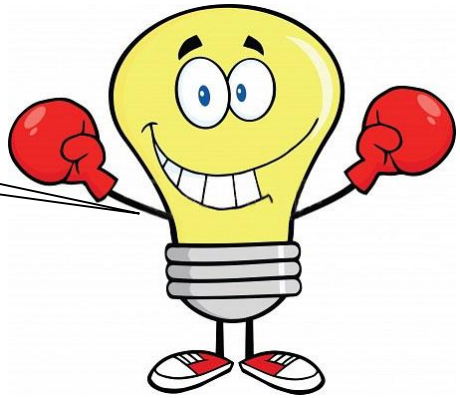
We're on a roll! Bring on Exam II!



Bl 121 Lecture 16

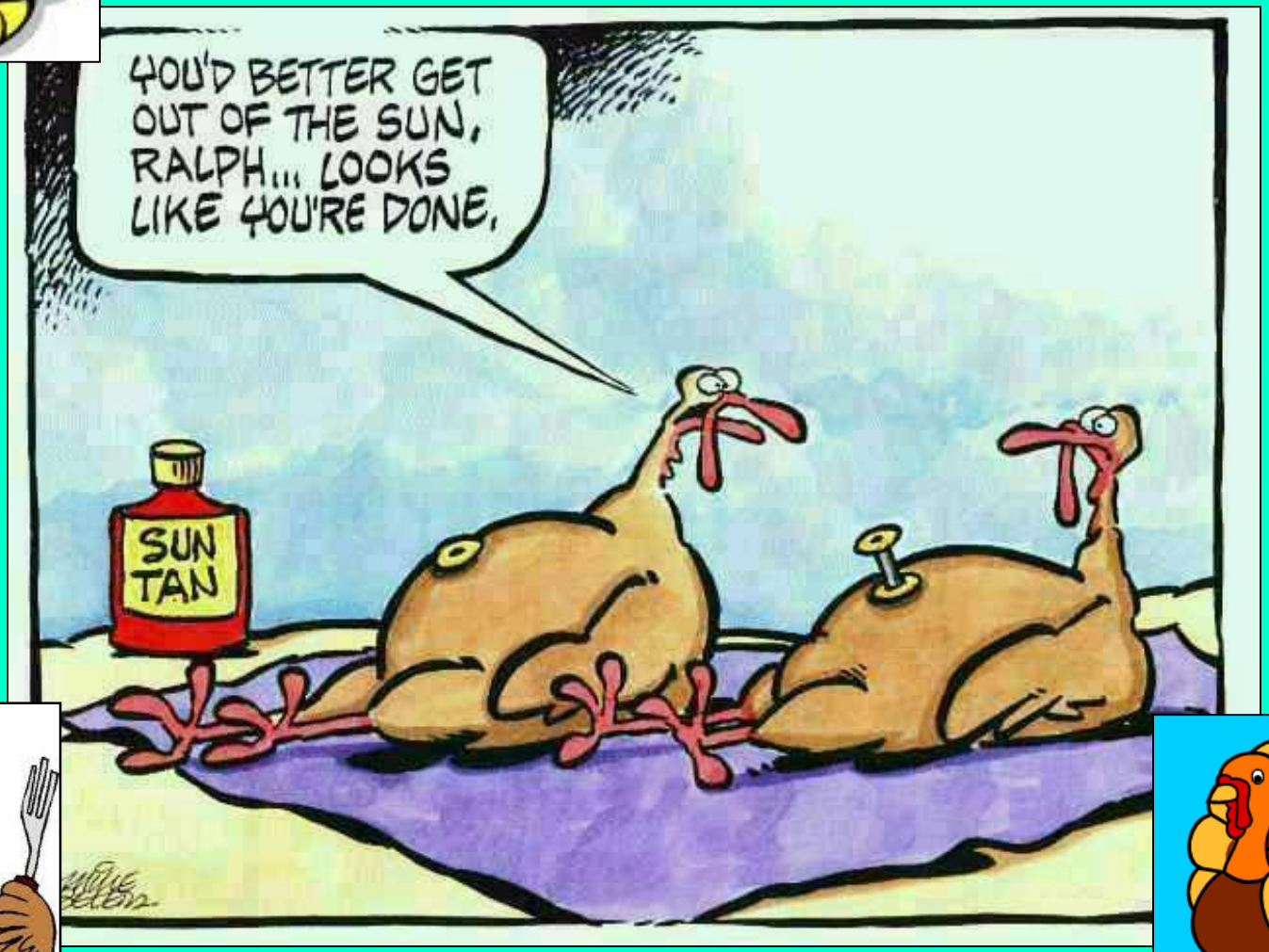
I. ***Announcements*** **Notebooks? Exam II, Dec 7th Wed 8 am. Review session in class next Thursday. Q?**

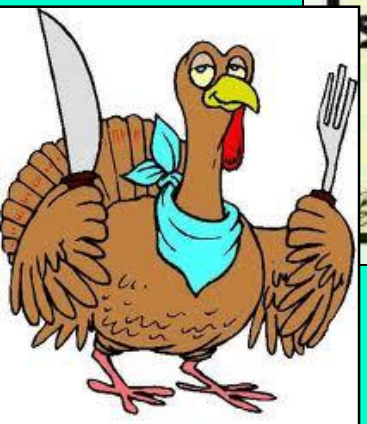
II. ***Muscle + Adaptation Connections*** **LS ch 8, DC Module 12**

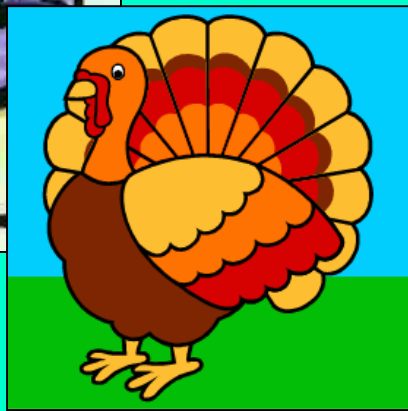
III. ***Respiratory System*** **LS ch 12, DC Module 7, Fox +...**

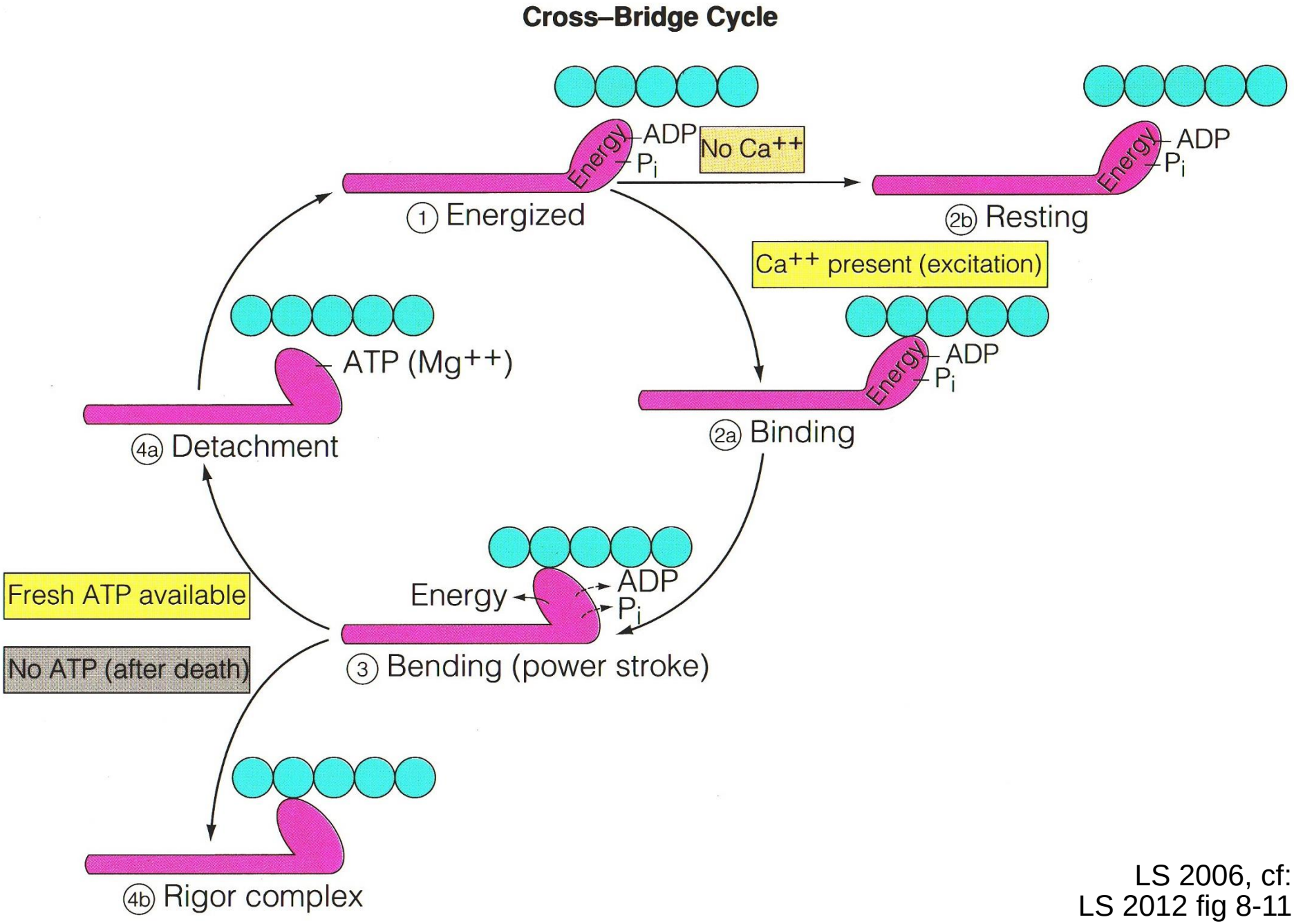
- **A. Steps of respiration? External *vs.* cellular/internal? LS fig 12-1 pp 345-347**
- **B. Respiratory anatomy LS fig 12-2 p 347, DC, Fox +...**
- **C. Histology LS fig 12- 4 pp 347-349, DC**
- **D. How do we breathe? LS fig 12-12, fig 12-25 pp 349-356, pp 373-378**
- **E. Gas exchange LS fig 12-19 pp 362-5**
- **F. Gas transport LS tab 12-3 pp 365-70**

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



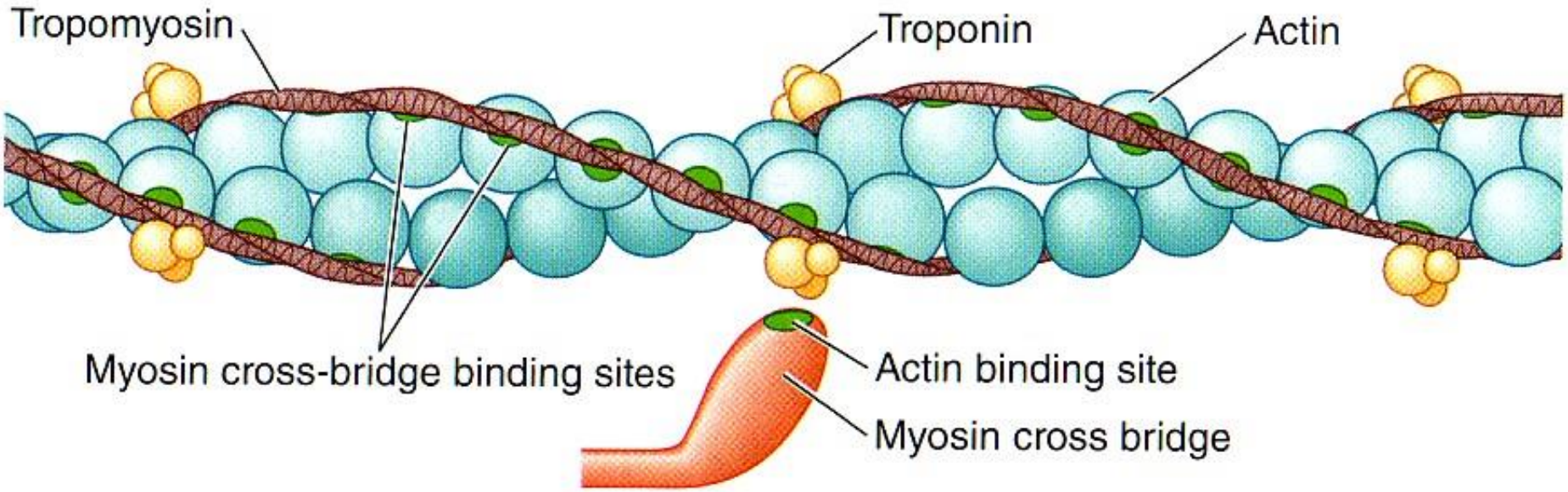






LS 2006, cf:
LS 2012 fig 8-11

Relaxed: No Cross-Bridge Binding



(a) Relaxed

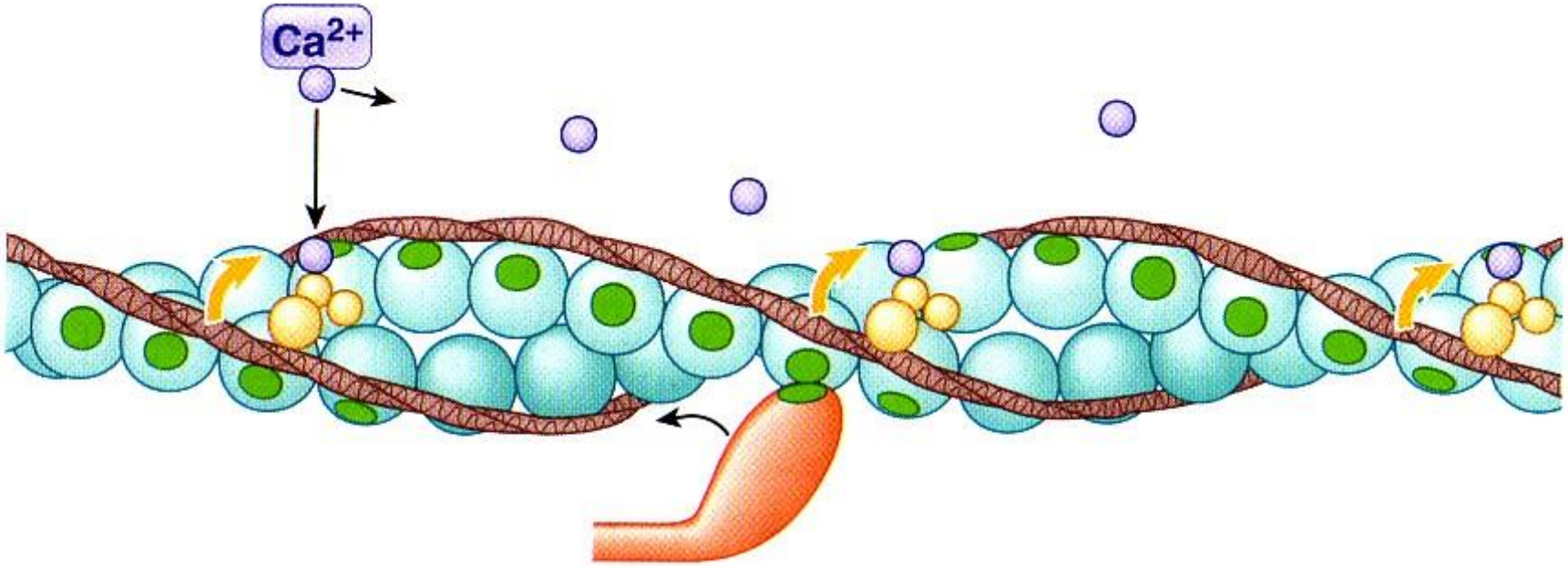
1. No excitation.

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.

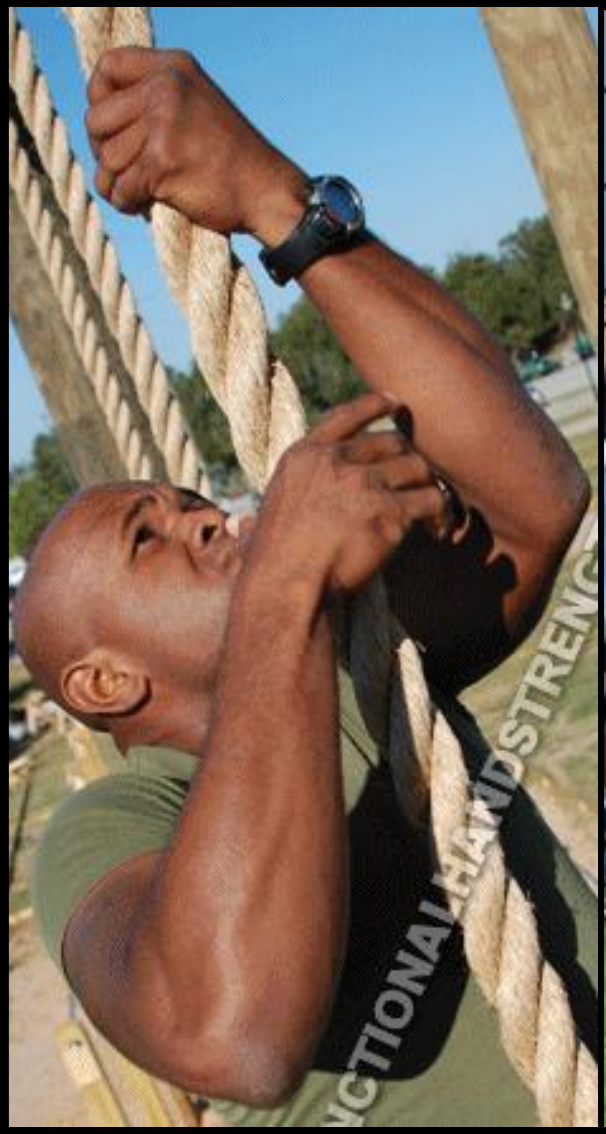
2. Released Ca^{2+} binds with troponin, pulling troponin–tropomyosin complex aside to expose cross-bridge binding site.

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

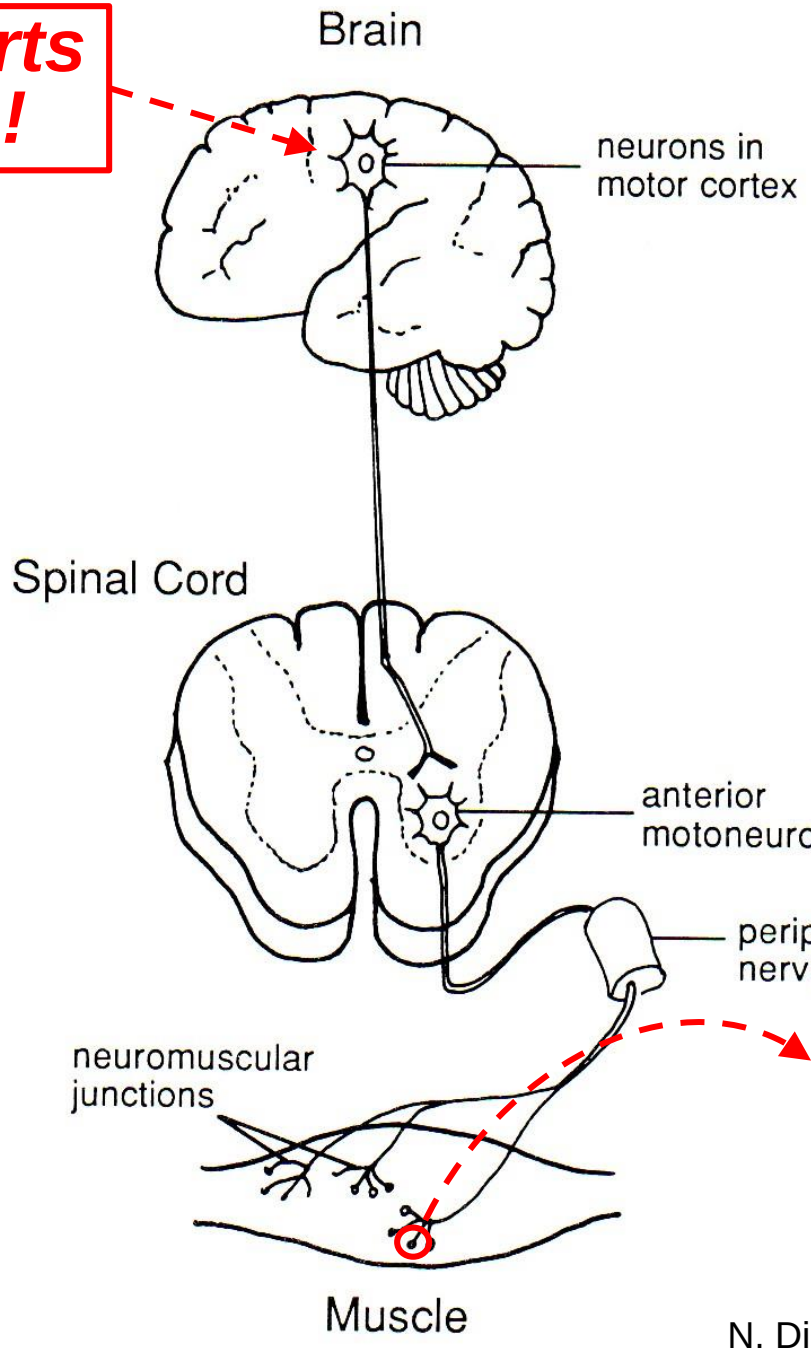
Rope Climb or Tug of War
Grasp, then Regrasp!



Muscle Contraction

Summary

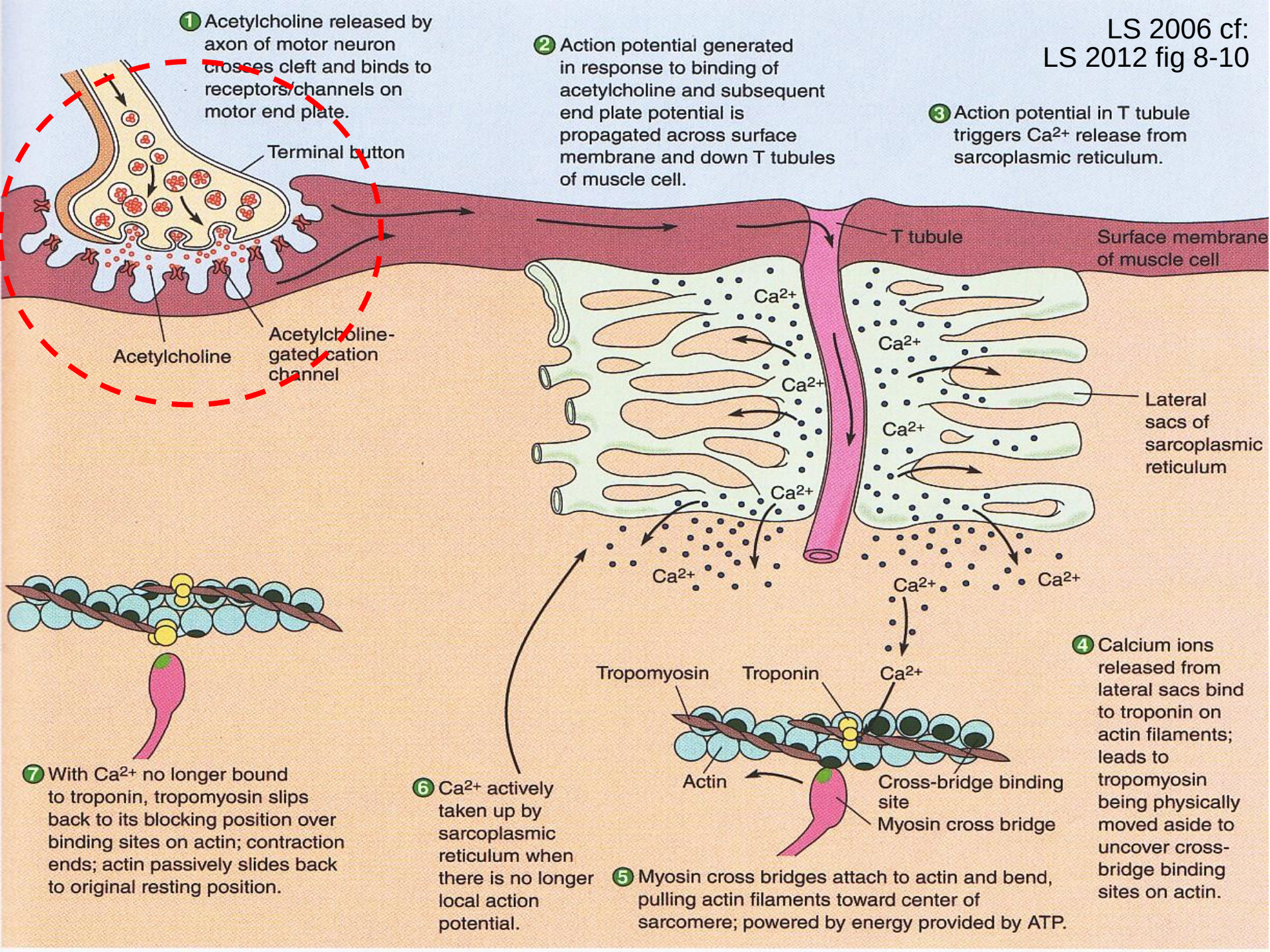
1st signal starts in the brain!



Let's look @ one bouton & one muscle fiber!

N. Diann Laing & VP Lombardi, 1989.

LS 2006 cf:
LS 2012 fig 8-10



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

muscleanimation.mov

http://www.youtube.com/watch?v=BMT4PtXRCVA

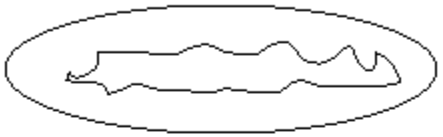
http://highered.mcgraw-hill.com/sites/0072495855/student_view0/chapter10/animation__action_potentials_and_muscle_contraction.html

A. Malcolm Campbell
Davidson College, Davidson, NC

www.bio.davidson.edu/courses/movies.html
http://www.bio.davidson.edu/misc/movies/musclcp.mov

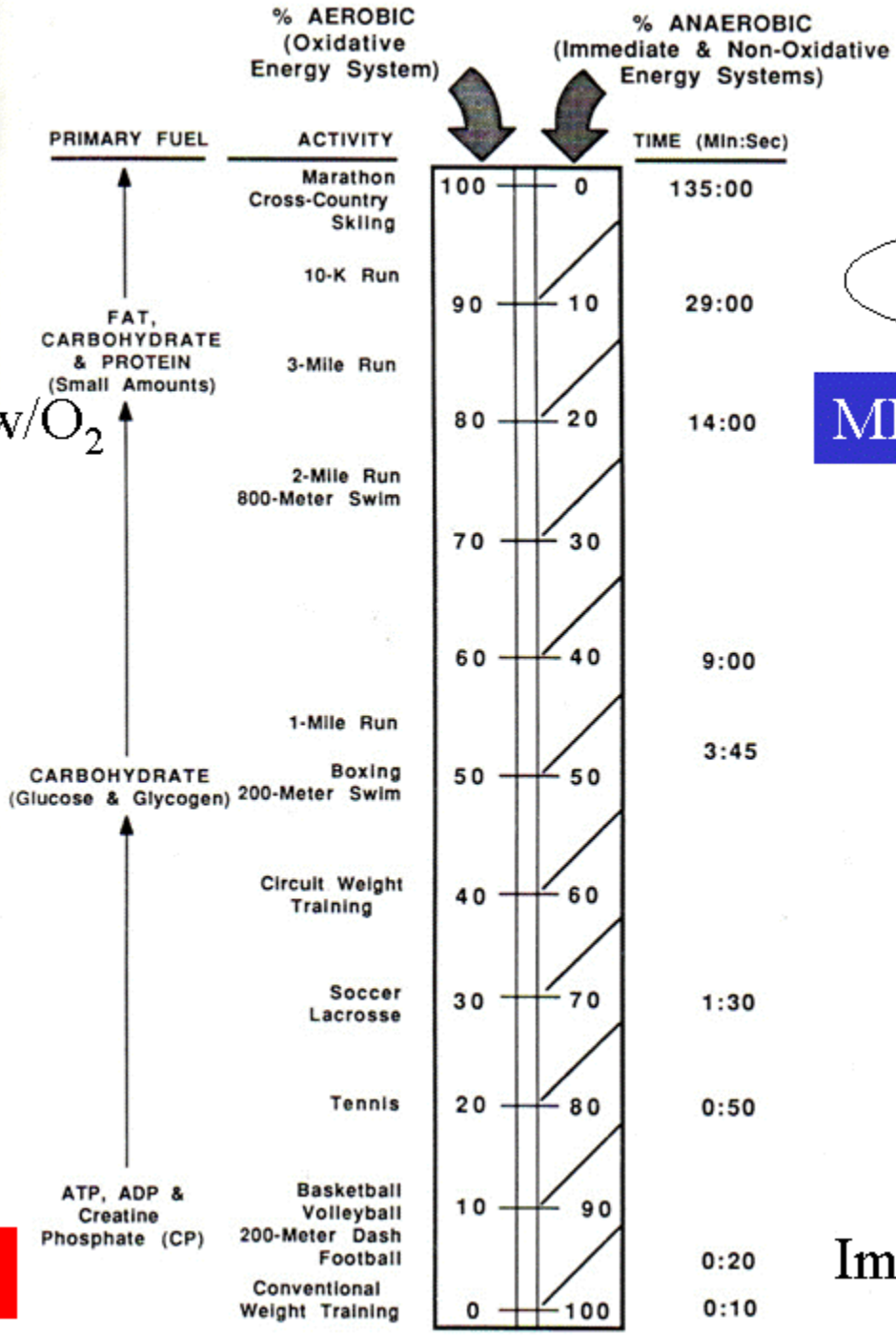
Musclcp.mov

AEROBIC w/O_2



MITOCHONDRIA

ANAEROBIC



CYTOSOL

Glycolysis

Immediate/ATP-PC

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

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)?

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 (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?

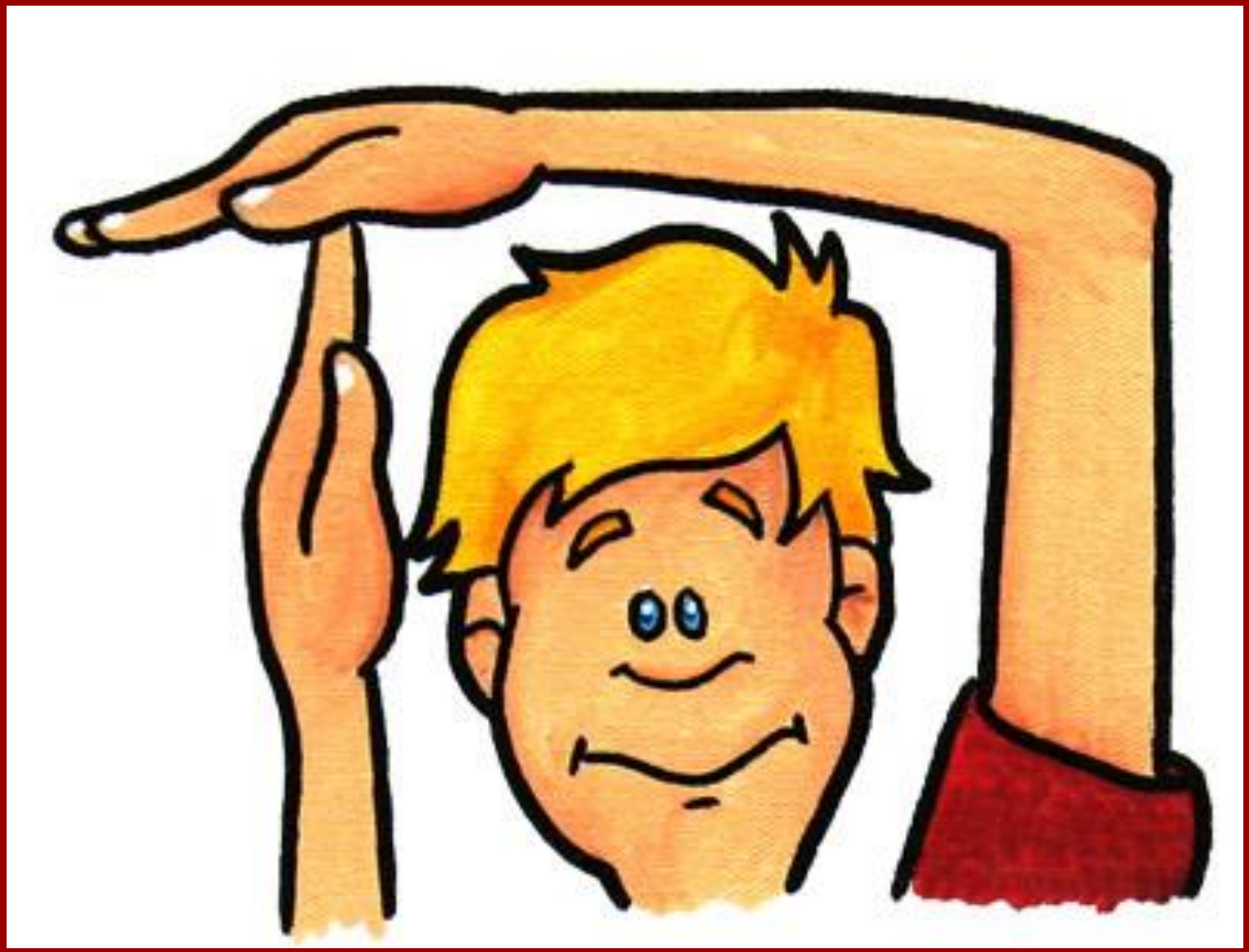
cf:


45

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

Extremes of the energy continuum!

Time-out for discussion!



Lombo's simplified steps!

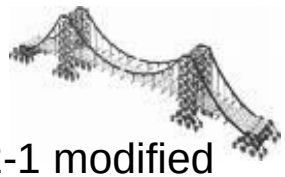
1 **Breathe in & out!**

2 **Cross membranes!**

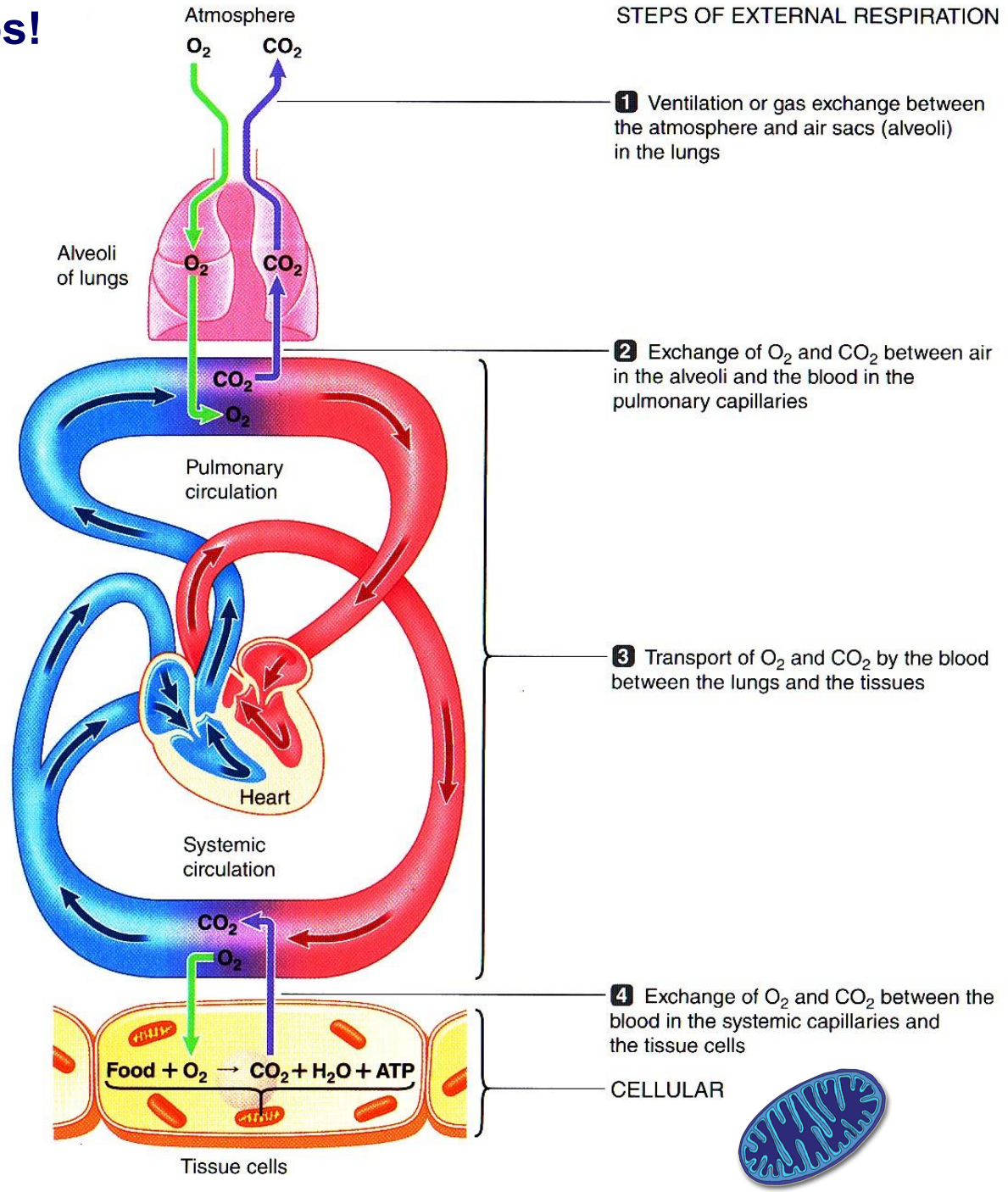
3 **Move with blood!**

Go with the flow!

4 **Cross membranes!**

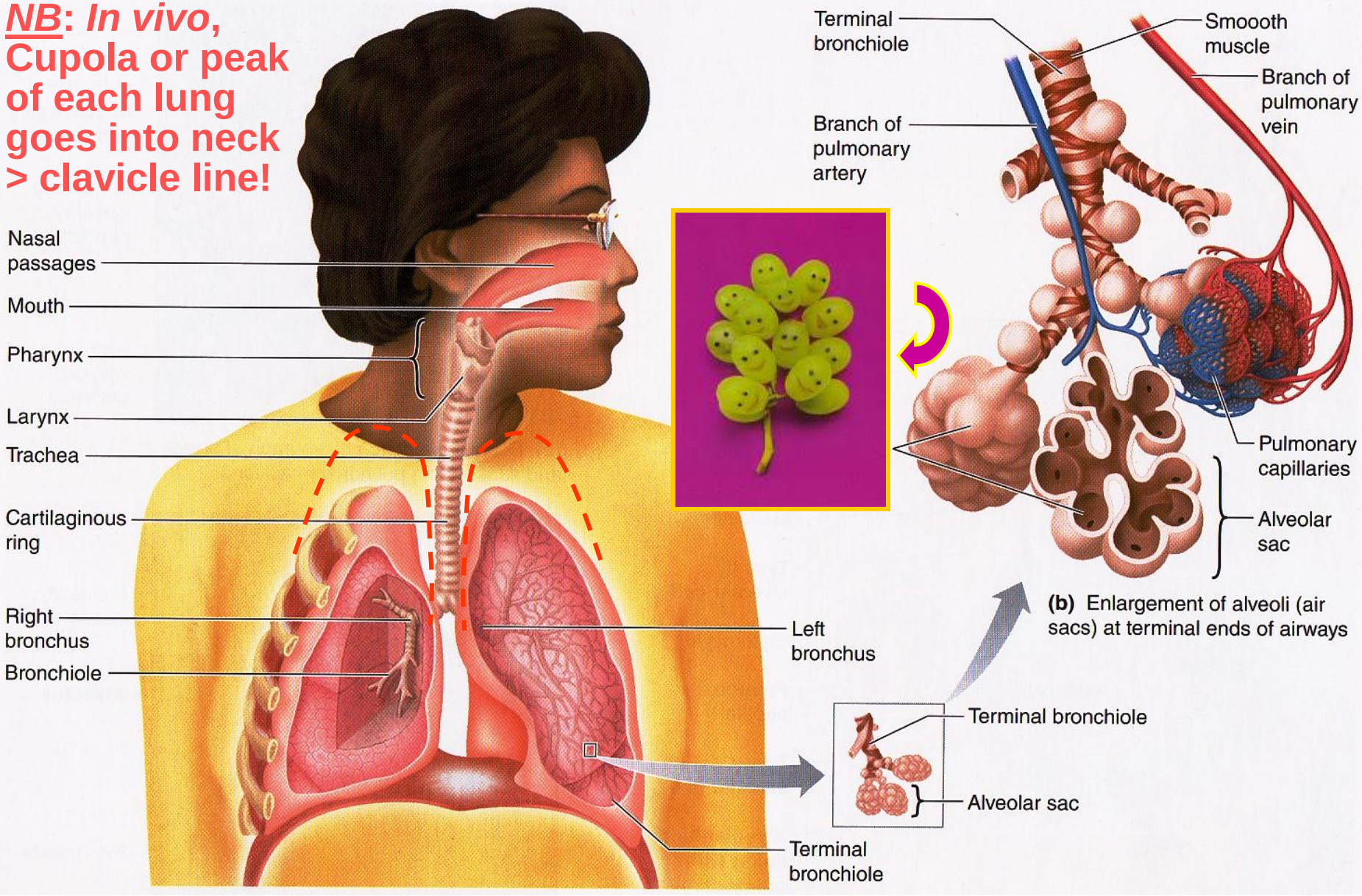


LS 2012 fig 12-1 modified



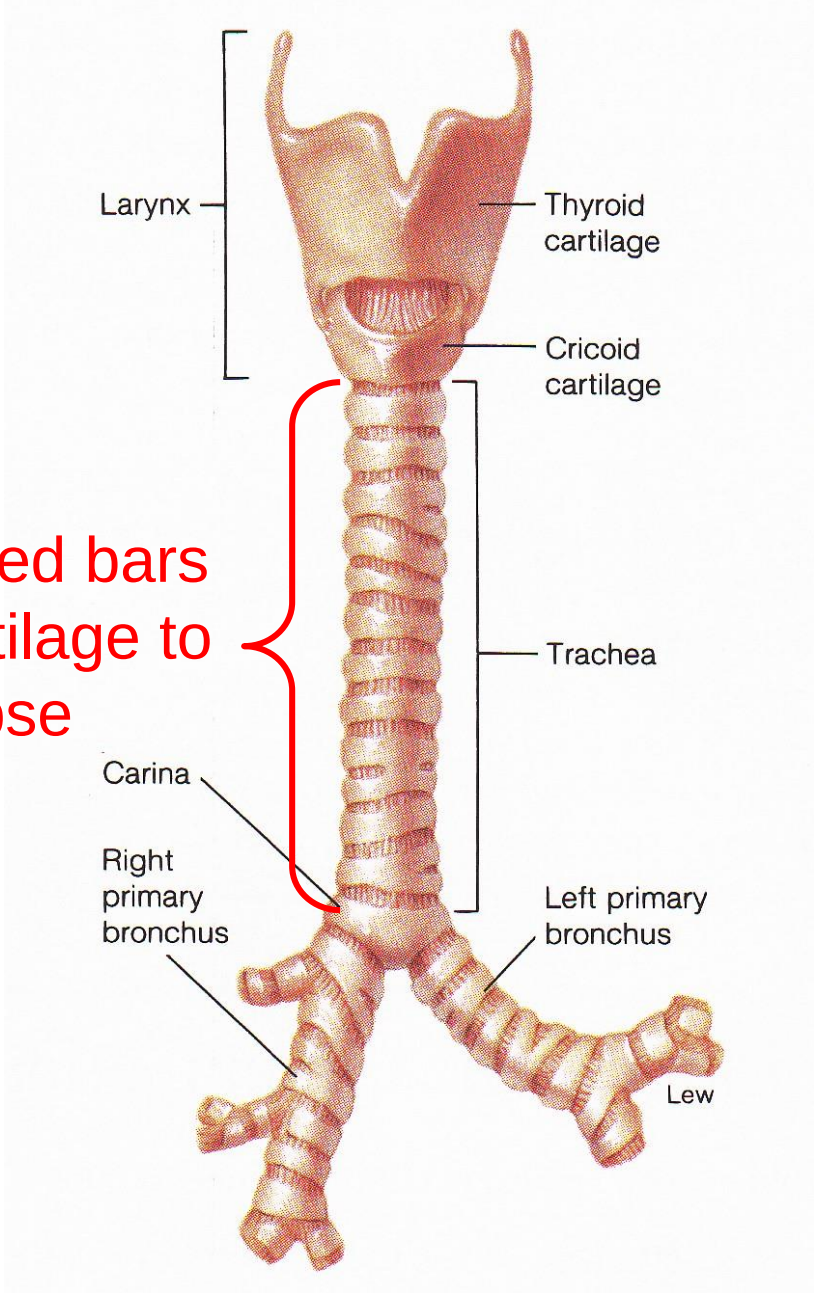
Respiratory System Anatomy

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

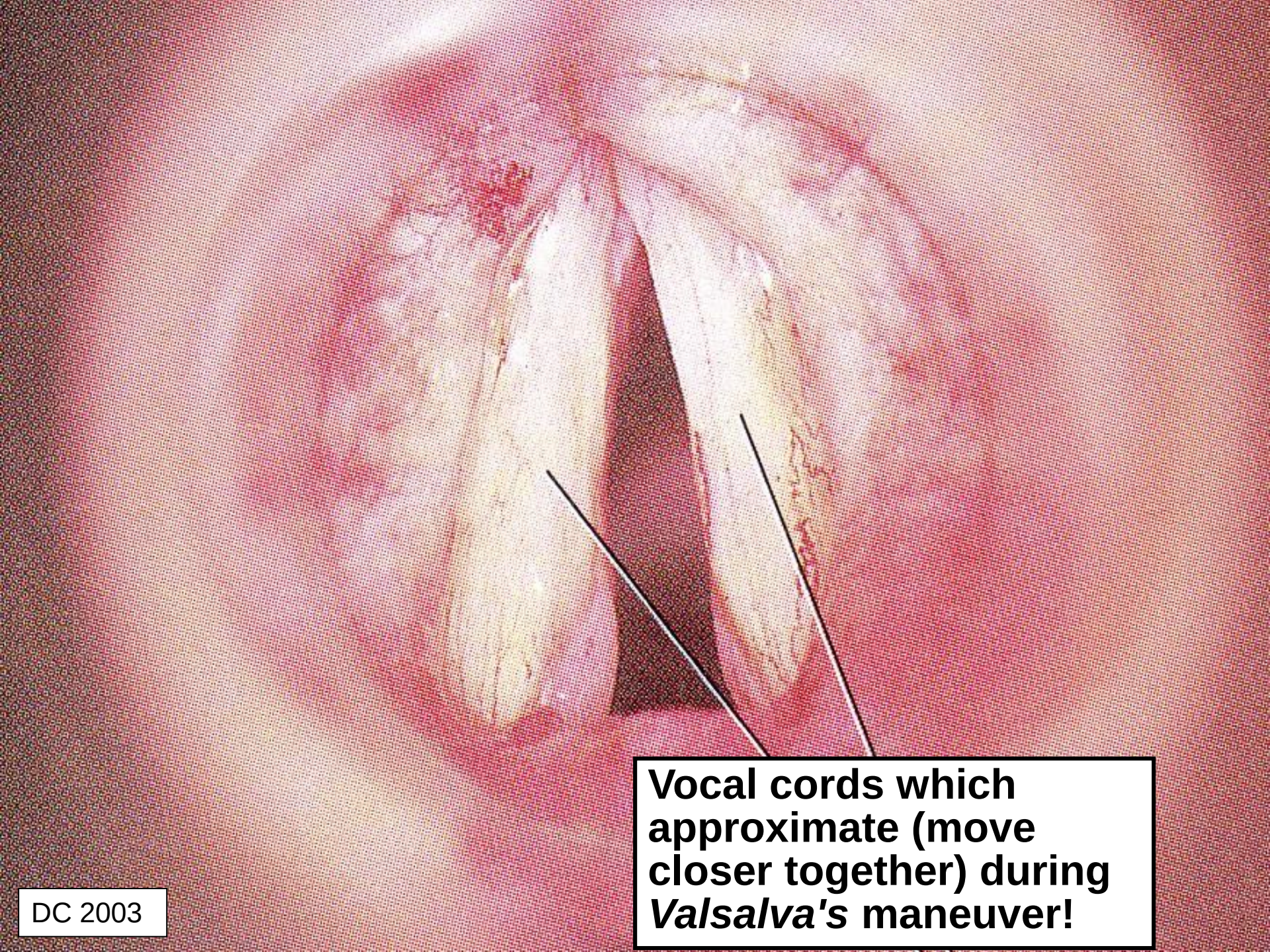


LS 2012 fig 12-2

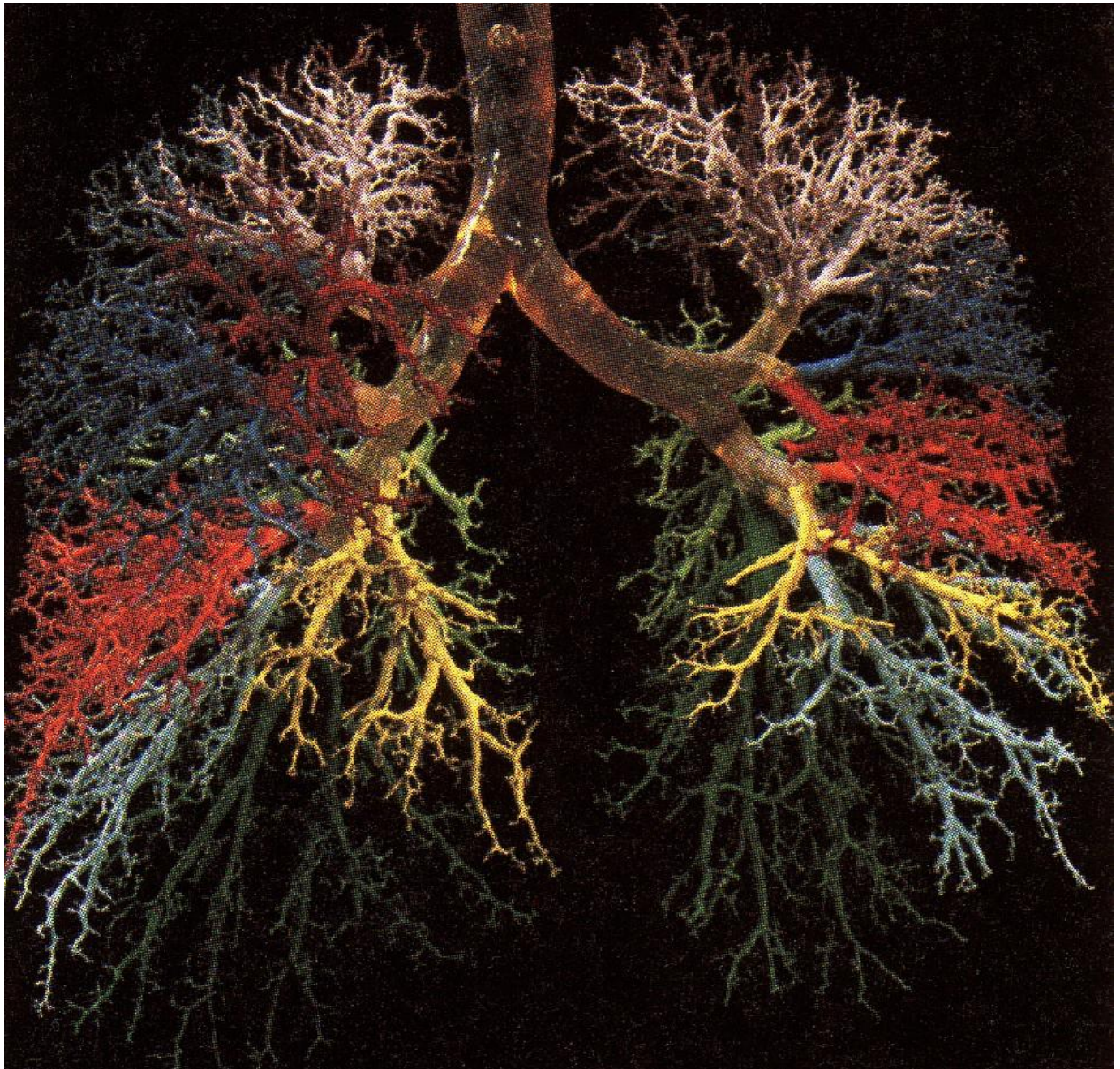
16-20 C-shaped bars of hyaline cartilage to prevent collapse



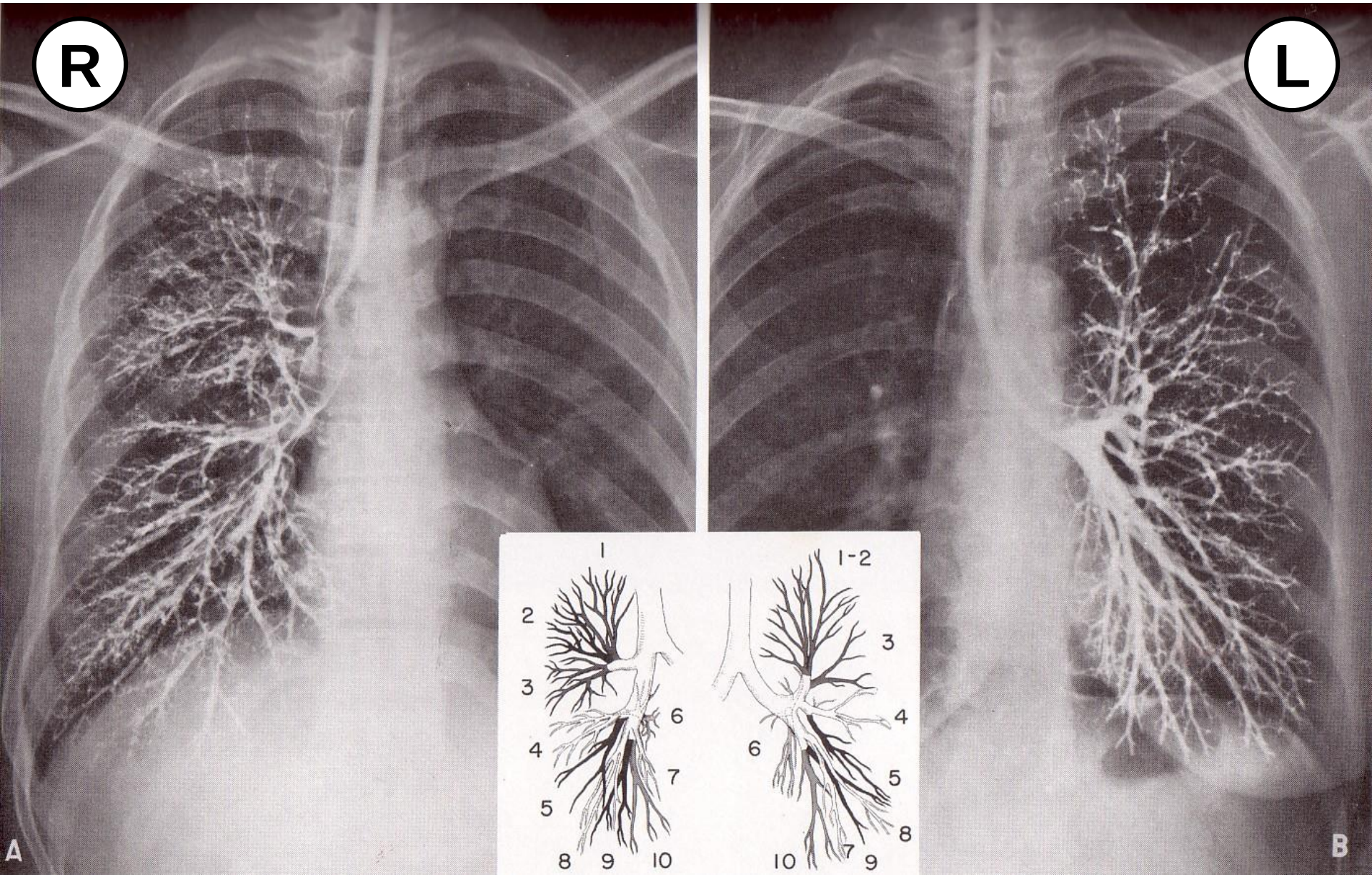
DC 2003


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

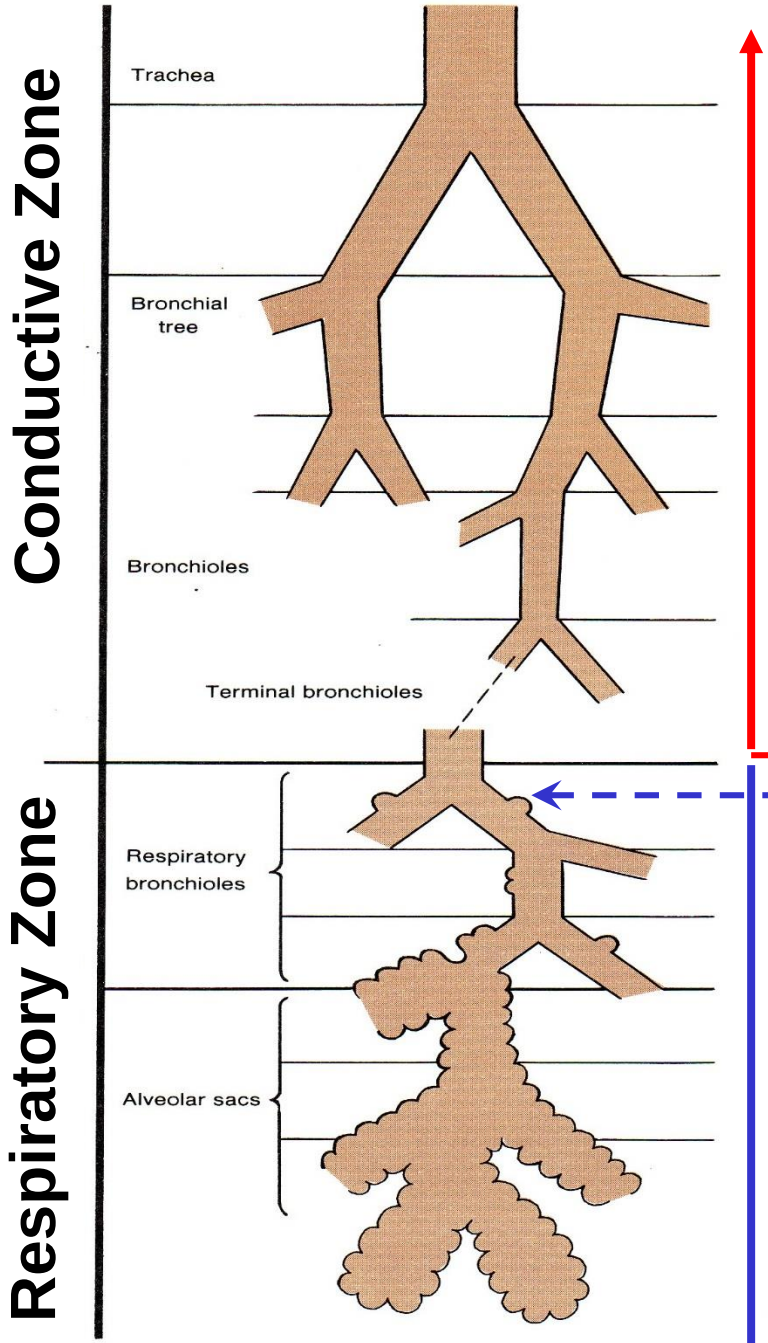
Pulmonary Latex Cast with Colored Segmentation



***Bronchograms*: bronchial tree x-rays > injecting contrast**



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

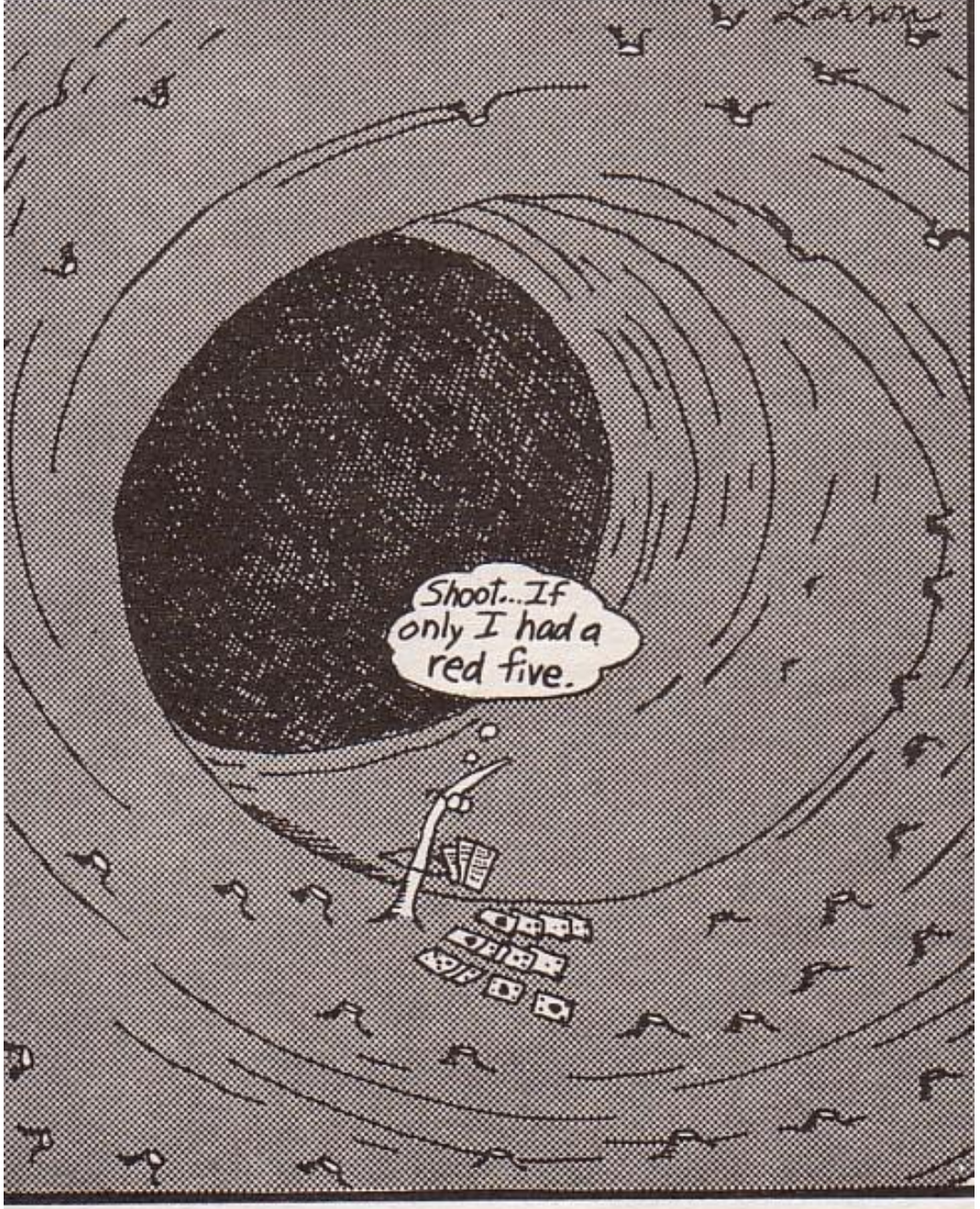


No Gas Exchange

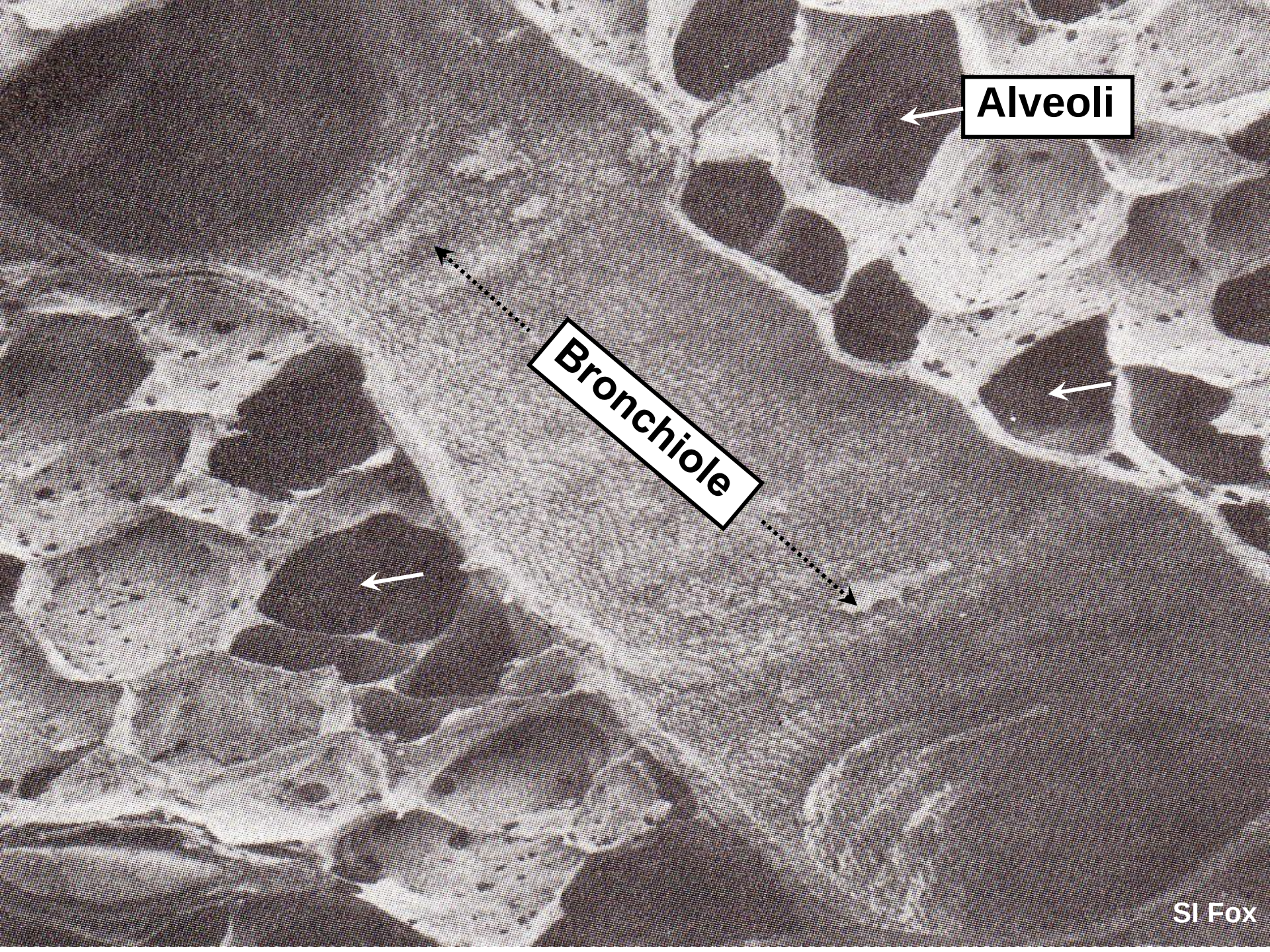
1st alveolar outpouching!

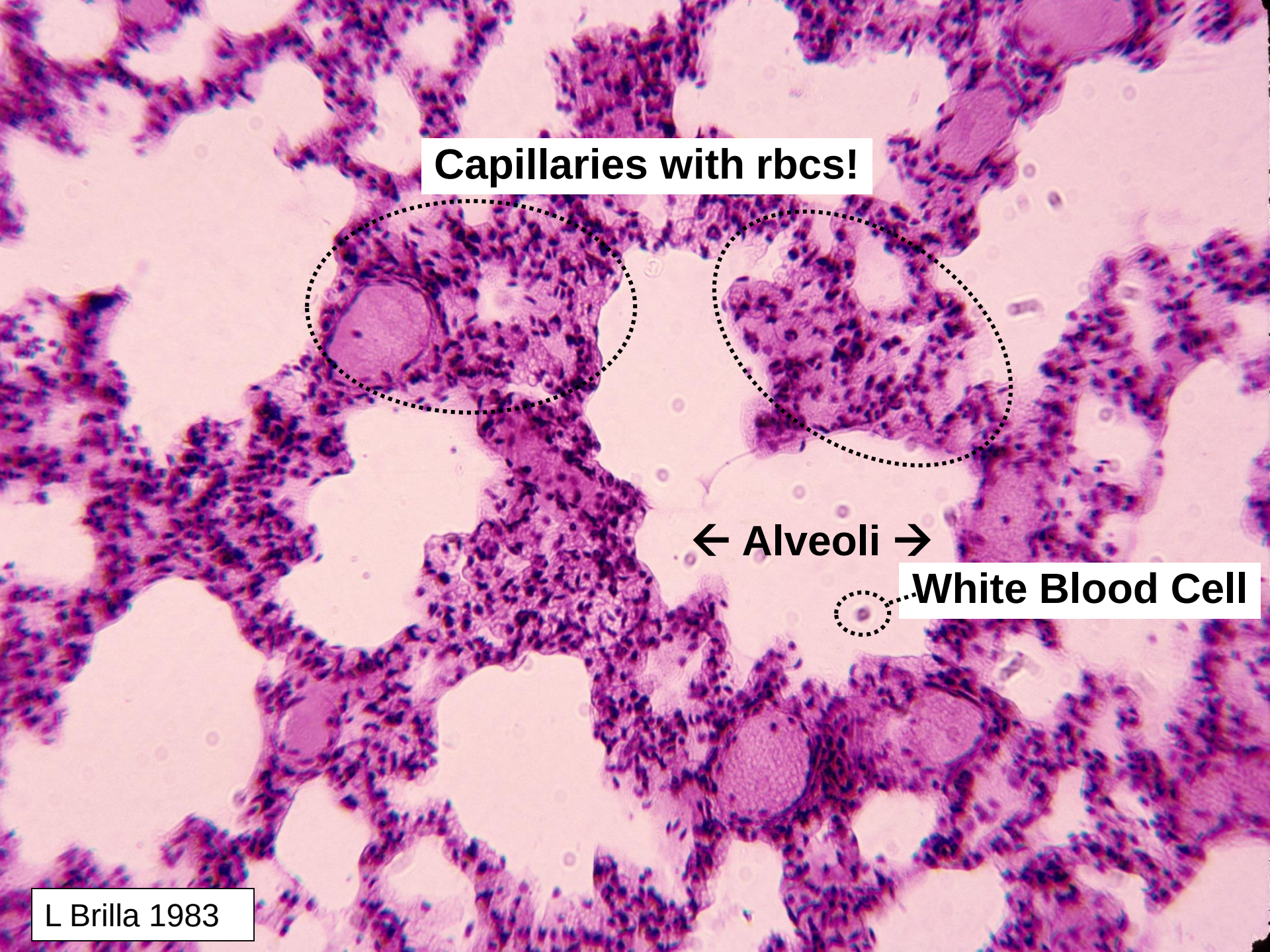
Gas Exchange

SI Fox



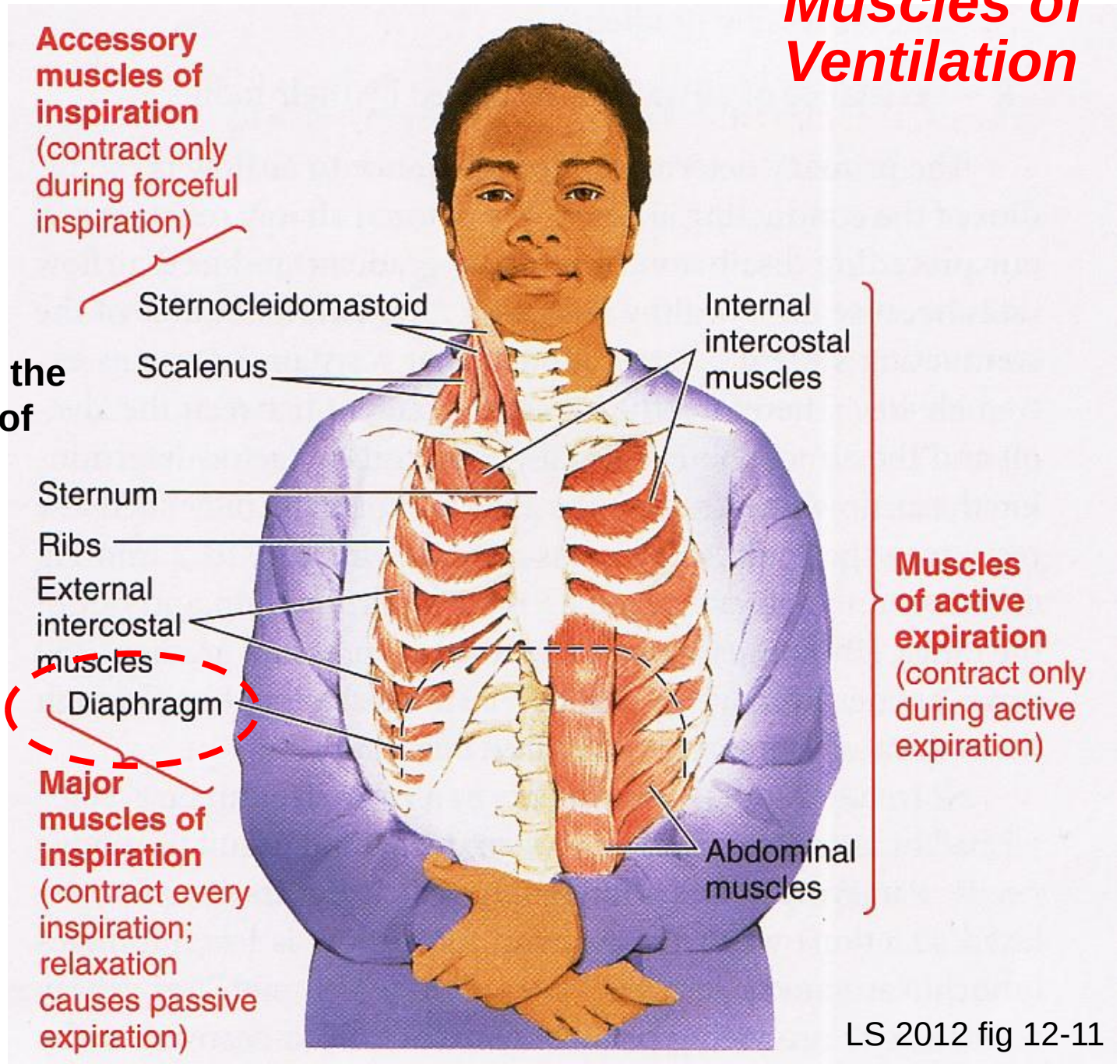
The last cilium on a smoker's lung


Alveoli
Bronchiole
SI Fox

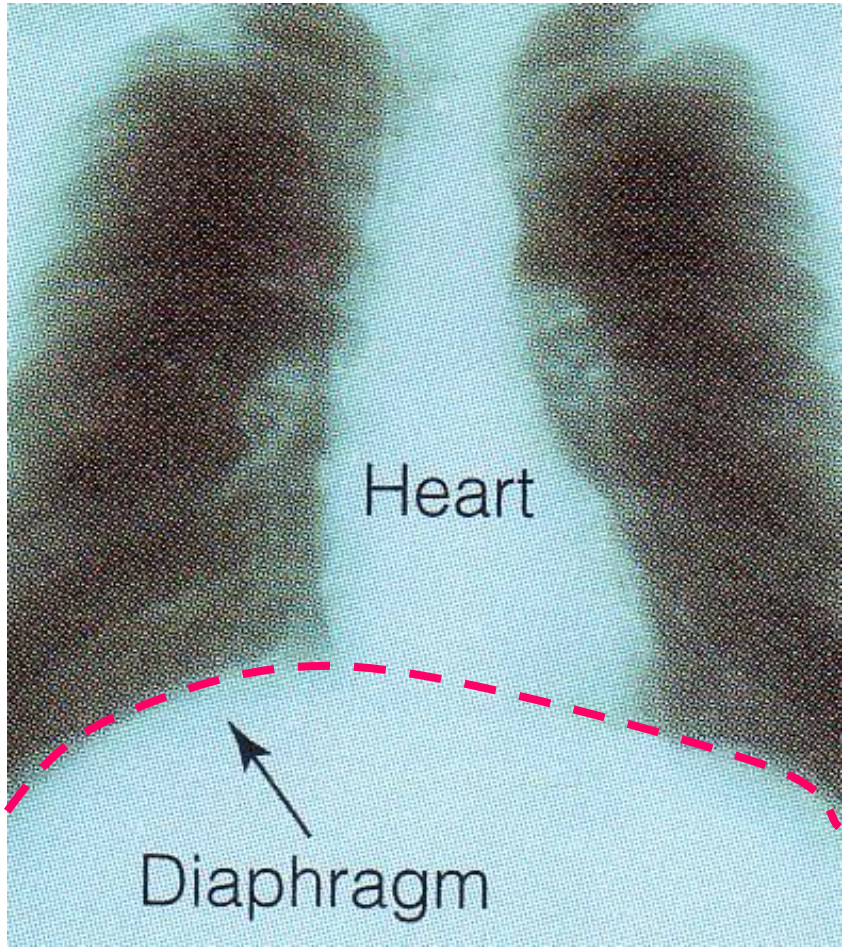

Capillaries with rbcs!
← Alveoli →
White Blood Cell
L Brilla 1983

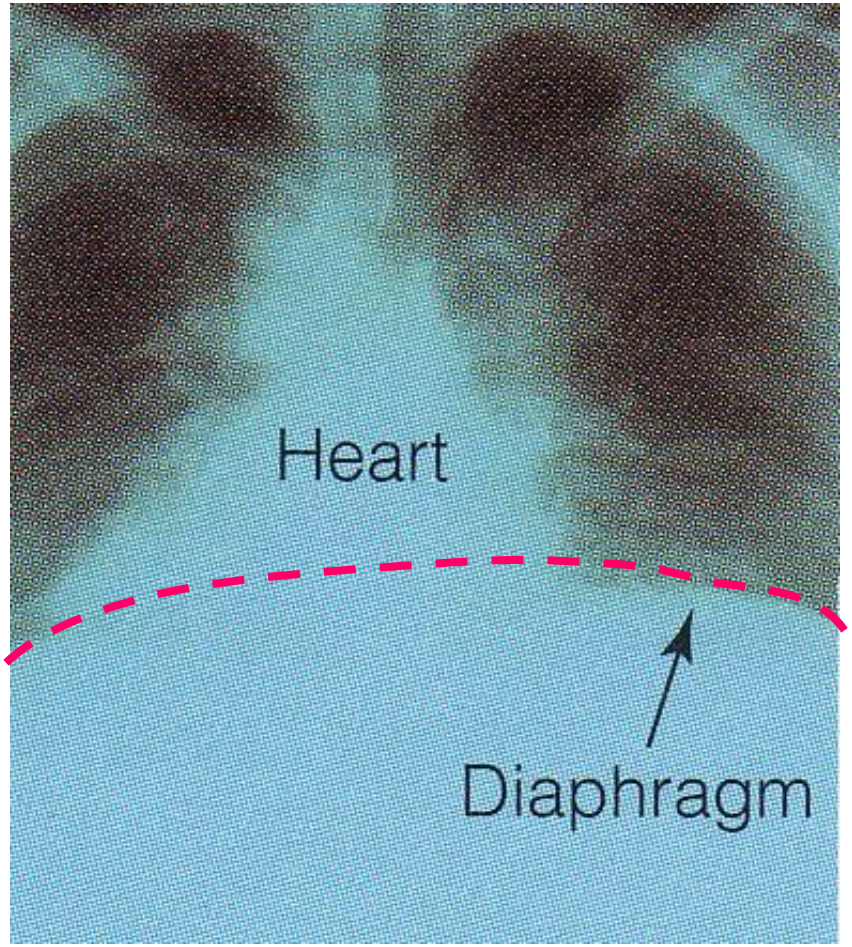
Muscles of Ventilation

NB: Diaphragm is the chief muscle of ventilation!



LS 2012 fig 12-11





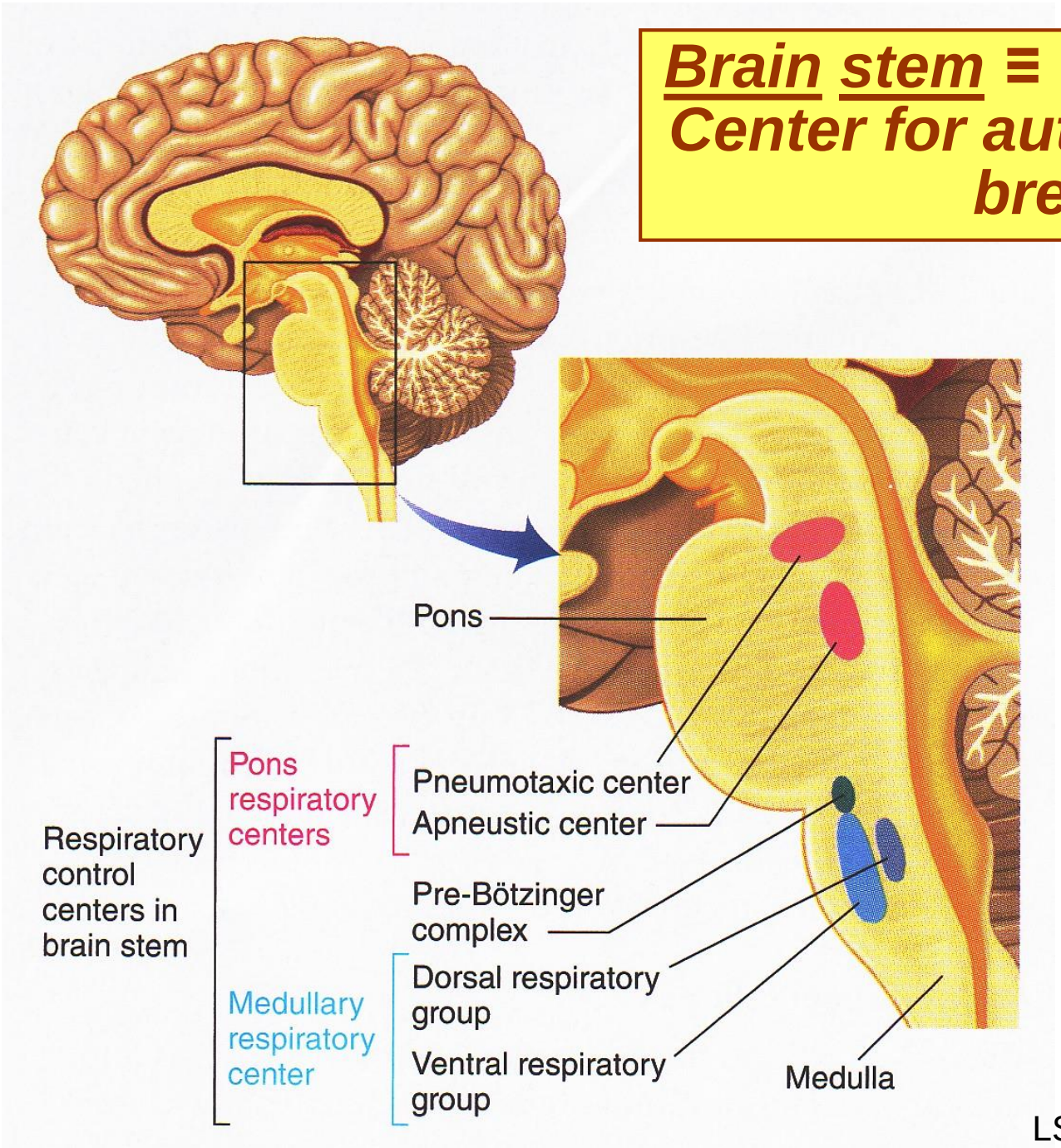
<u>Inhale</u> (active)

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

<u>Contract</u> & flatten diaphragm

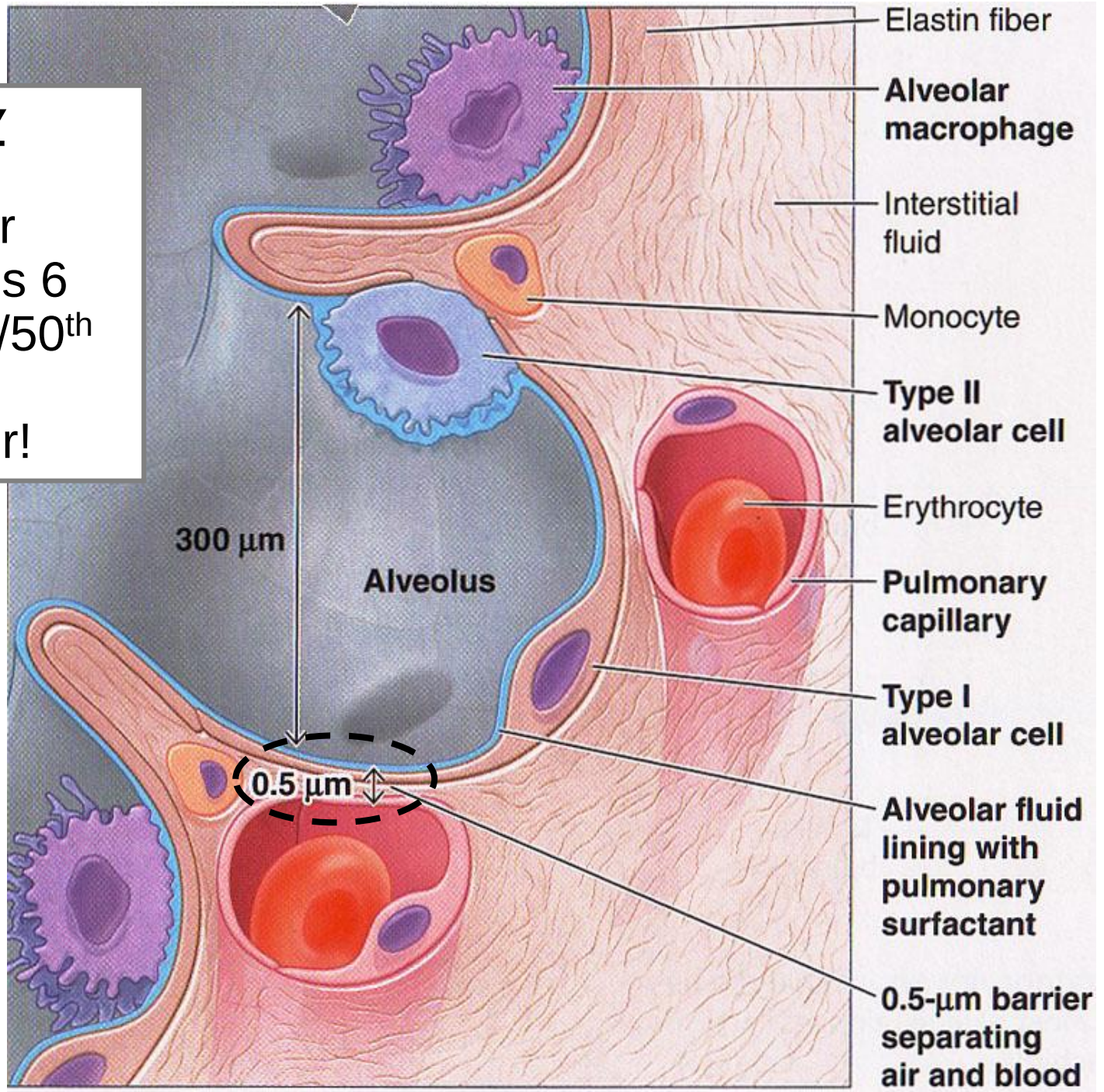
<u>Relax</u> & pouch up diaphragm!

Brain stem ≡ Control Center for automatic breathing!



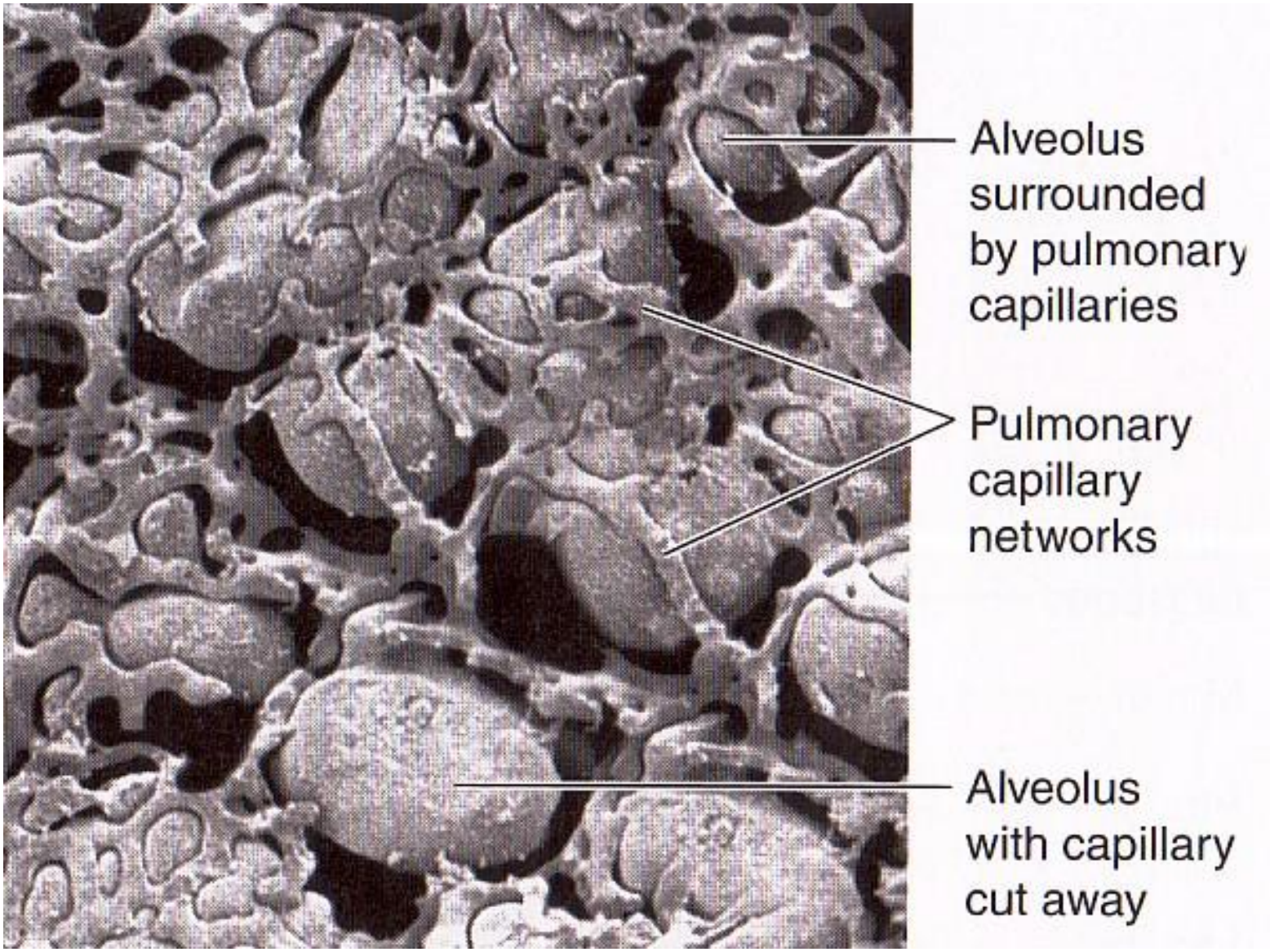
LS 2012 fig 12-25

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



LS 2012 fig 12-4a

Alveoli are surrounded by jackets of capillaries!

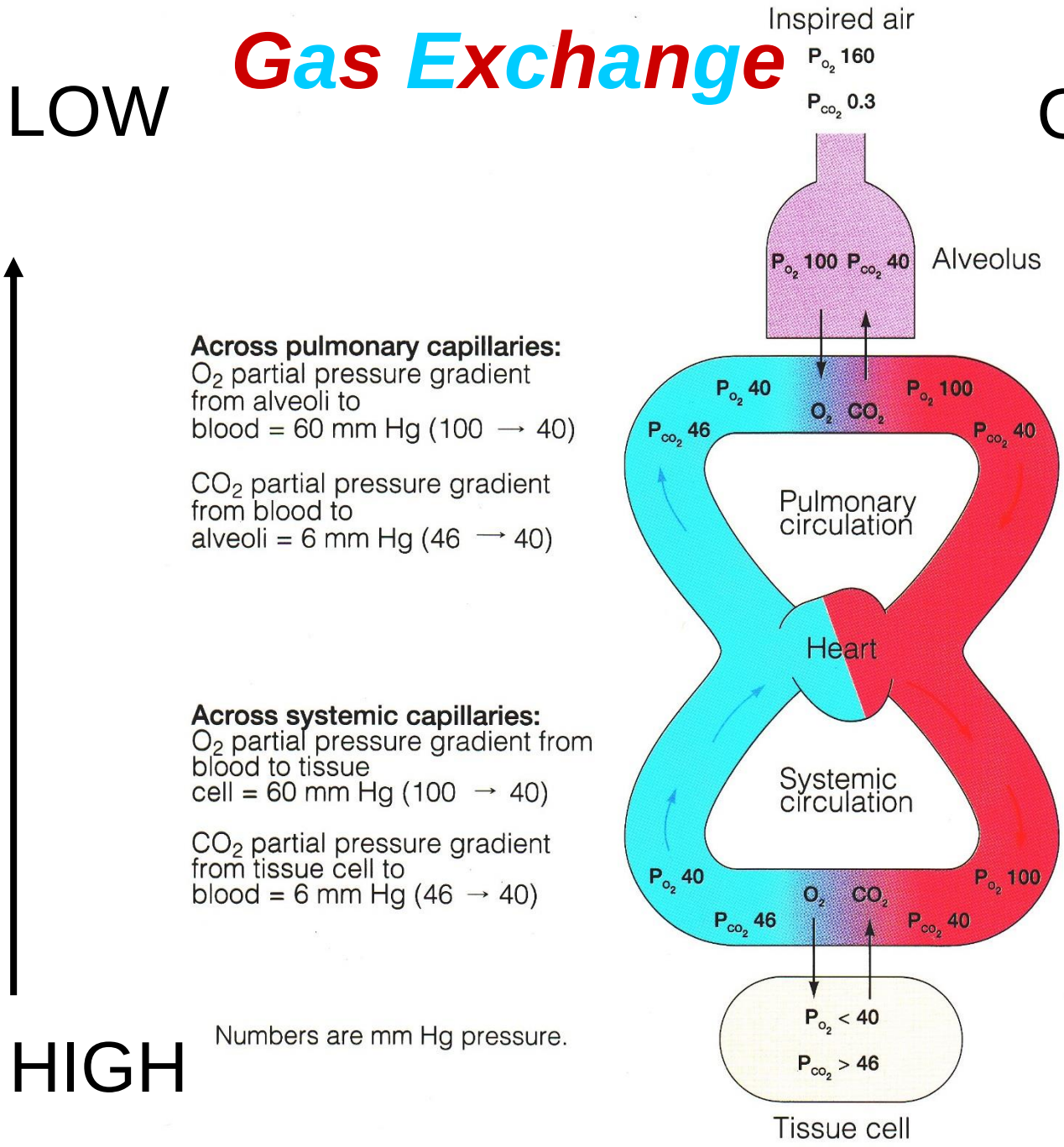


LS 2012 fig 12-4b

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)

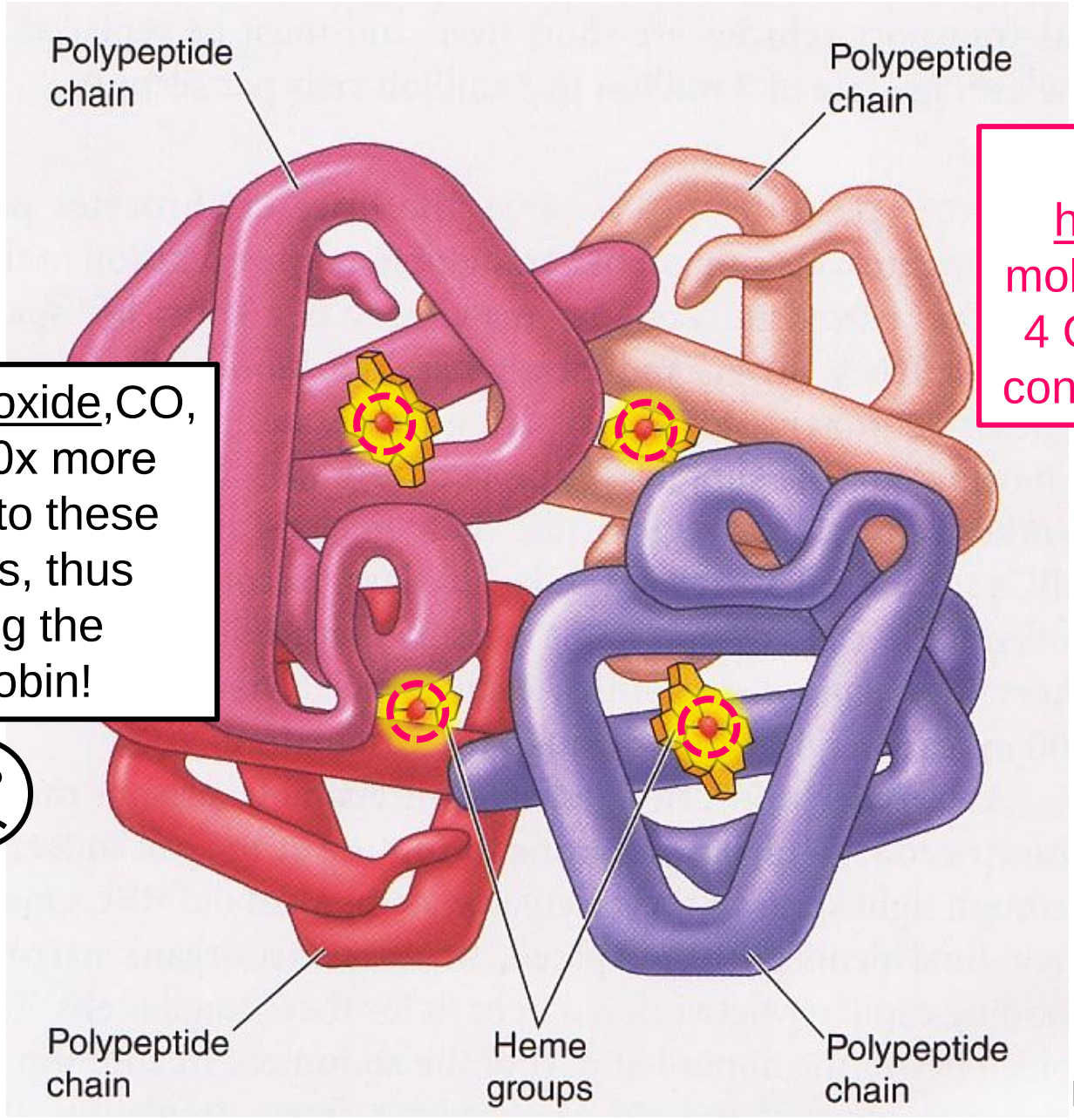
Numbers are mm Hg pressure.

CO_2 HIGH

O_2 LOW

cf: LS 2012 fig 12-19

O_2 is carried mainly by red blood cell <u>hemoglobin</u>!



<u>Each hemoglobin</u> molecule carries 4 O_2 on 4 iron-containing disks!

<u>Carbon monoxide</u>,CO, binds ≥ 200x more powerfully to these same sites, thus poisoning the hemoglobin!

LS 2012 fig 11-2

TABLE 12-3

Methods of Gas Transport in the Blood

GAS	METHOD OF TRANSPORT IN BLOOD	PERCENTAGE CARRIED IN THIS FORM
O_2	Physically dissolved	1.5
	Bound to hemoglobin	98.5
CO_2	Physically dissolved	10
	Bound to hemoglobin	30
	As bicarbonate (HCO_3^-)	60

LS 2006, cf: LS 2012 tab 12-3

American Cancer Society Great American Smoke Out!

http://www.cancer.org/healthy/stayawayfromtobacco/greatamericansmokeout/