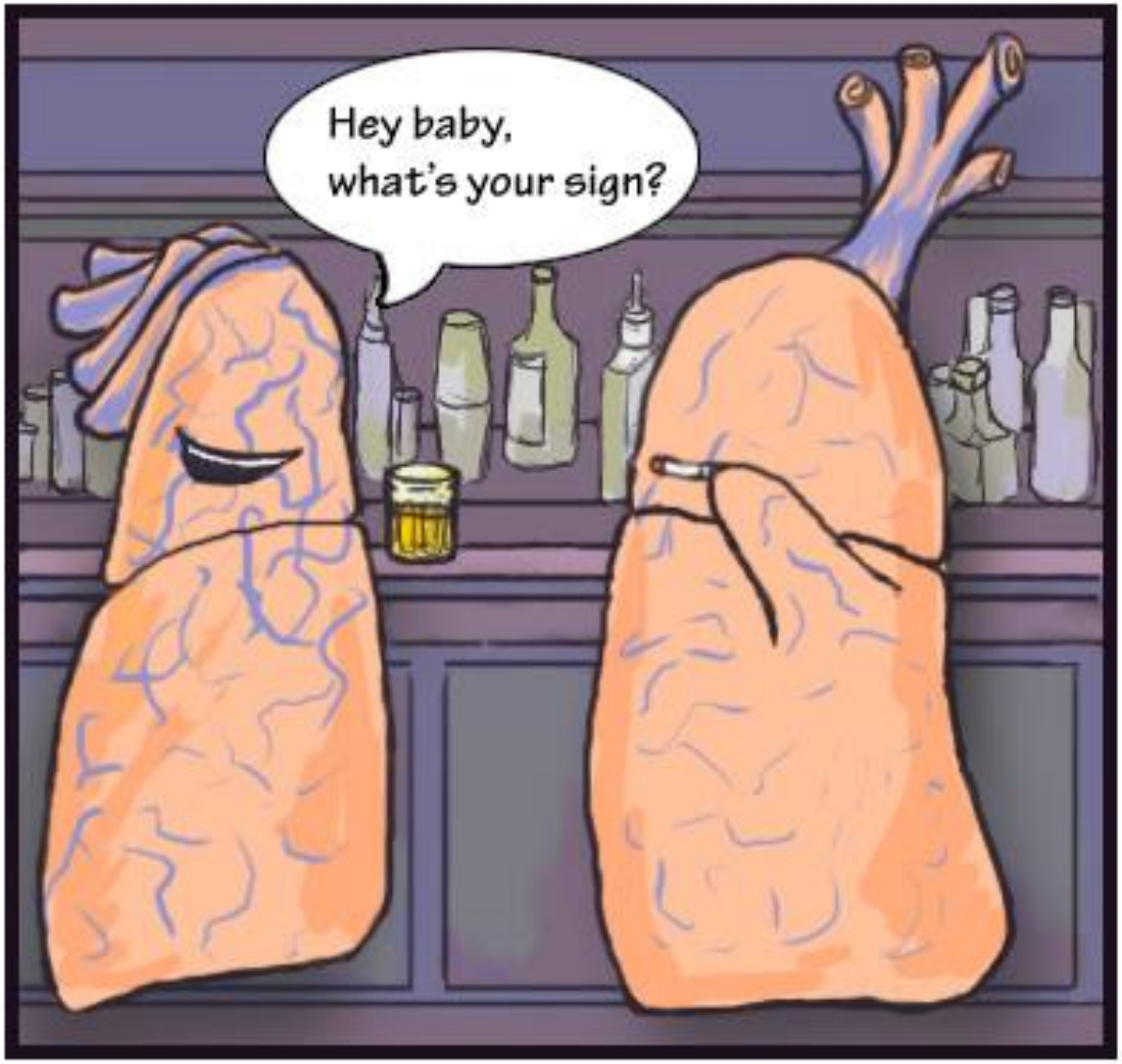
+ Which specific muscles?

cf:


45

Dancing can be super aerobic exercise, too, & you don't have to be a star!

Extremes of the energy continuum!



Cancer.

Lombo's simplified steps!

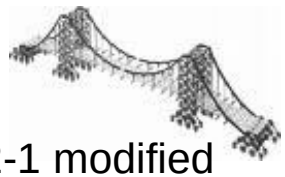
1 **Breathe in & out!**

2 **Cross membranes!**

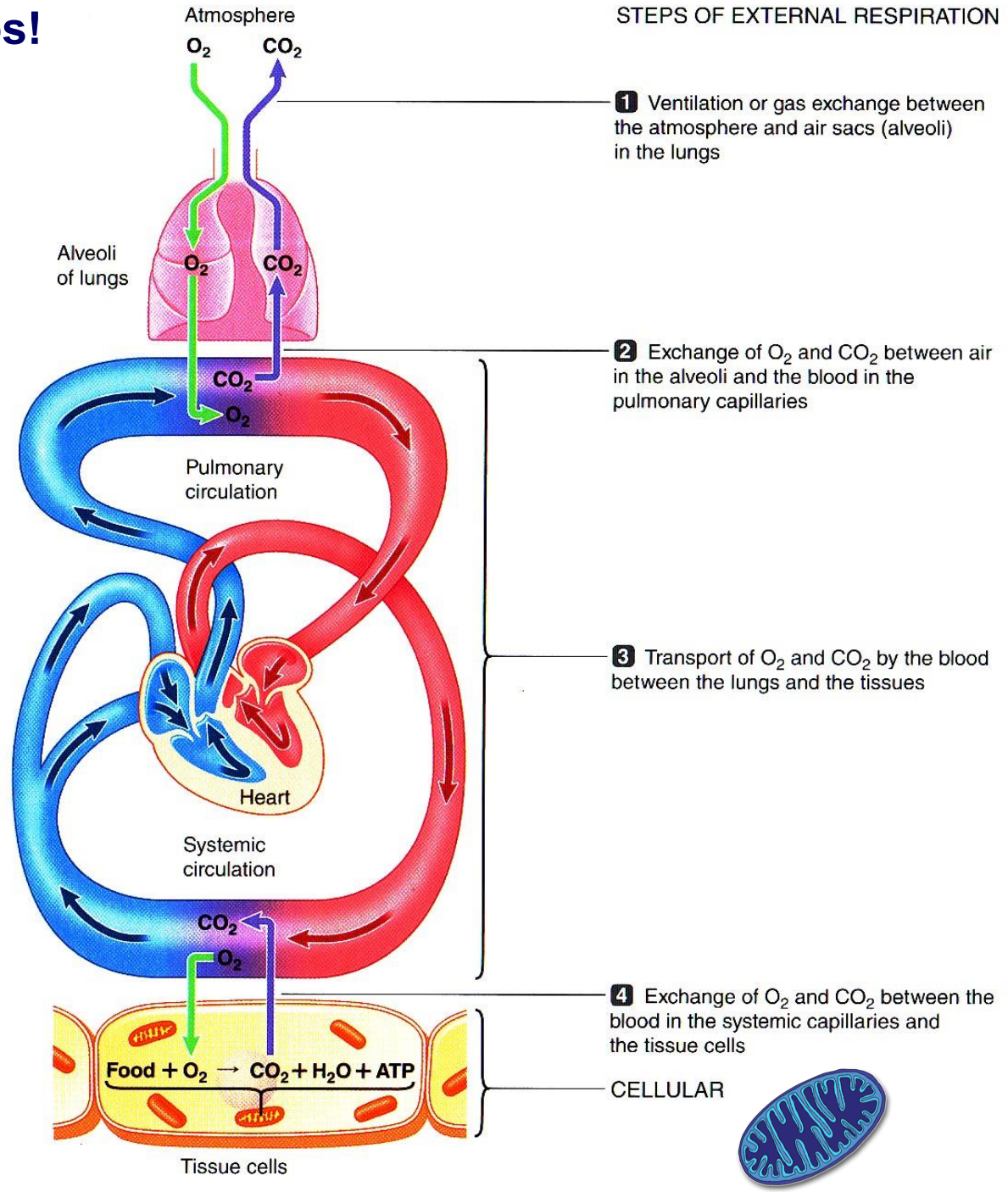
3 **Move with blood!**

Go with the flow!

4 **Cross membranes!**

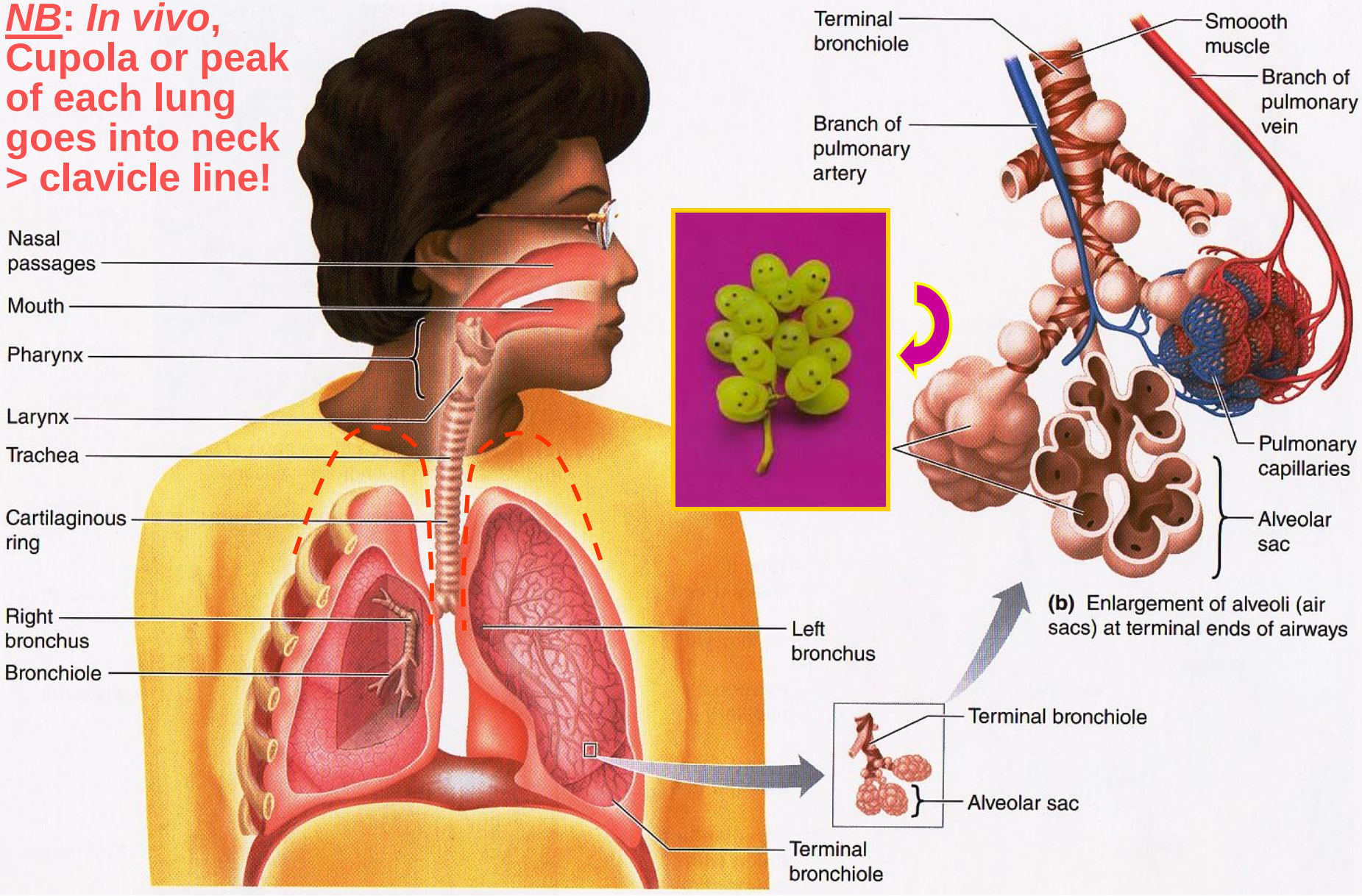


LS 2012 fig 12-1 modified



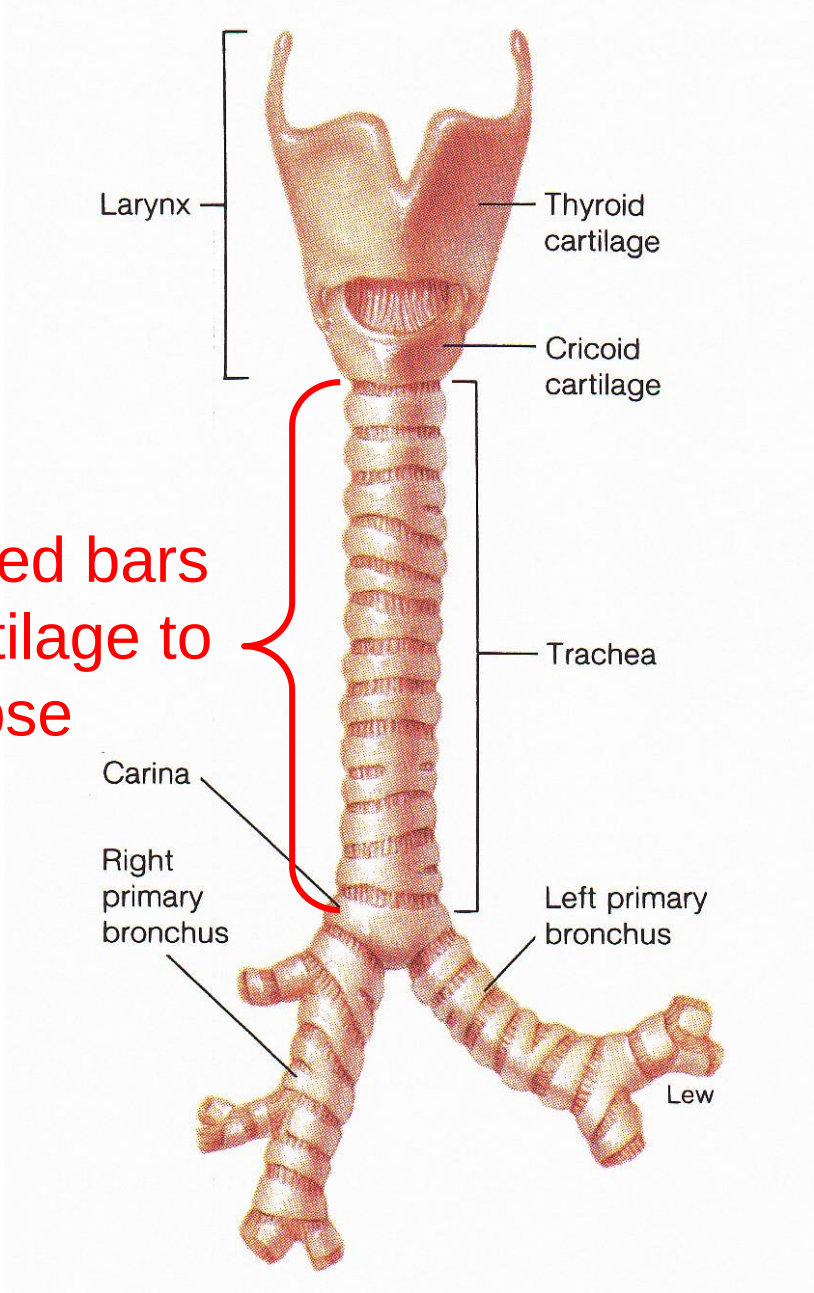
Respiratory System Anatomy

NB: *In vivo*, Cupola or peak of each lung goes into neck > clavicle line!

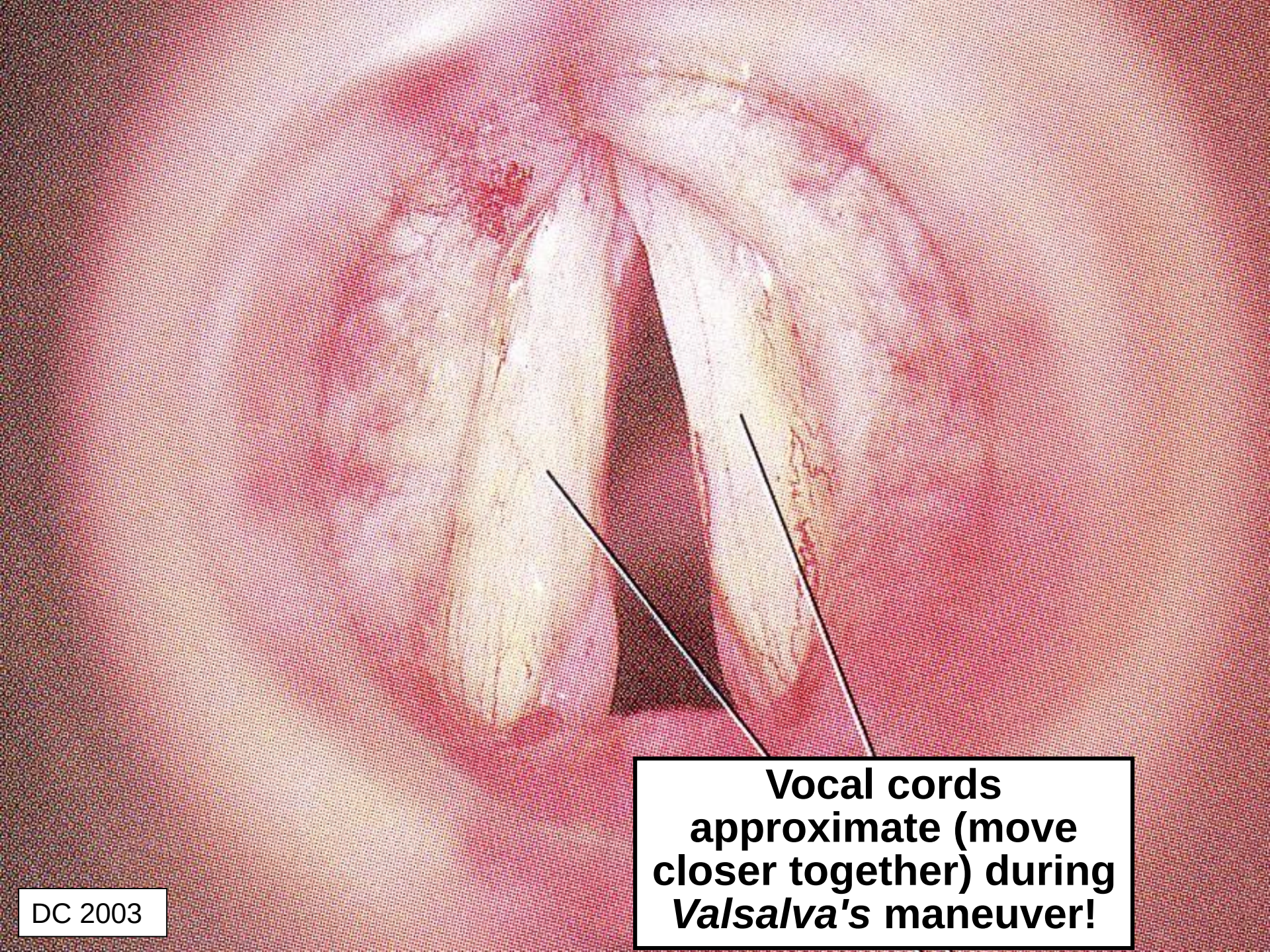


LS 2012 fig 12-2

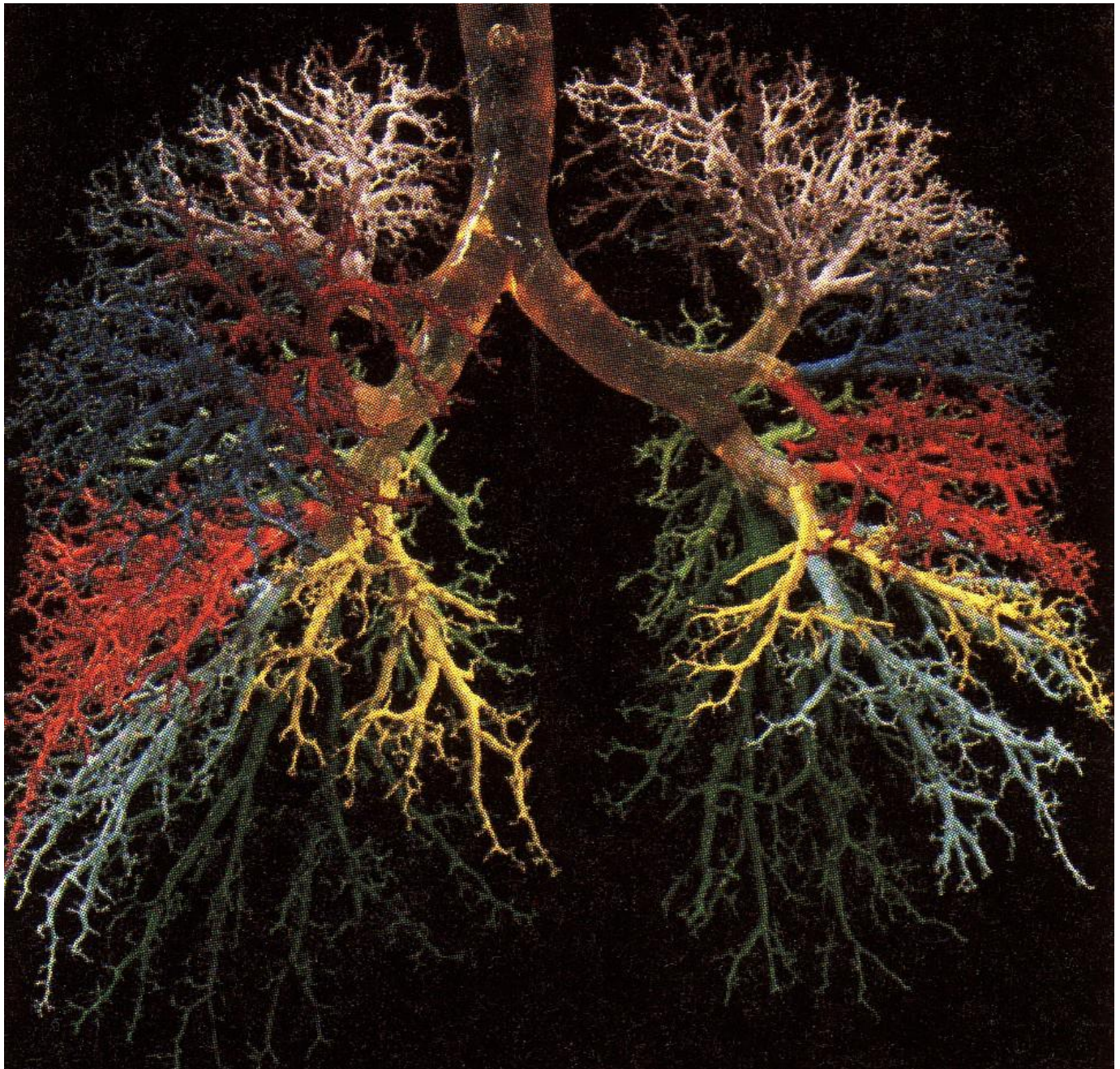
16-20 C-shaped bars of hyaline cartilage to prevent collapse



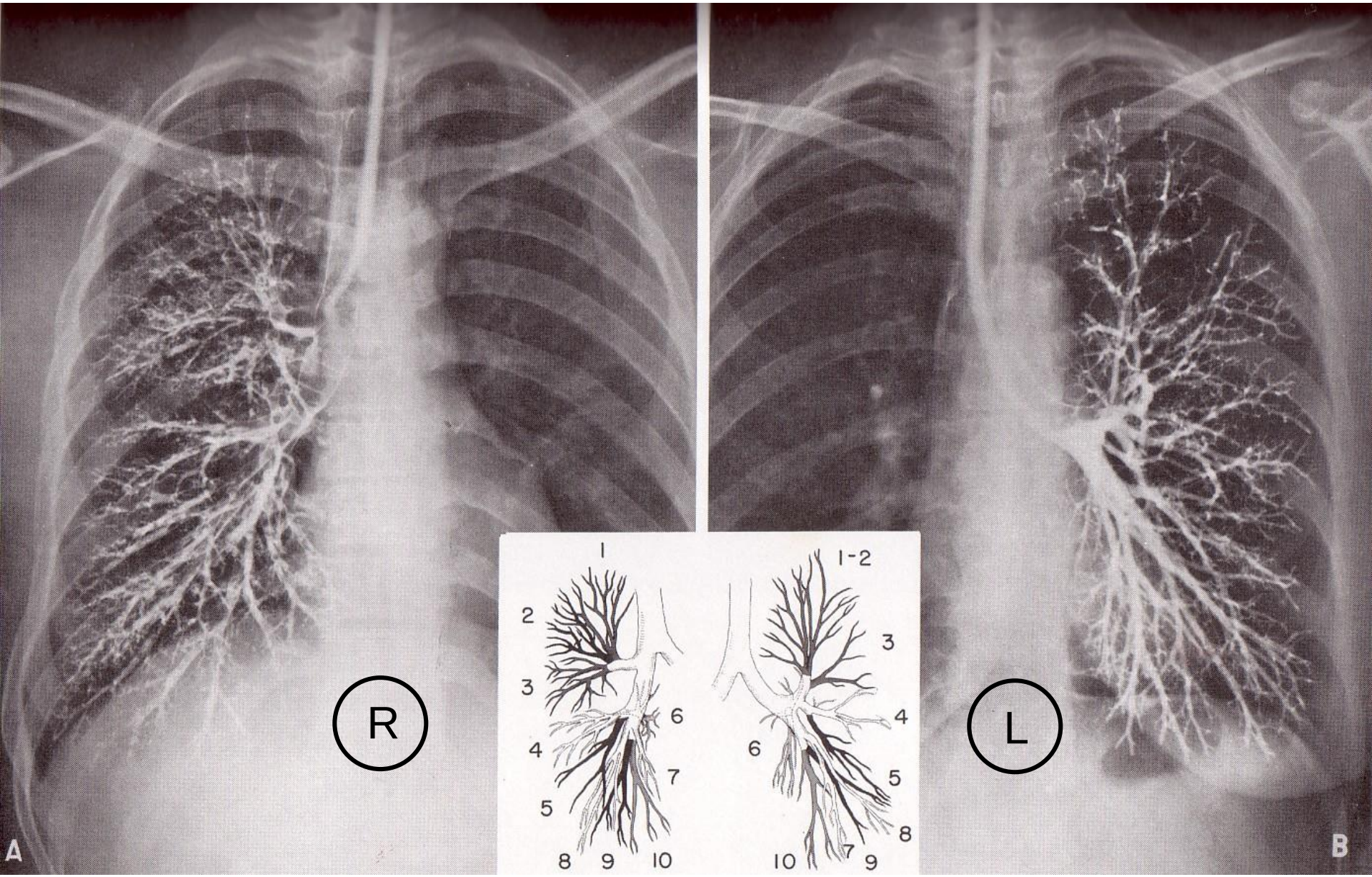
DC 2003


Vocal cords approximate (move closer together) during *Valsalva's* maneuver!
DC 2003

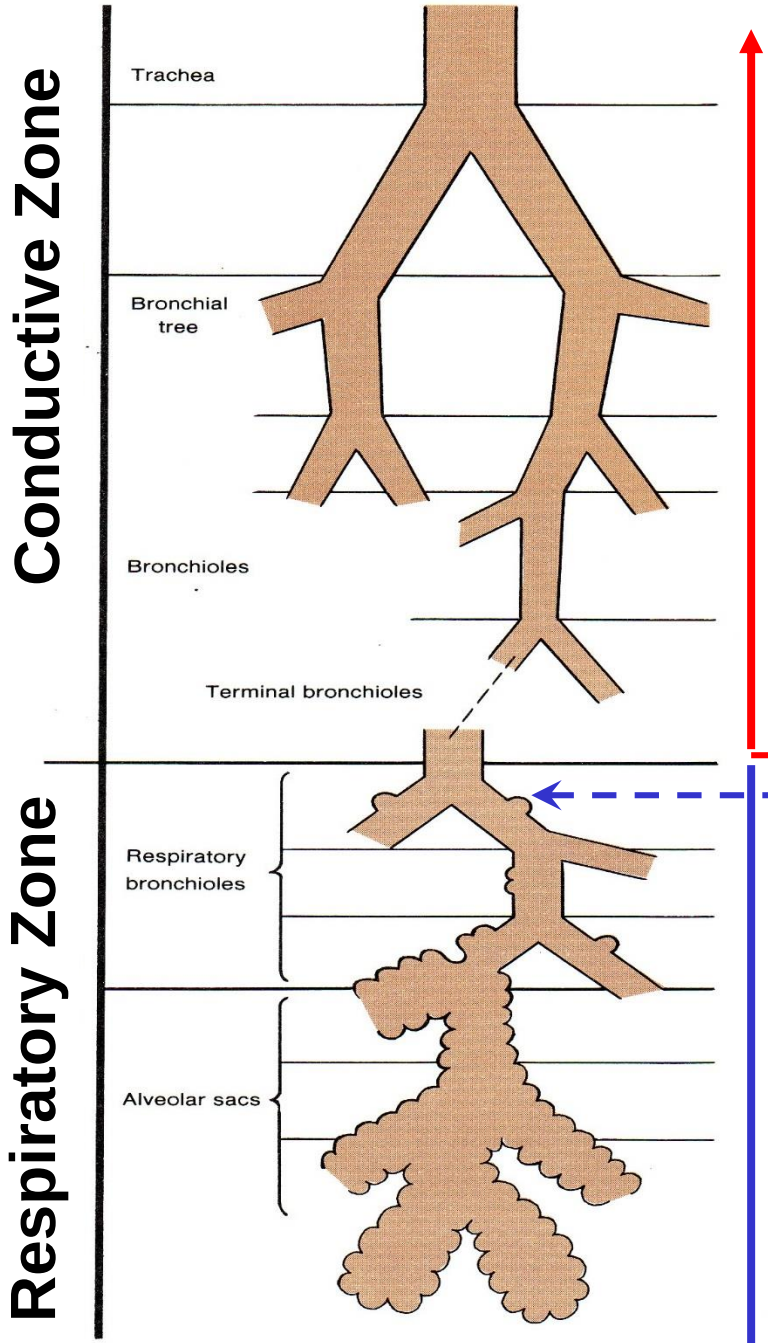
Pulmonary Latex Cast with Colored Segmentation



Bronchograms (posteroanterior)



Source: Gardner, Gray, O'Rahilly, *Anatomy*, fig 29-11, p 295.

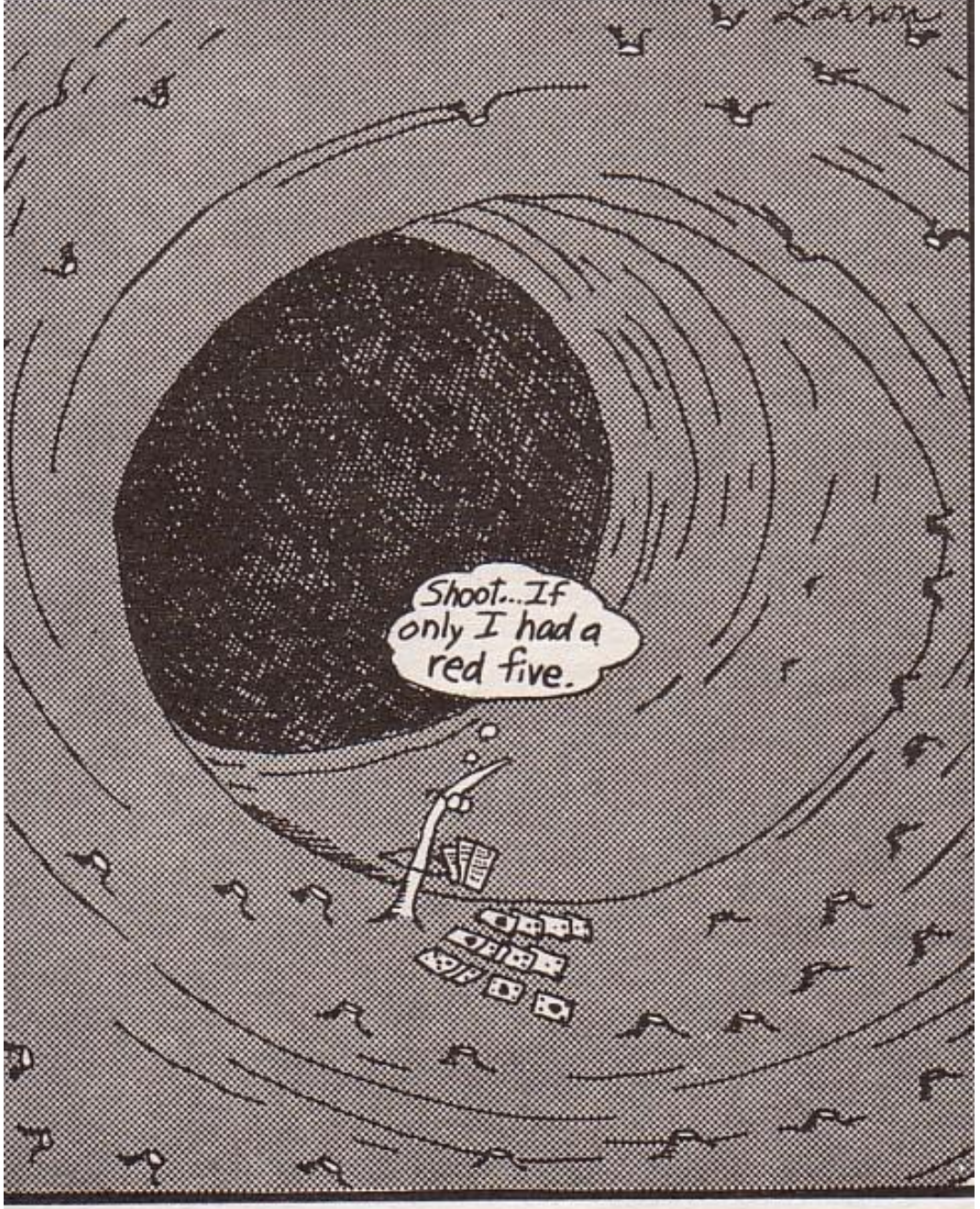


No Gas Exchange

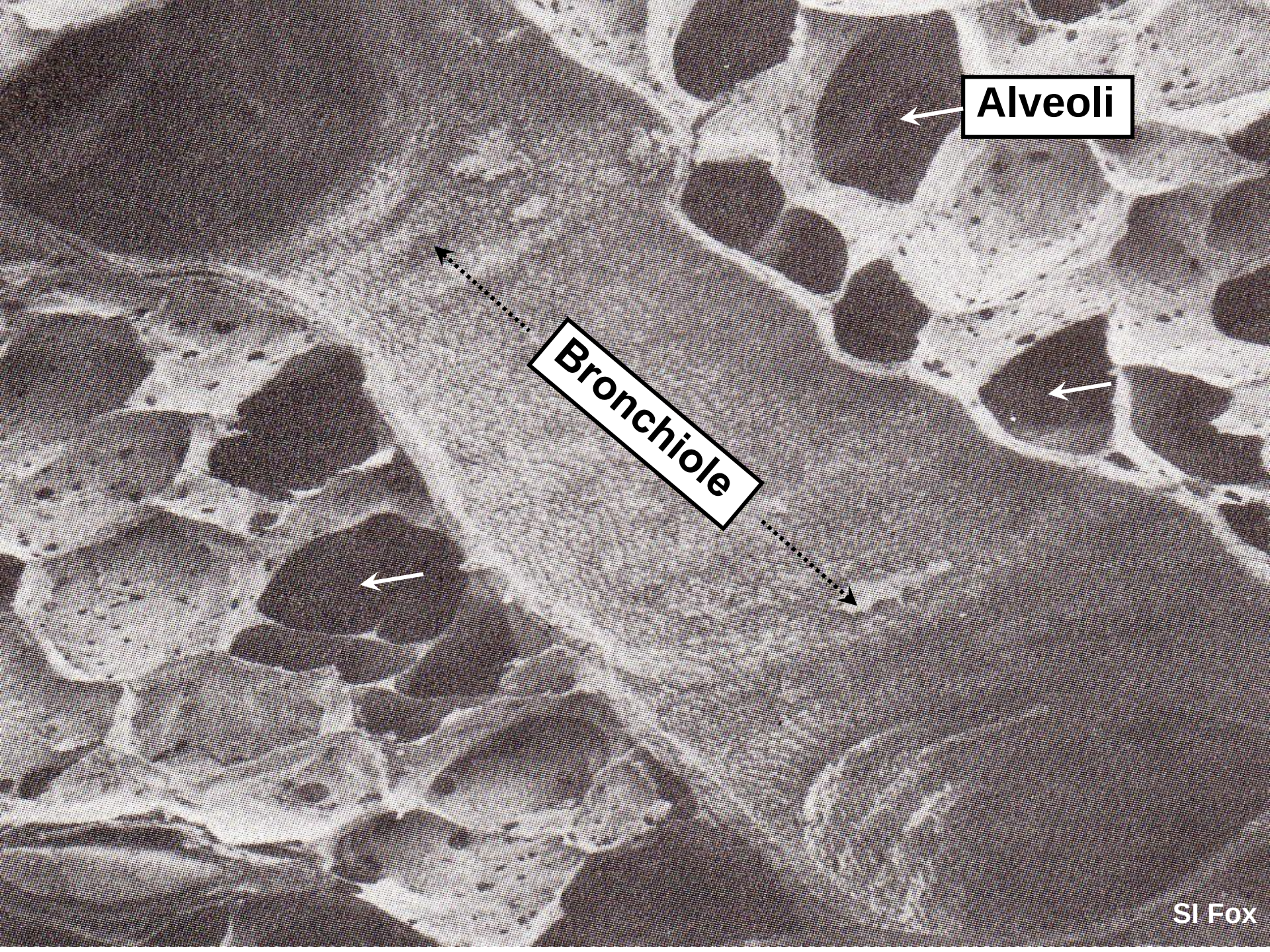
1st alveolar outpouching!

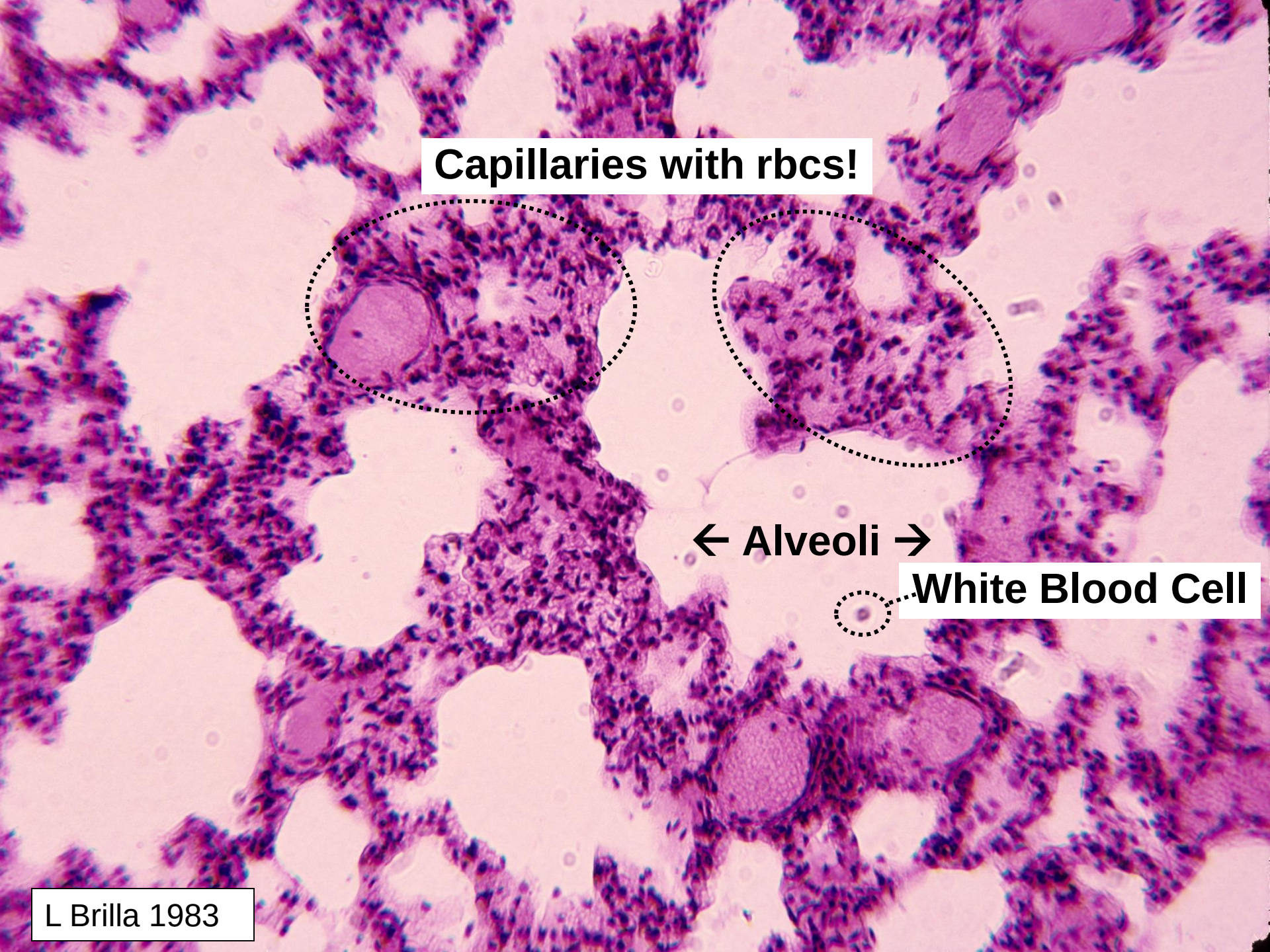
Gas Exchange

SI Fox



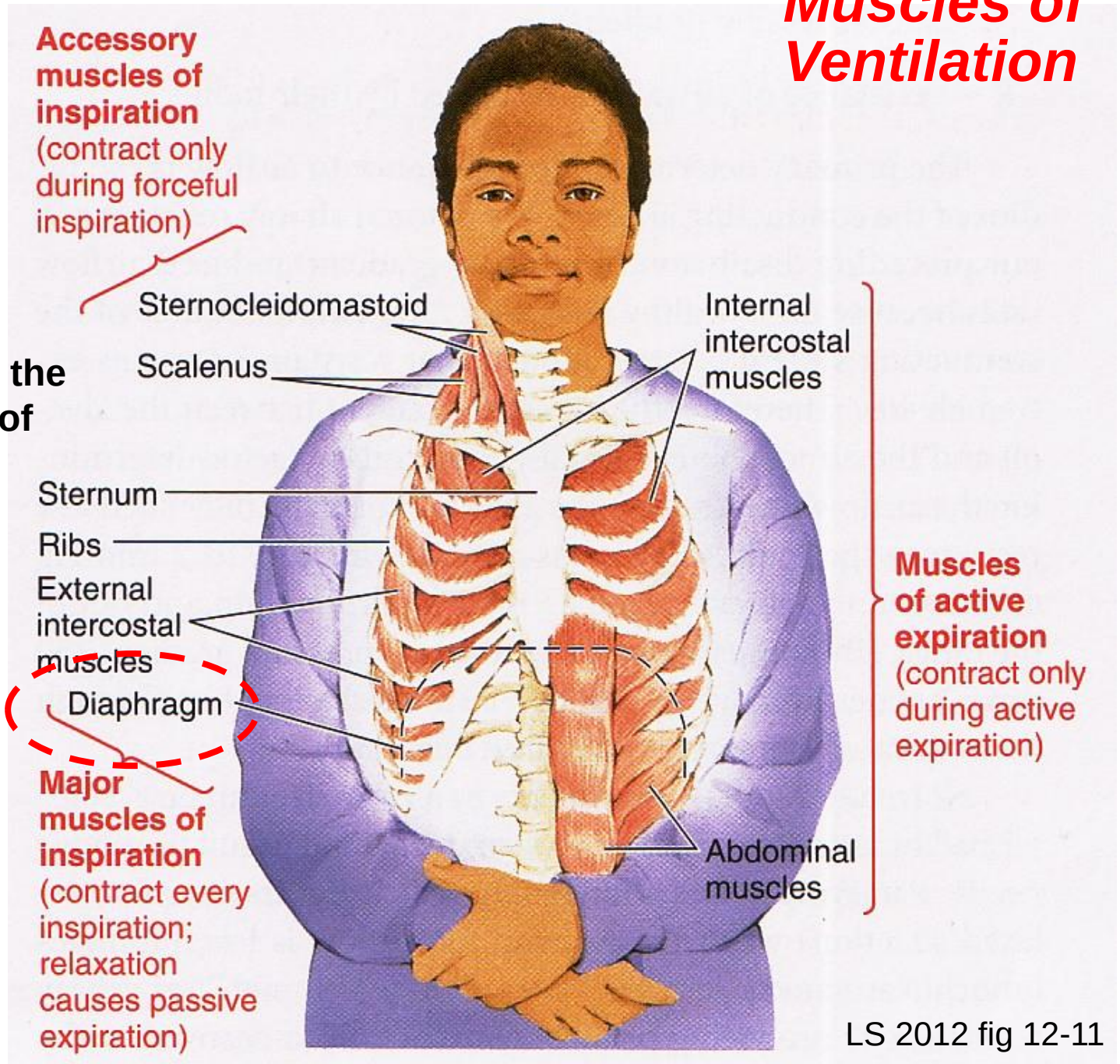
The last cilium on a smoker's lung


Alveoli
Bronchiole
SI Fox

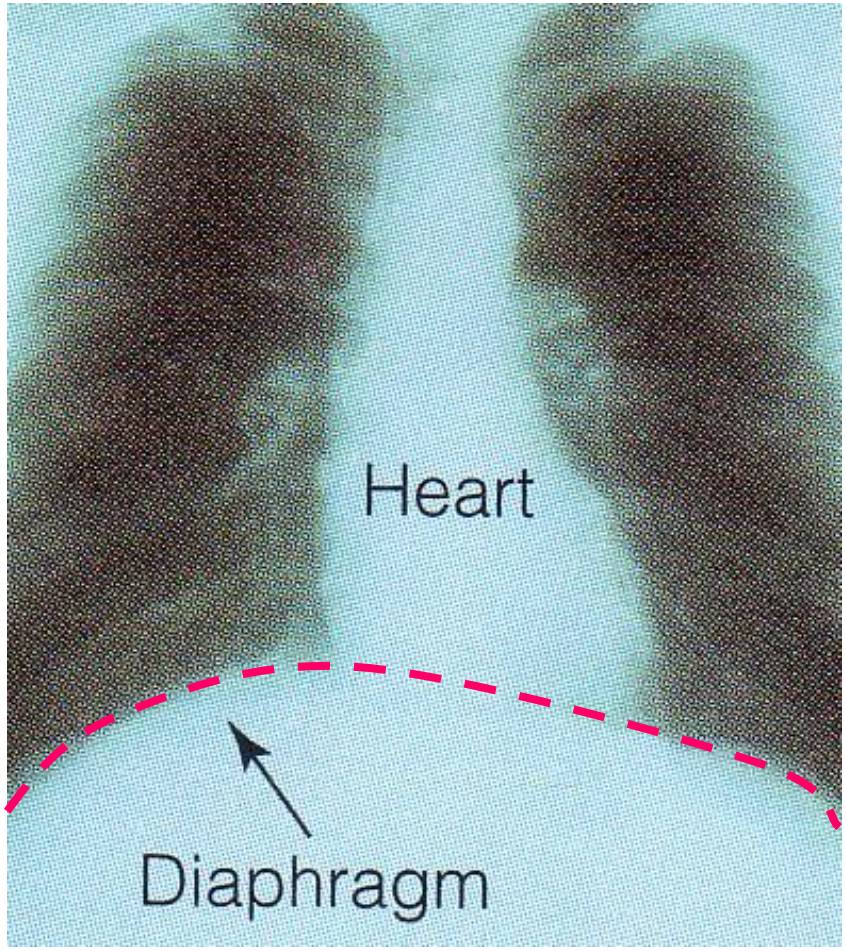

Capillaries with rbcs!
← Alveoli →
White Blood Cell
L Brilla 1983

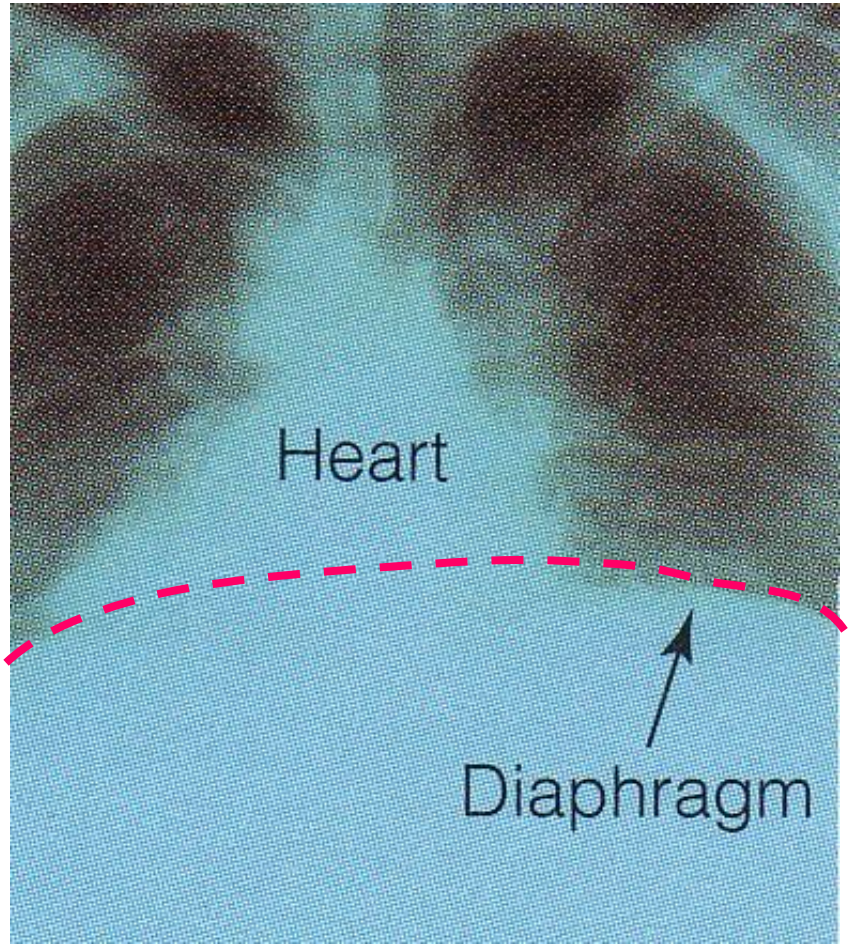
Muscles of Ventilation

NB: Diaphragm is the chief muscle of ventilation!



LS 2012 fig 12-11





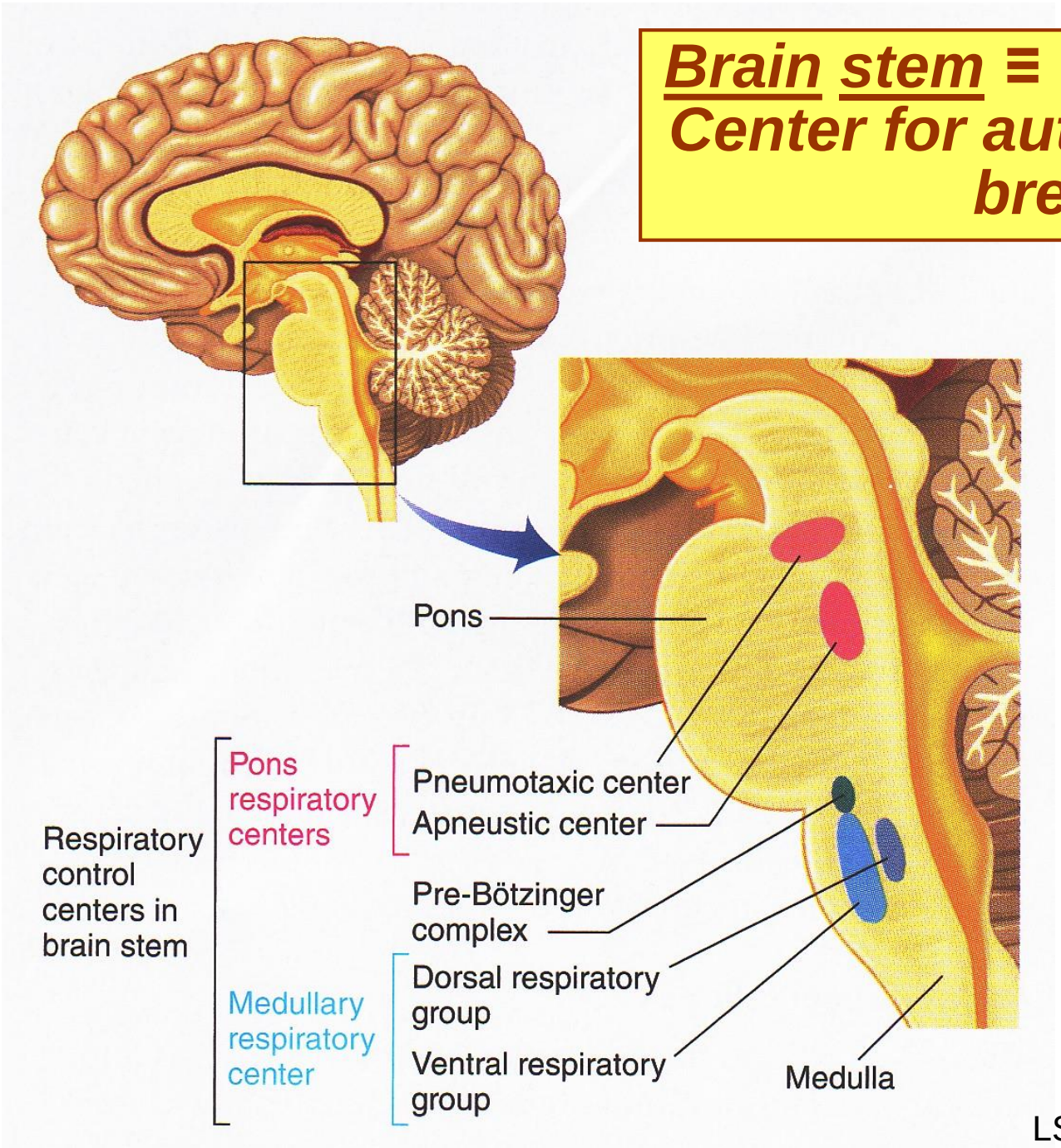
<u>Inhale</u> (active)

<u>Exhale</u> (passive @ rest)

<u>Contract</u> & flatten diaphragm

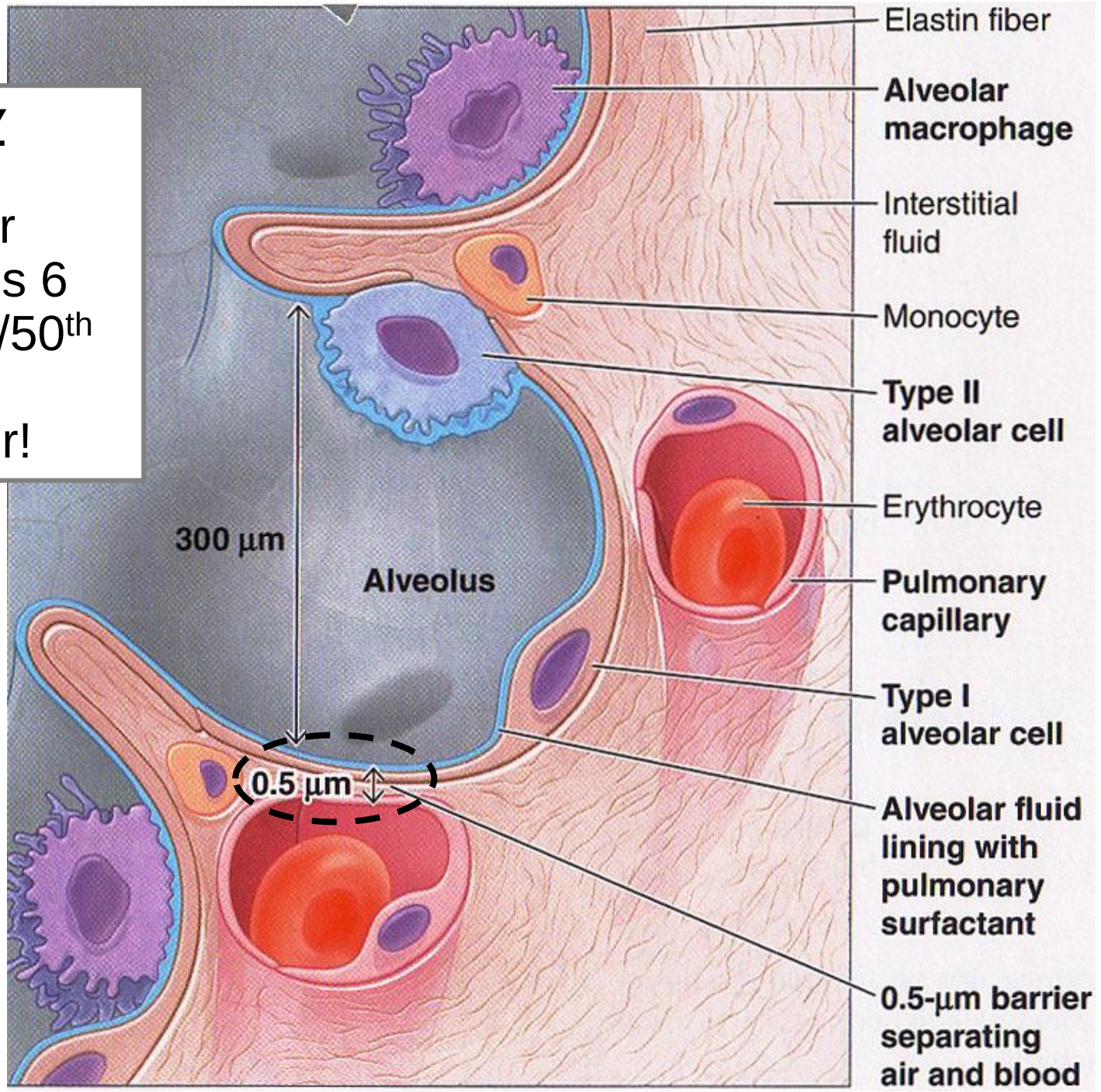
<u>Relax</u> & pouch up diaphragm!

Brain stem ≡ Control Center for automatic breathing!



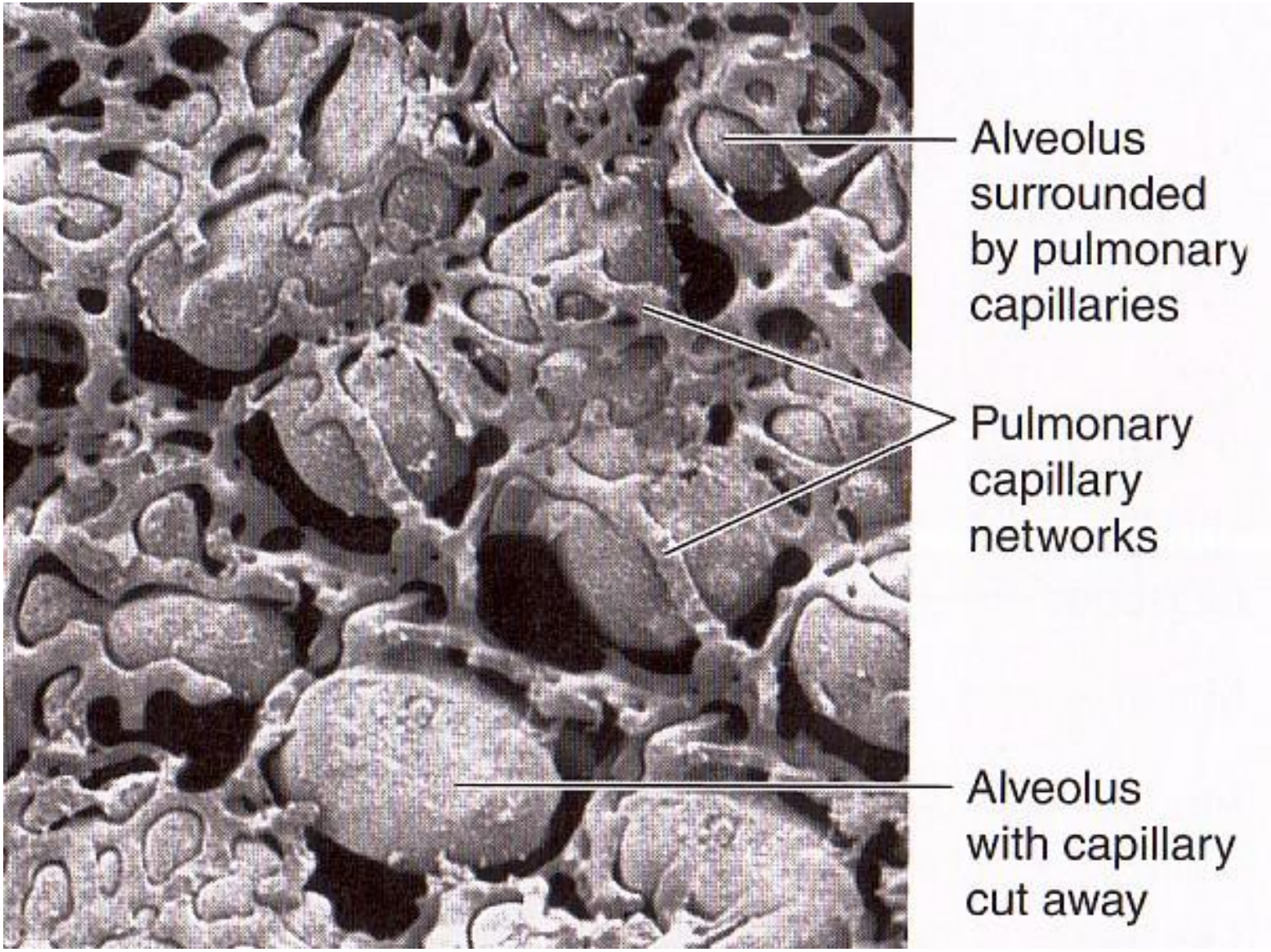
LS 2012 fig 12-25

Respiratory membrane separates air from blood, is 6 layers, yet 1/50th thickness of tracing paper!



LS 2012 fig 12-4a
cf: DC 2013 fig 7-4

Alveoli are surrounded by jackets of capillaries!

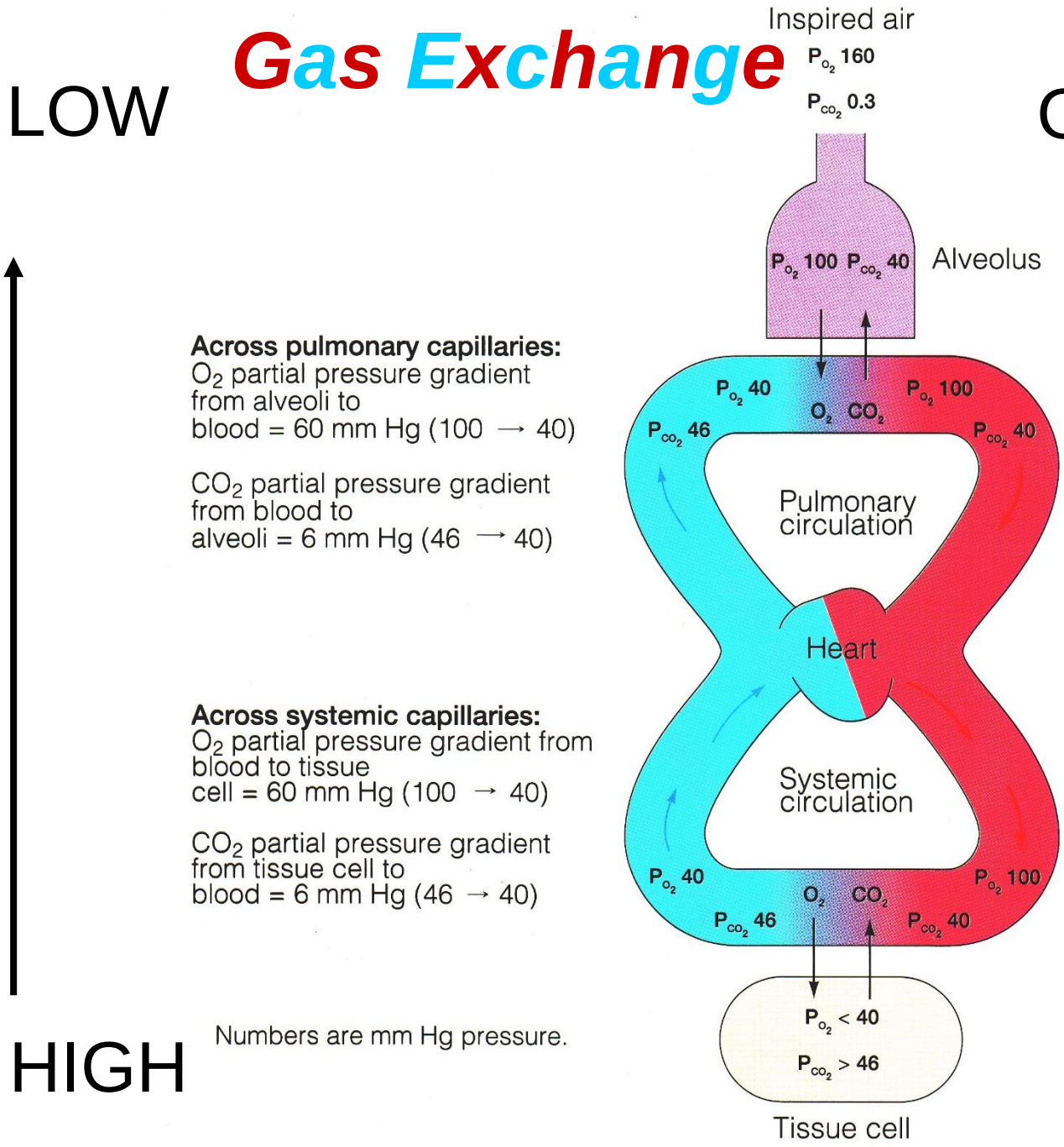


LS 2012 fig 12-4b

Gas Exchange

CO_2 LOW

O_2 HIGH



Across pulmonary capillaries:
O_2 partial pressure gradient from alveoli to blood = 60 mm Hg (100 → 40)

CO_2 partial pressure gradient from blood to alveoli = 6 mm Hg (46 → 40)

Across systemic capillaries:
O_2 partial pressure gradient from blood to tissue cell = 60 mm Hg (100 → 40)

CO_2 partial pressure gradient from tissue cell to blood = 6 mm Hg (46 → 40)

Numbers are mm Hg pressure.

CO_2 HIGH

O_2 LOW

cf: LS 2012 fig 12-19