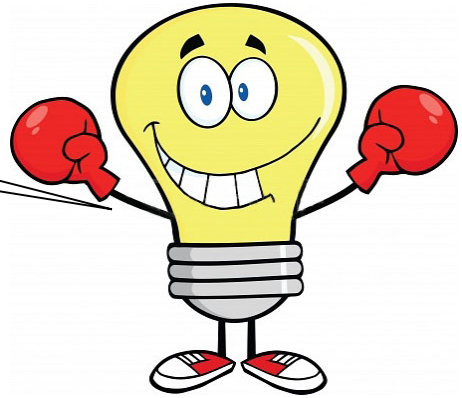
We're on a roll! Bring on Exam II!



**BI 121 Lecture 16**

I. ***Announcements*** **Notebooks? Exam II, December 8th Tuesday 8 am. Review session in class next Thursday. Q?**

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

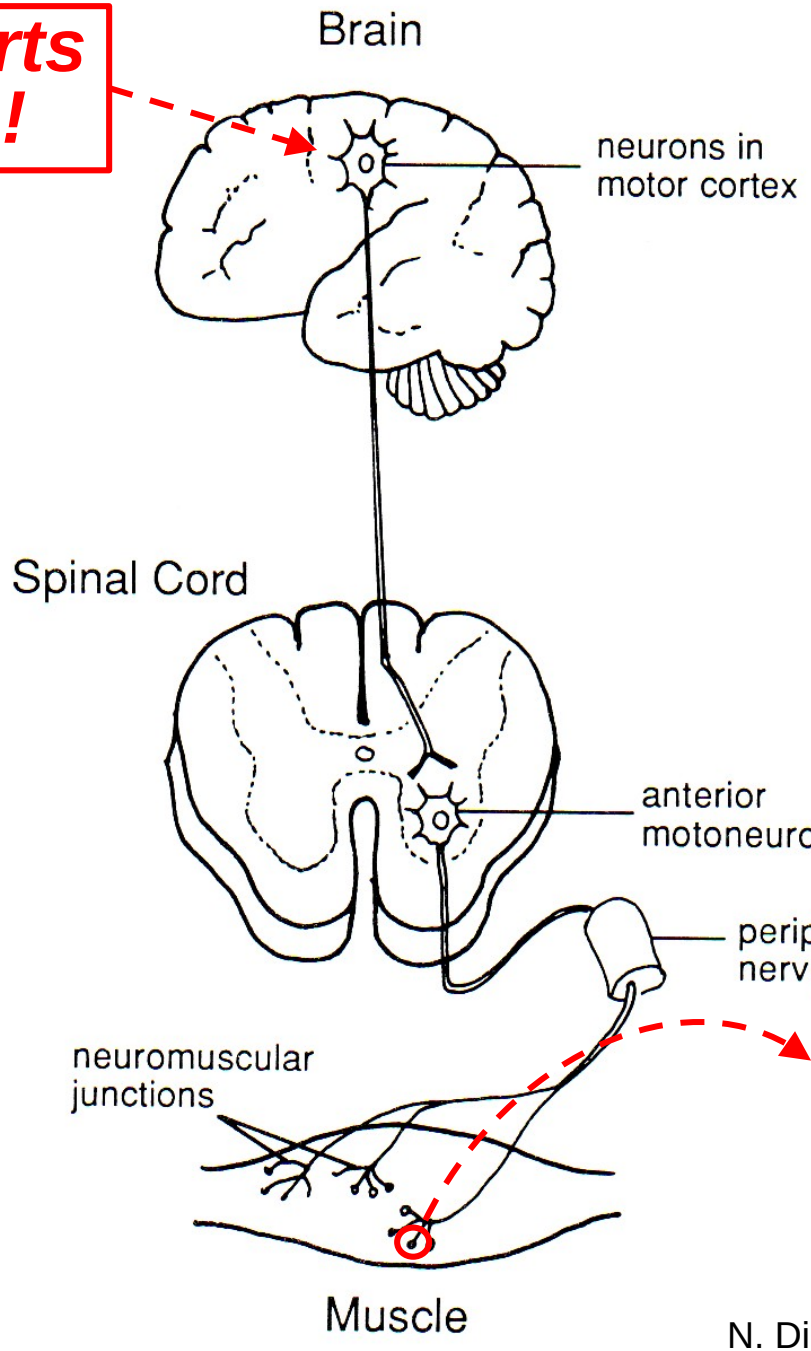
III. ***Respiratory System*** **LS ch 12, DC Module 7, Fox +...**

- **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**

# Muscle Contraction

# Summary

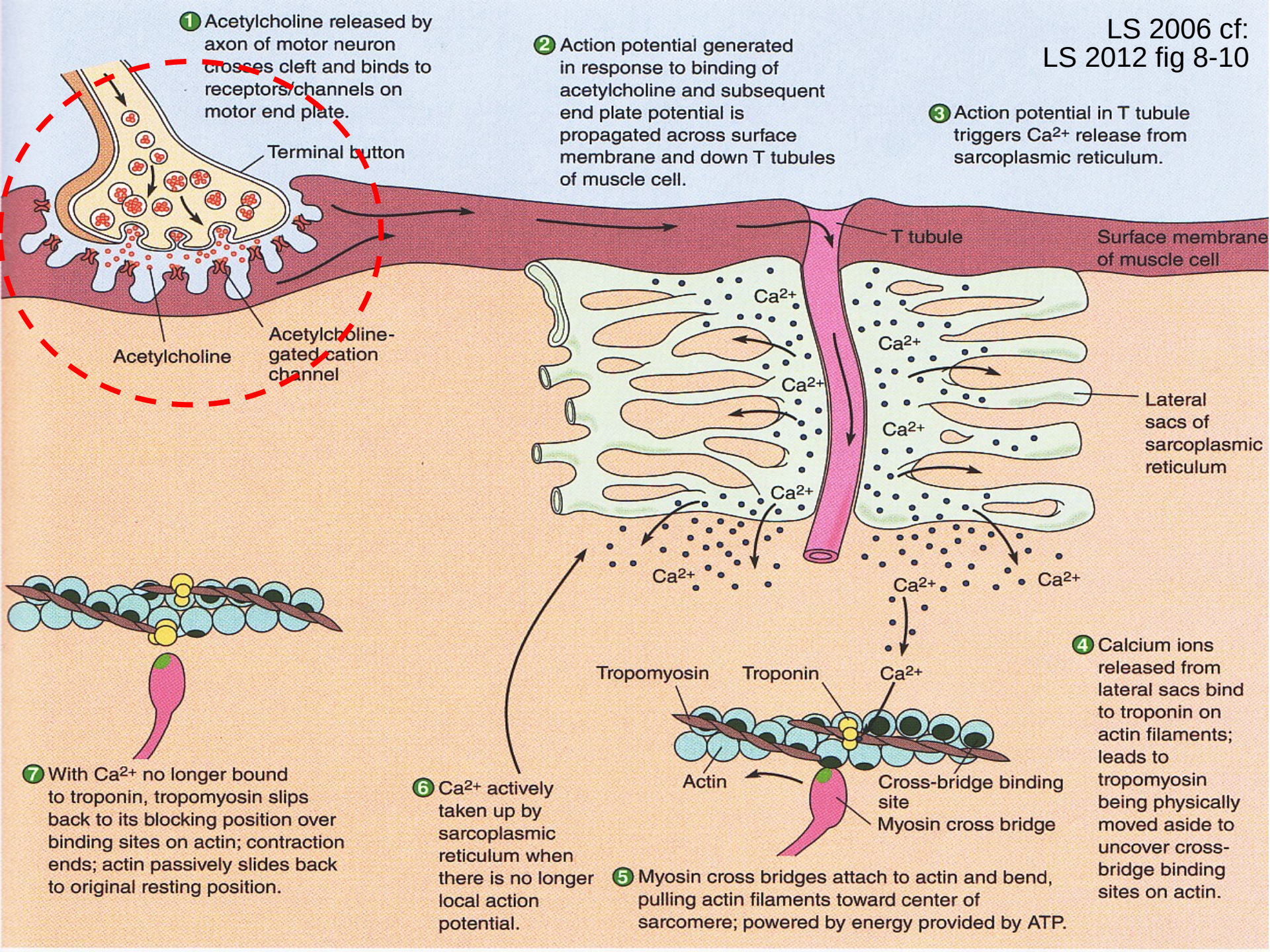
***1st signal starts in the brain!***




**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*

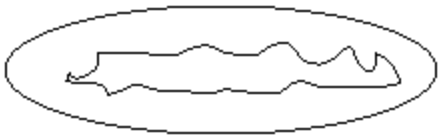
# *A. Malcolm Campbell*
# *Davidson College, Davidson, NC*


***www.bio.davidson.edu/courses/movies.html***

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

Musclcp.mov

AEROBIC w/$O_2$



MITOCHONDRIA

ANAEROBIC

| % AEROBIC (Oxidative Energy System) | % ANAEROBIC (Immediate & Non-Oxidative Energy Systems) | PRIMARY FUEL | ACTIVITY | TIME (Min:Sec) |
|---|---|---|---|---|
| 100 | 0 | FAT, CARBOHYDRATE & PROTEIN (Small Amounts) | Marathon Cross-Country Skiing | 135:00 |
| 90 | 10 | | 10-K Run | 29:00 |
| 80 | 20 | | 3-Mile Run | 14:00 |
| 70 | 30 | | 2-Mile Run 800-Meter Swim | |
| 60 | 40 | | | 9:00 |
| 50 | 50 | CARBOHYDRATE (Glucose & Glycogen) | 1-Mile Run Boxing 200-Meter Swim | 3:45 |
| 40 | 60 | | Circuit Weight Training | |
| 30 | 70 | | Soccer Lacrosse | 1:30 |
| 20 | 80 | | Tennis | 0:50 |
| 10 | 90 | ATP, ADP & Creatine Phosphate (CP) | Basketball Volleyball 200-Meter Dash Football | 0:20 |
| 0 | 100 | | Conventional Weight Training | 0:10 |

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:


SUBARU
45

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

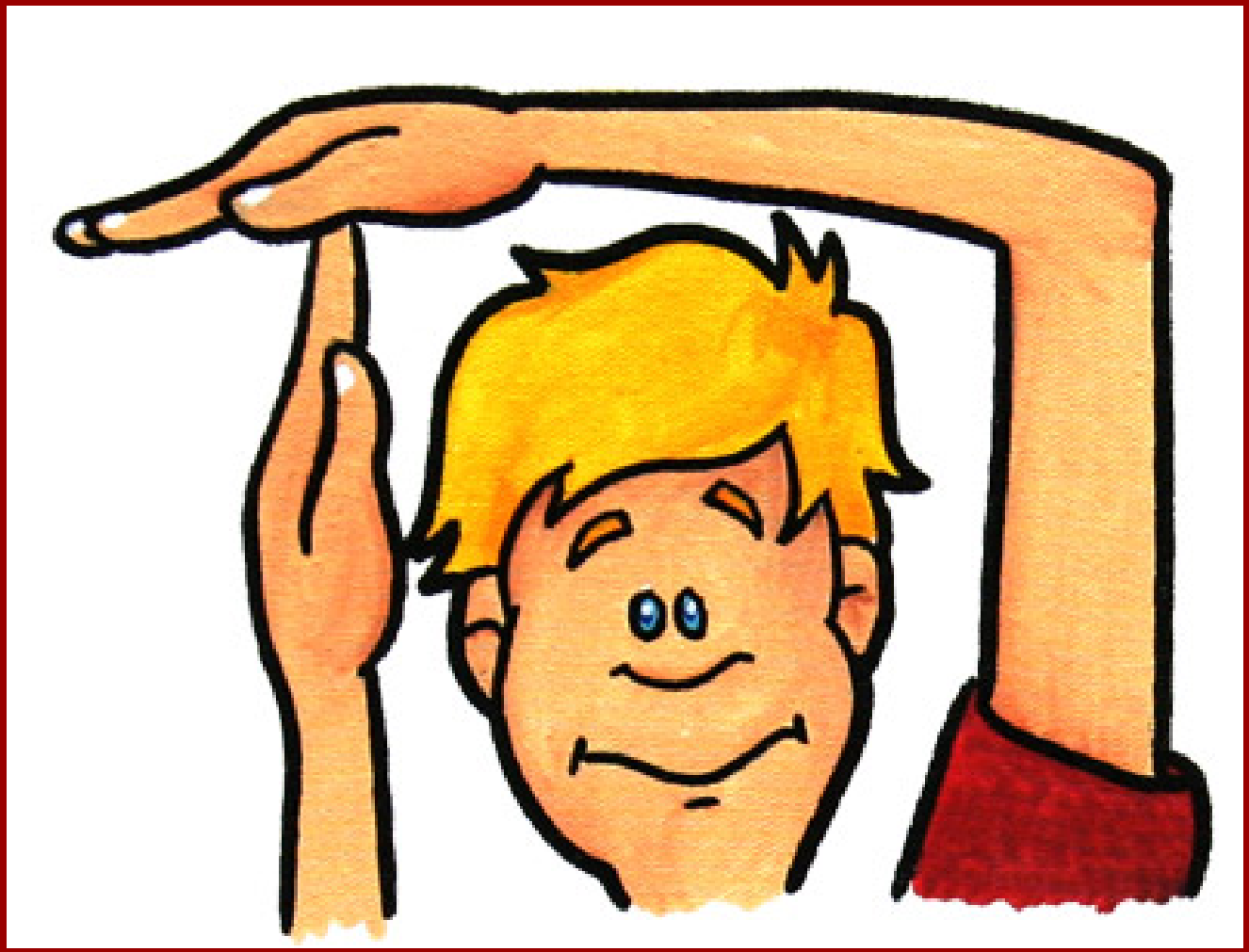
# *Extremes of the energy continuum!*







# *Time-out for discussion!*



# Lombo's simplified steps!

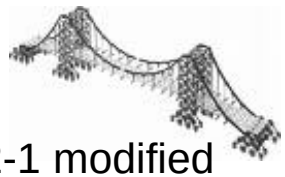
1 **Breathe in & out!**

2 **Cross membranes!**

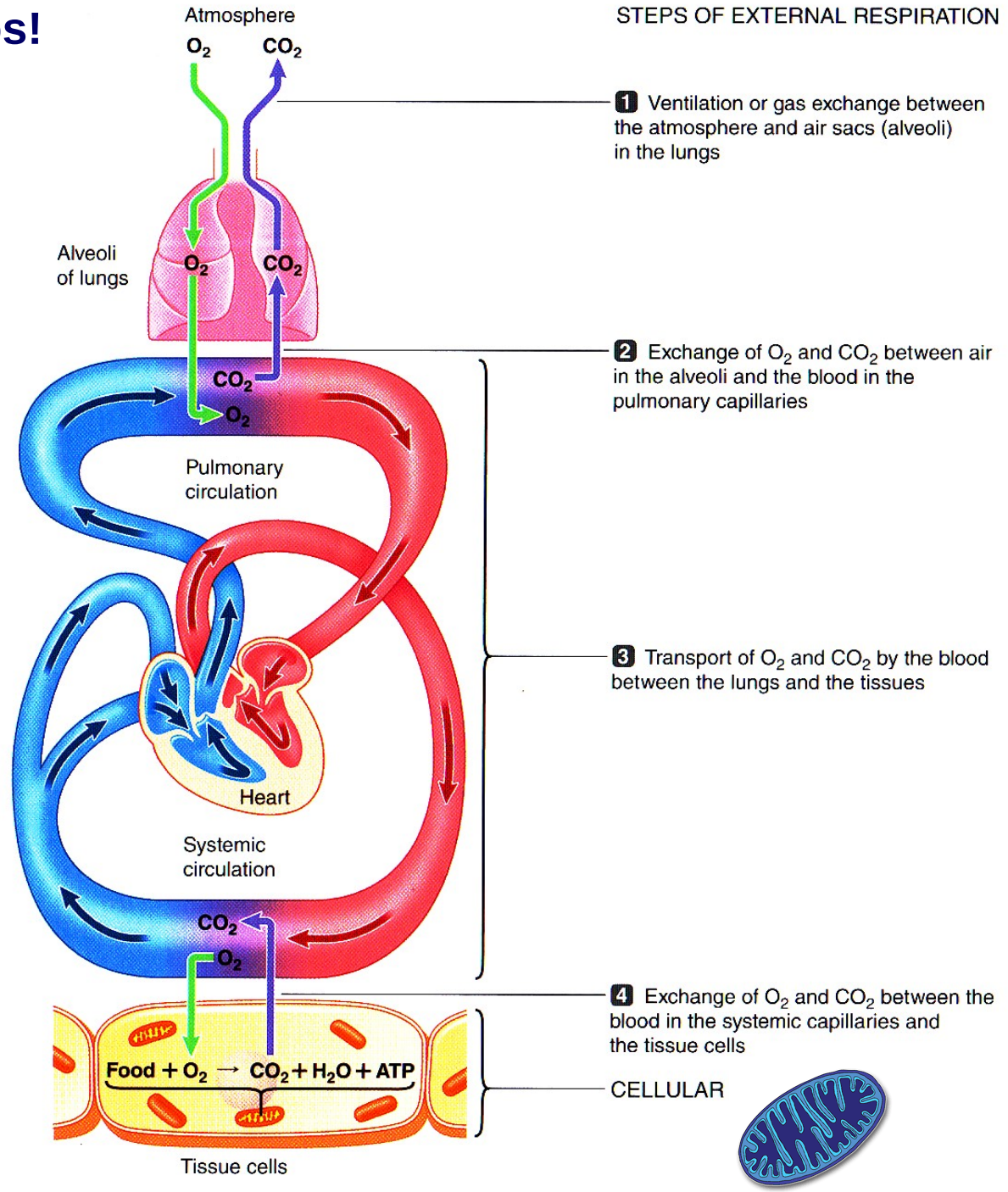
3 **Move with blood!**

Go with the flow!

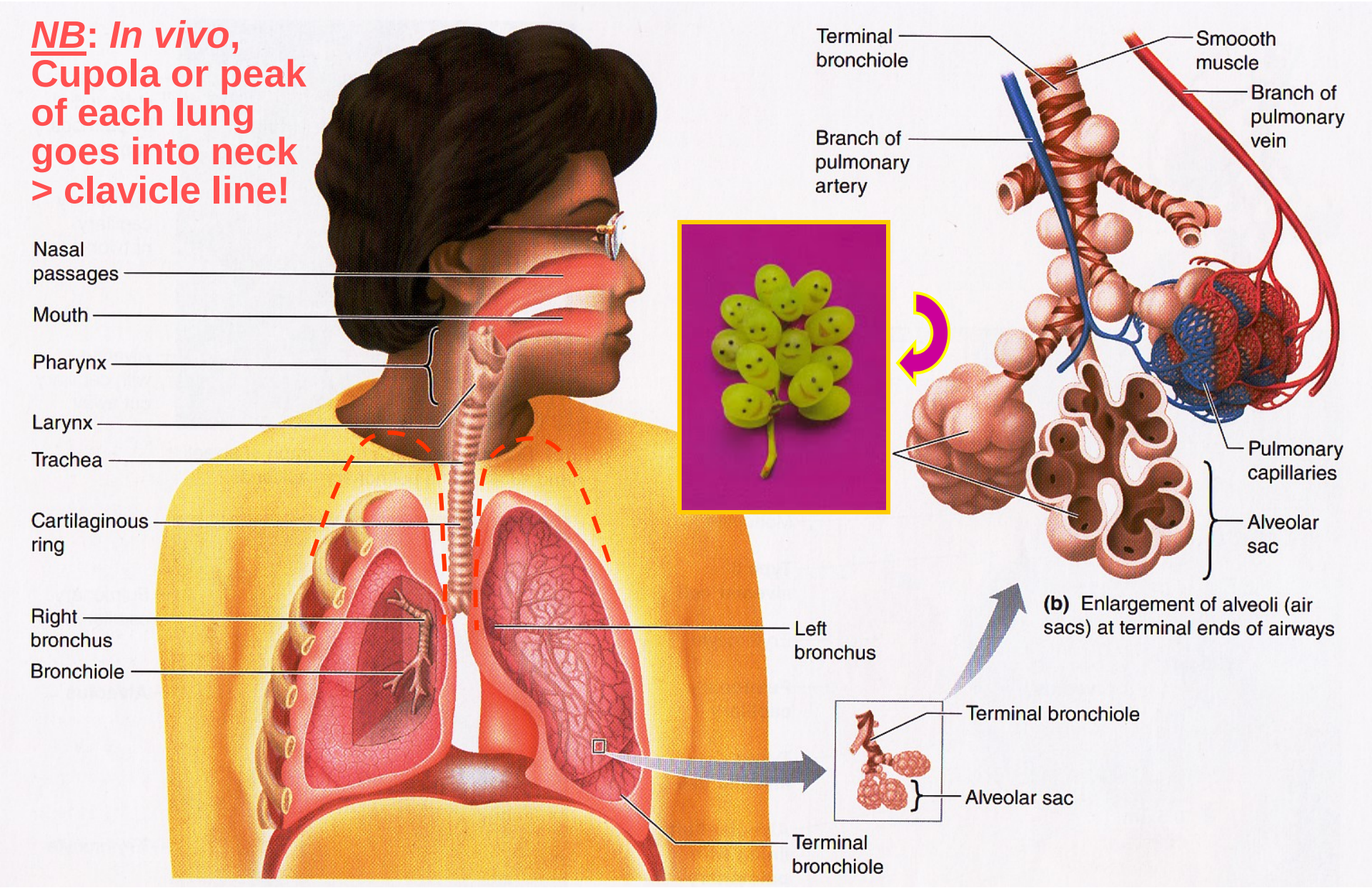
4 **Cross membranes!**



LS 2012 fig 12-1 modified

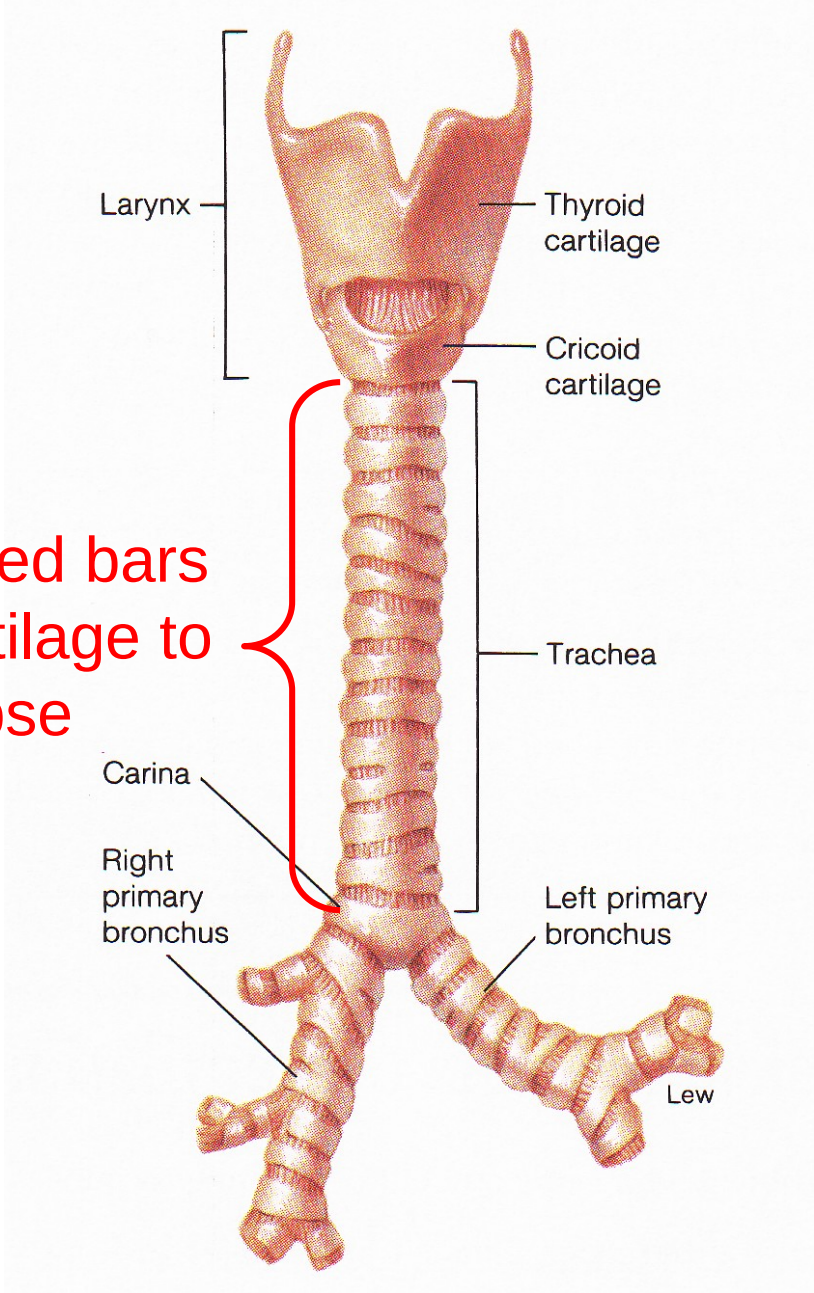


# Respiratory System Anatomy

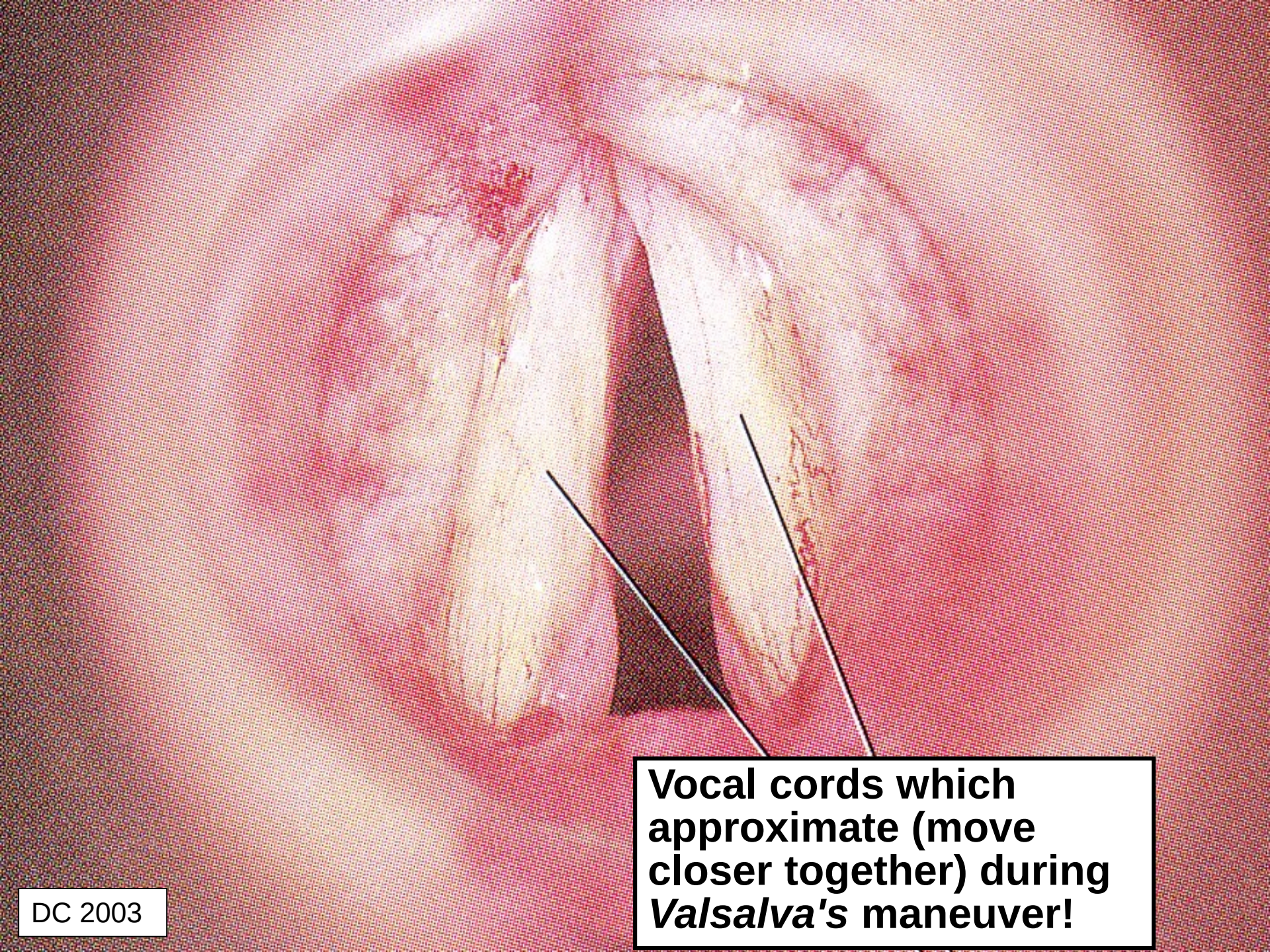



LS 2012 fig 12-2

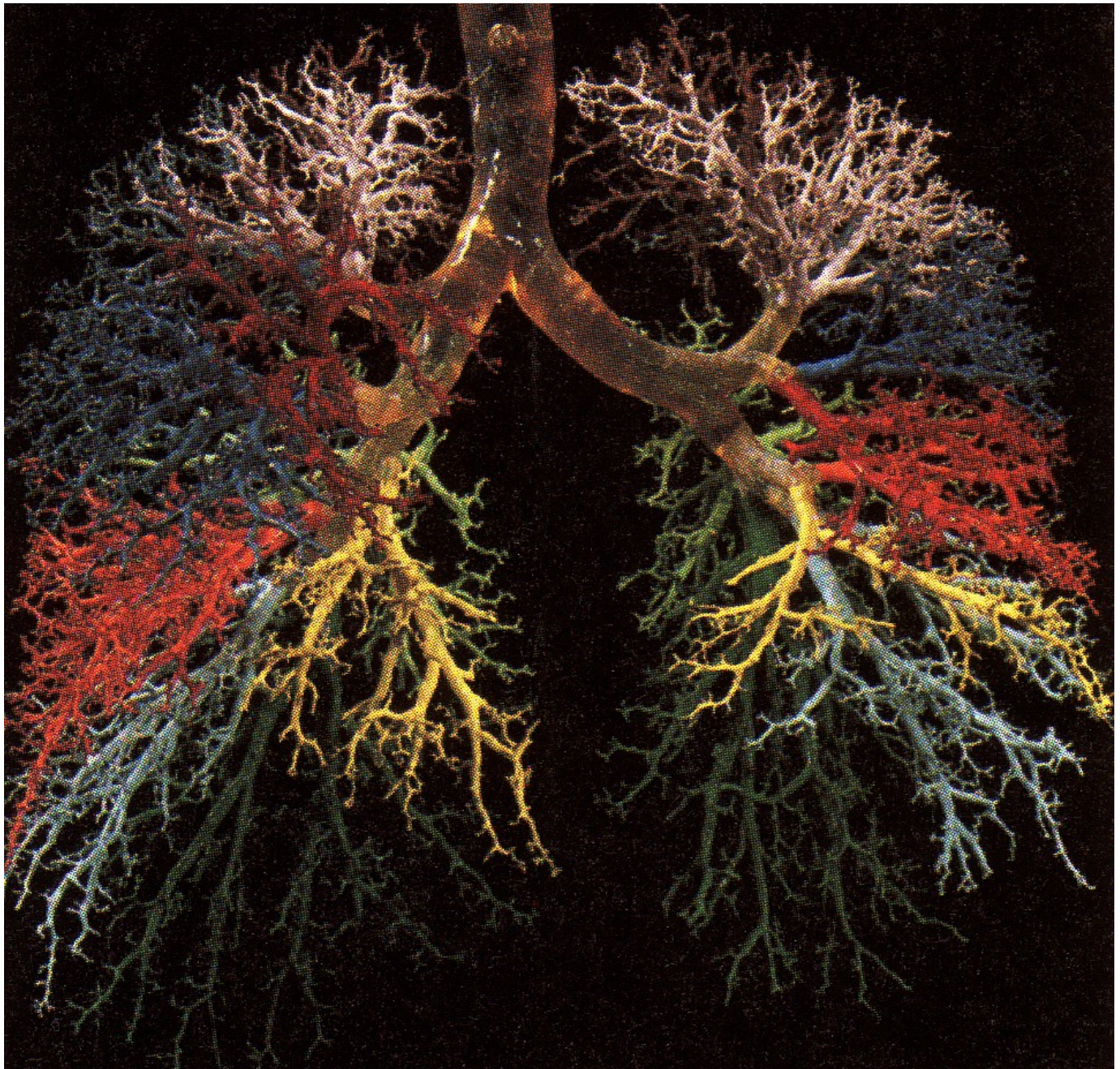
16-20 C-shaped bars of hyaline cartilage to prevent collapse



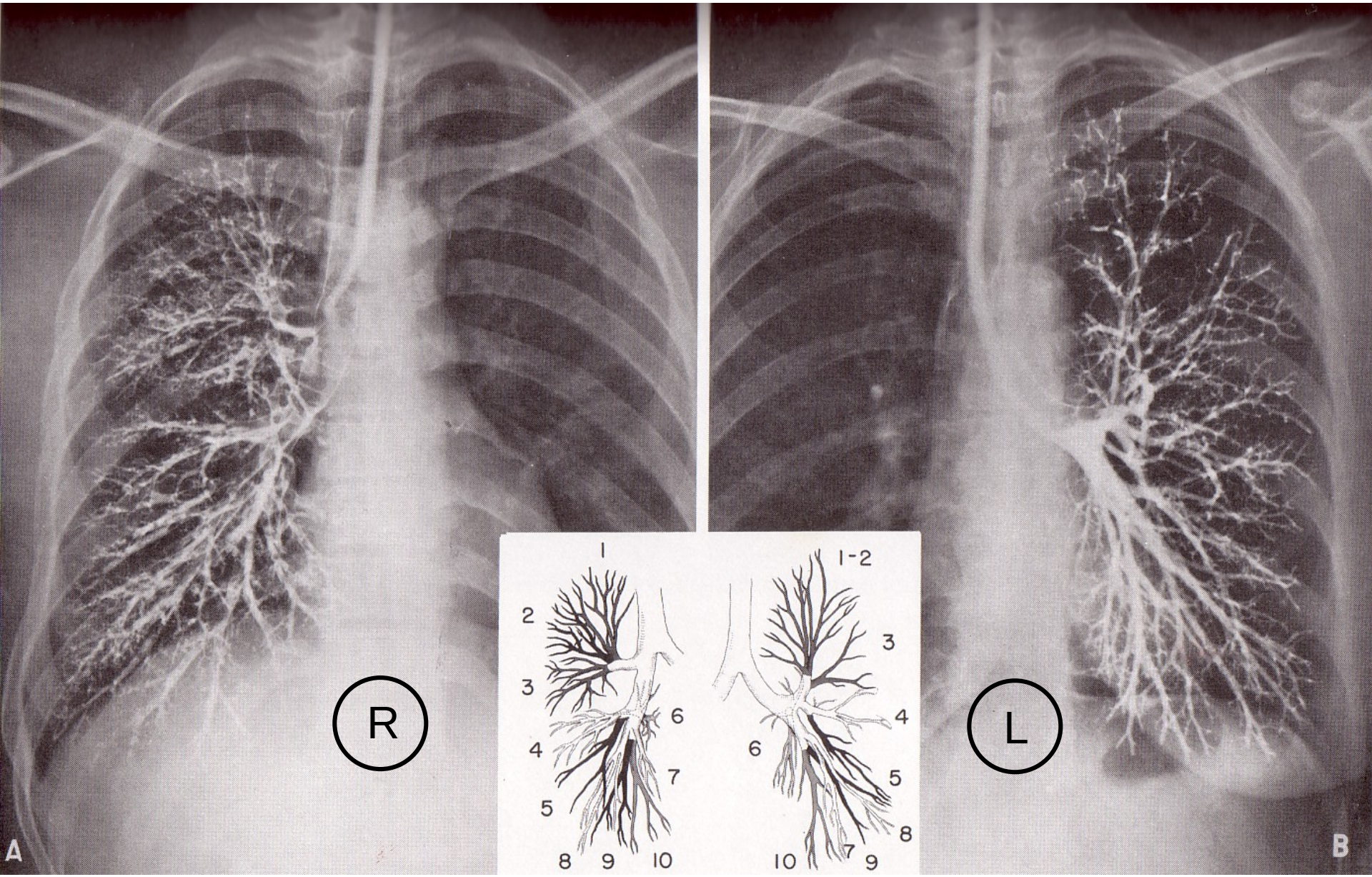

DC 2003


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

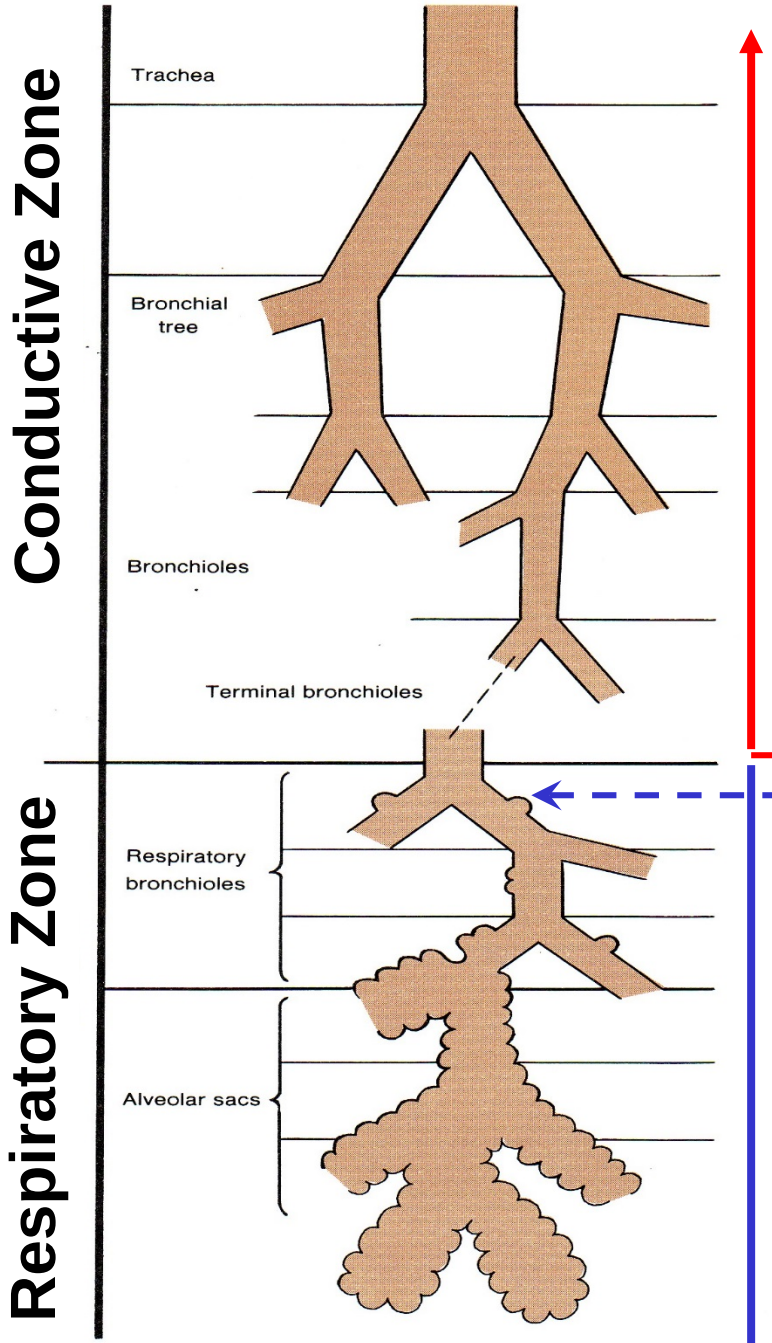
# *Pulmonary Latex Cast with Colored Segmentation*



# *Bronchograms (posteroanterior)*




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

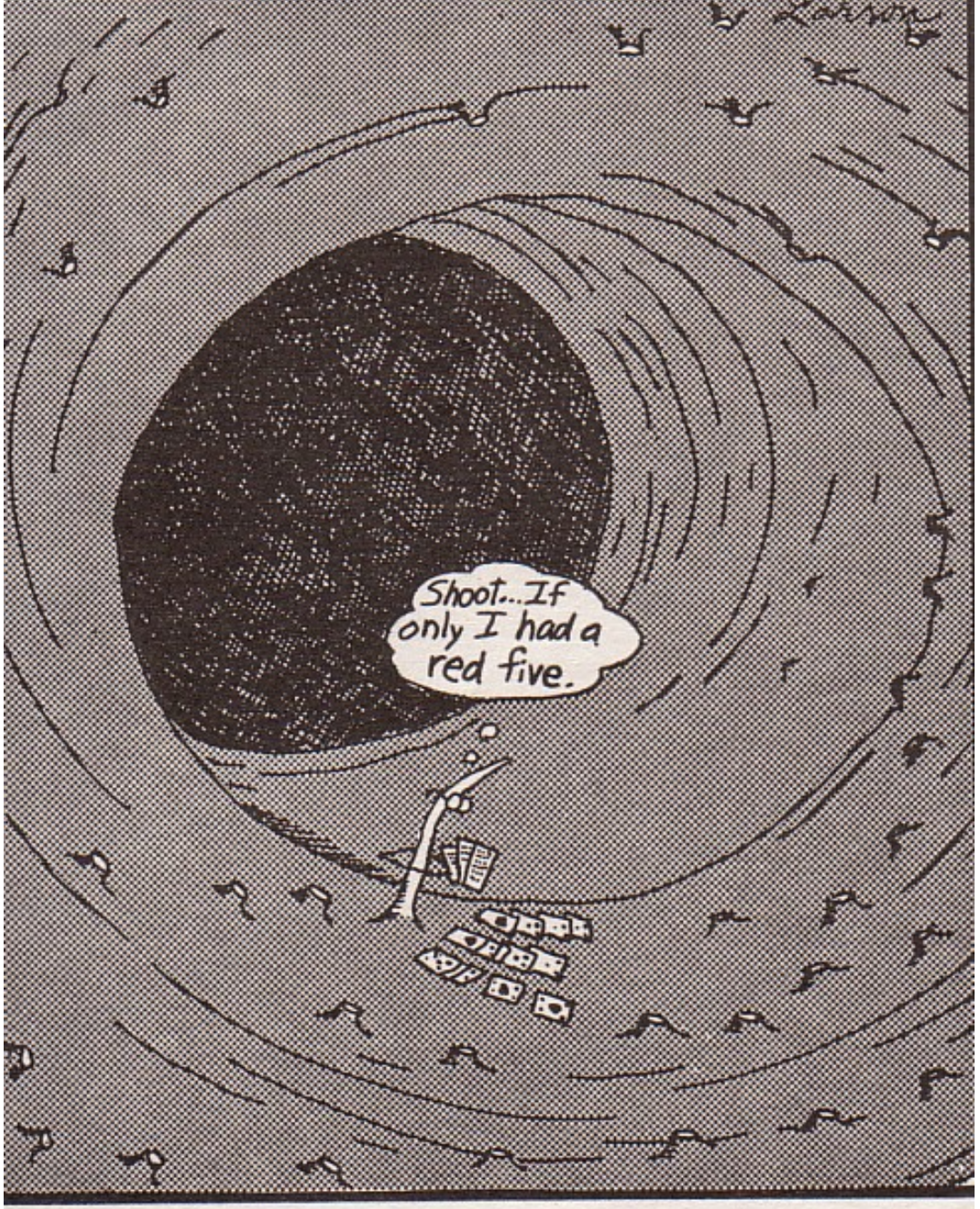



No Gas Exchange

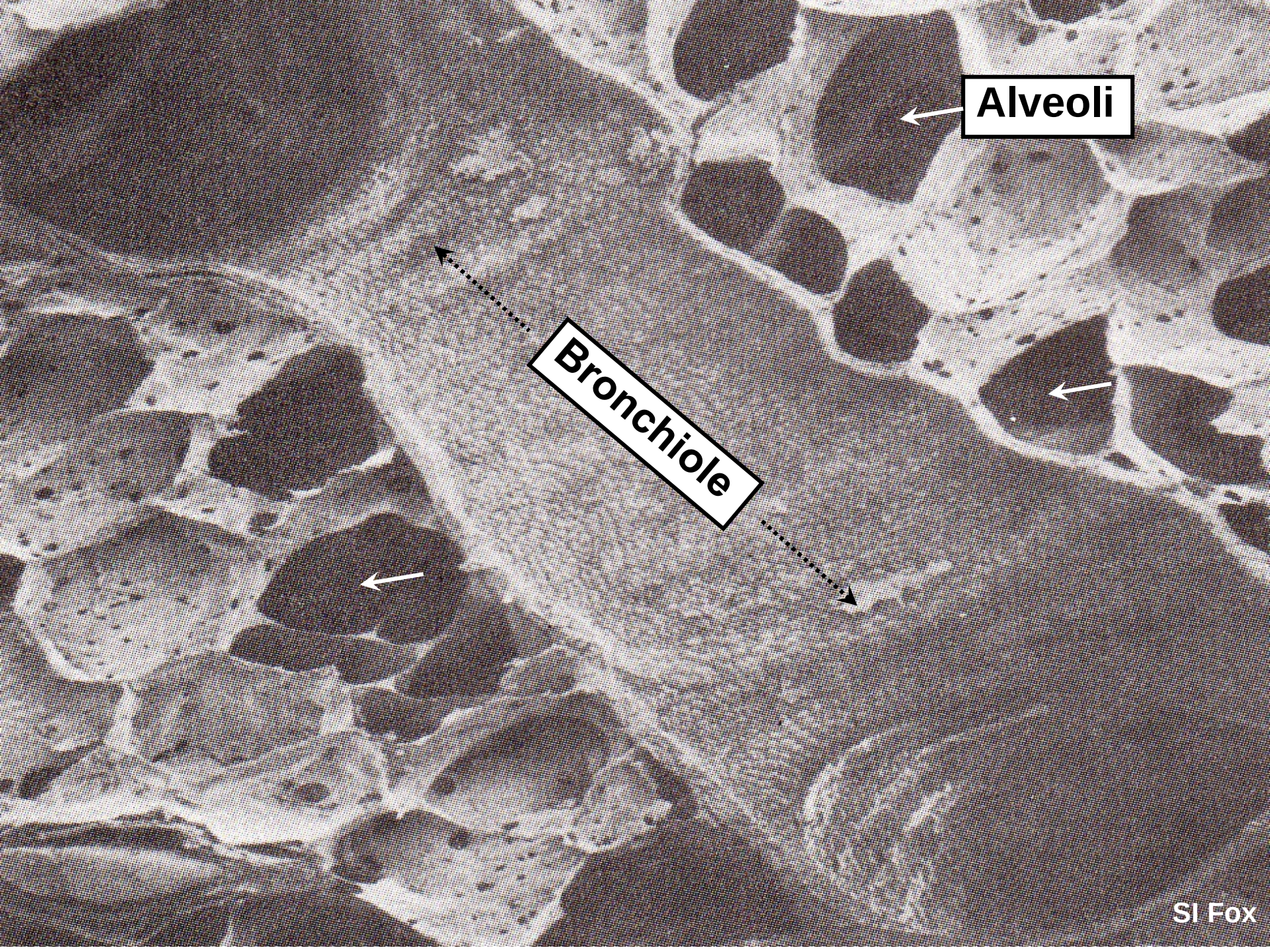
1st alveolar outpouching!

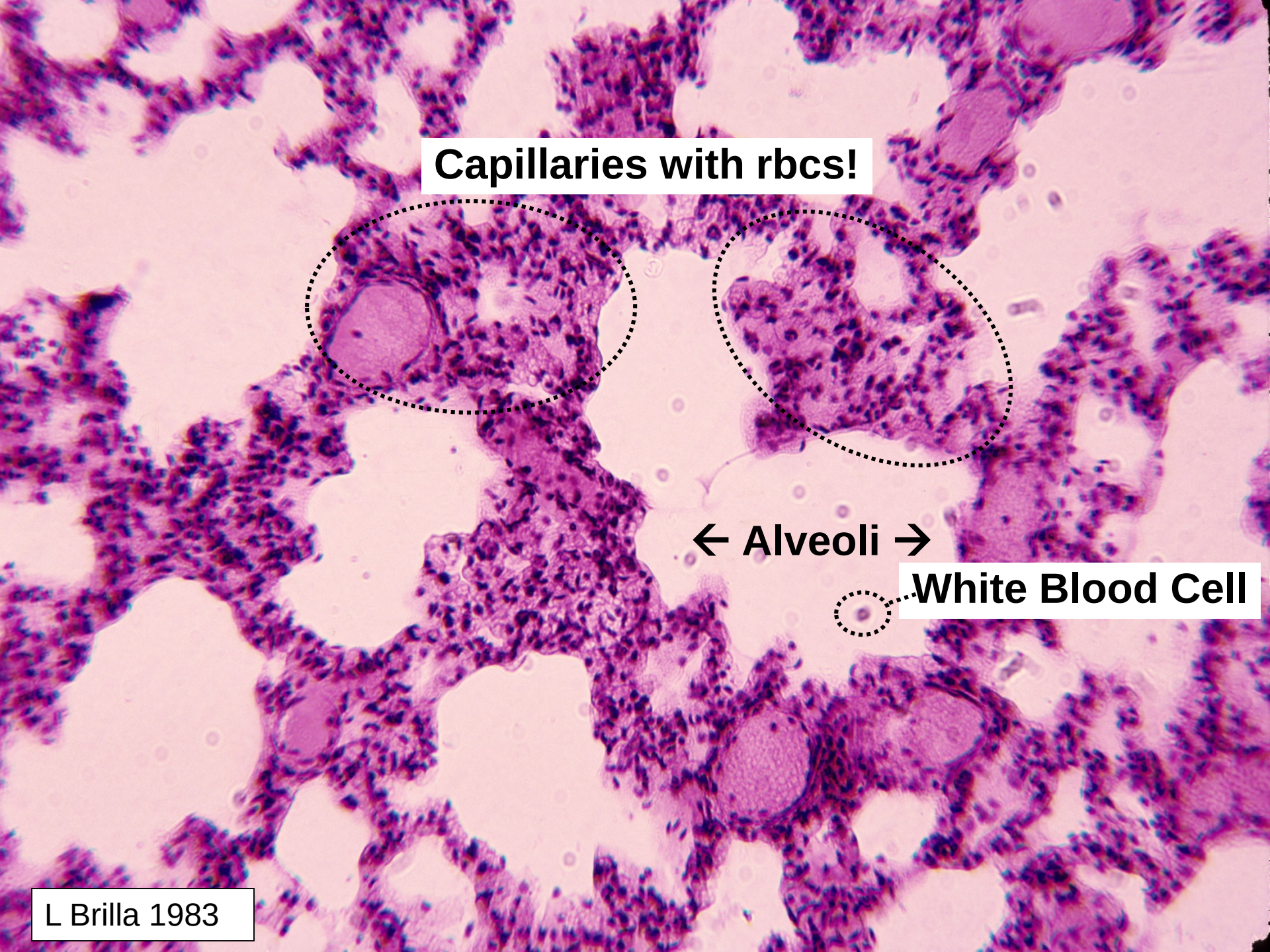
Gas Exchange

SI Fox



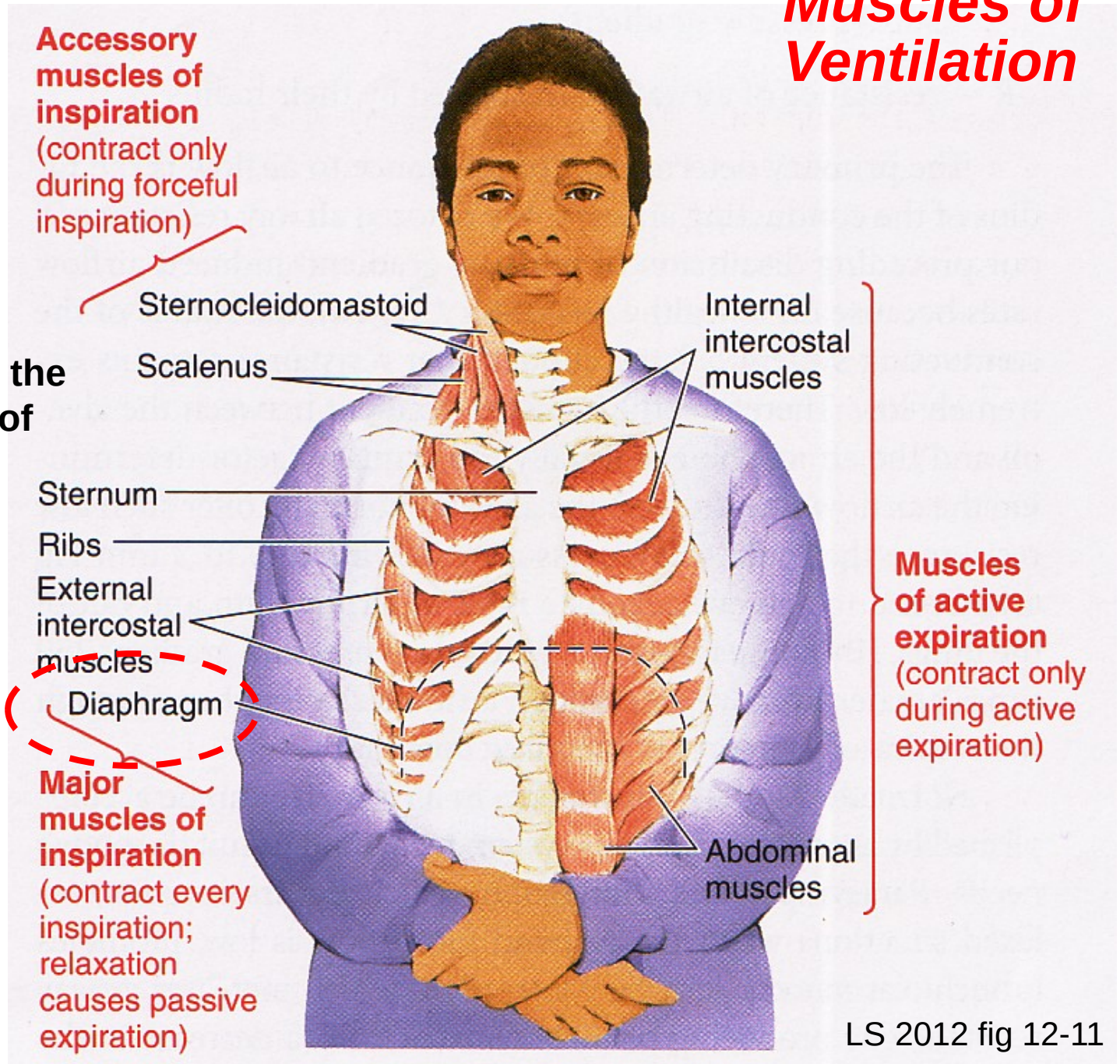

**The last cilium on a smoker's lung**


Alveoli
Bronchiole
SI Fox

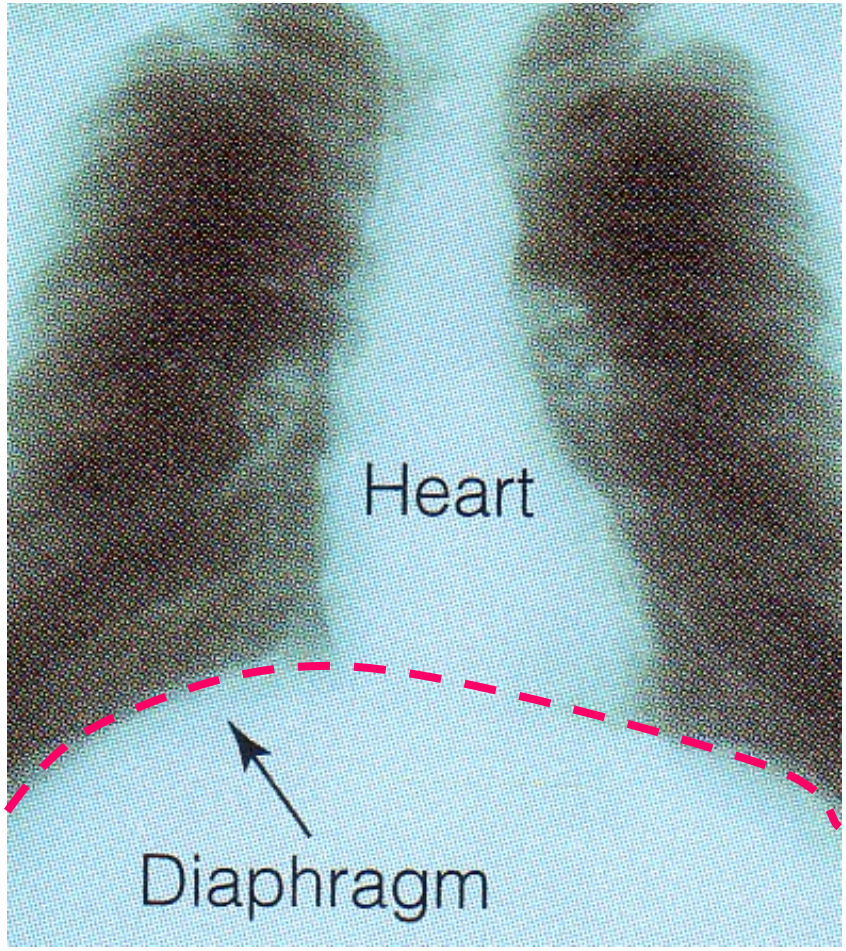

Capillaries with rbcs!
← Alveoli →
White Blood Cell
L Brilla 1983

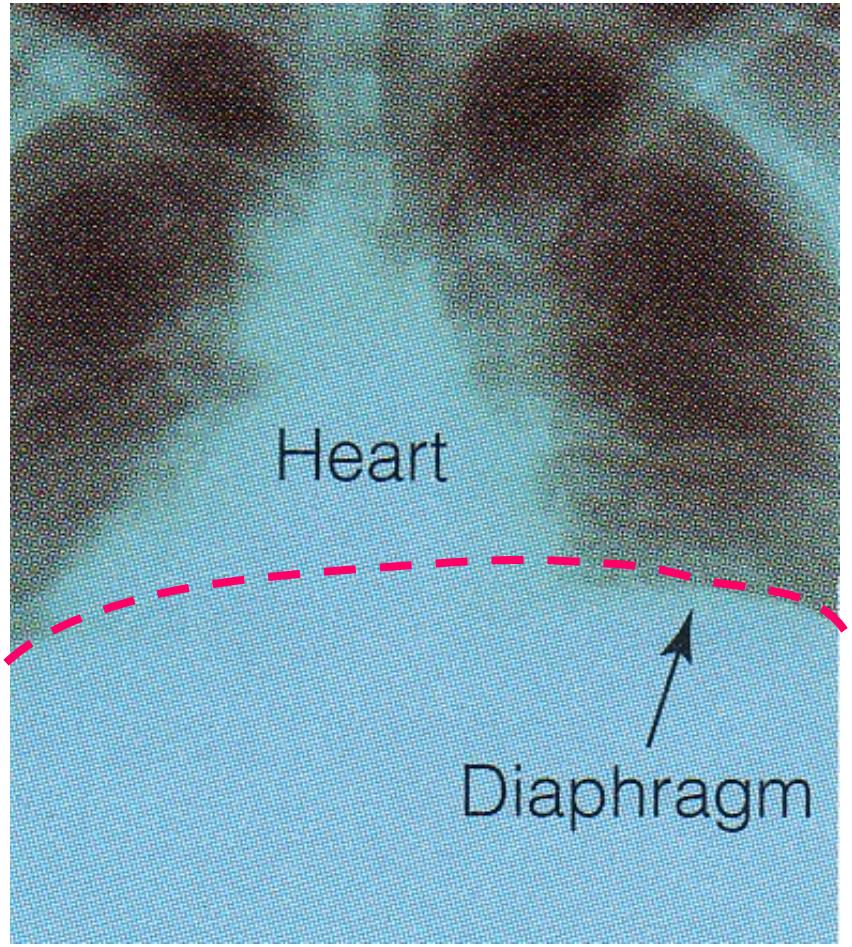
# Muscles of Ventilation

**NB**: **Diaphragm is the chief muscle of ventilation!**




LS 2012 fig 12-11



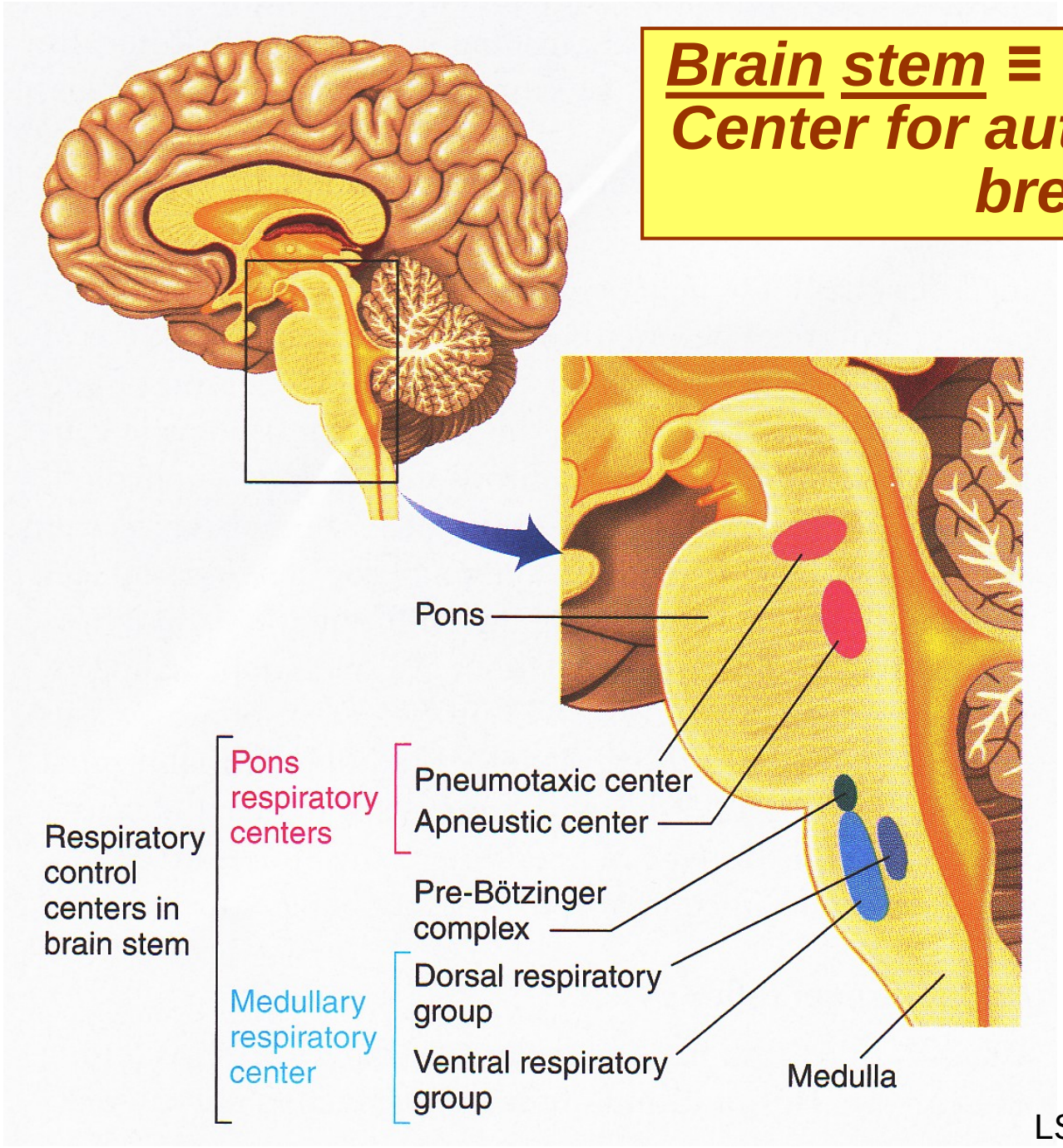

*<u>Inhale</u> (active)*

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

**<u>Contract</u> & flatten diaphragm**

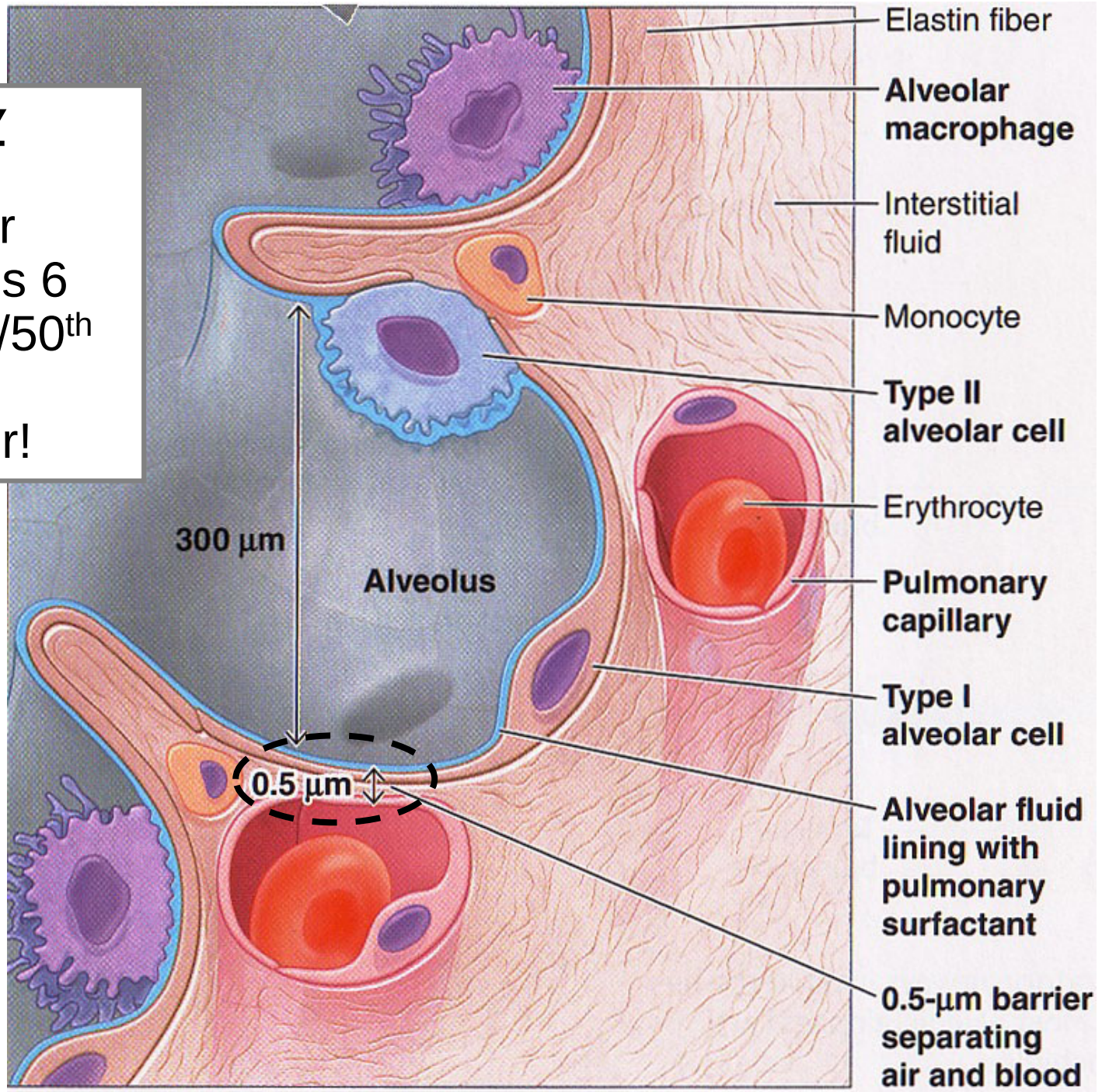
**<u>Relax</u> & pouch up diaphragm!**

# ***Brain stem ≡ Control Center for automatic breathing!***



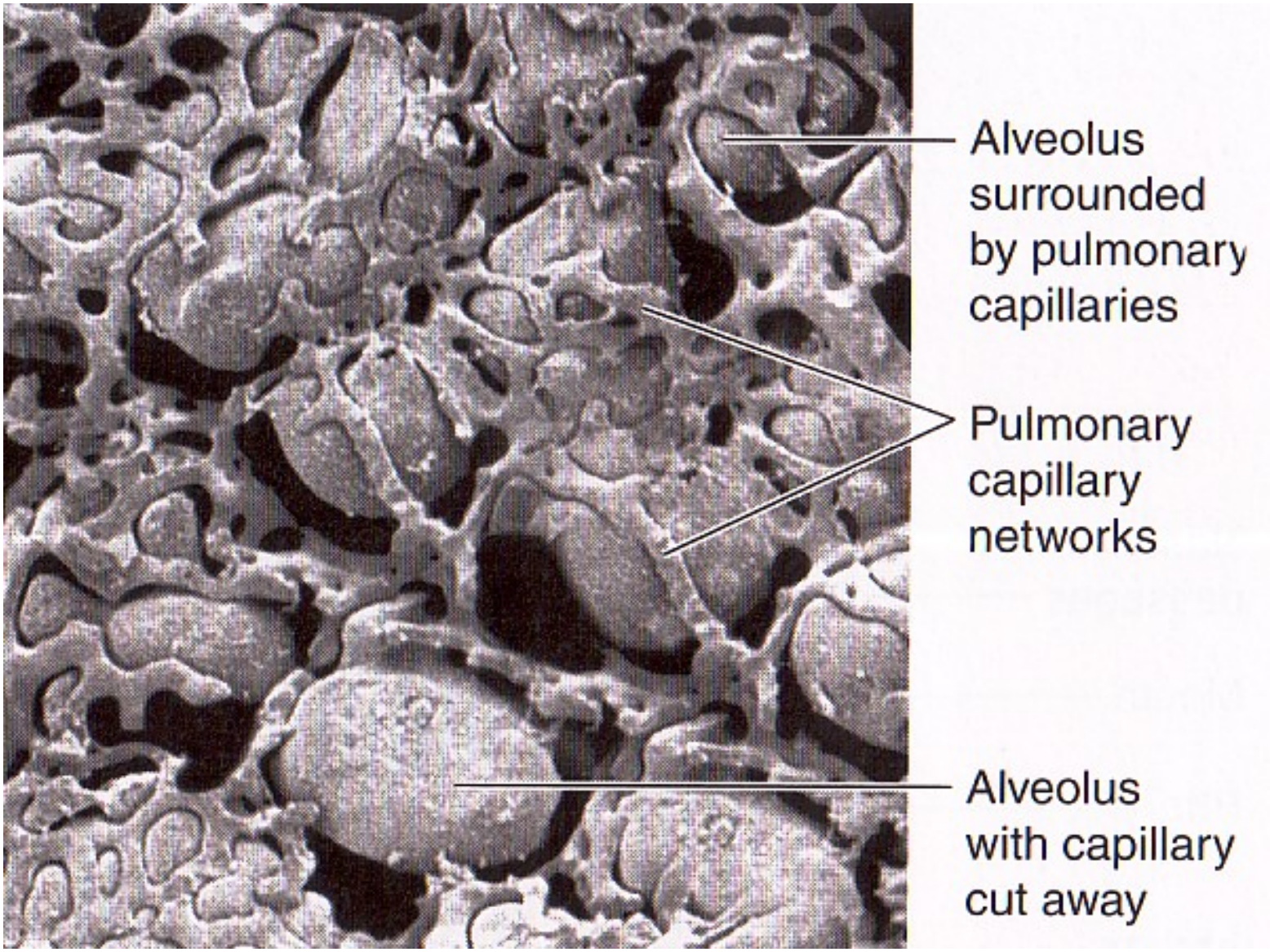

LS 2012 fig 12-25

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




LS 2012 fig 12-4a

# *Alveoli are surrounded by jackets of capillaries!*

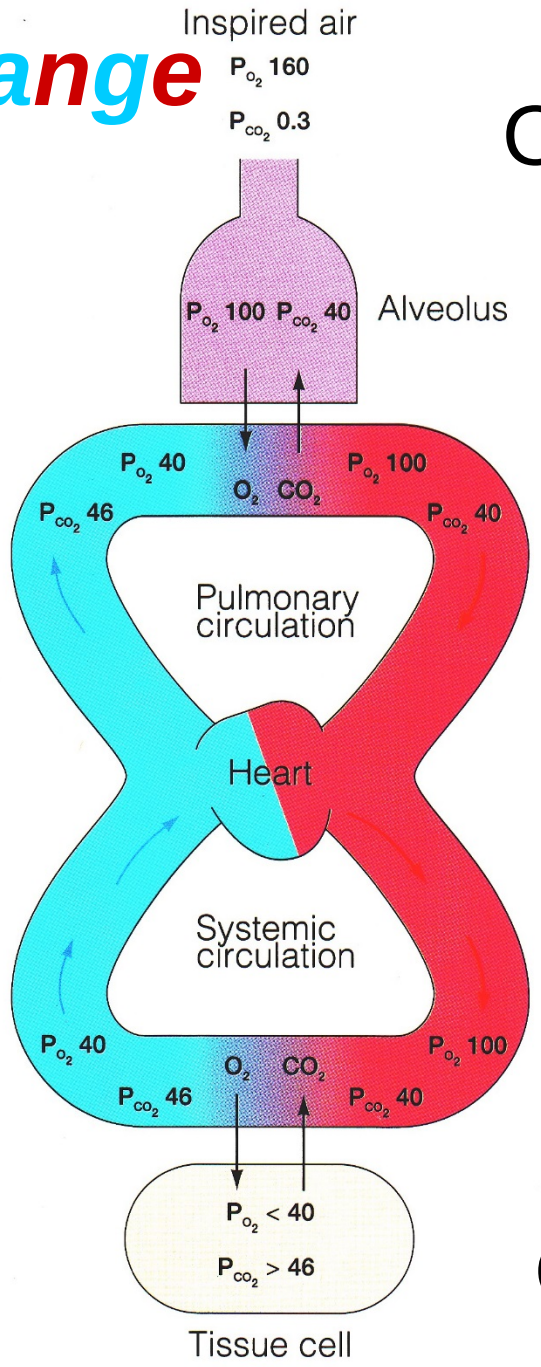



LS 2012 fig 12-4b

# 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)

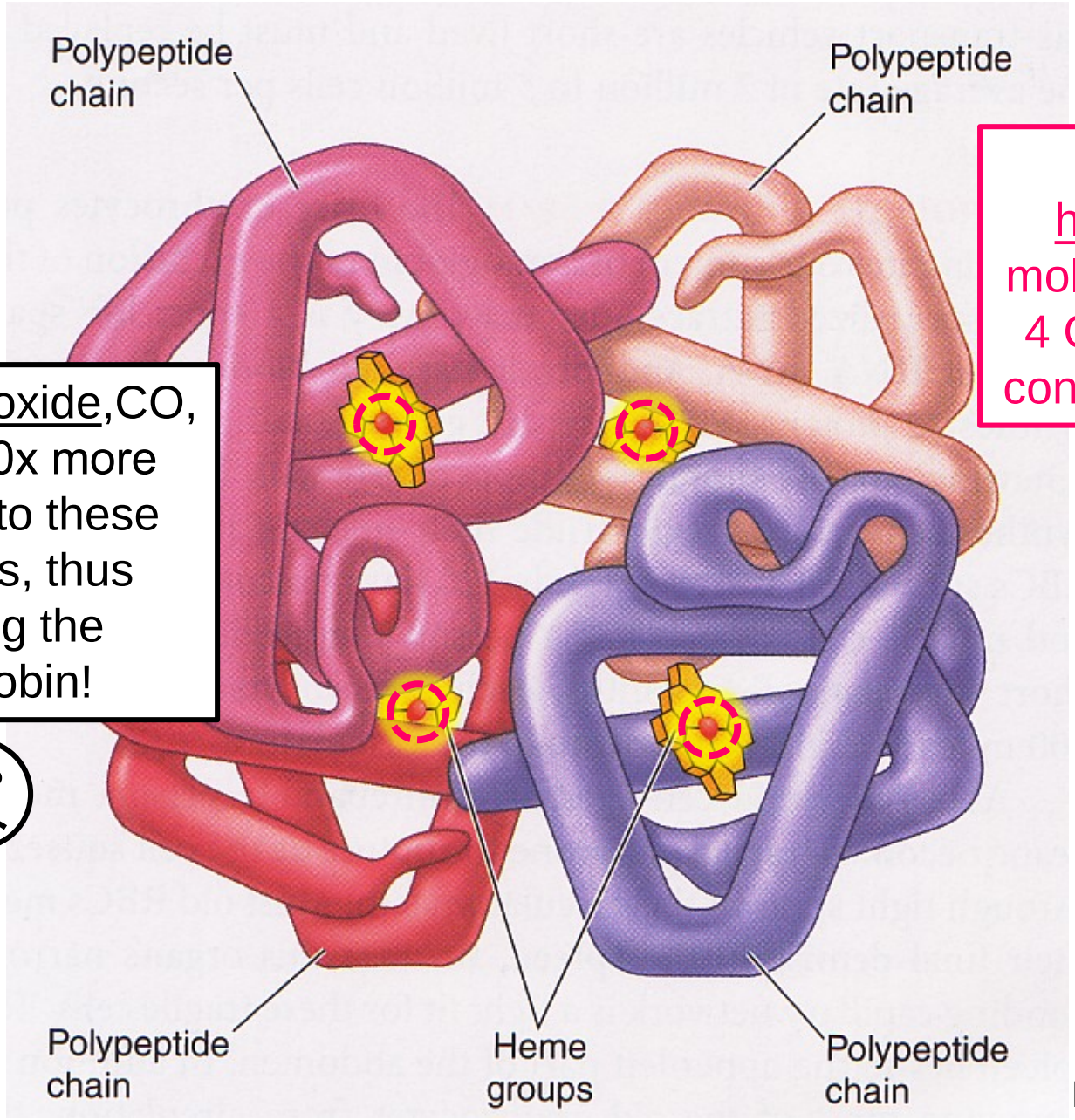
Numbers are mm Hg pressure.

$CO_2$ HIGH

$O_2$ LOW

cf: LS 2012 fig 12-19

# *$O_2$ is carried mainly by red blood cell hemoglobin!*




Each hemoglobin molecule carries 4 $O_2$ on 4 iron-containing disks!

Carbon monoxide,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/***

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