BI 121 Lecture 8  *... Welcome back – let's get to work!!*

I. ***Announcements*** **Tomorrow HR & BP Lab 4 + Required Notebook Check. Turn in today? Thurs Blood Chemistry Lab 5. Please read Lab 5 twice prior to Thursday. Thanks!**

II. ***Cardiovascular System*** **LS 2012 ch 9, Torstar Books 1984, DC 2013 Module 4, Guyton & Hall (G&H) 2011 +...**

A. **Circulatory vs Cardiovascular (CV)? cf + parts**
   LS pp 229, CV vs Lymphatic, DC pp 23, 31

B. **CV Pulmonary & Systemic circuits**
   DC fig 4-1 p 24, LS fig 9-2b p 231
C. **Arteries,capillaries,veins G&H +Torstar**
D. **Varicose veins? Phlebitis? DC**
E. **♥ layers, box, chambers, valves, inlets, outlets**
   LS fig 9-4 p 233, fig 9-2a p 231; DC pp 23-6
F. **Normal vs abnormal blood flow thru ♥ & CV system**
   Billy has a hole in his ♥ Sl Fox 2009 fig 13.16, 13.17

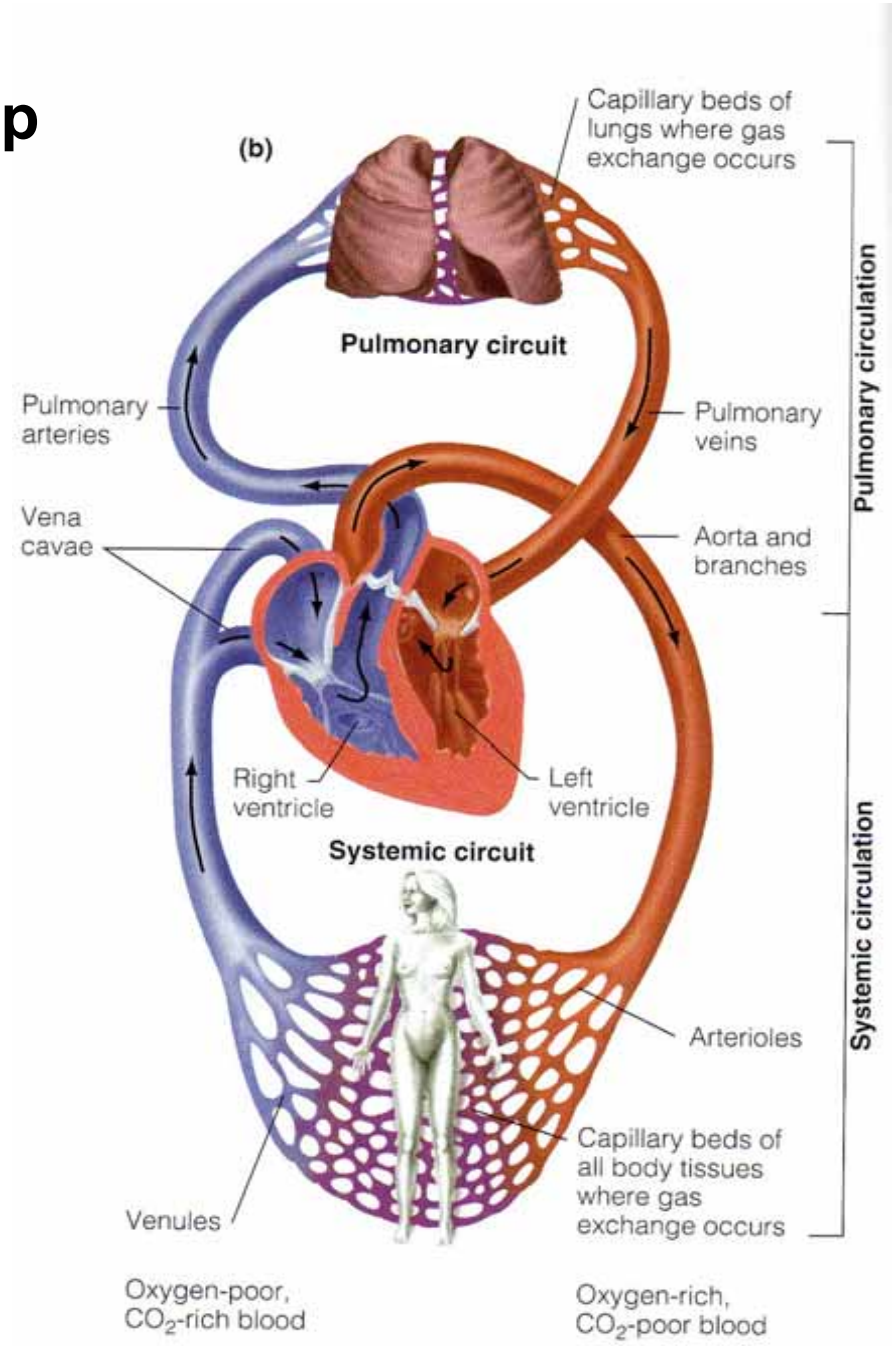
III. ***Comments on Midterm & Tests Returned***

NB: Figure-8 loop

Pulmonary

8

Systemic

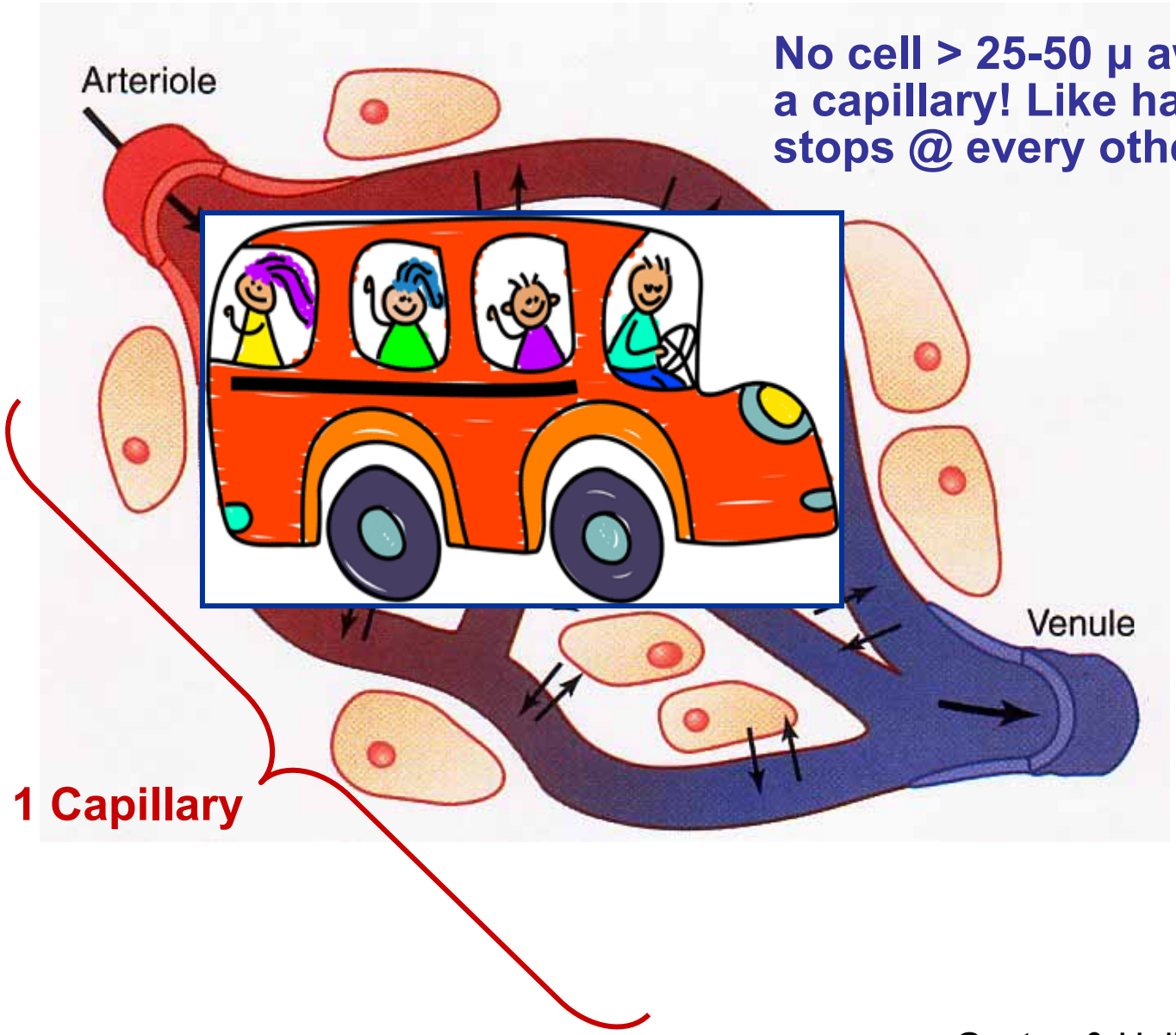


DC 2003

Lymphatic System Blockage in Elephantiasis from Mosquito-borne Parasitic Filaria Worm

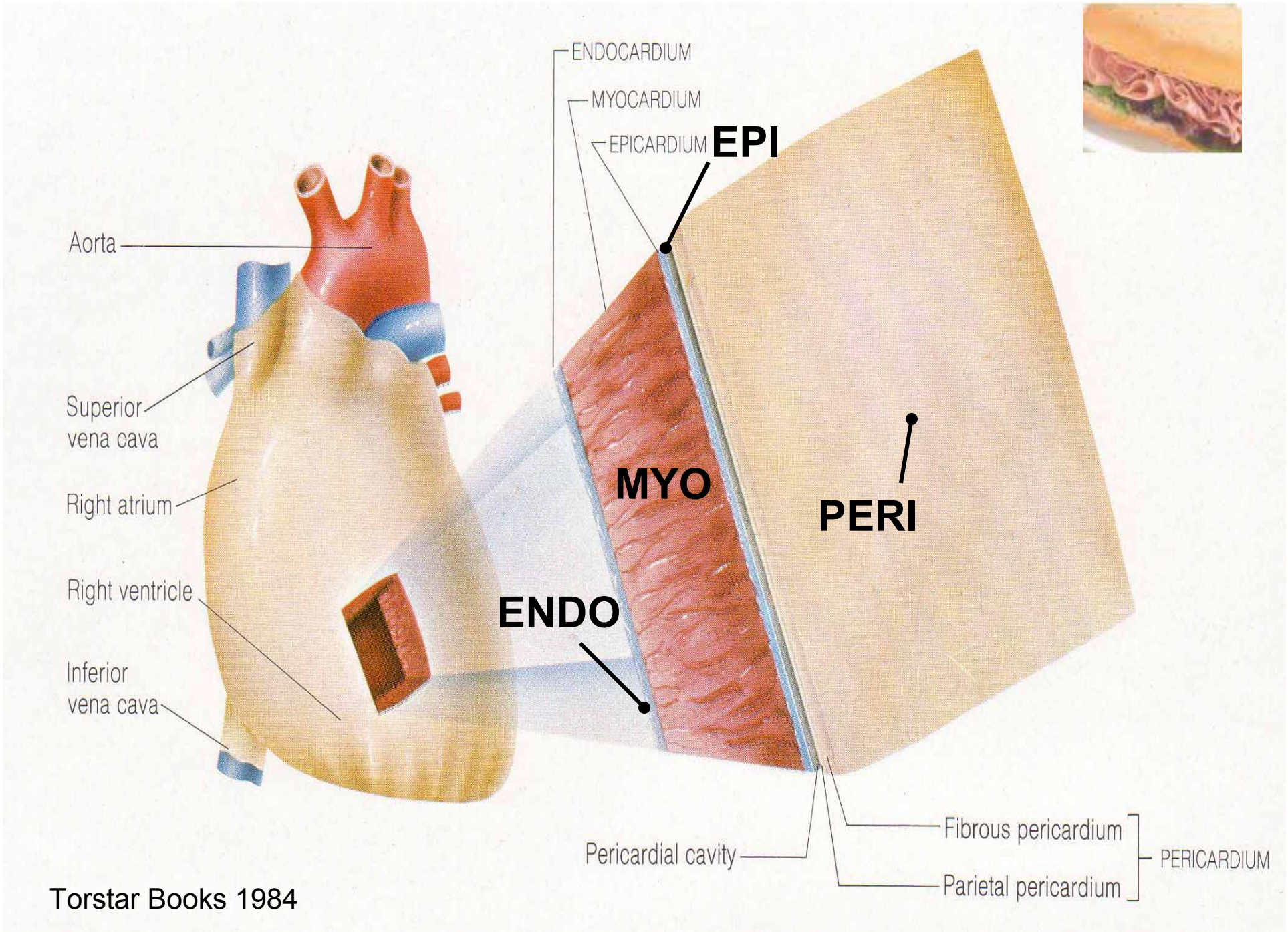
LS 2012 fig 10-21 p 283

Microcirculation Exchange: 10 Billion Capillaries!



No cell > 25-50 μ away from a capillary! Like having bus stops @ every other block!

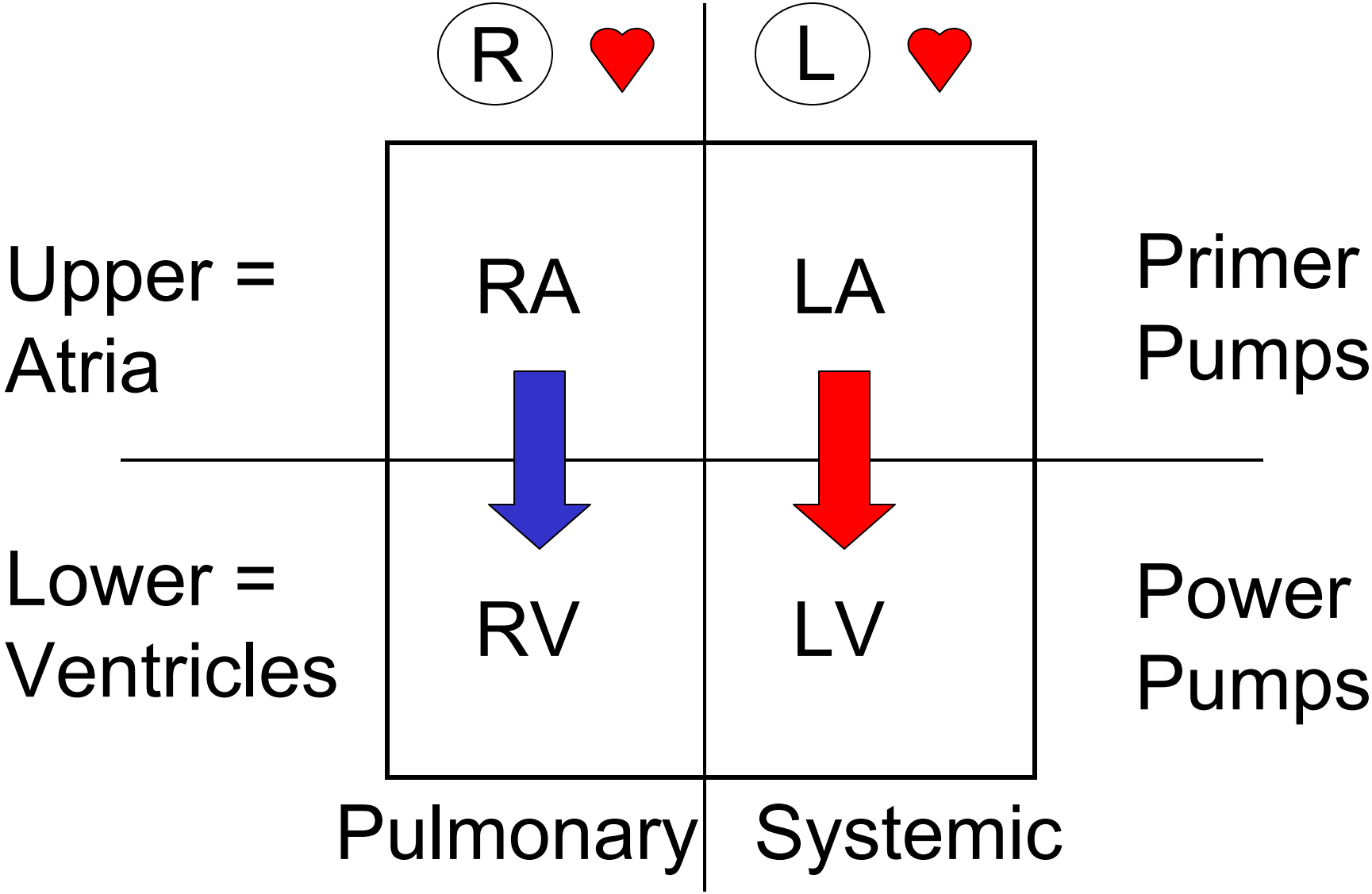
Guyton & Hall 2011 fig 1-2



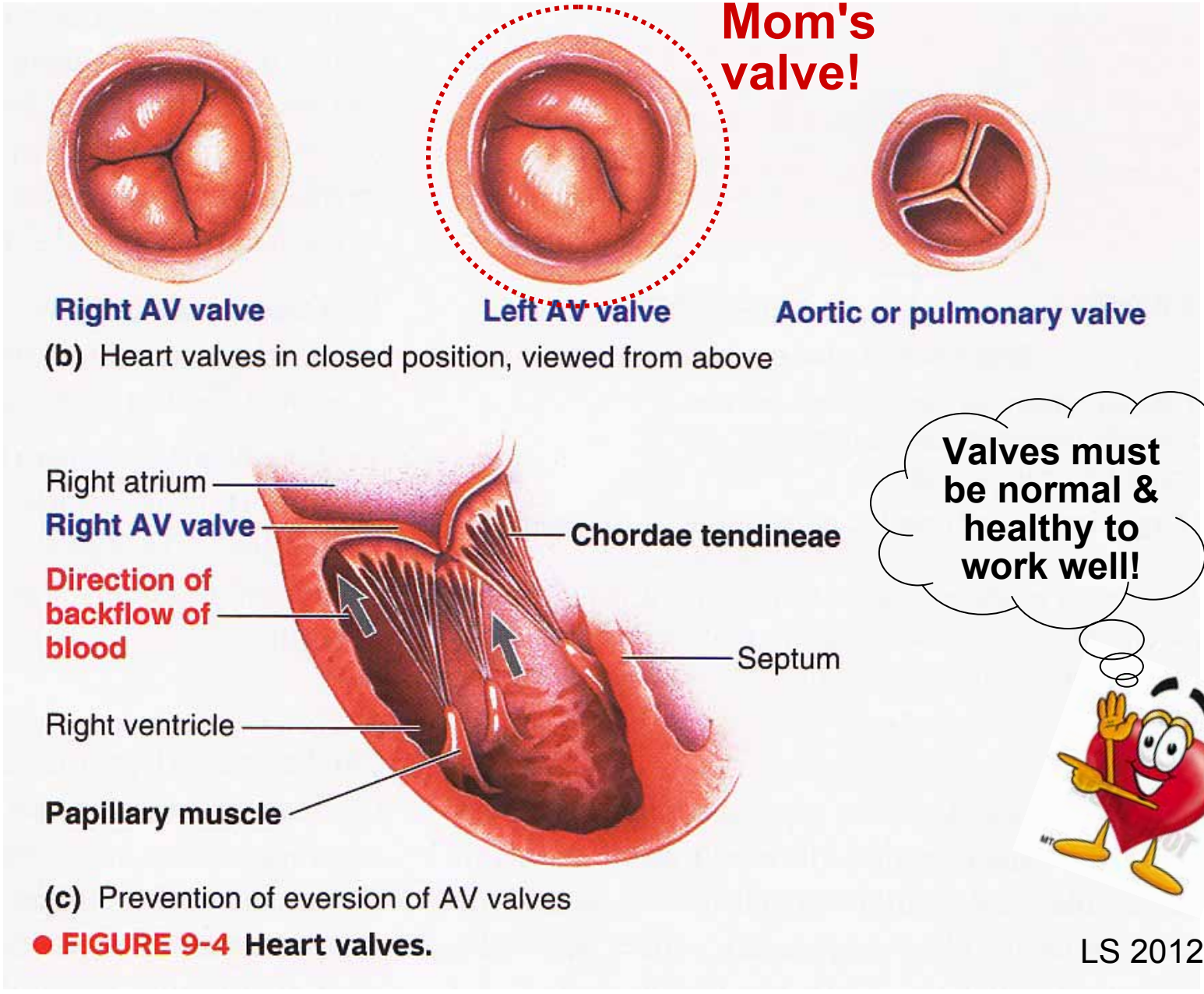
Torstar Books 1984

Human ♥ = 4-chambered box?

2 separate pumps?



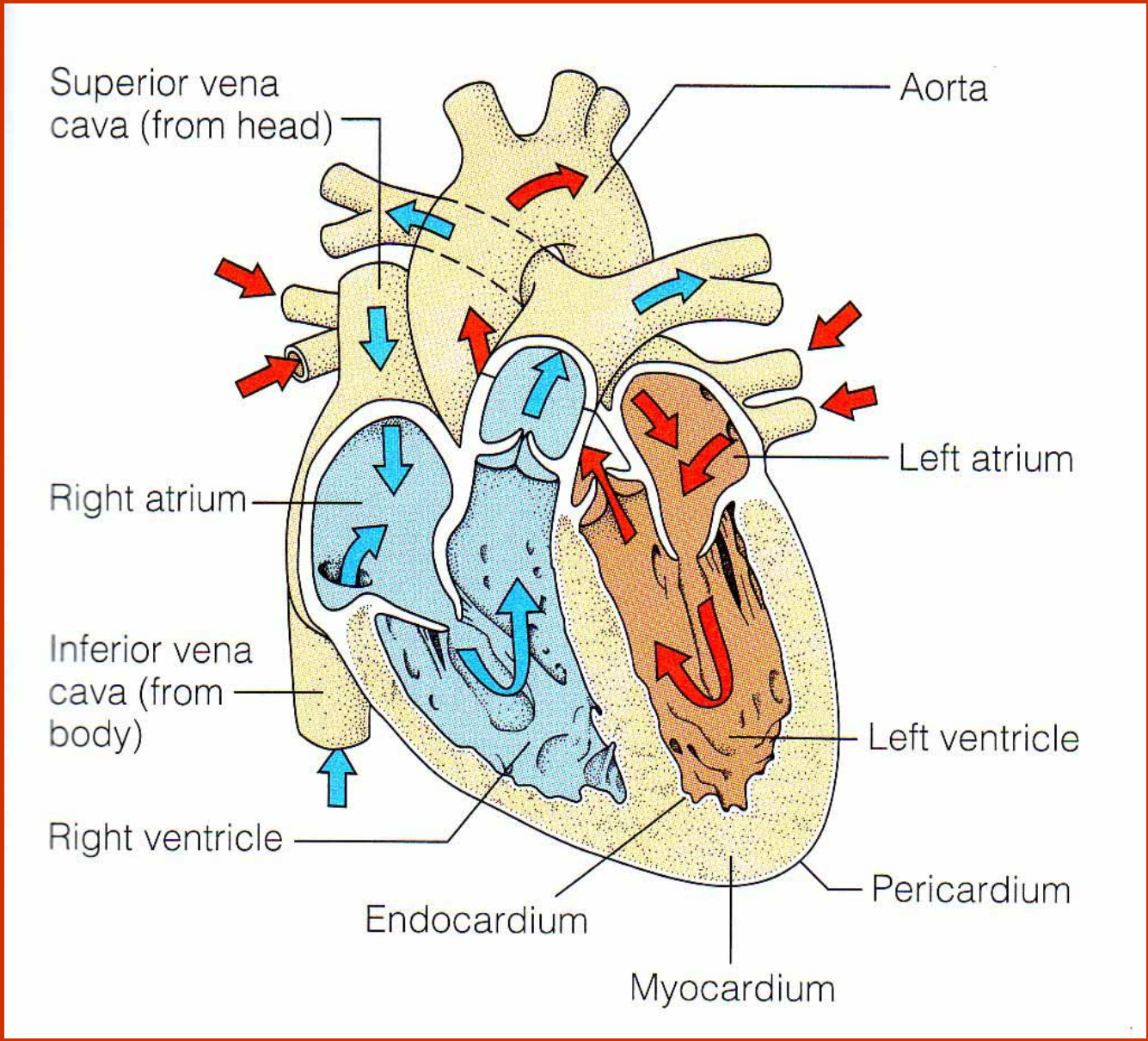
Heart Valves Ensure Unidirectional Blood Flow!



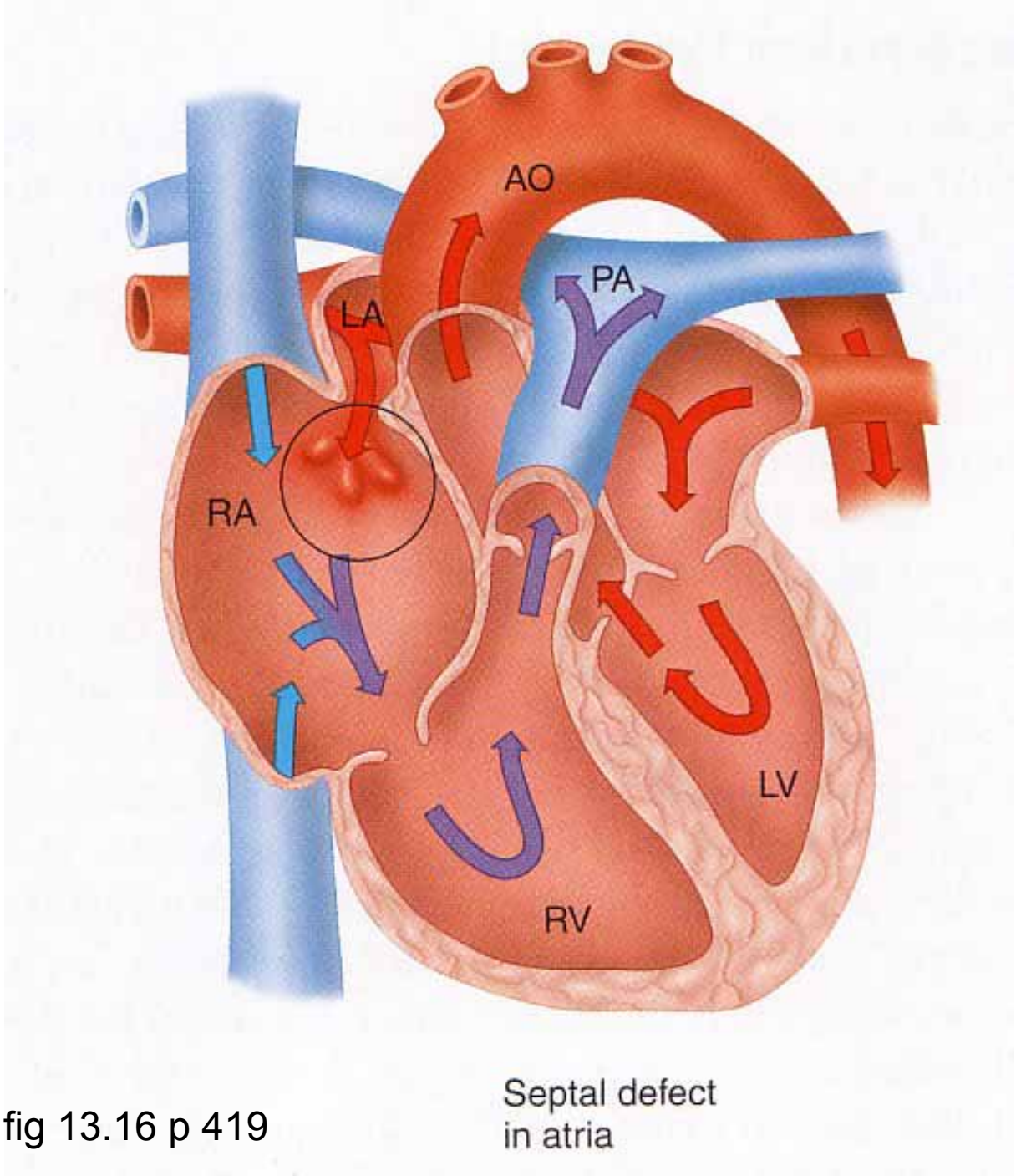
● FIGURE 9-4 Heart valves.

LS 2012 p 233

Veins → Atria → Ventricles → Arteries



LS 2006



SI Fox 2009 fig 13.16 p 419

BI 121 Lecture 9

I. *Announcements* **Lab notebook due today! Lab 4 HR & BP. Thursday, Lab 5 Blood Chemistry. Read pp 5-1 thru 5-6 x2. Q?**

II. *Overview of Labs* **HR & BP. Blood chem lab review**

III. *Cardiovascular Connections* **LS 2012 ch 9**

- **A. Cardiac cyle? Contract-relax!**
- **B. ♥'s electrical highway + Pacemaker activity LS fig 9-7 p 235, tab 9-1 p 236, fig 9-8 p 237**
- **C. NHLBI & AHA websites**

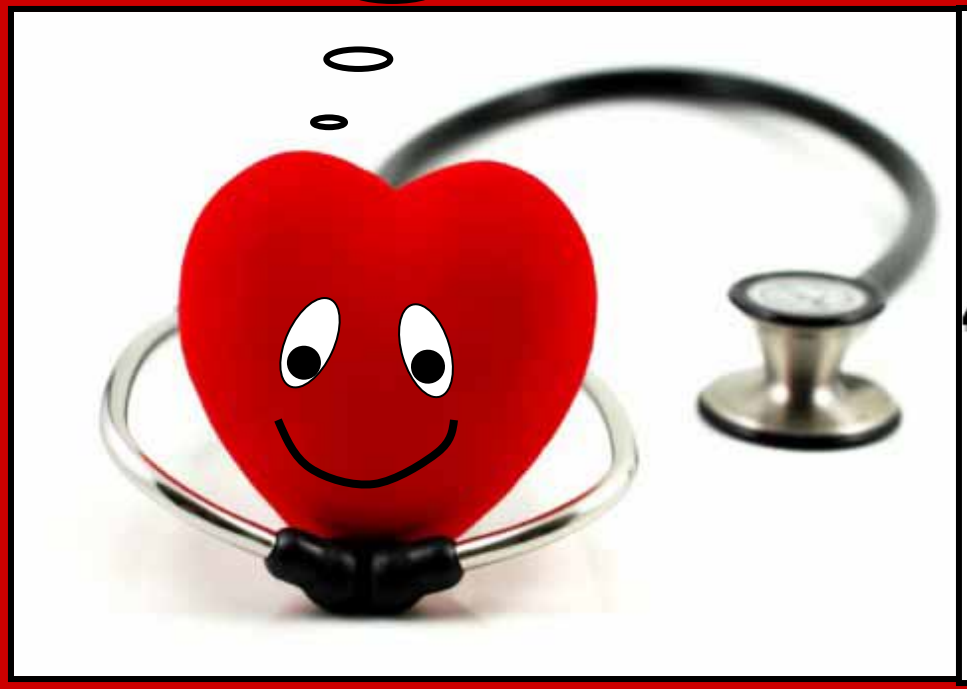
IV. *CV Physiology in the News* **NHLBI & AHA websites Exercise & Nic? Exercise guidelines: ACSM, AHA, CDC**

V. *CV Pathophysiology & Risk Reduction* **LS ch 9, 10 +…**

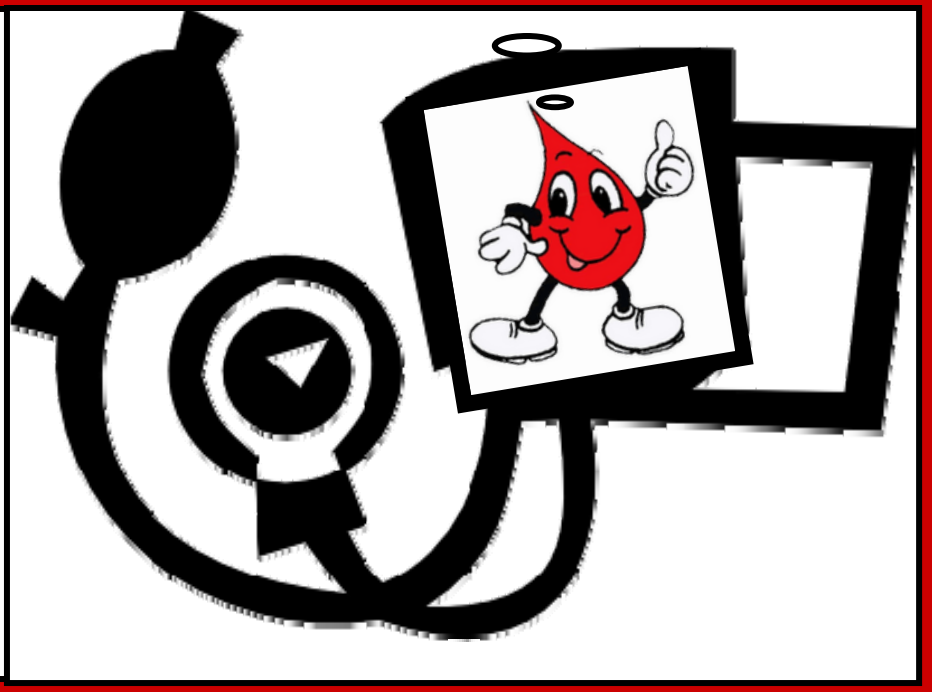
- **A. AMI, CVA, CVD, PVD, TIA, HTN? + surgical treatments**
- **B. Atherosclerosis? LS fig 9-27, 9-25, 9-26 pp 266-8**
- **C. How to minimize risk of CVDs? Treatment triad: Exercise, Diet, Drugs + Surgery**
- **D. Food choices make a difference? What's HAPOC?**

Heart-Blood Pressure Lab Today!

Lub-dup!



I'm cool!



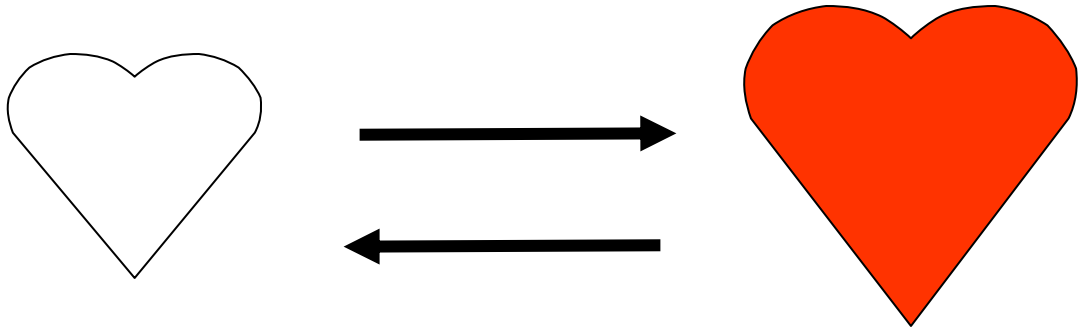
Cardiac Cycle

Systole

Contract
& Empty

Diastole

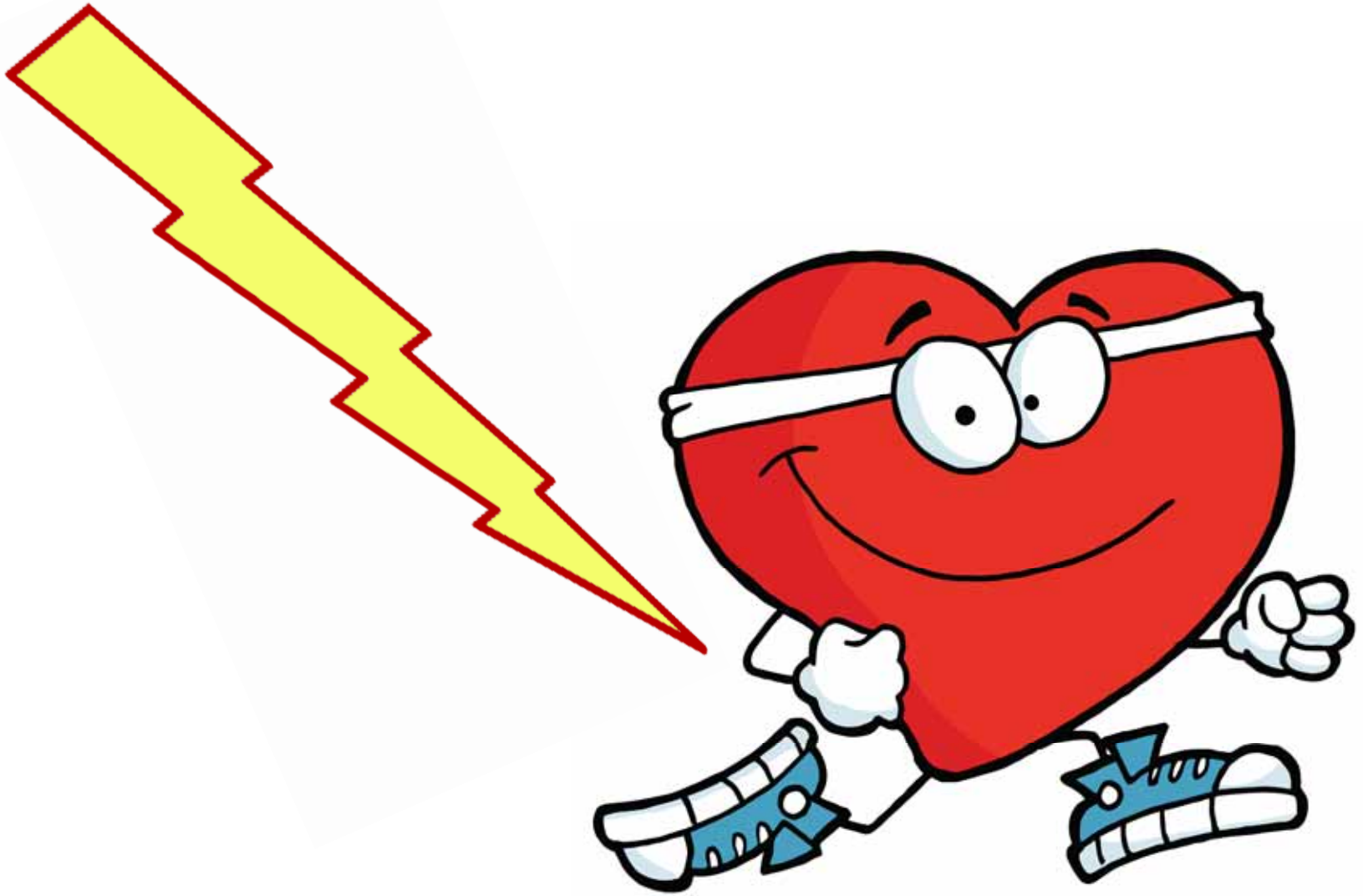
Relax
& Fill



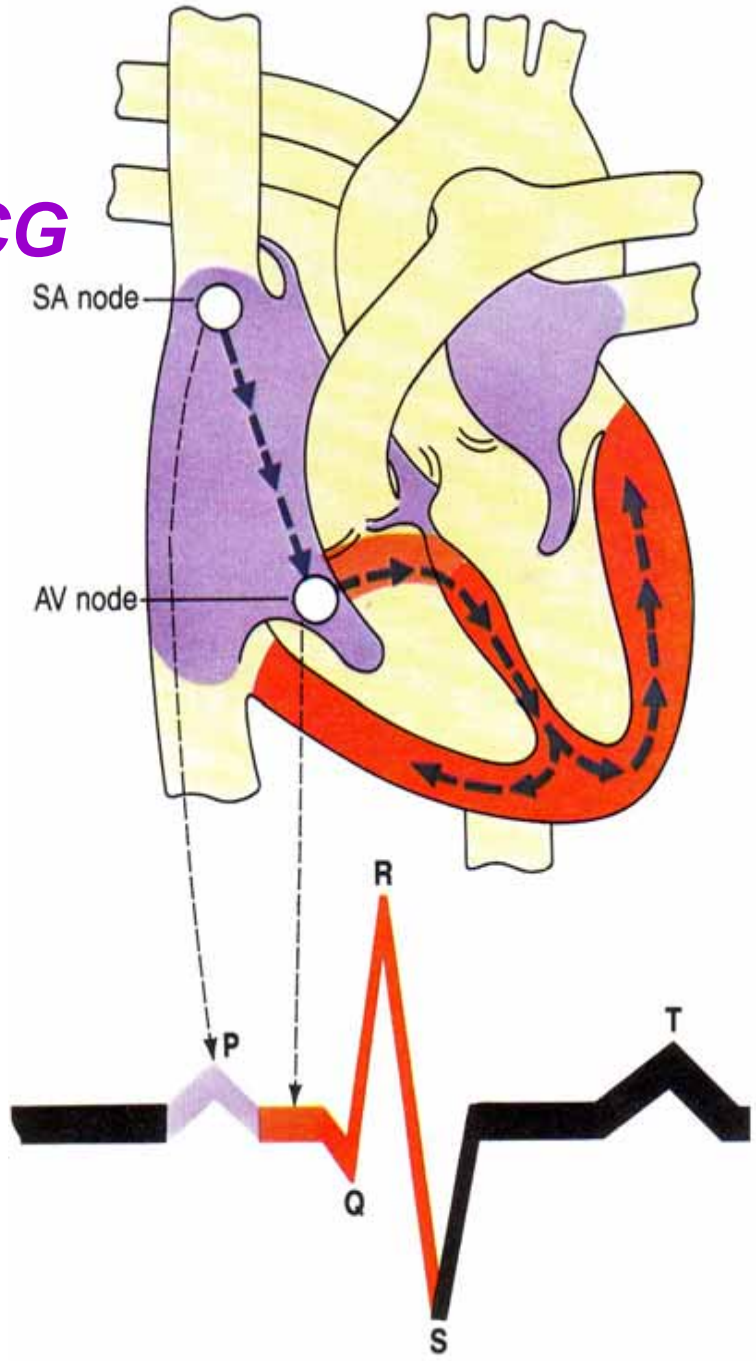
Blood Chemistry on Thursday!
No food, drink or gum in lab!

Thanks sincerely!

(Automatically) Shock the Heart then it Contracts!

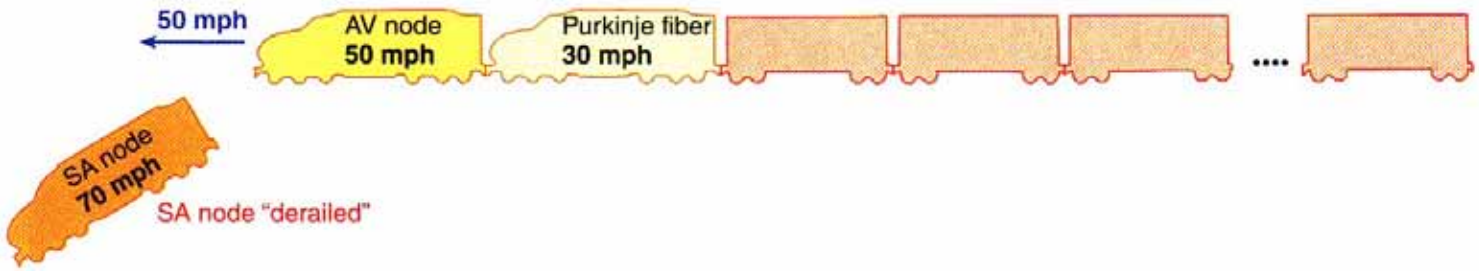


EKG/ECG Origin

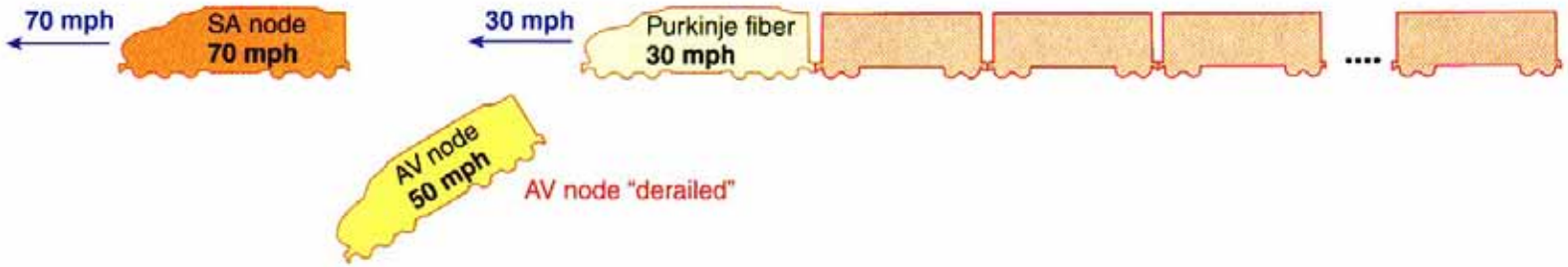


Torstar Books 1984

(a) Normal pacemaker activity: Whole train will go **70 mph** (heart rate set by SA node, the fastest autorhythmic tissue).



(b) Takeover of pacemaker activity by AV node when the SA node is nonfunctional: Train will go **50 mph** (the next fastest autorhythmic tissue, the AV node, will set the heart rate).



(c) Takeover of ventricular rate by the slower ventricular autorhythmic tissue in complete heart block: First part of train will go **70 mph**; last part will go **30 mph** (atria will be driven by SA node; ventricles will assume own, much slower rhythm).

LS 2012 fig 9-8 p 237

Guidelines: Healthy Adults < 65 yr

American Heart Association®
Learn and Live℠

Do moderately intense aerobic exercise
30 min/d, 5 d/wk

OR

Do vigorously intense aerobic exercise
20 min/d, 3 d/wk

AND

Do 8-10 strength-training exercises
8-12 repetitions/each exercise, 2 d/wk

CVDs

AMI

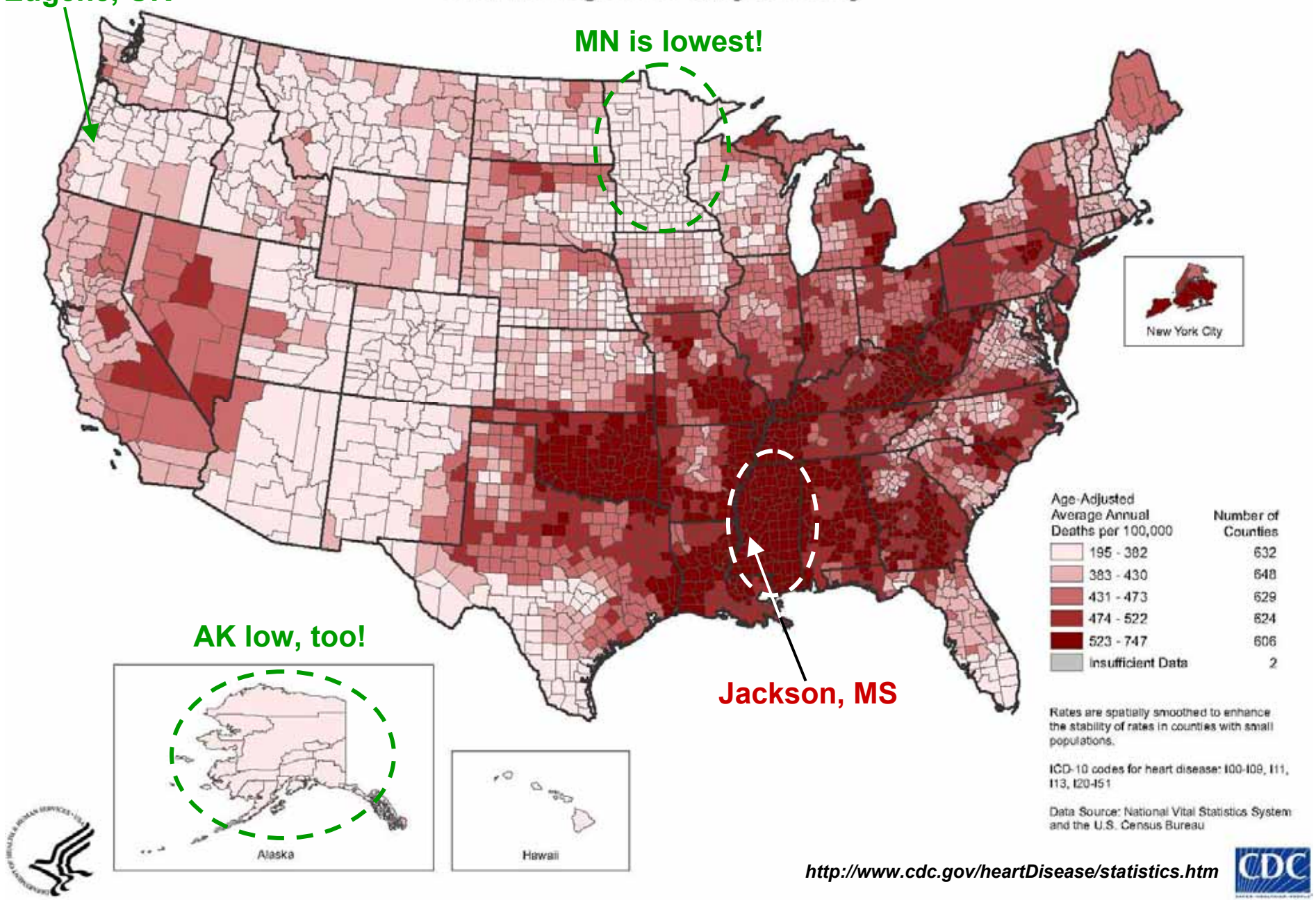
CVA

TIA

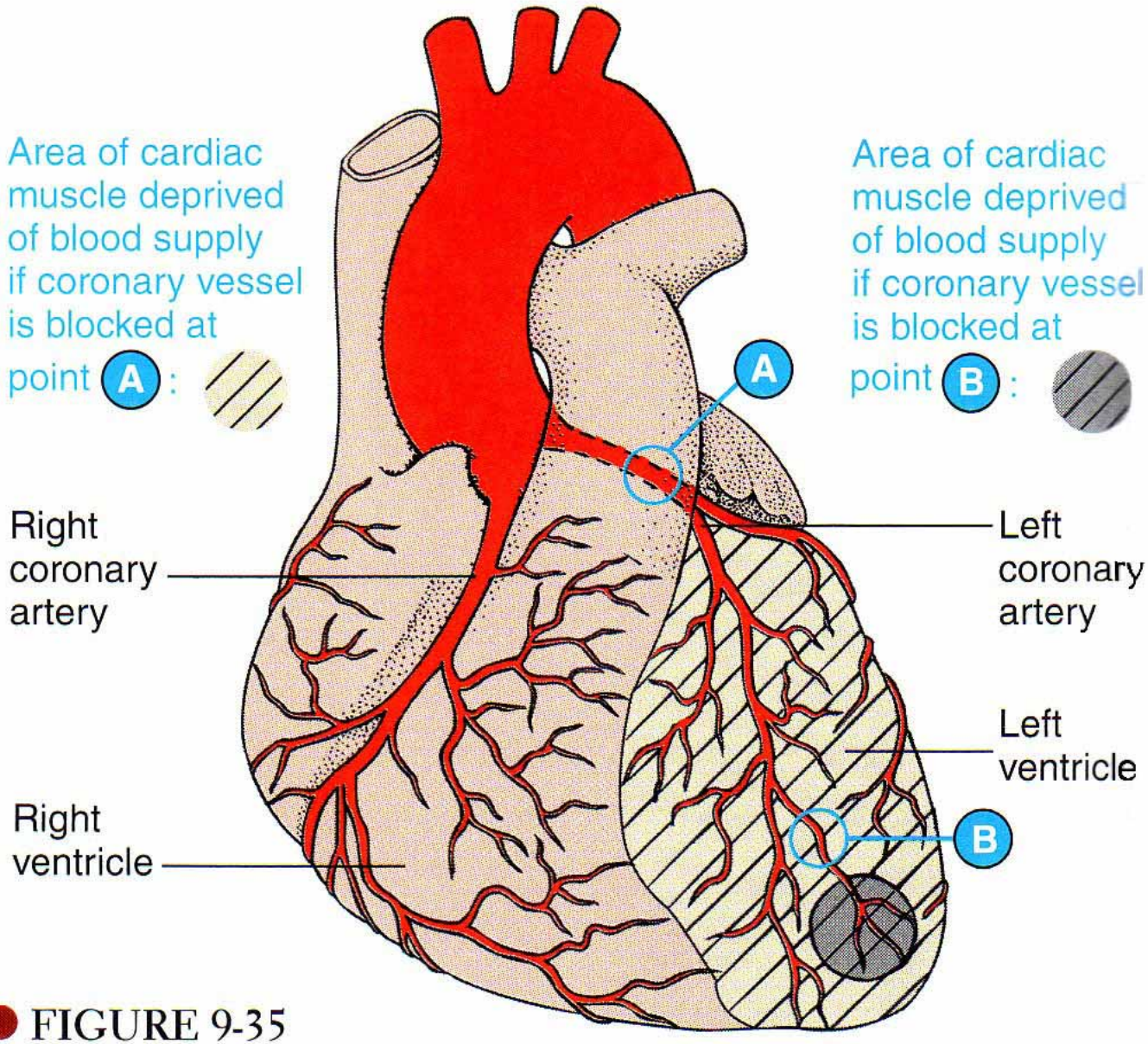
HTN

PVD

Heart Disease Death Rates, 2000-2006
Adults Ages 35+, by County



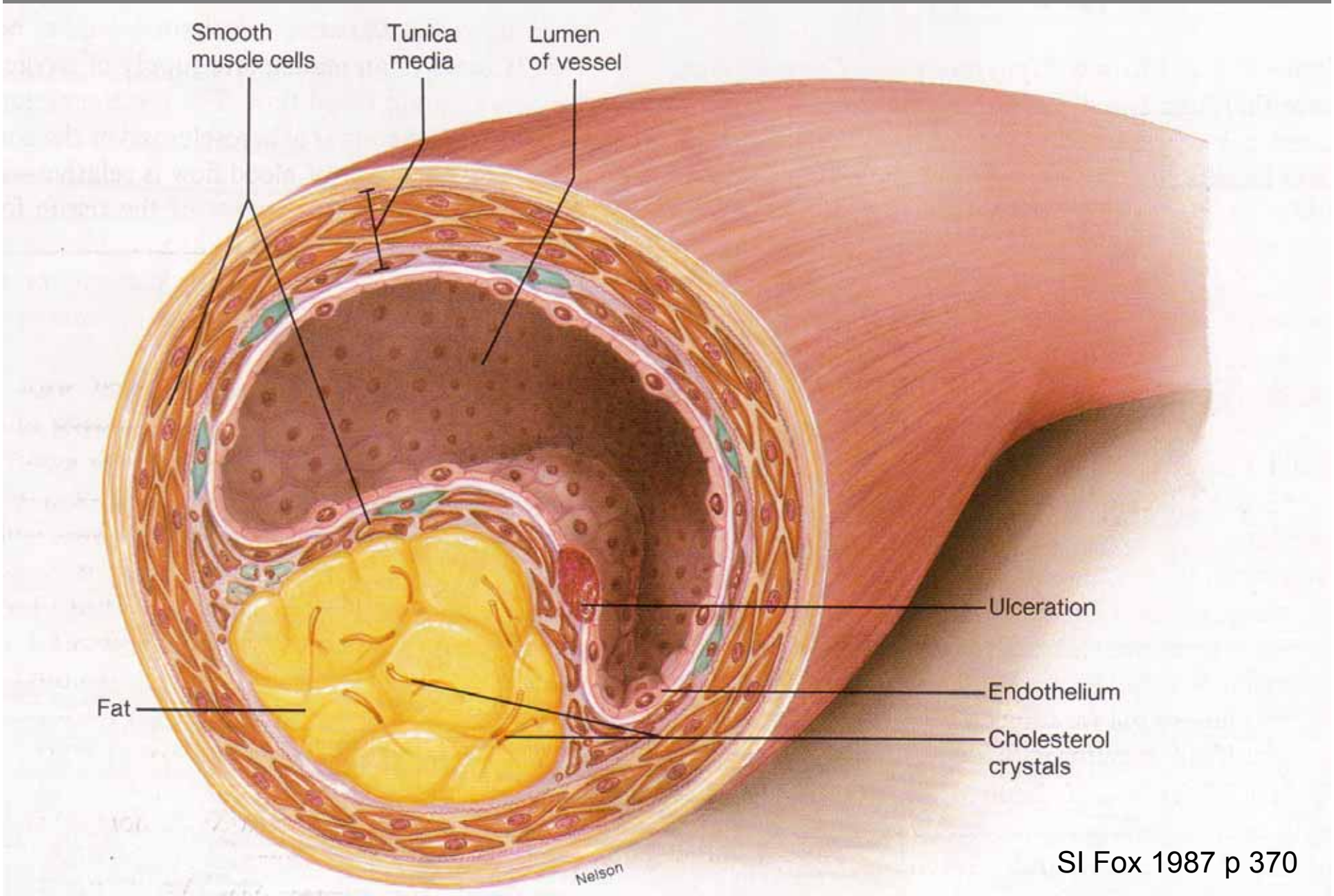
http://www.cdc.gov/heartDisease/statistics.htm



● FIGURE 9-35

Extent of myocardial damage as a function of the size of the occluded vessel

L Sherwood 2004 p 336

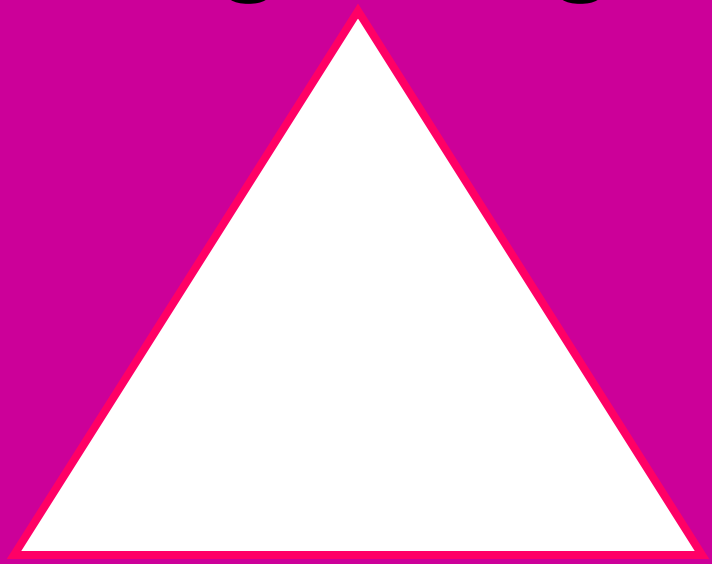


SI Fox 1987 p 370

Treatment Triad

NB: Last blasted resort!!

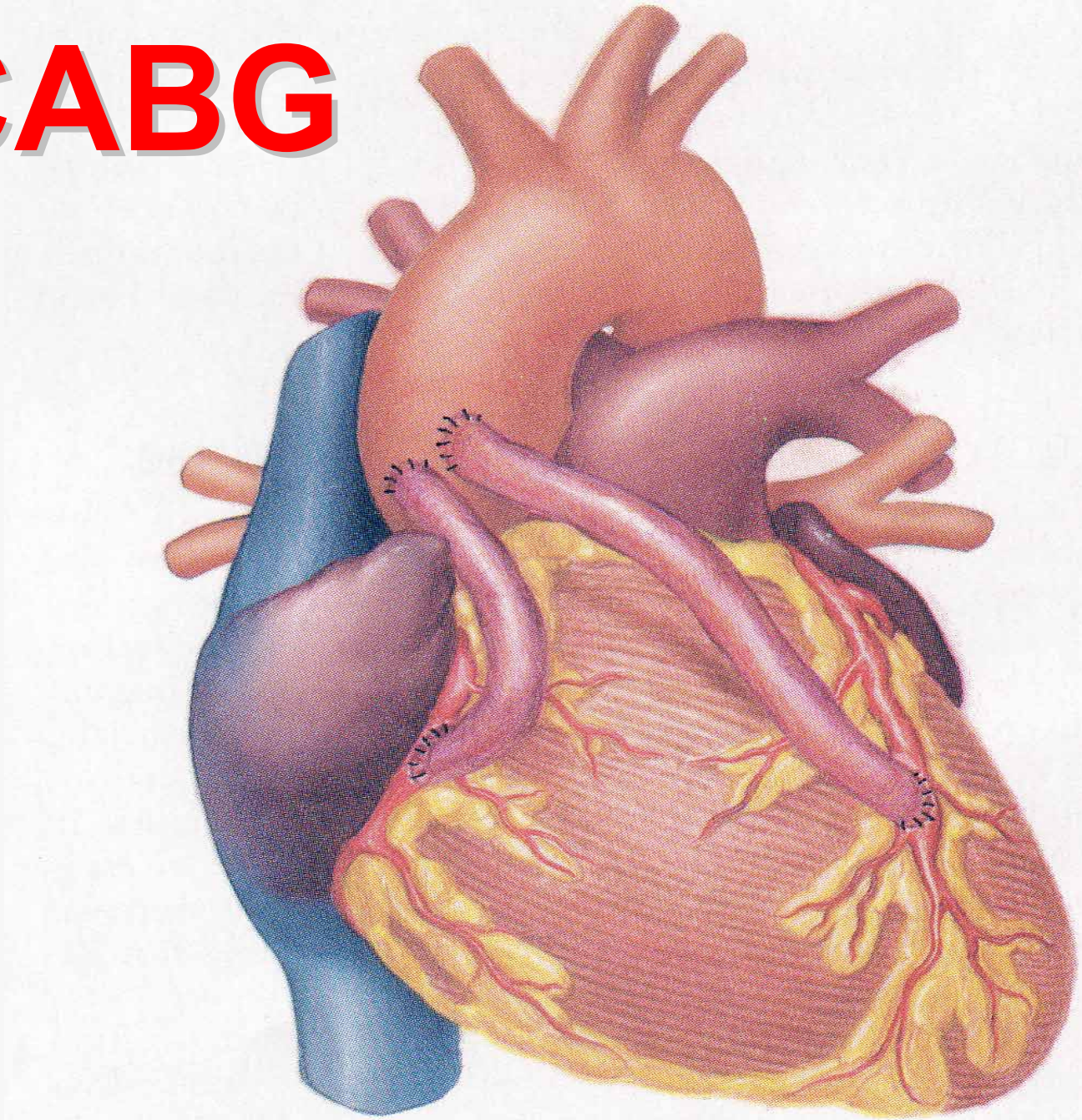
Drugs/Surgery



Exercise

Dietary Modification

CABG



BI 121 Lecture 10

...Fun lab week with much personal data!

I. *Announcements* **Remember to read Lab 5 before Thursday. Thanks for helping us be well-prepared. Q from last time? Calculating grade from estimated final. Keys to success? Q? Notebooks returned at the end of lecture today.**

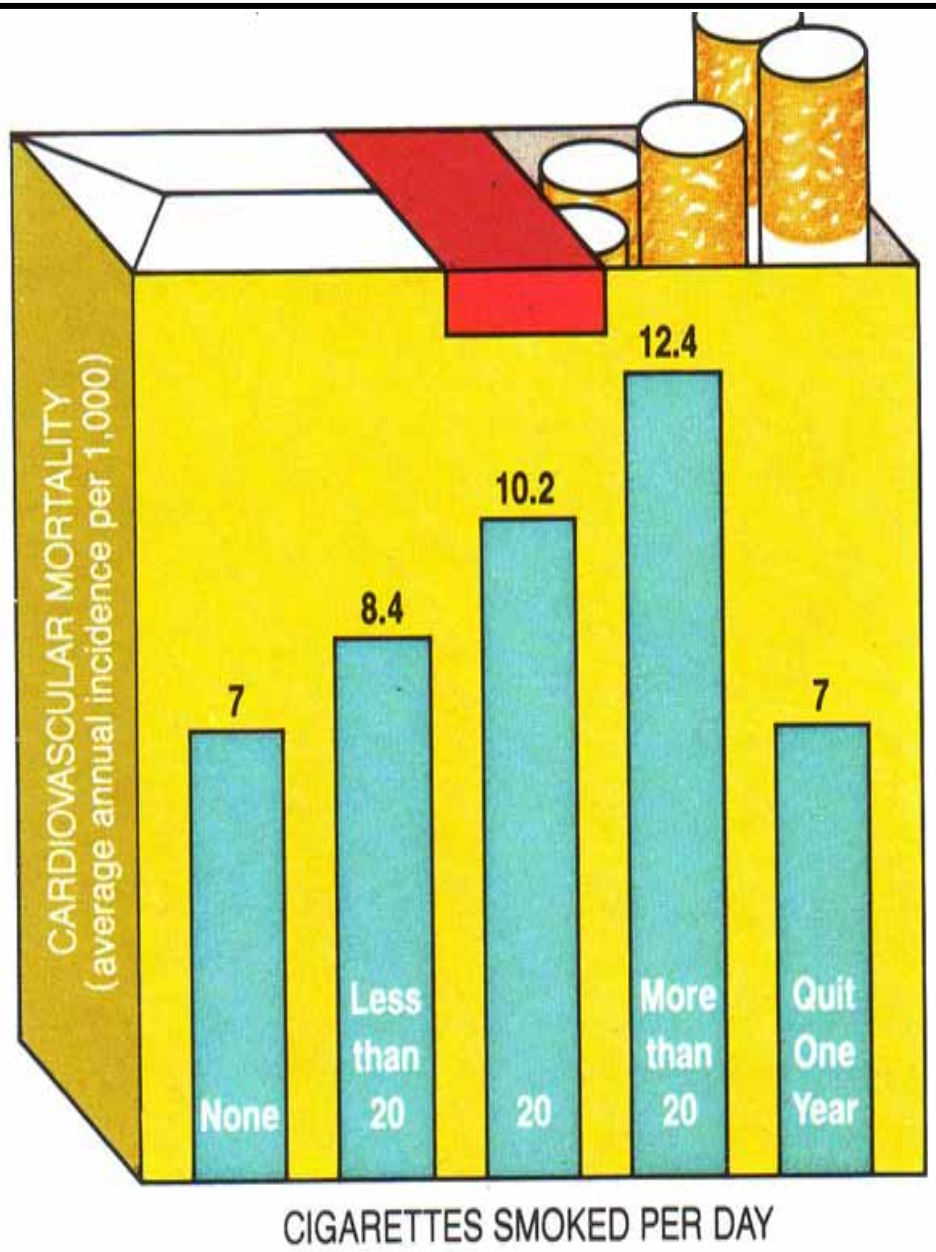
II. *CVDs Risk Reduction Connections* **LS ch 9-10, DC Module 4**
Minimizing risk of CVDs: U of O Smoke-Free! Exercise!!
Can food choices make a difference? What's HAPOC?

III. *Blood Form & Function* **LS ch 11 pp 296-304, 309-12**
DC Module 5 + SI Fox + *National Geographic* Lennart Nilsson

- **A. Formed vs. nonformed/cells vs. plasma fig+tab 11-1**
- **B. Red blood cells/erythrocytes: O_2-carrying sickle cells, ABO blood typing, Rh factor pp 299-304.**
- **C. White blood cells/leukocytes: Defense/immunity differential + general functions pp 309-12**
- **D. Platelets/thrombocytes: Initial clotting p 304**

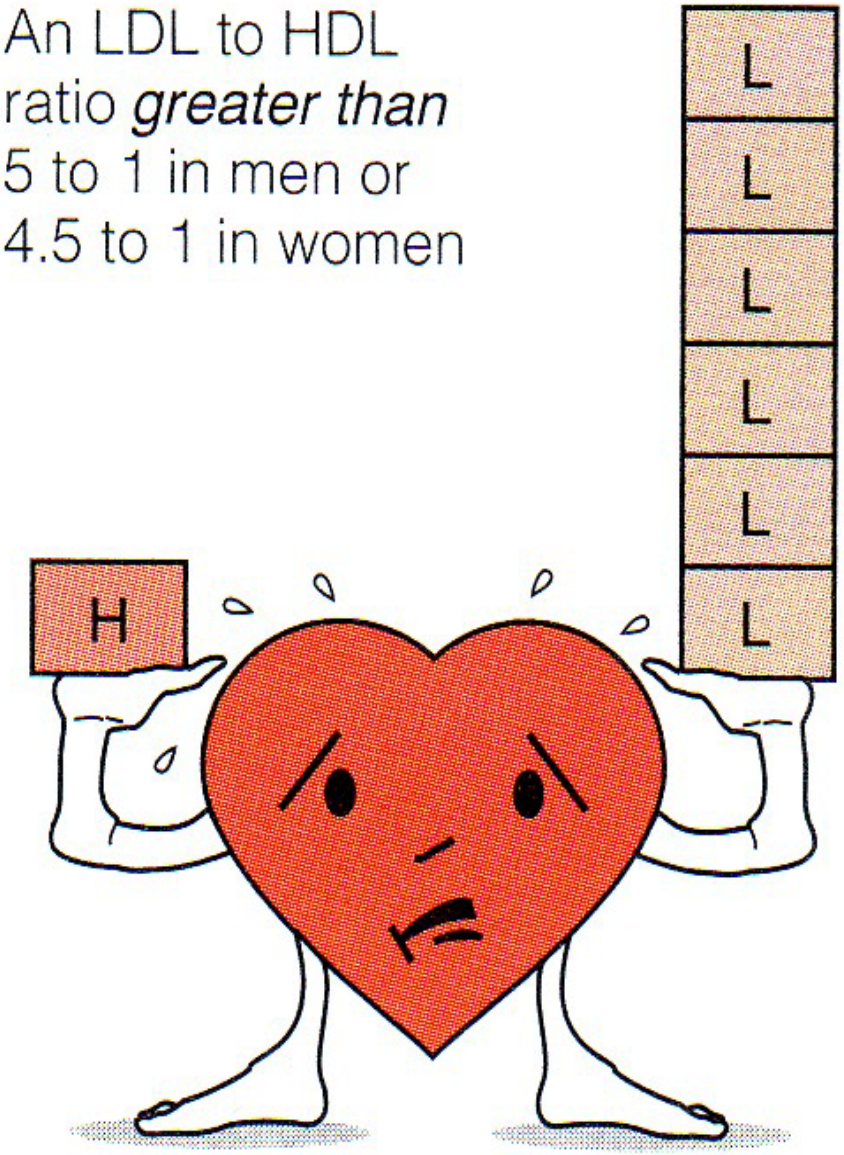
IV. *Blood Glucose & Diabetes Mellitus* **LS ch 17, DC Module 13**

Cigarettes smoked/day & cardiovascular mortality!




KA-BOOM!
300/200
Hg

An LDL to HDL ratio *greater than* 5 to 1 in men or 4.5 to 1 in women

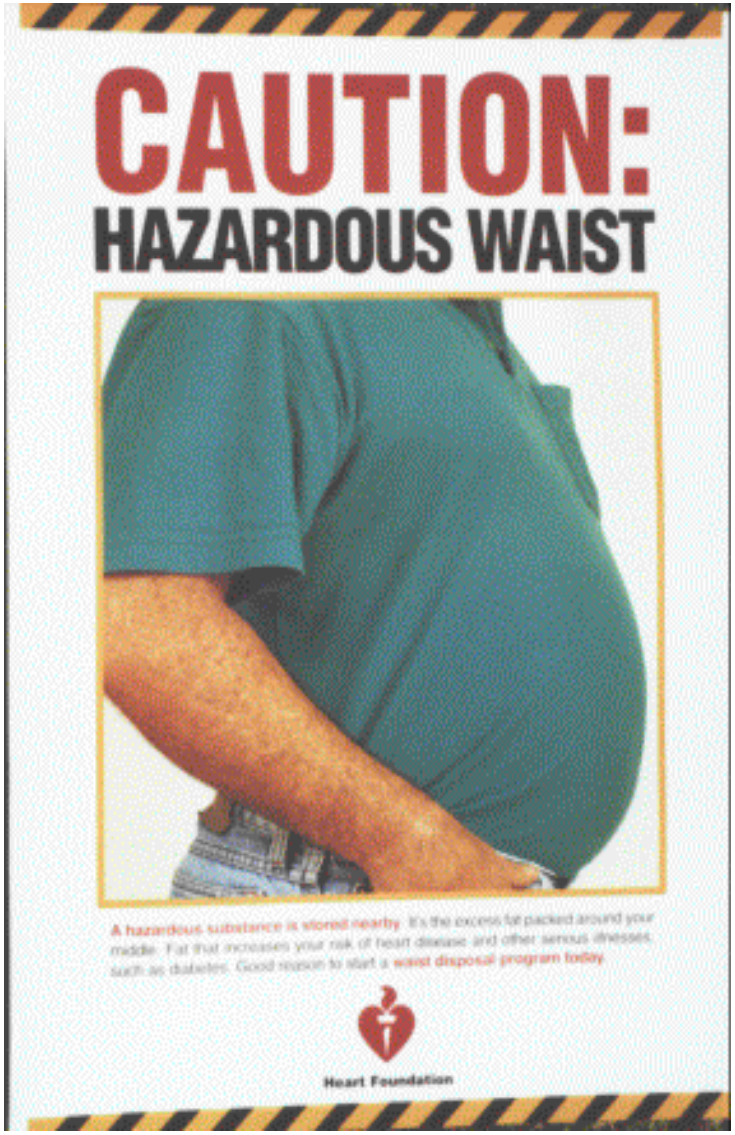


Increased risk of heart disease

Apple type of obesity predisposed to CVD!

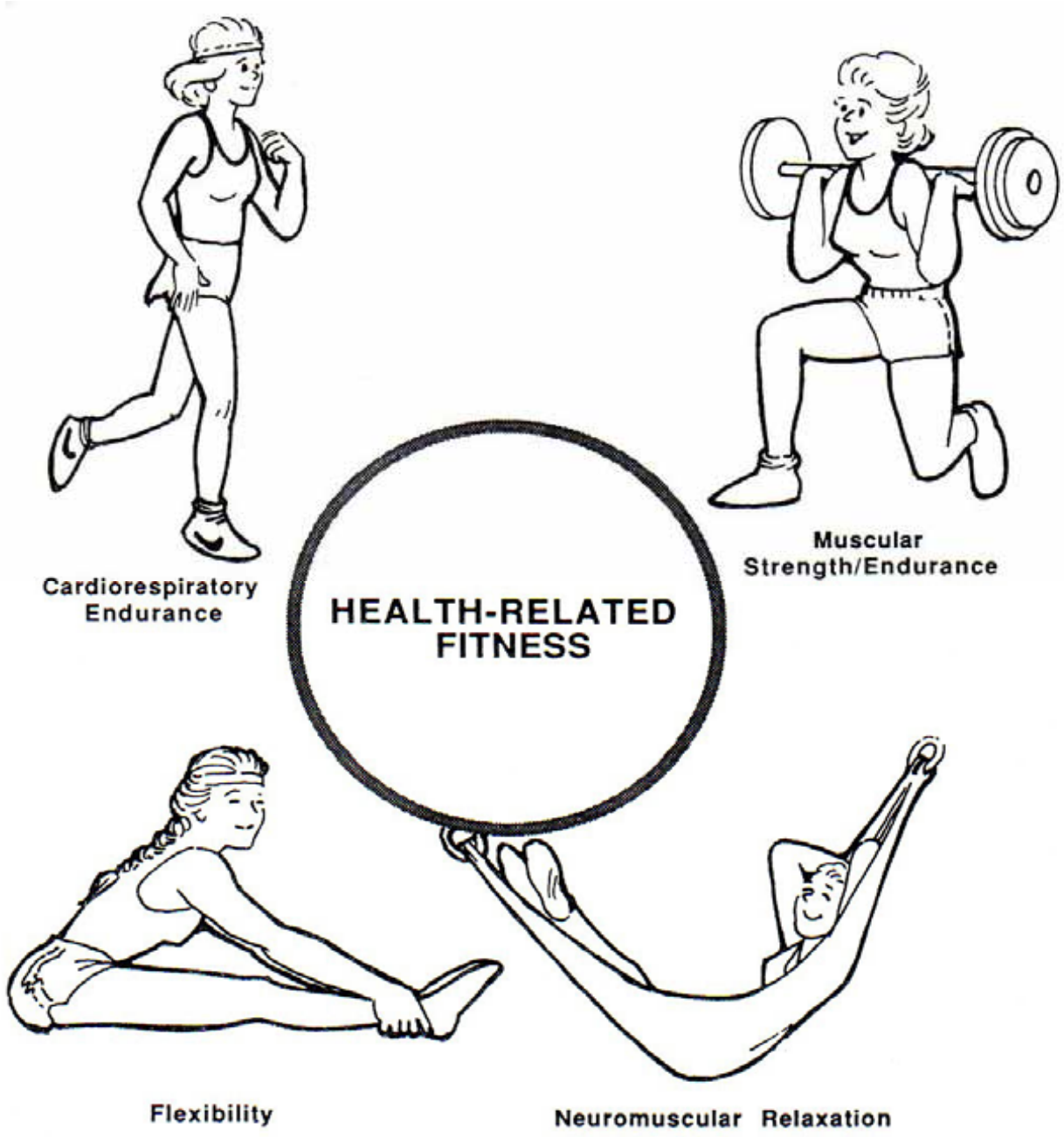
Pear type of fat pattern…

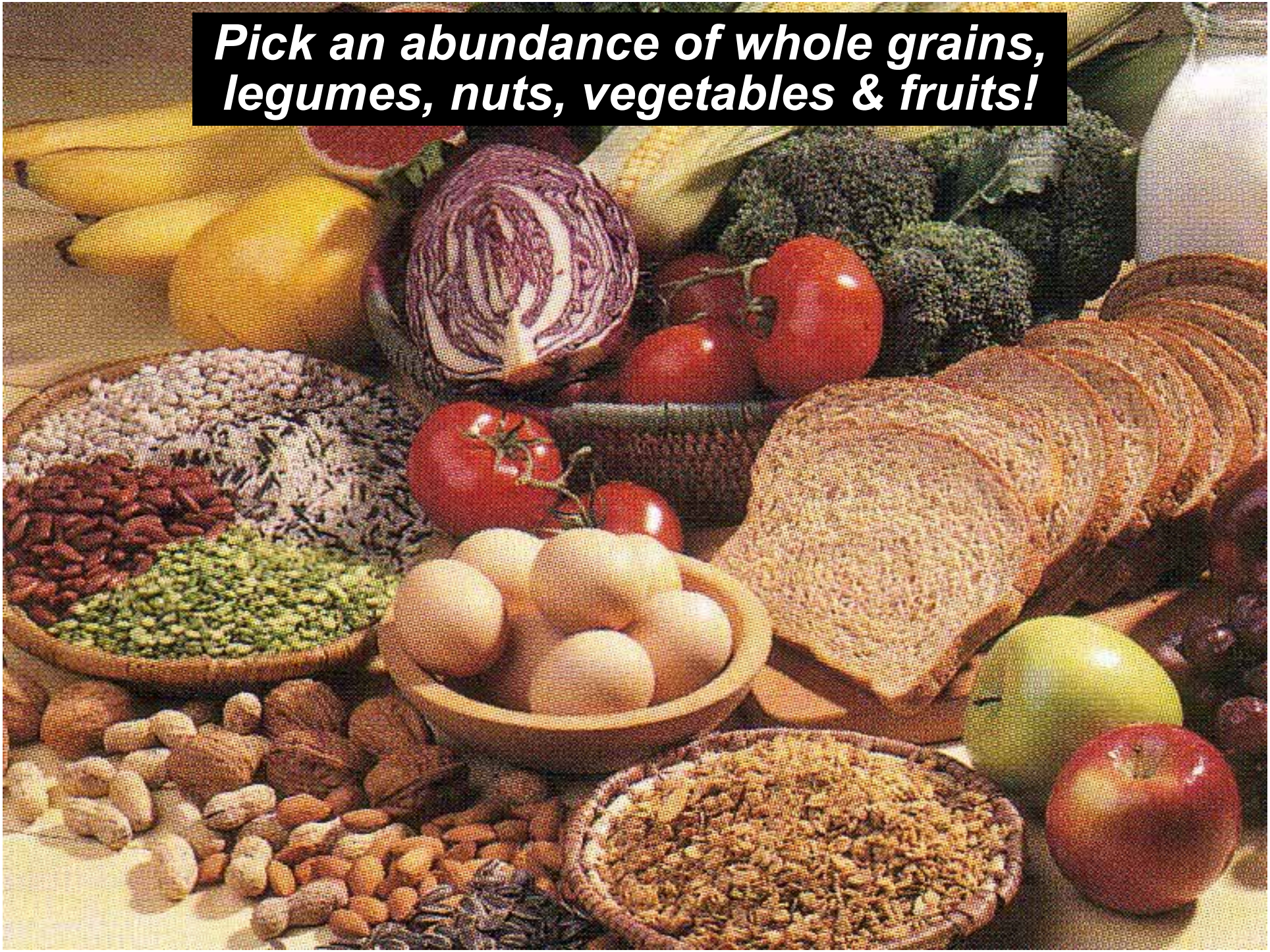
implies lower disease risk!



Eat more apples…

to help prevent the apple type of obesity!


HEALTH-RELATED FITNESS
Cardiorespiratory Endurance
Muscular Strength/Endurance
Flexibility
Neuromuscular Relaxation


Pick an abundance of whole grains,
legumes, nuts, vegetables & fruits!

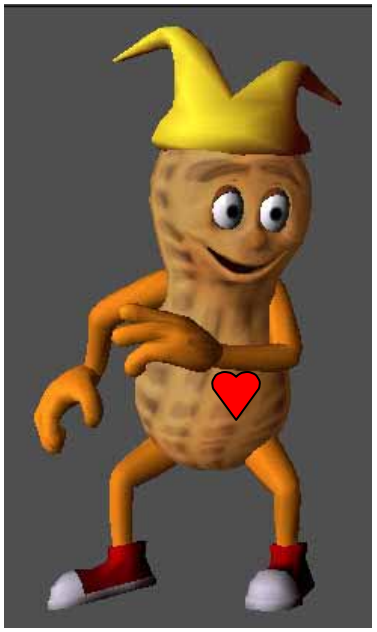
Deep cold water fish are fabulous sources of Ω-3 fatty acids!

S&W p 167

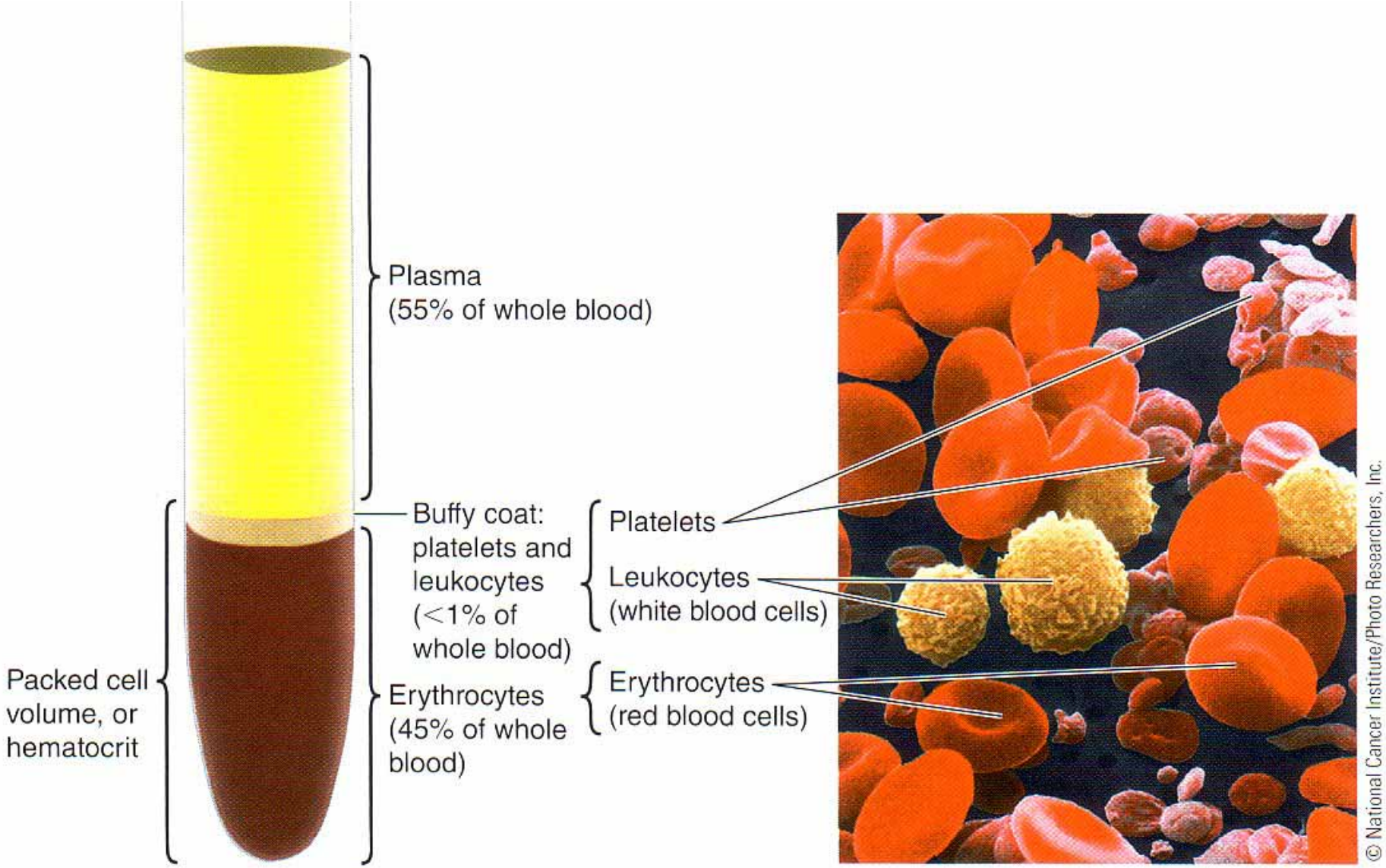
Healthy Oils to Minimize Atherosclerosis

HAPOC?

H A P O C

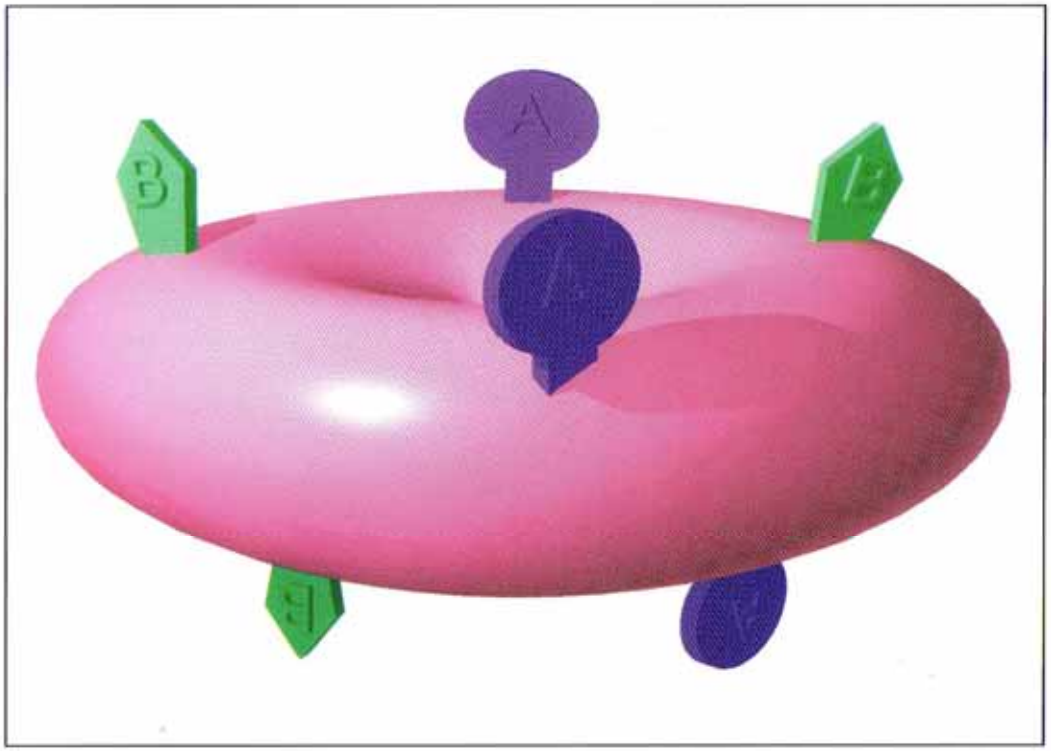


What's in Blood? Plasma & Blood Cells



LS 2012 fig 11-1

AB



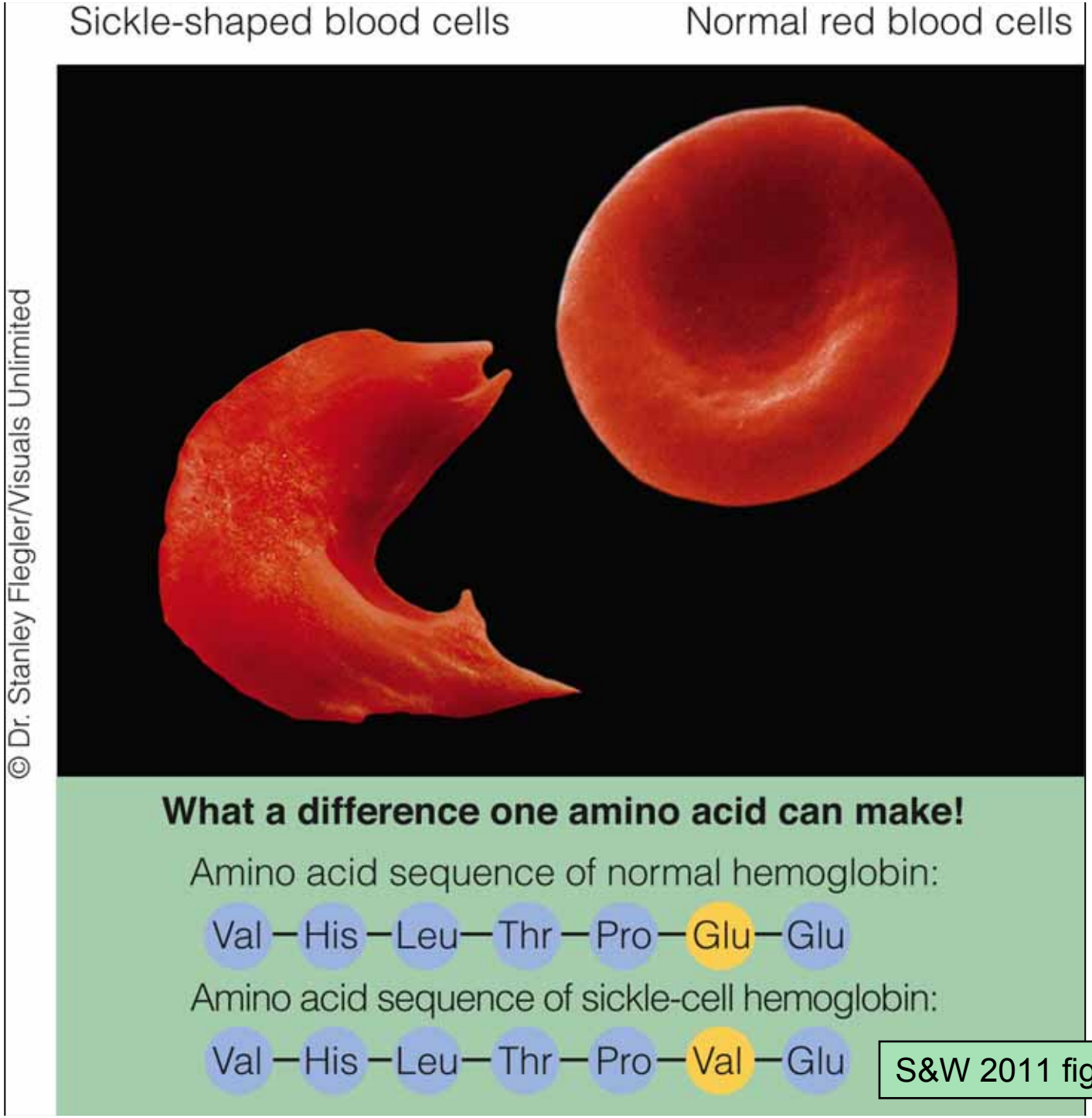
A & B Antigens

(Agglutinogens)

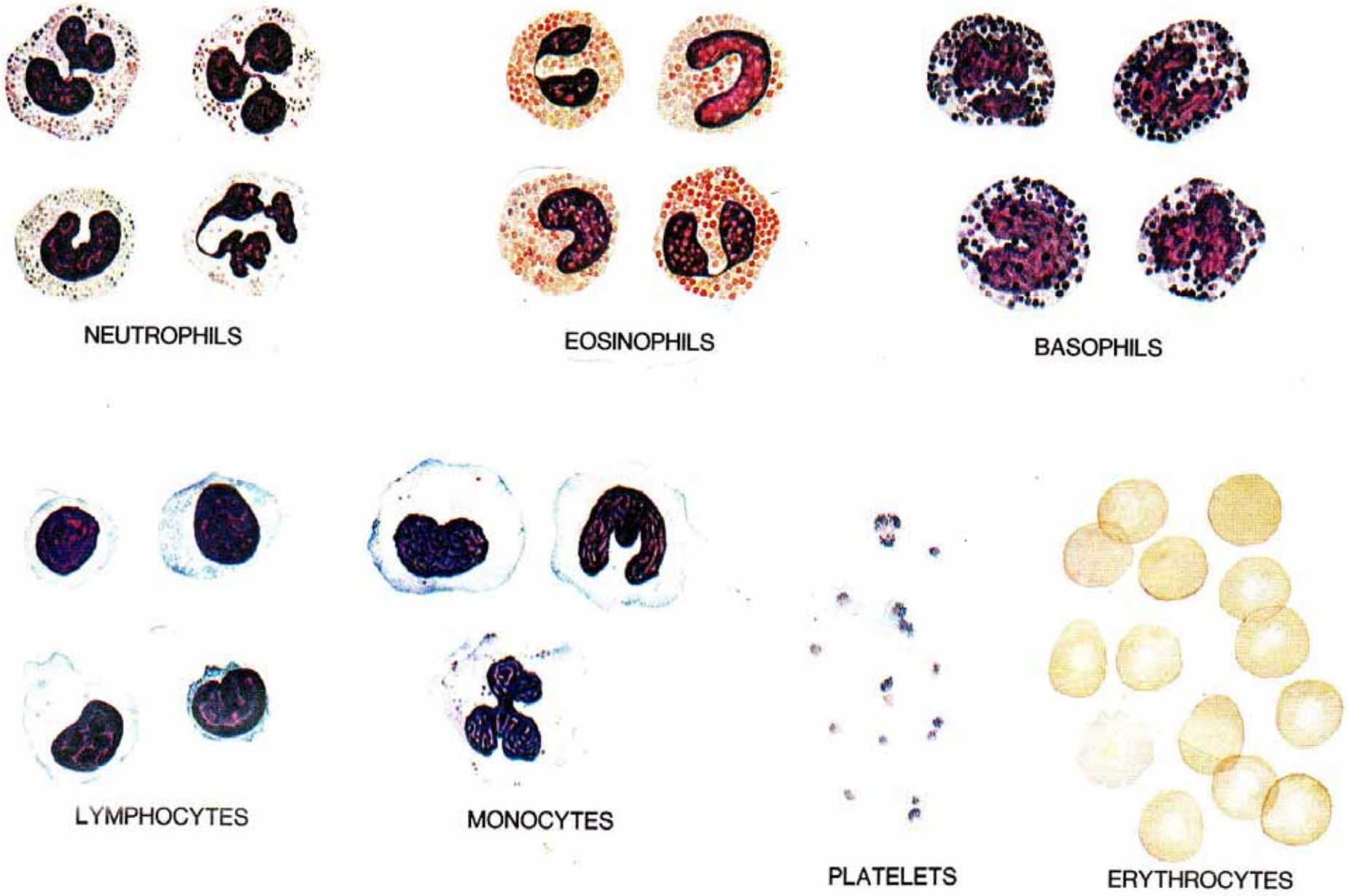
Erythroblastosis Fetalis?

eg, Rh- mom
Rh+ baby

http://www.nlm.nih.gov/MEDLINEPLUS/ency/article/001298.htm#Alternative%20Names



S&W 2011 fig 6-5 p 194

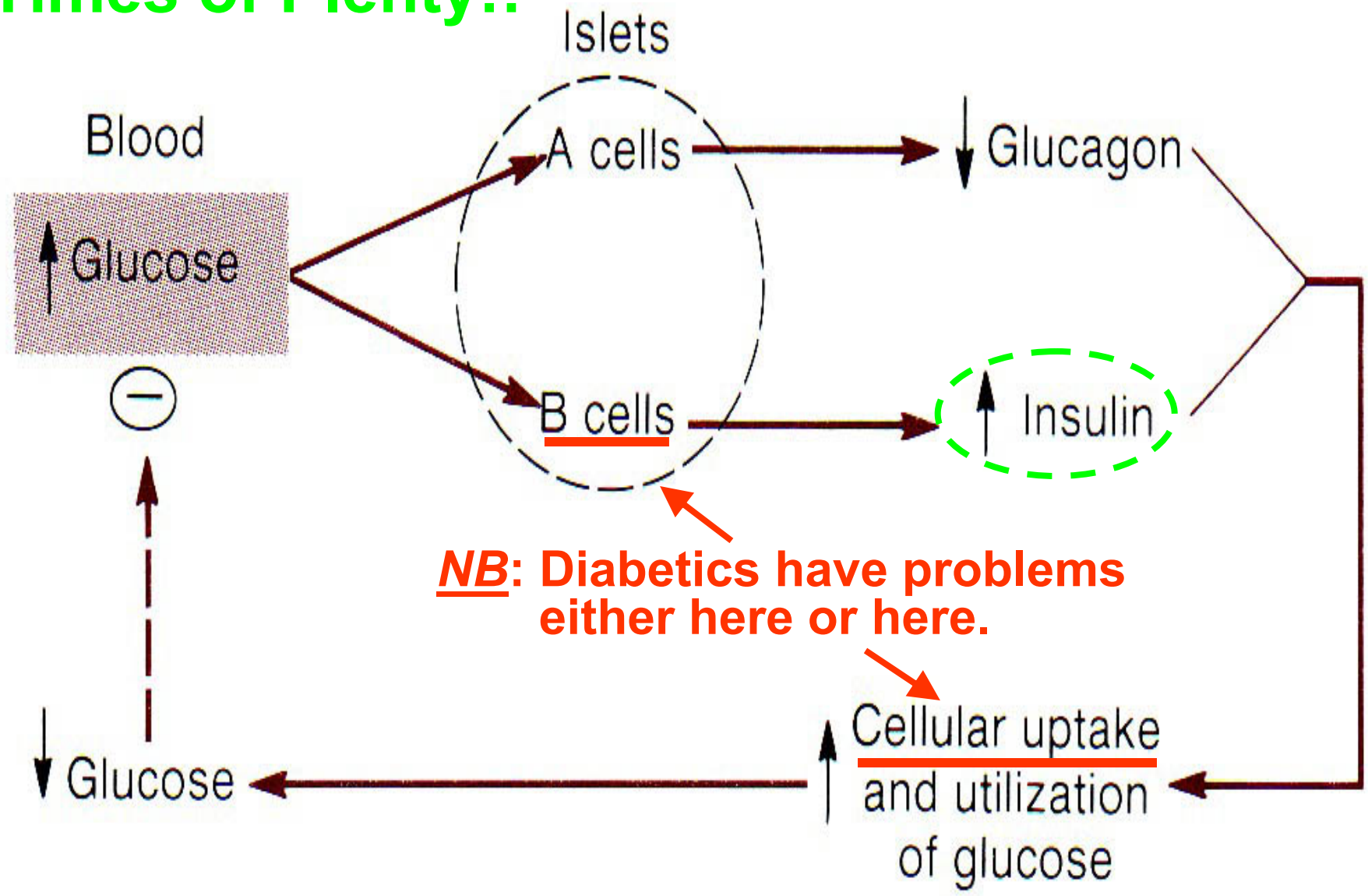


SI Fox 2009 fig 10-2

Glucose:
Sugar in Blood

Normal: 70-99
Pre-Diabetes: 100-125
Diabetes: ≥ 126 mg/dL

Times of Plenty!!



Fox 1987

Store!

BI 121 Lecture 11

··· Fun lab today! Data for a lifetime!
Thanks for being prepared!

I. ***Lab 5 Review: Safety & Techniques*** **Q?**

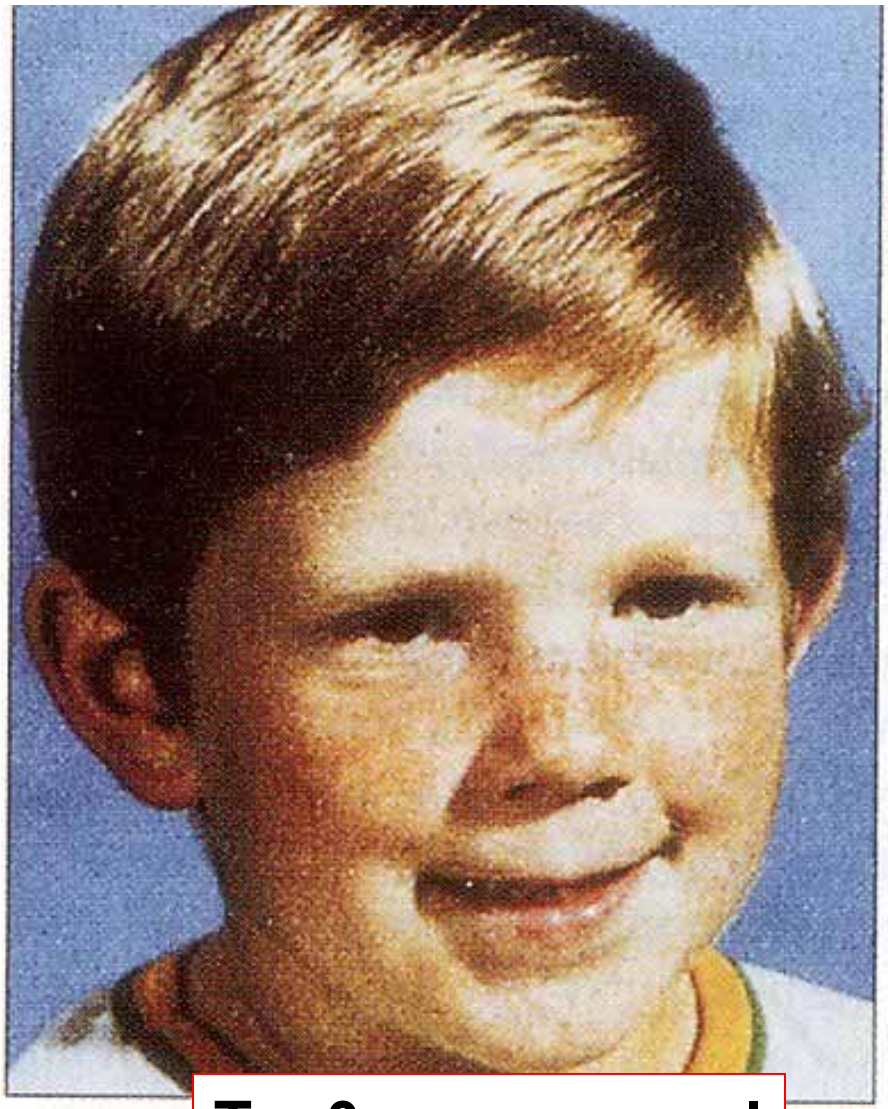
II. ***Introduction to Endocrinology*** **LS ch 17, DC Module 13, SI Fox+**

- **A. Endocrine vignette: Cushing's syndrome LS fig17-20 p 521-2**
- **B. Endocrine system DC p 103 fig 13-1, LS fig 17-1, tab 17-1**
- **C. What's an endocrine? + classes ~ LS pp 495 - 6**
- **D. Hypothalamus (Master) – Pituitary (subcontroller) DC pp 104-6 + LS pp 499-506**
- **E. Posterior pituitary + hormones DC p 108, LS fig 17-4 p 502**
- **F. Anterior pituitary + hormones DC pp 105-7, LS pp 502-6**
- **G. GH: Body builder's dream? Fountain of youth? LS pp 506-11**
- **H. Peripheral endocrine organs DC pp 109-13, LS pp 513-36**
  1. Pancreas (insulin, glucagon, diabetes) 2. Thyroid 3. Adrenals

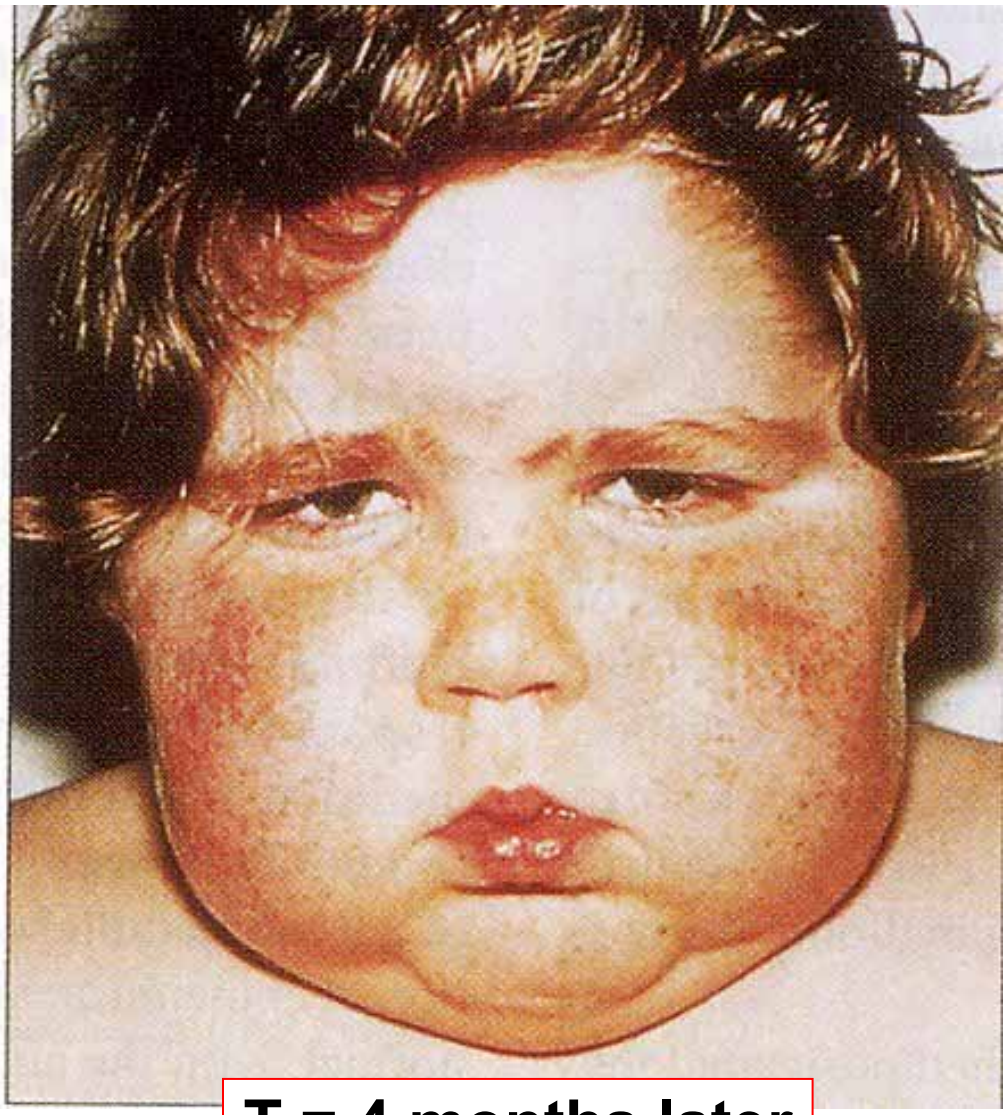
III. ***Nervous System & Excitable Cell Connections*** **LS ch 5, 4, 7**

- **A. How is the nervous system organized? fig 5-1 p 108**
- **B. Neurons? What kind? fig 5-2 p 109**
- **C. Brain structure & function fig 5-7, 5-8 pp 116 - 7**
- **D. Protect your head with a helmet! Bicycle head injury statistics, *NHTSA & BHSI***
- **E. Autonomic nervous system overview LS pp 178 – 85**

Cushing's Syndrome = Hypersecretion of Cortisol: Hypothalamic (CRH), Pituitary (ACTH), or Adrenal (Cortisol)



T = 0, near normal

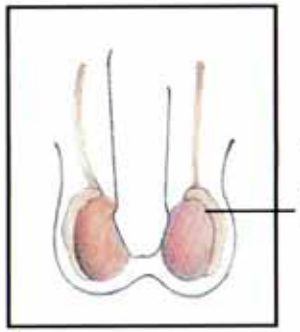


T = 4 months later

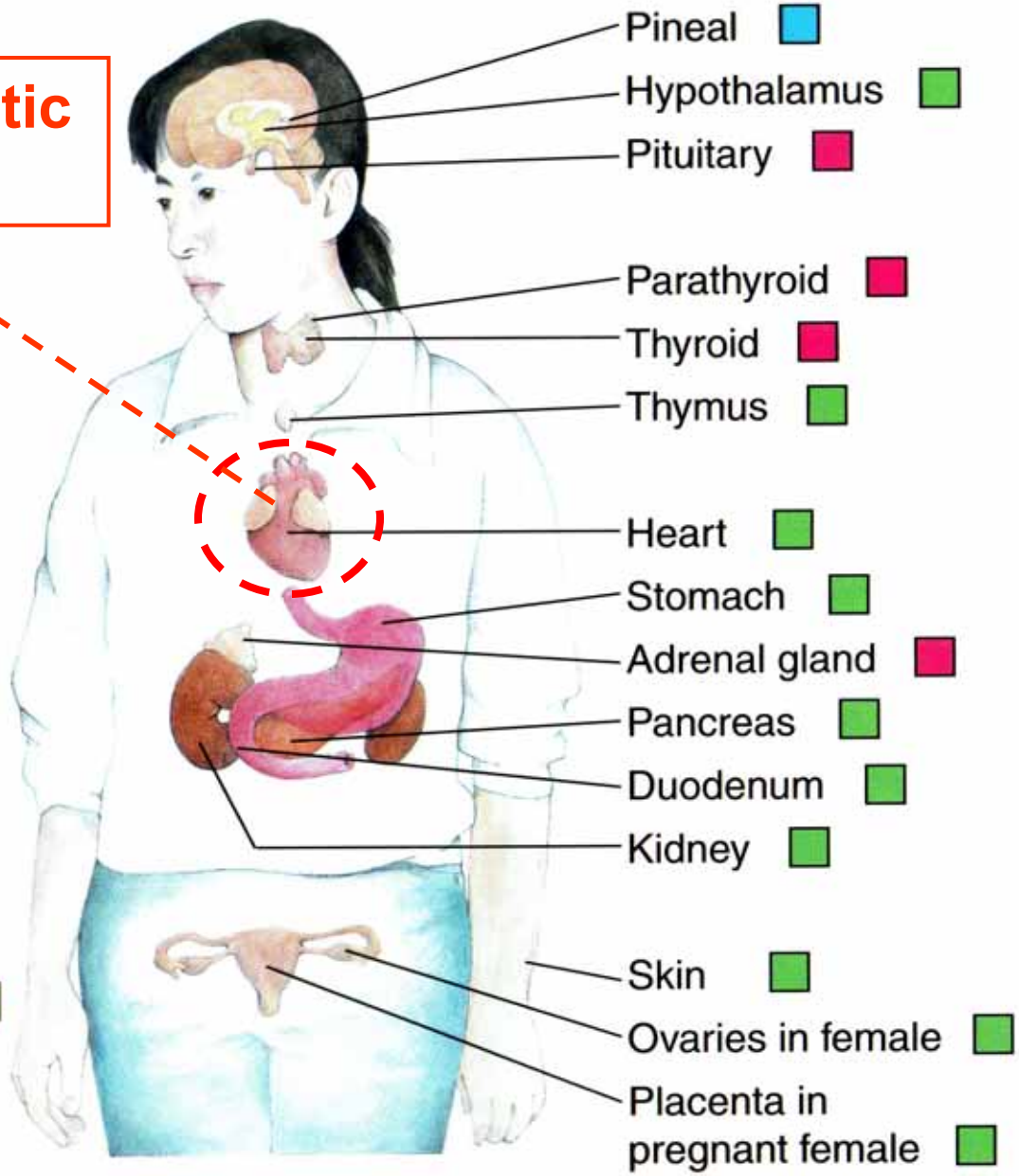
Endocrine System

ANP = Atrial Natriuretic Polypeptide

- Solely endocrine function
- Mixed function
- Complete function uncertain



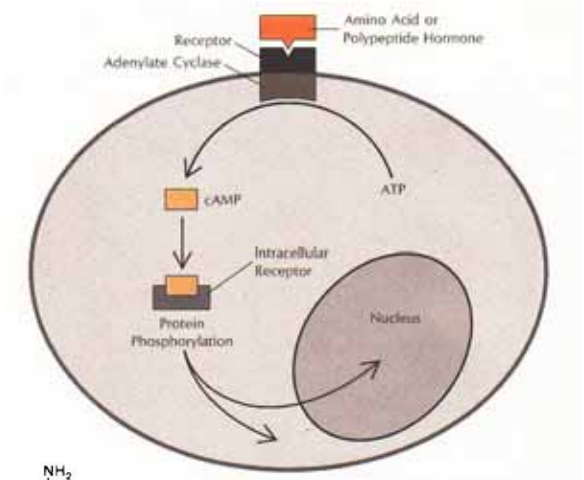
Testes in male

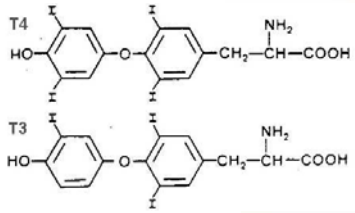


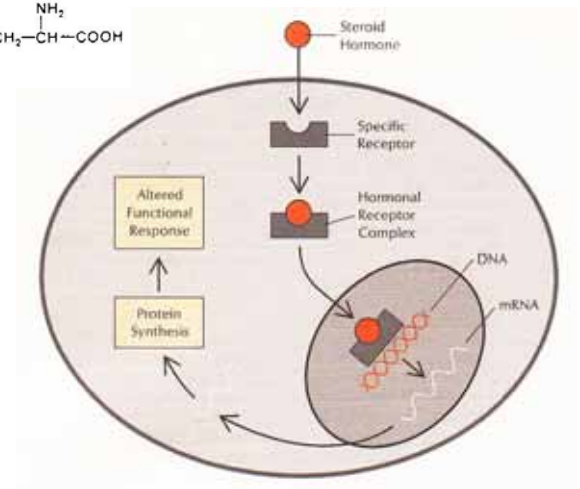
Hormone/Endocrine Classifications

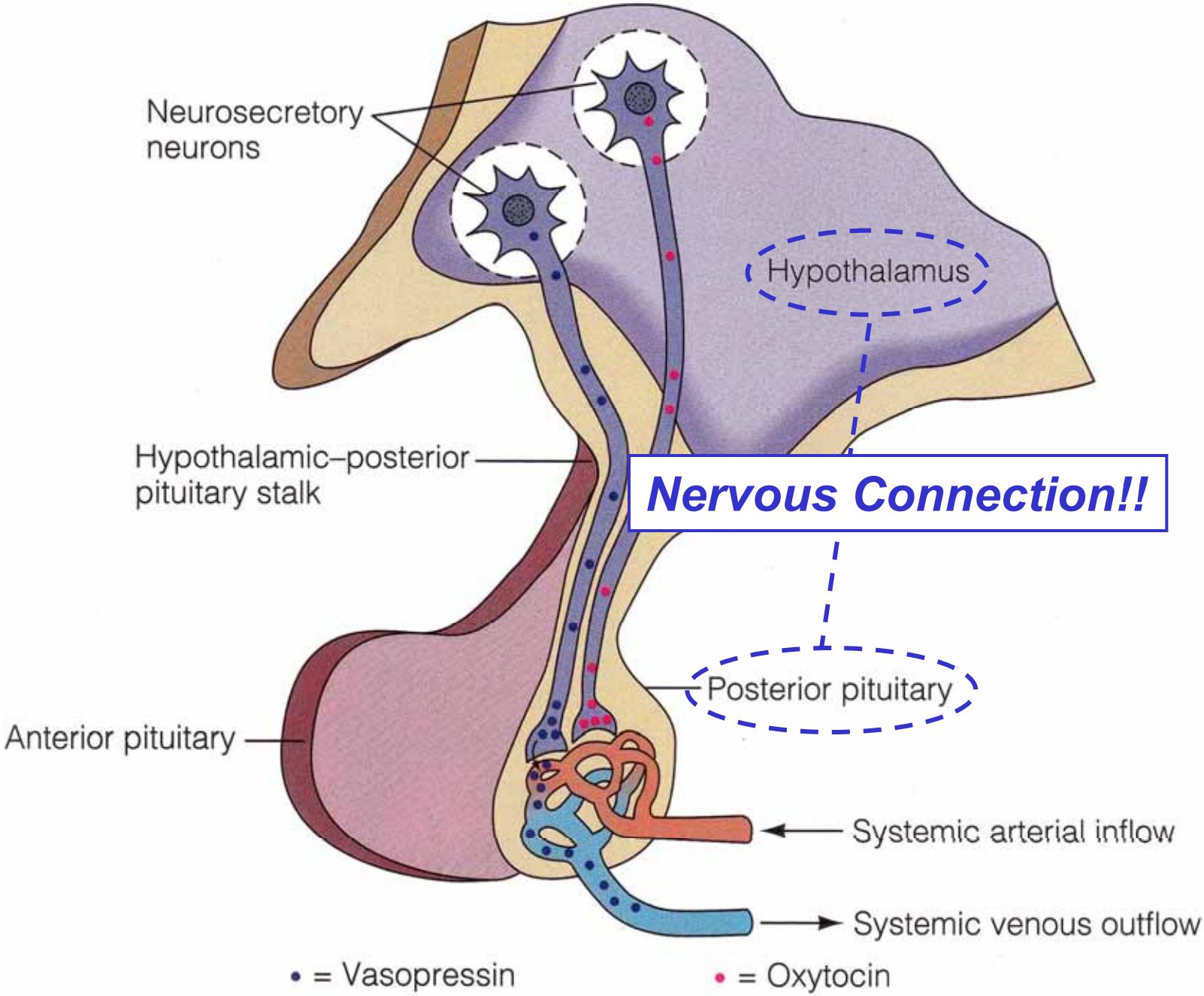
Exogenous

Endogenous



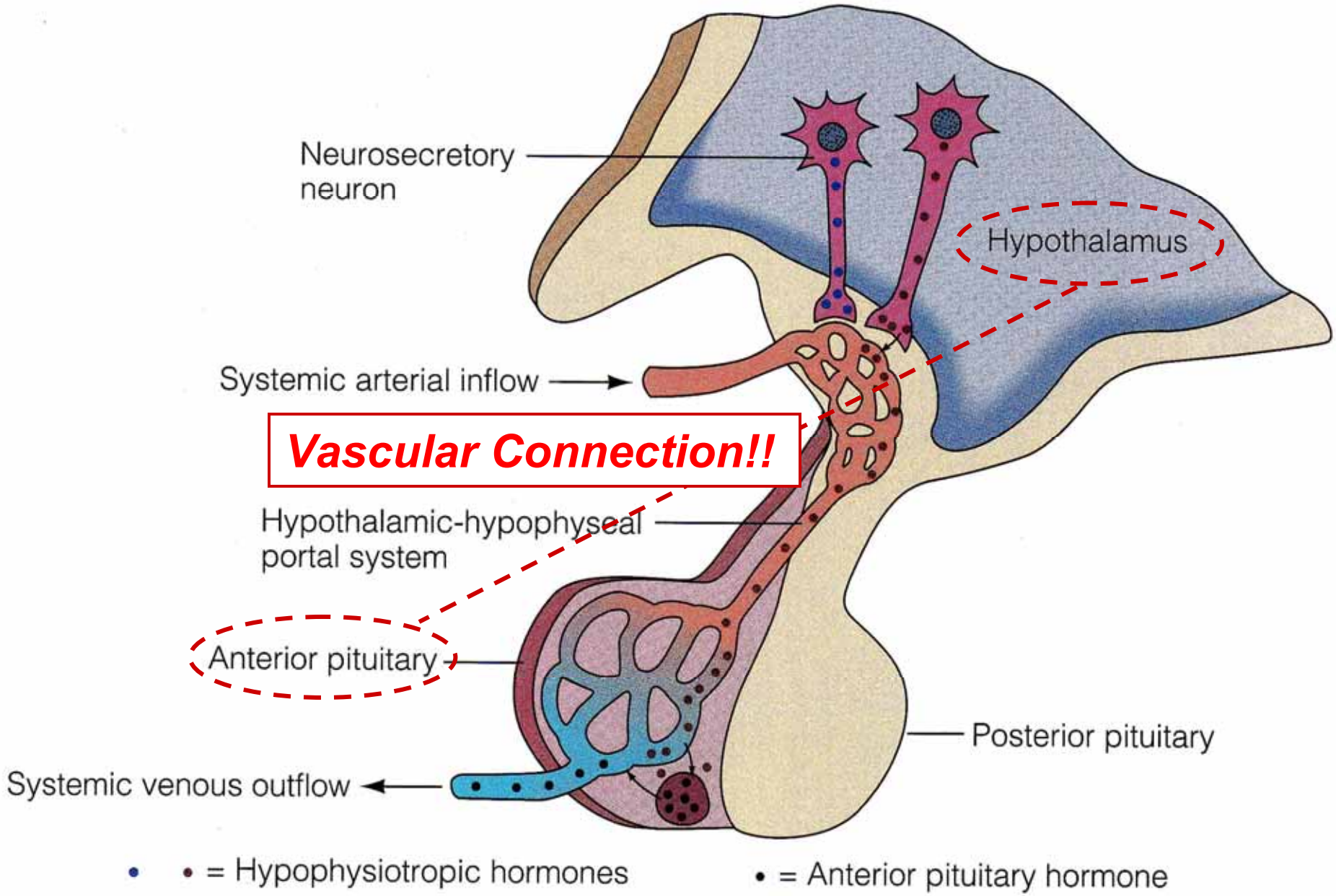




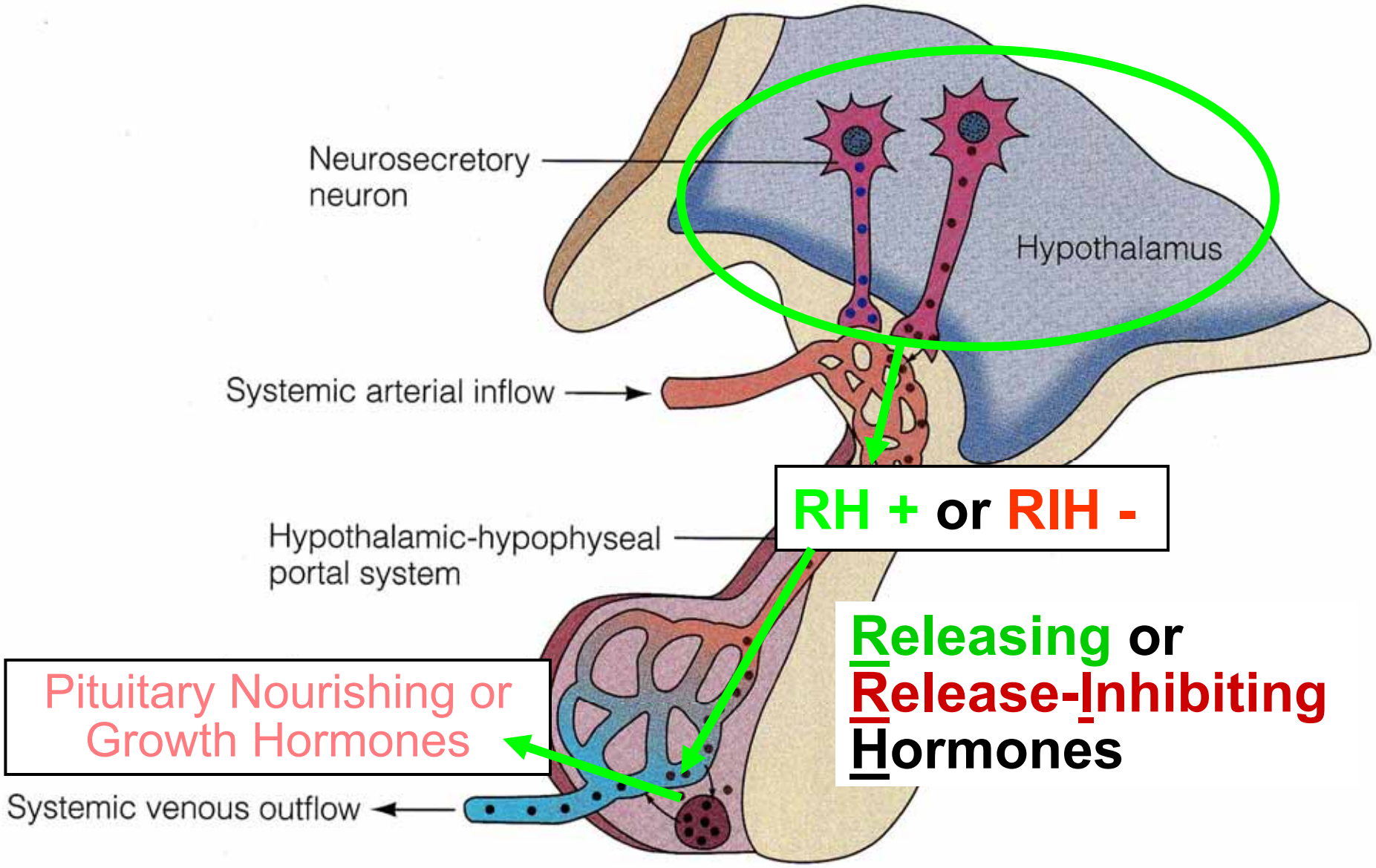

Neurosecretory neurons
Hypothalamus
Hypothalamic–posterior pituitary stalk
Nervous Connection!!
Posterior pituitary
Anterior pituitary
Systemic arterial inflow
Systemic venous outflow
• = Vasopressin
• = Oxytocin

LS 2007

Hypothalamus-Anterior Pituitary Vascular Connection!



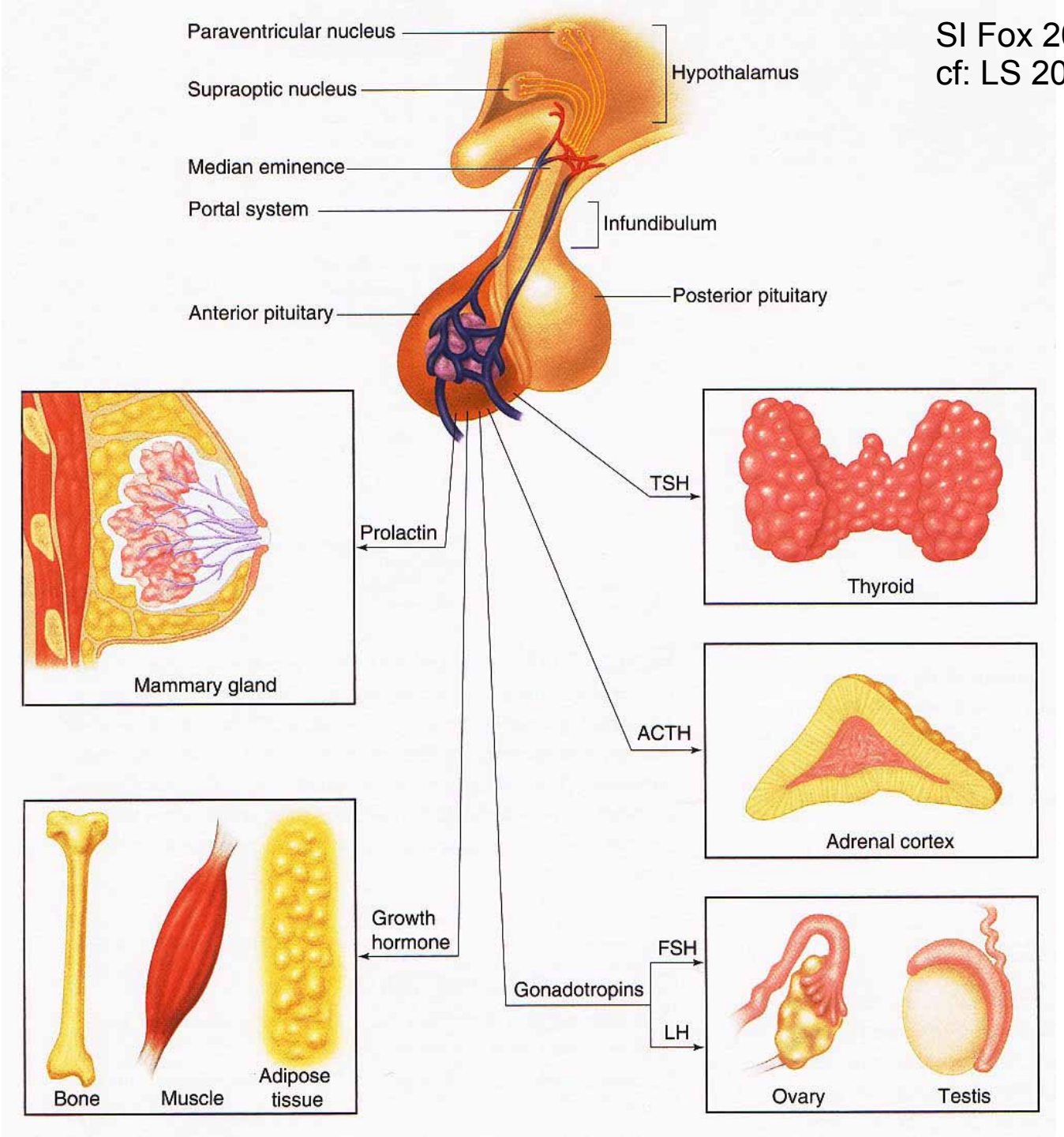
LS 2007



Hypophysis = Pituitary

LS 2007

SI Fox 2008
cf: LS 2012 fig 17-5



GH/STH Effects: Insulin Resistance/Type II Diabetes?

↑ Amino Acid uptake & Protein synthesis

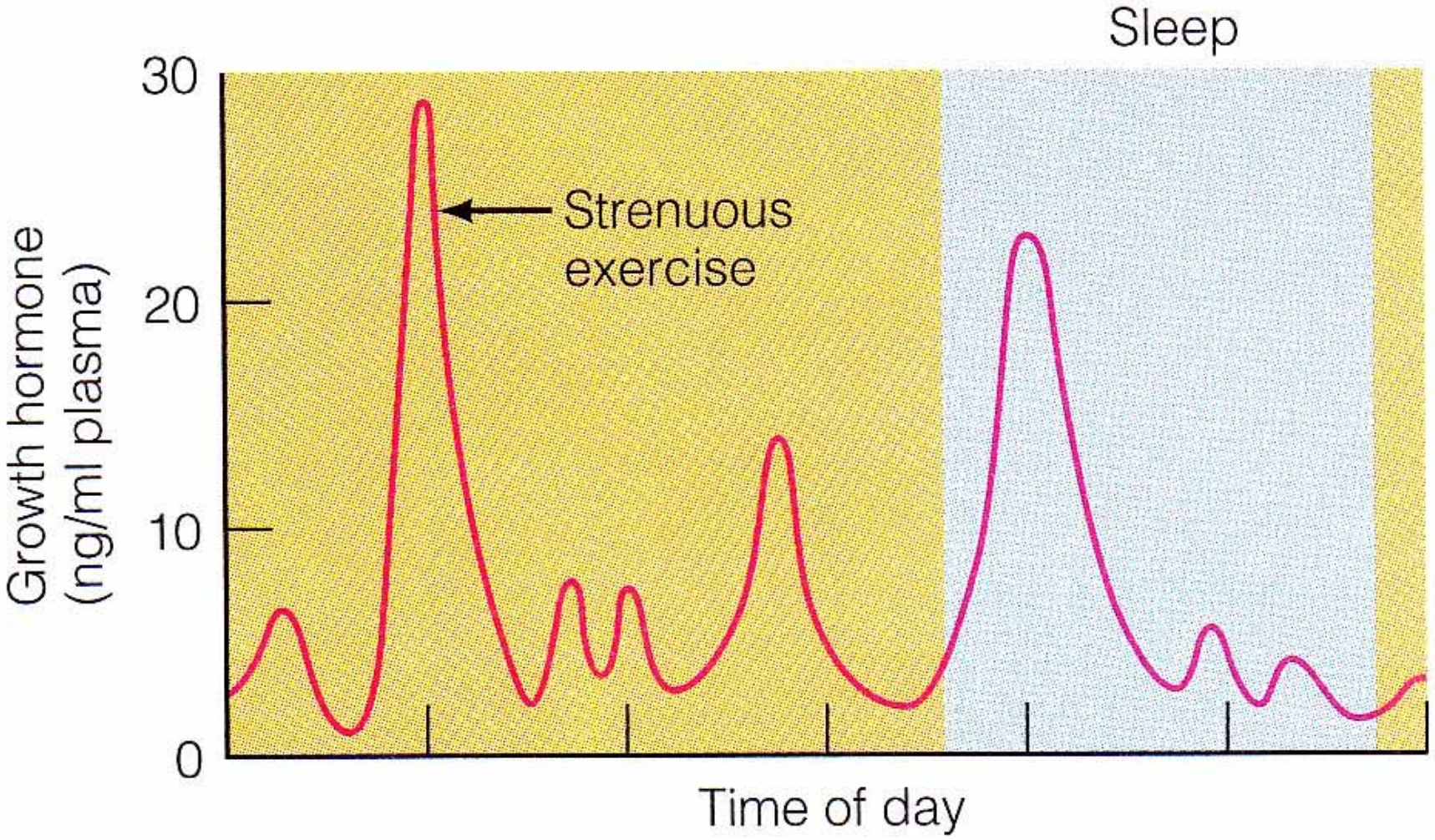
↑ Lipolysis & Fatty Acid mobilization

↓ Glucose uptake
(skeletal muscle & adipocytes)

↑ Glucose production
(liver glycogenolysis)

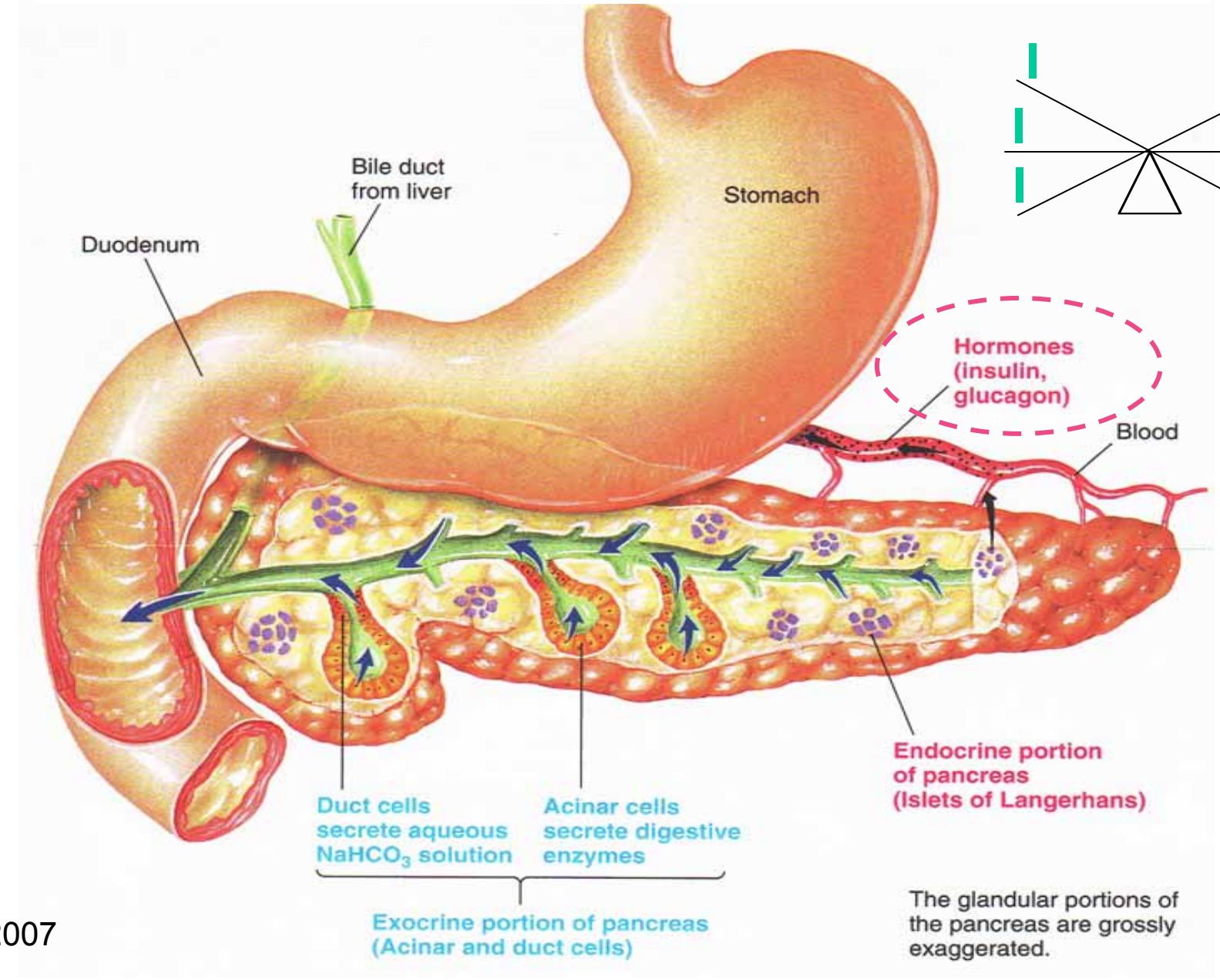
↑ Insulin secretion

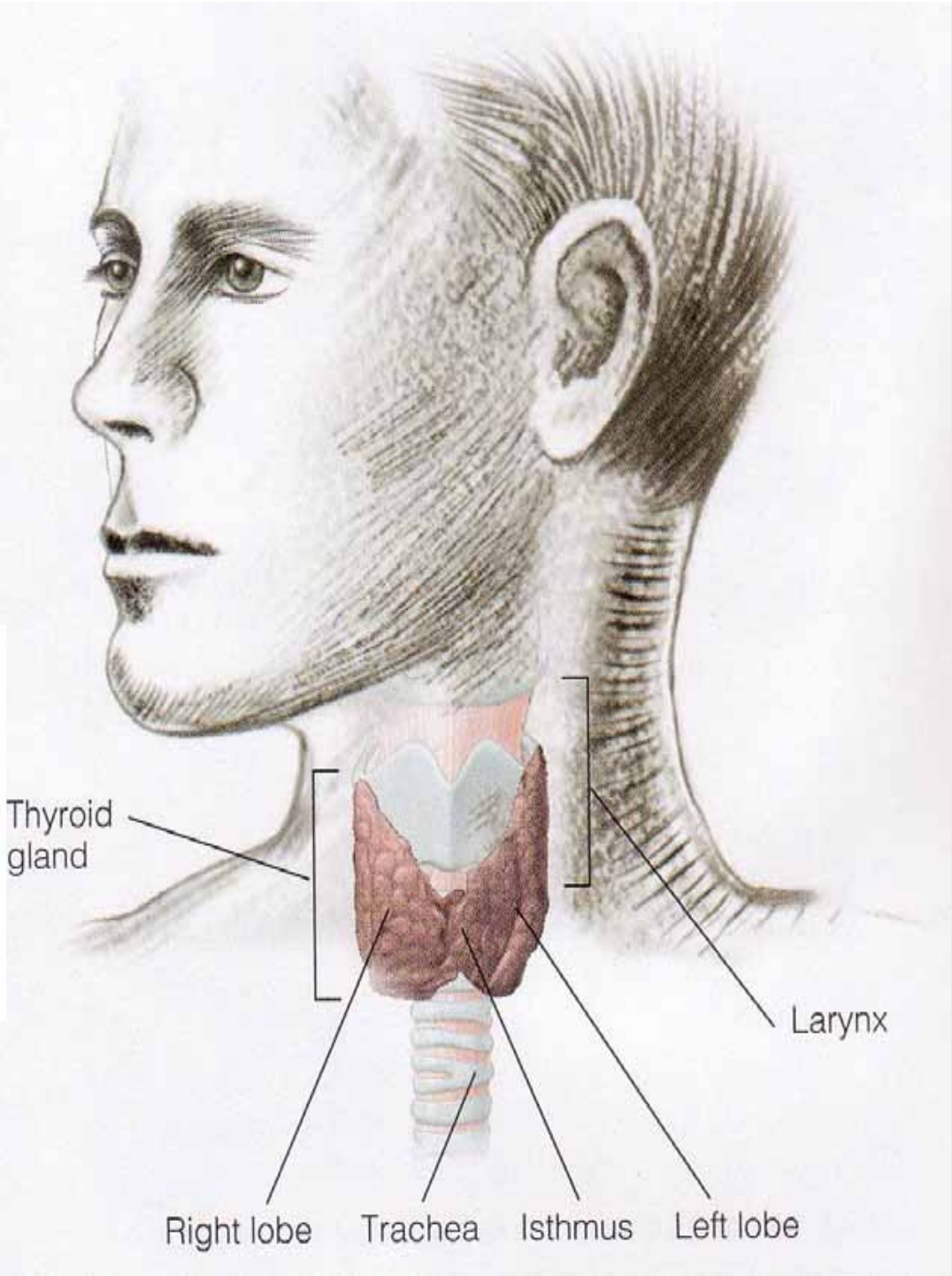
Increase GH naturally with exercise & sleep!!



ng/ml = nanograms per mililiter

Endocrine Pancreas: Insulin (I) & Glucagon (G) See-Saw Hormones in Regulating Blood Glucose

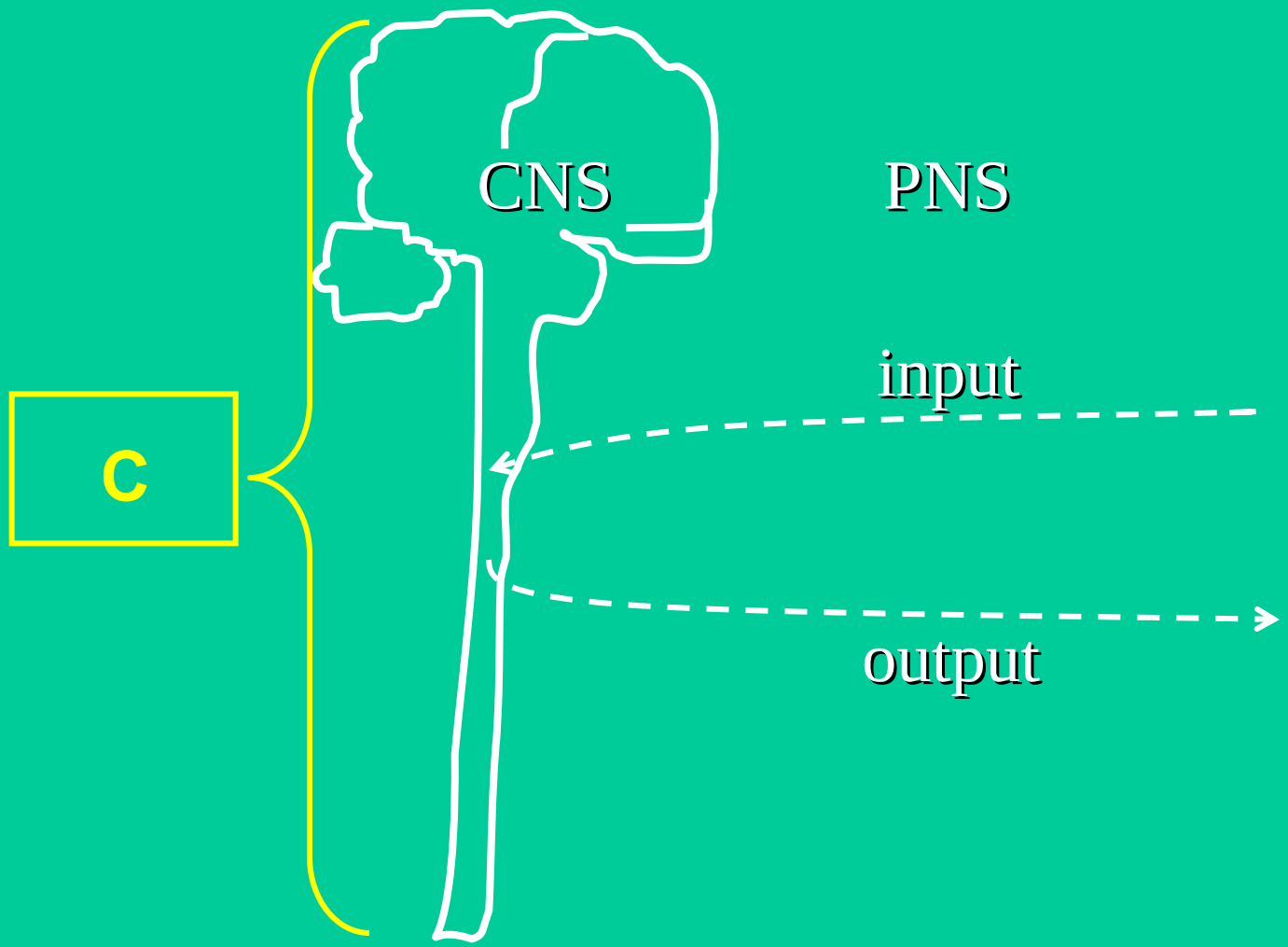


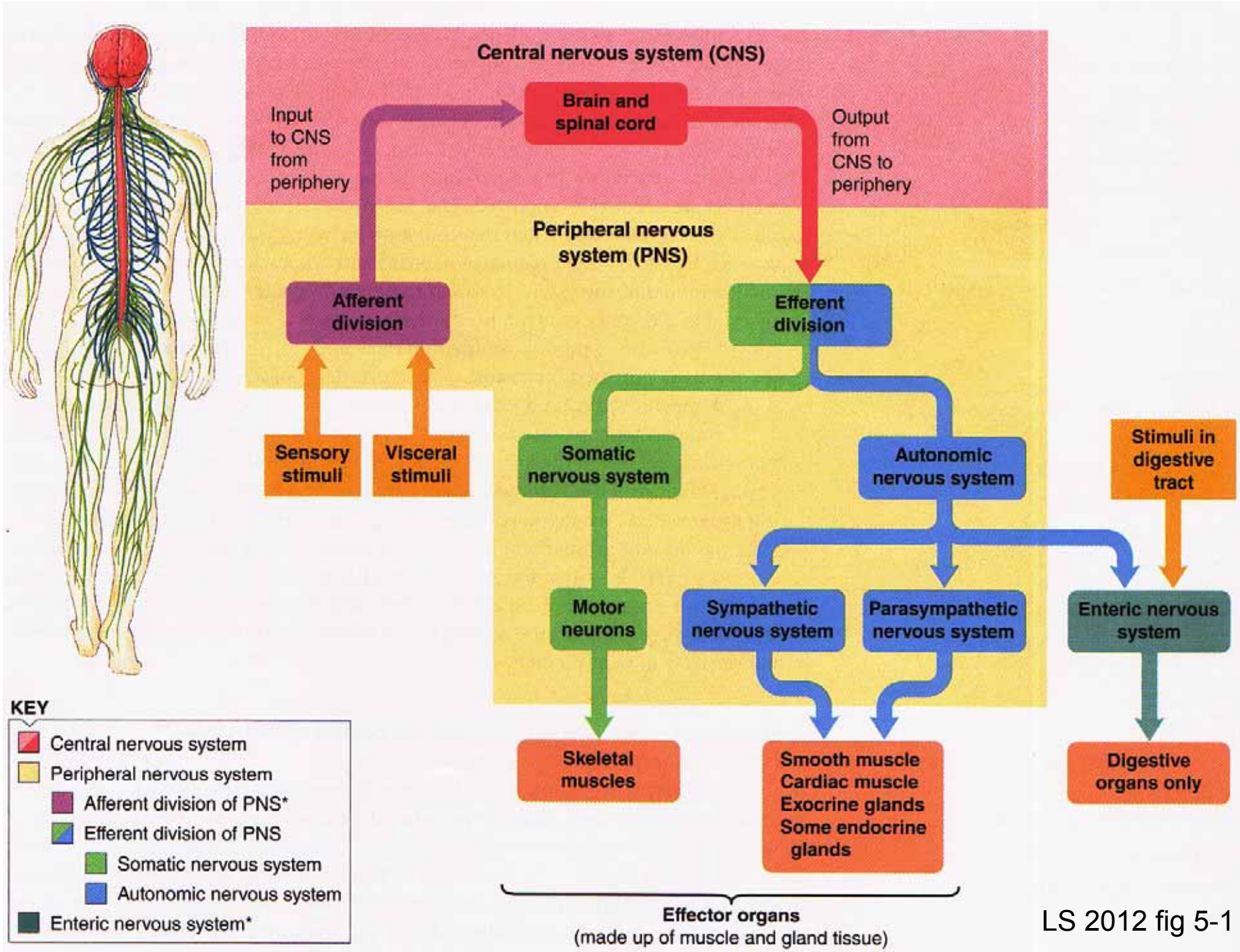


DC 2003

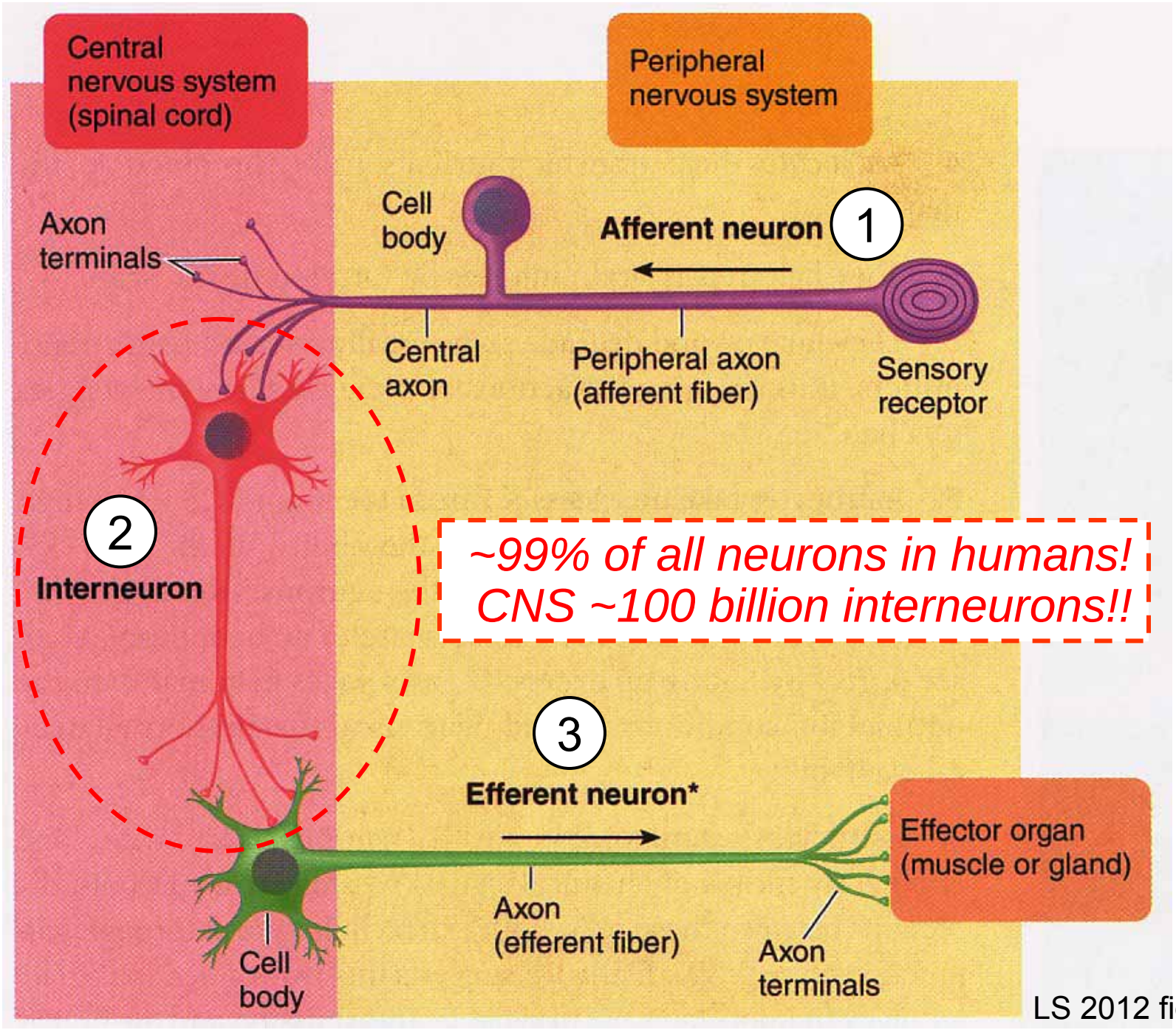
LS 2012 fig 17-17

Nervous System

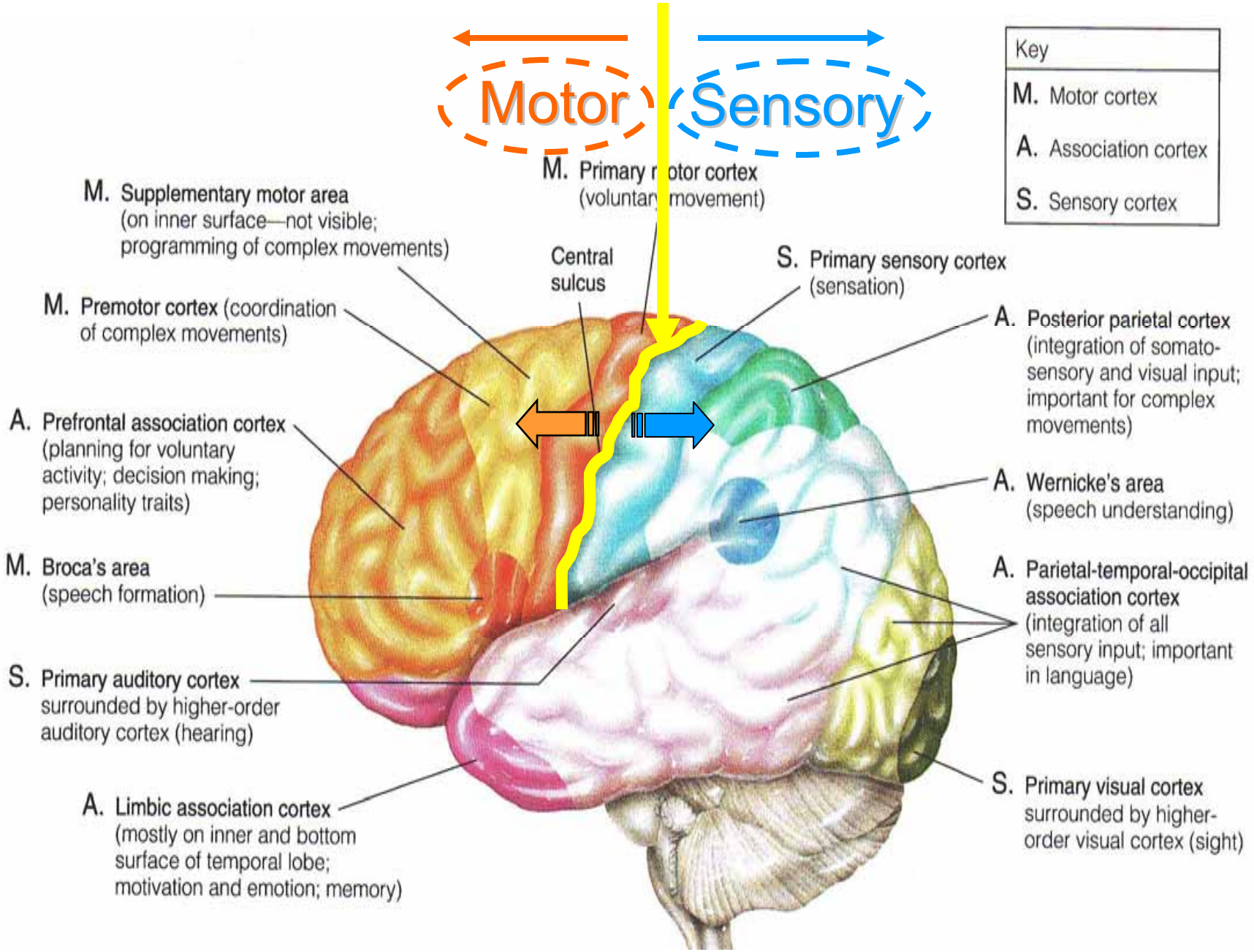




LS 2012 fig 5-1



LS 2012 fig 5-2



LS 2006, cf: LS 2012 fig 5-8a

Helmets Cheap, Brains Expensive!!
Use Your Head, Get a Helmet!!

http://www-nrd.nhtsa.dot.gov/pubs/811156.pdf
http://www.bhsi.org/stats.htm

~540,000 bicyclists/yr visit emergency rooms

67,000 head injuries, 1 in 8 brain injuries

716 cyclists died in 2008 ≡ 2% of all traffic fatalities

½ of deaths children < 15 yr

53,000 cyclists have died since 1932

that's more than the population of

Springfield, OR	52,864
Bend, OR	52,029
Corvallis, OR	49,322

Bicycle crashes & injuries are under reported,
since majority not serious enough for ER visits.

Helmets may prevent 45-88% of brain injuries!

~$81 million/yr = direct injury costs from not using helmets!

BI 121 Lecture 12

Thanks for your help with the blood chemistry lab!...

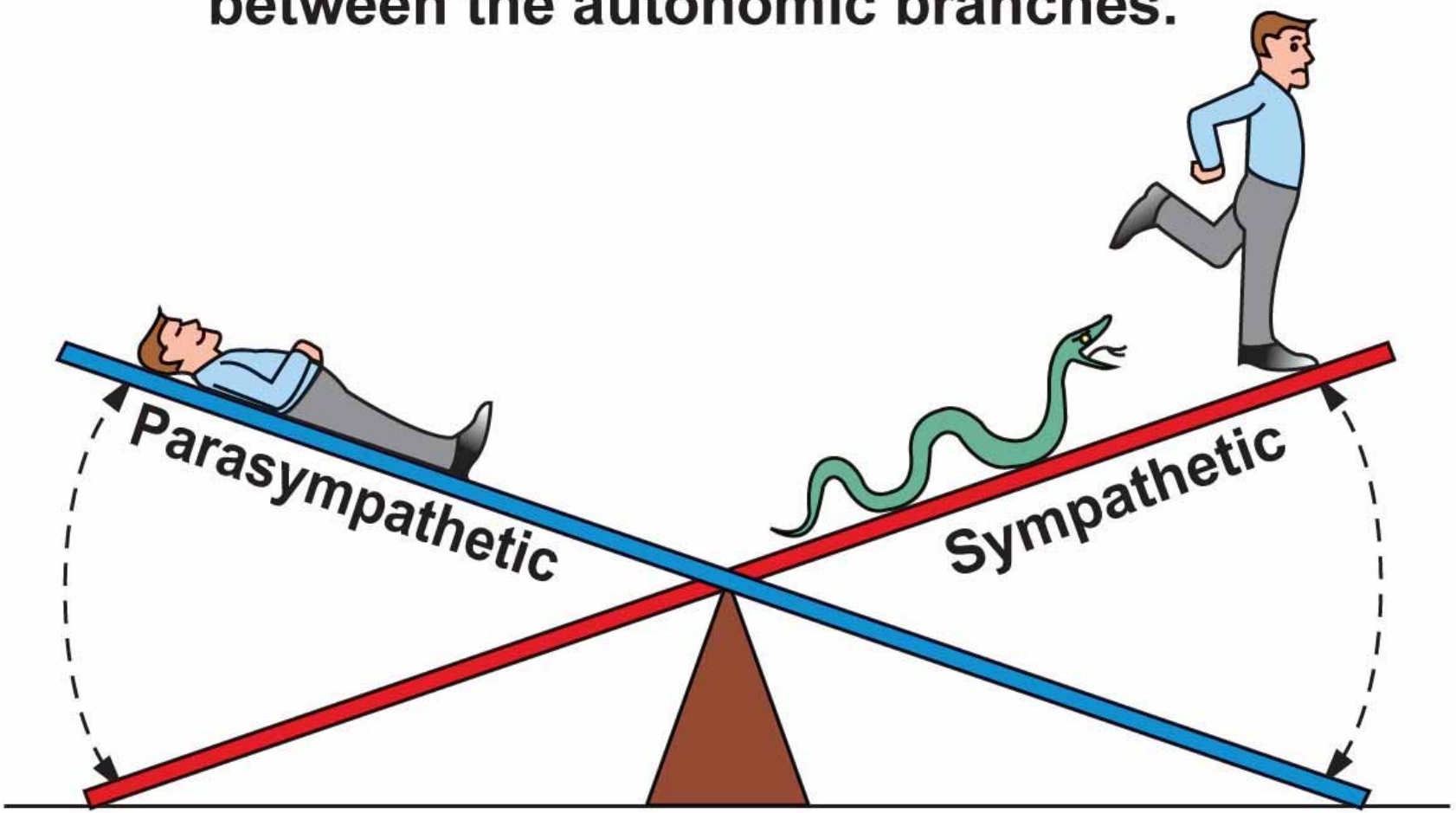
I. ***Announcements*** Optional notebook check + Lab 6 tomorrow. Pulmonary Function Testing. Final exam > your Q on Wed. Q?

II. ***Autonomic Nervous System Overview*** LS pp 178 – 85
LS Table 7-1 p 183 + stories to remember *fight-or-flight!*

III. ***Neuromuscular Connections*** LS ch 7 pp 186-92, DC pp 69-71
How does the signal cross the nerve-muscle gap? LS fig 7-5
   A. Normal function? Ca2+ for bones!…but what else? LS p 190
   B. What do black widow spider venom, botulism, curare & nerve gas have in common? Botox? LS p 189-91

IV. ***Muscle Structure, Function & Adaptation*** LS ch 8, DC Module 12
   A. Muscle types: cardiac, smooth, skeletal LS fig 8-1 p 194-6
   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. How about thin filaments? LS fig 8-5
   E. Banding pattern? LS fig 8-3, fig 8-7
   F. How do muscles contract? LS fig 8-6, 8-10
   G. What's a cross-bridge cycle? LS fig 8-11 +…
   H. Summary of skeletal muscle contraction
   I. Exercise adaptation variables: *mode*, *intensity*, *duration*, *frequency*, *distribution*, *individual* & environmental char...?
   J. Endurance *vs.* strength training continuum? fiber types...

Homeostasis is a dynamic balance between the autonomic branches.



Rest-and-digest: Parasympathetic activity dominates.

Fight-or-flight: Sympathetic activity dominates.

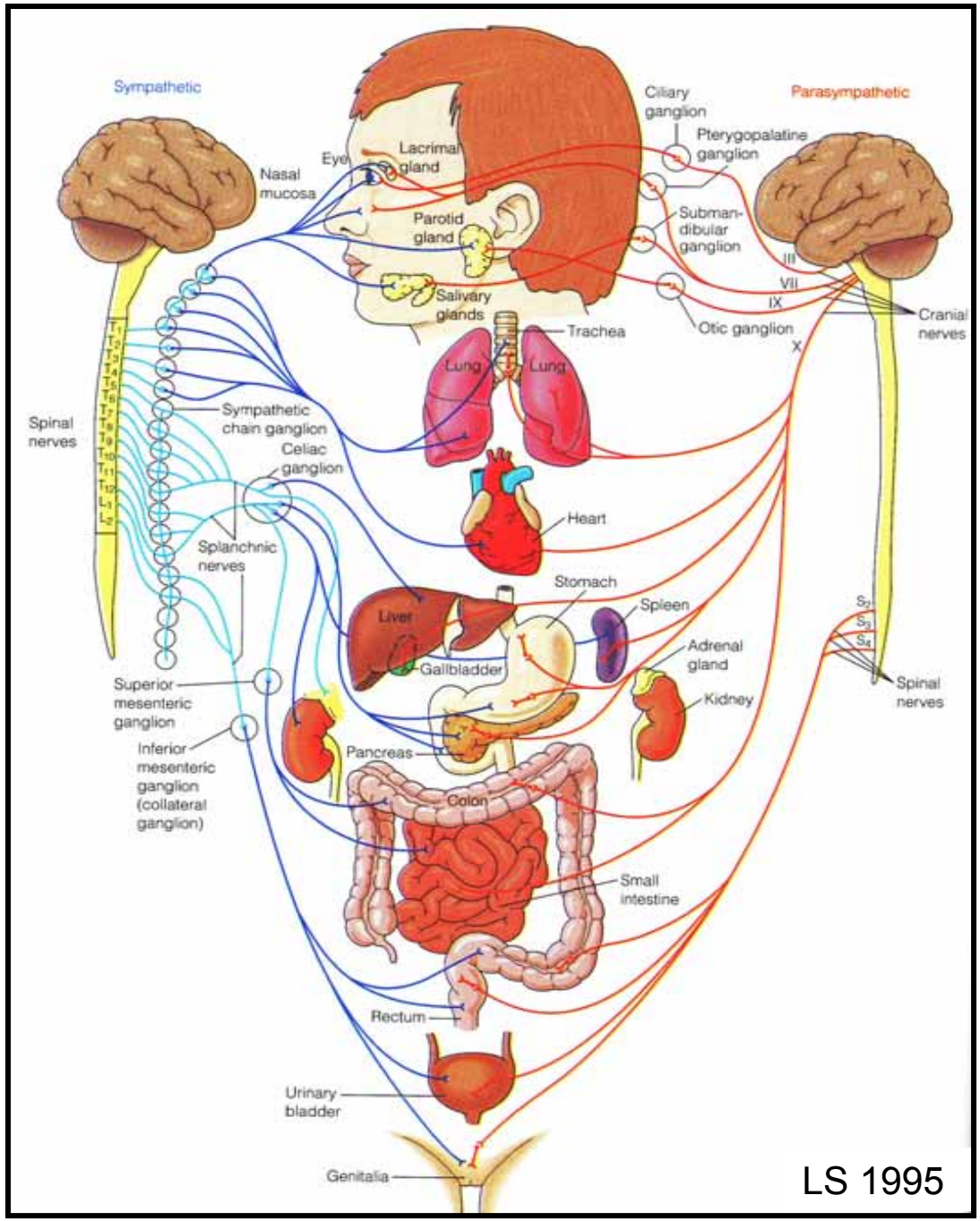
D Silverthorn 2010

Autonomic Nervous System

Why overlap or dual innervation?

Fine-tune control & safety!

cf: LS 2012 fig 7-3



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

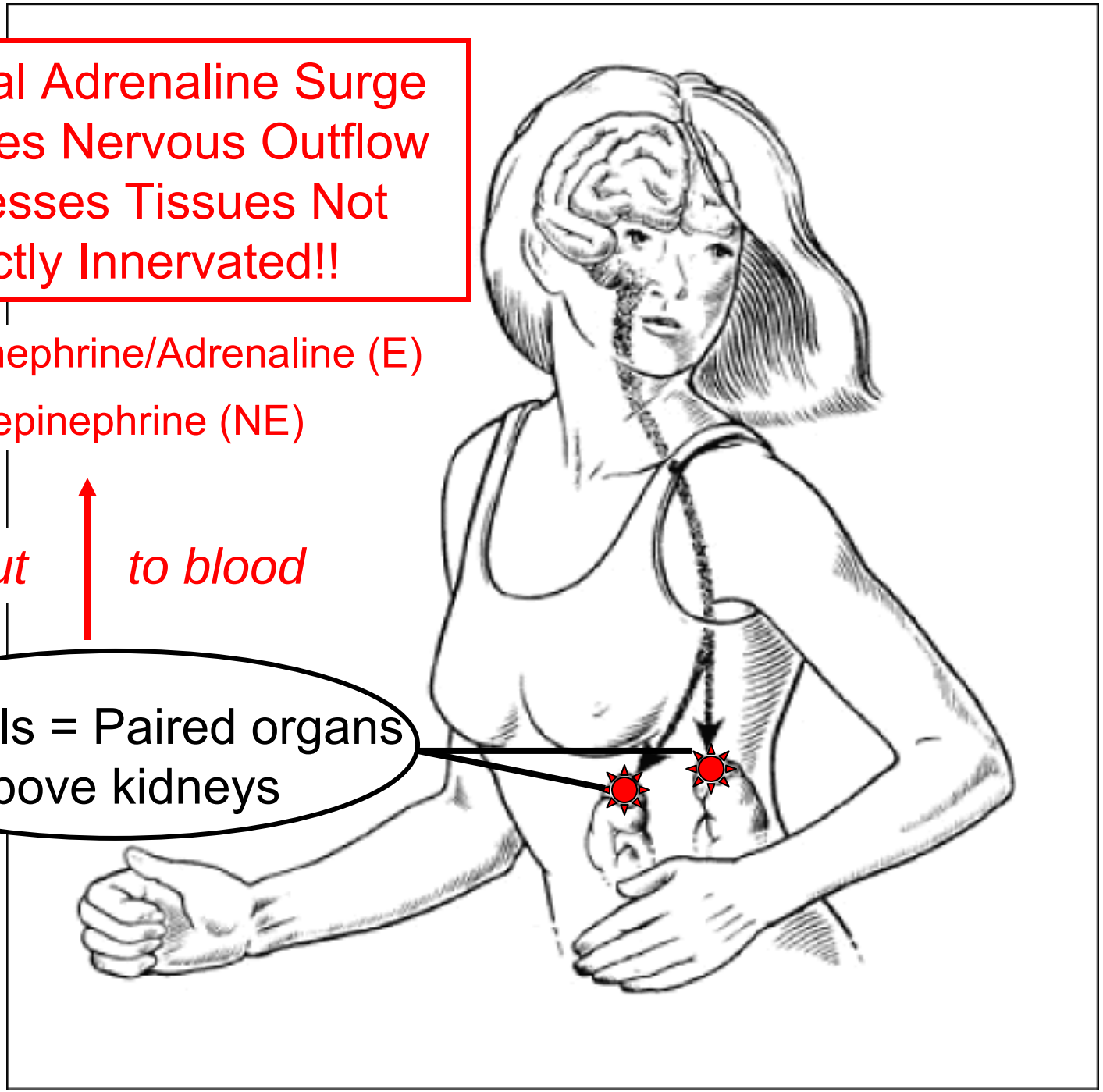
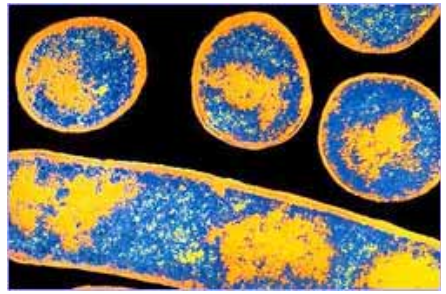


Table 7-1 Effects of Autonomic Nervous System on Various Organs

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

LS 2012



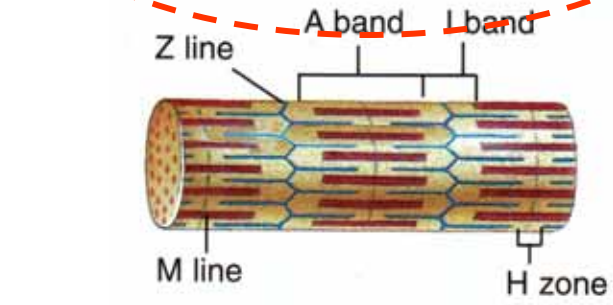
Axon of motor neuron
Myelin sheath
Action potential propagation in motor neuron
1
Axon terminal
Terminal button
Vesicle of acetylcholine
Ca^{2+}
Calcium channel
2
Action potential propagation in muscle fiber
6
Muscle fiber
3
Plasma membrane of muscle fiber
4
K^+
Acetylcholine receptor site
5
Cation channel
Na^+
7
Acetylcholinesterase
Local current flow between depolarized end plate and adjacent membrane
Motor end plate
Contractile elements within muscle fiber

Whole Muscle

Organ

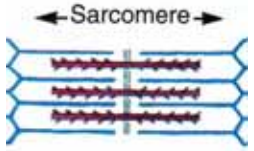
Myocyte or Muscle Fiber

Cell



Myofibril

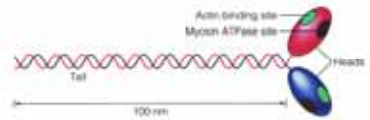
Cytoskeleton

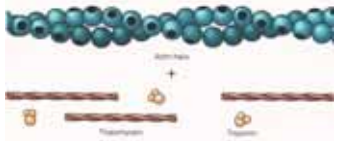


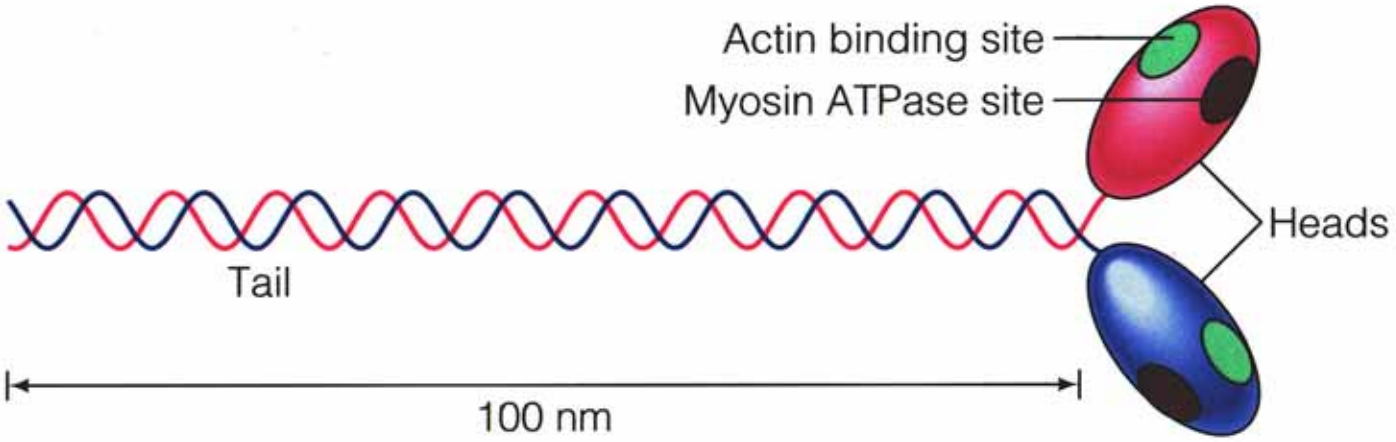
Thick & Thin Filaments

Myosin & Actin

Molecules

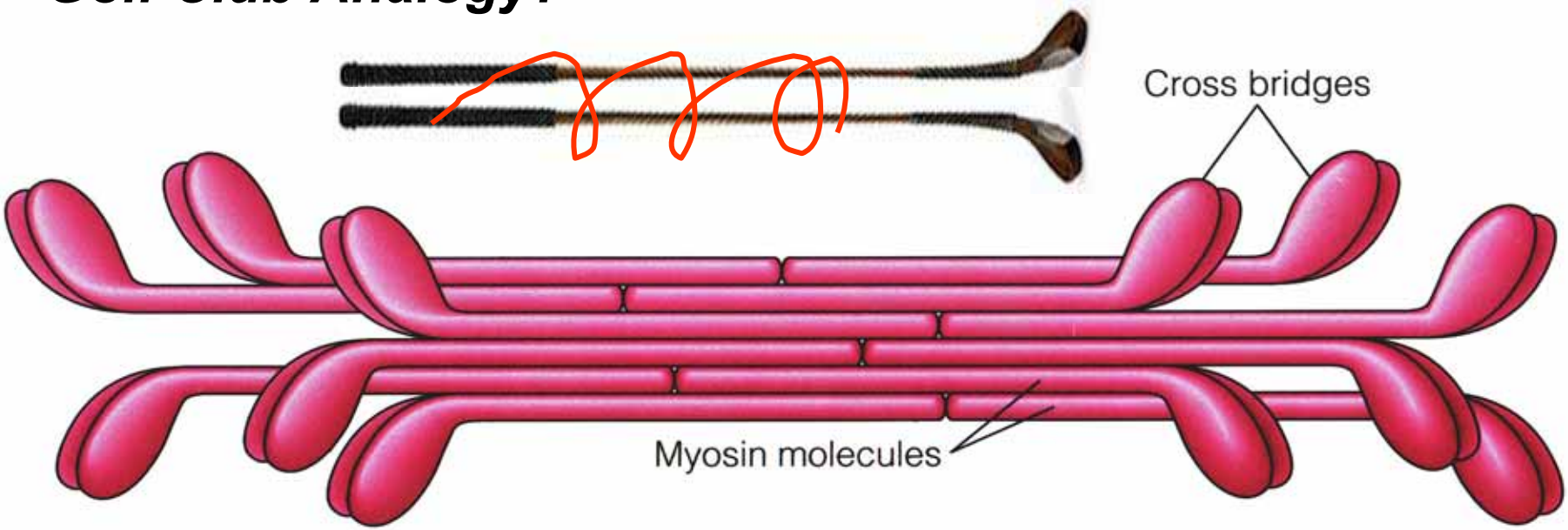






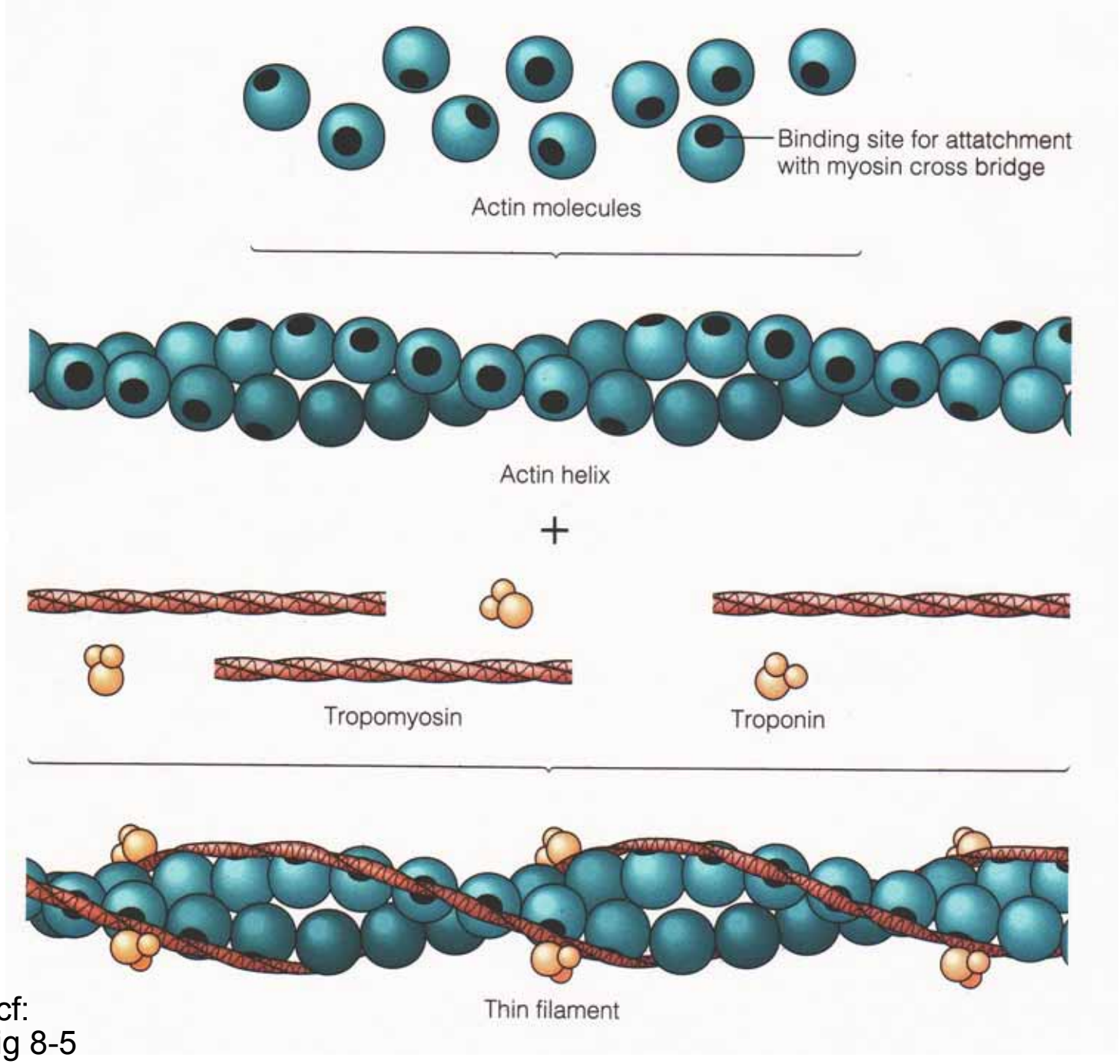
(a)

Golf Club Analogy?

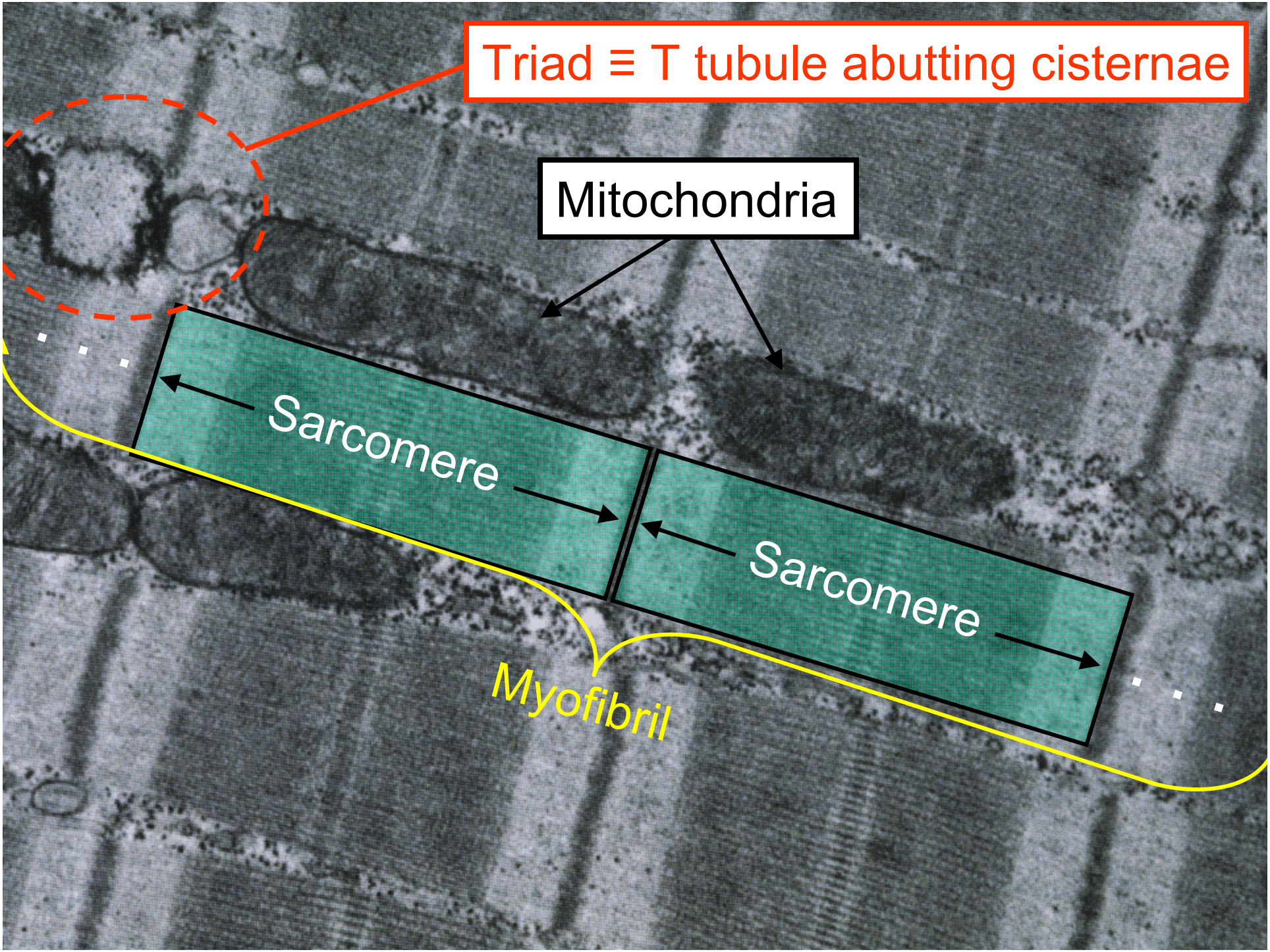


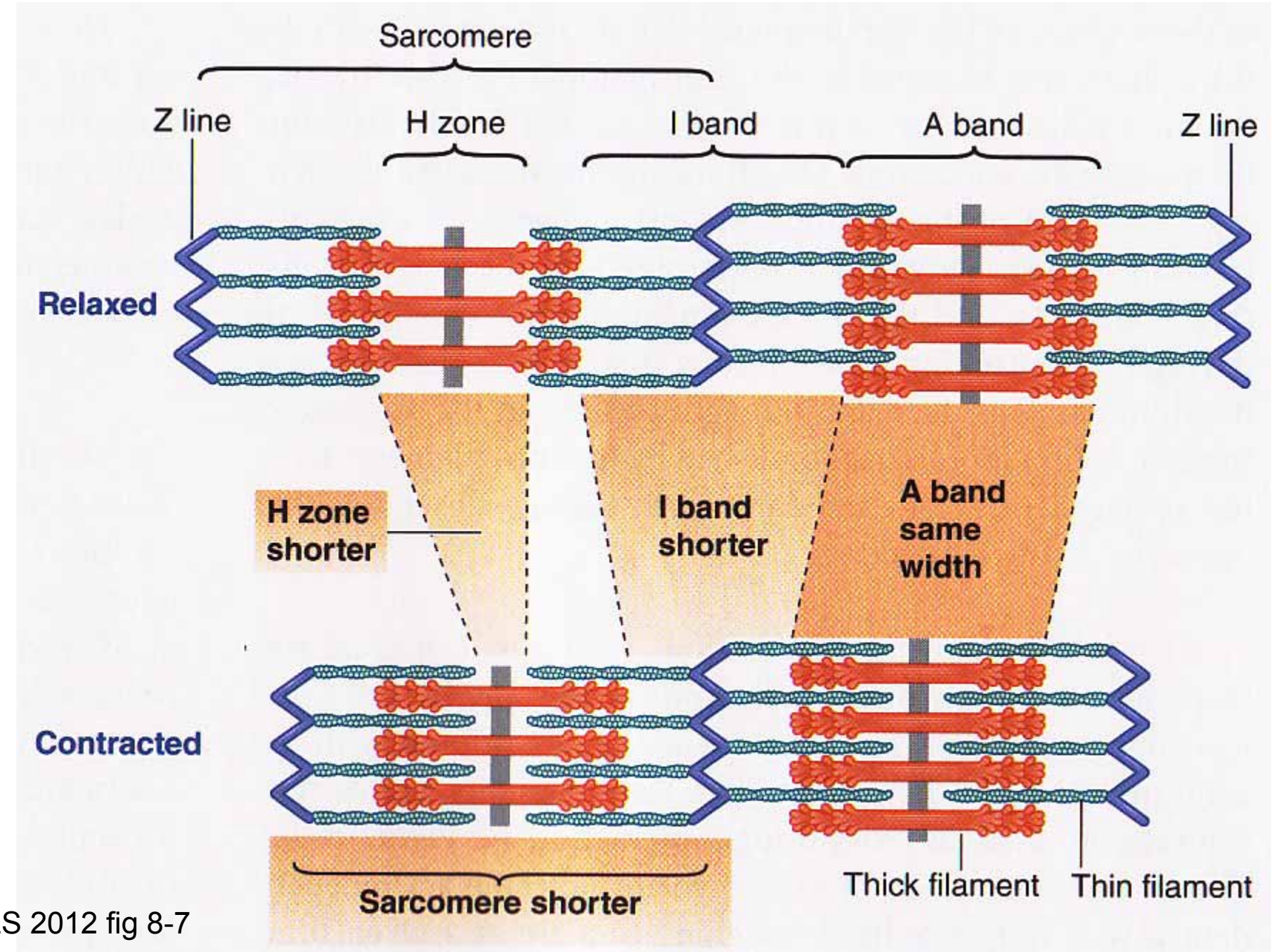
(b)

LS 2006, cf:
LS 2012 fig 8-4



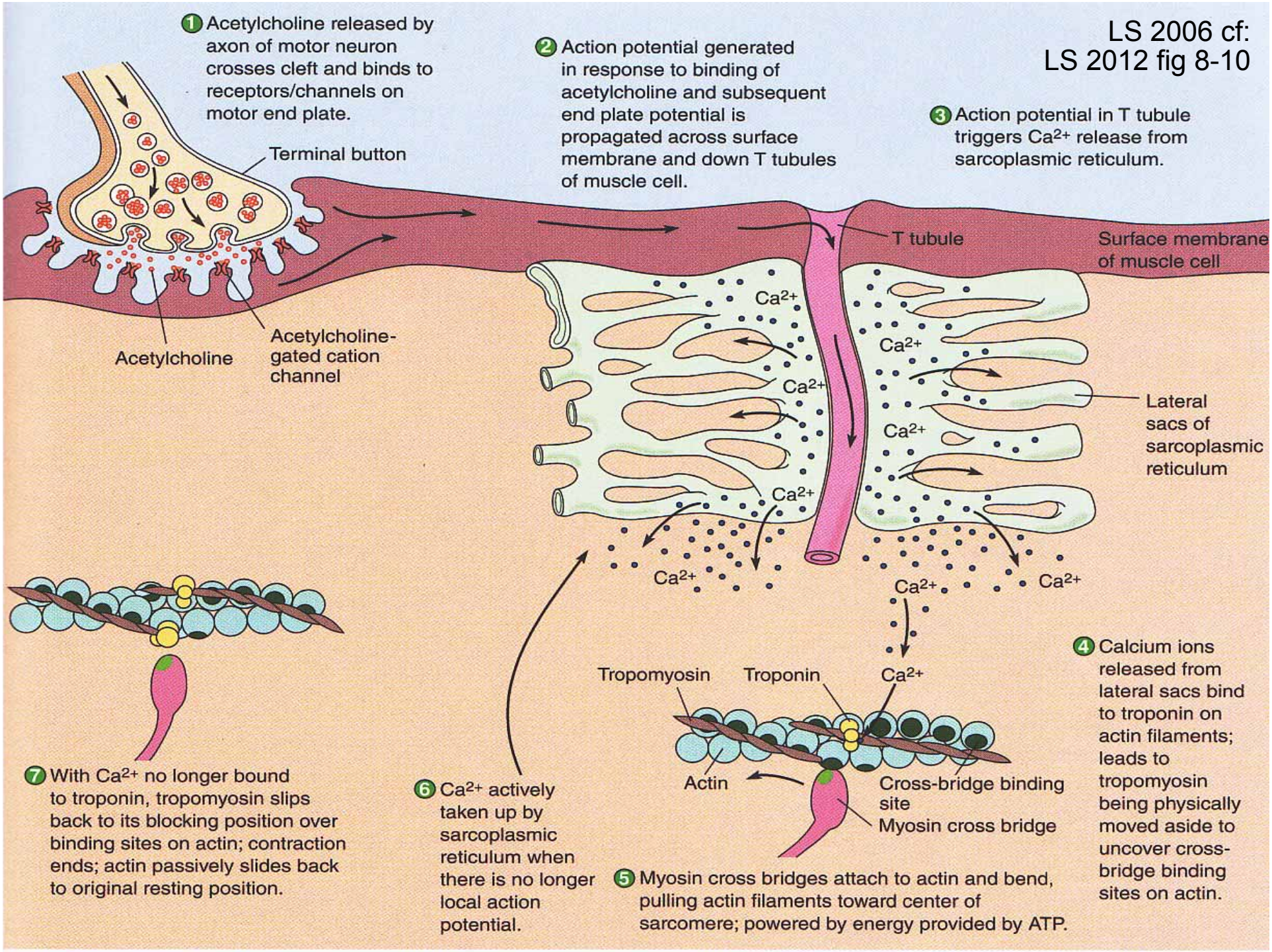
LS 2006, cf:
LS 2012 fig 8-5


Triad ≡ T tubule abutting cisternae
Mitochondria
Sarcomere
Sarcomere
Myofibril



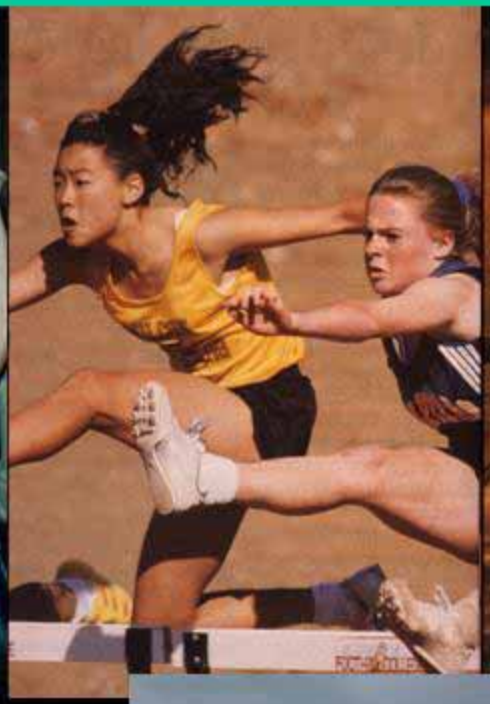
LS 2012 fig 8-7

LS 2006 cf:
LS 2012 fig 8-10



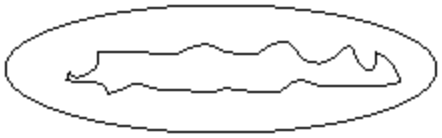
Adaptations to Exercise?

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



AEROBIC w/O_2

ANAEROBIC



MITOCHONDRIA

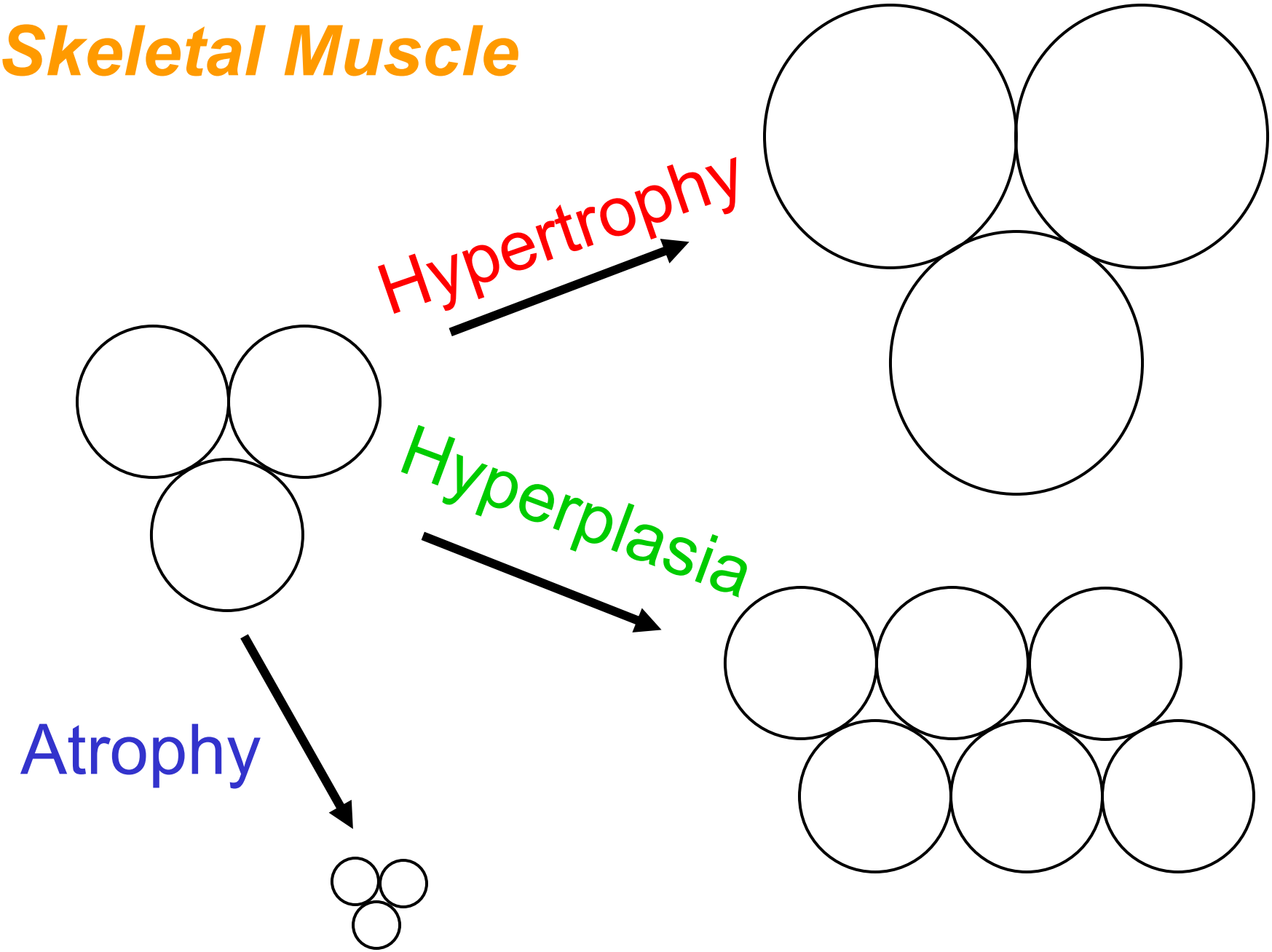
CYTOSOL

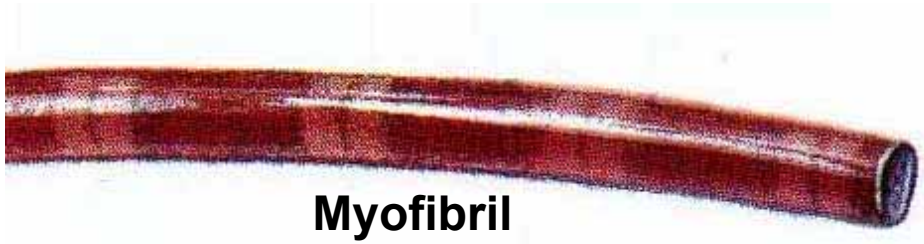
Glycolysis

Immediate/ATP-PC

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

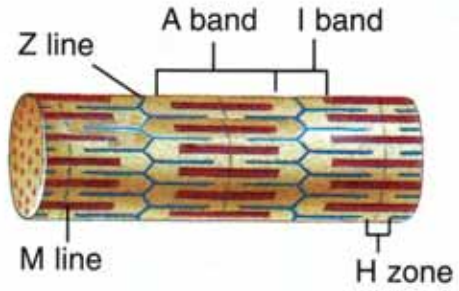
Skeletal Muscle





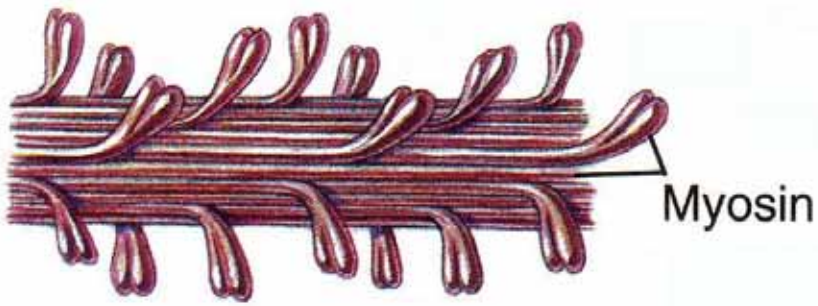
Myofibril

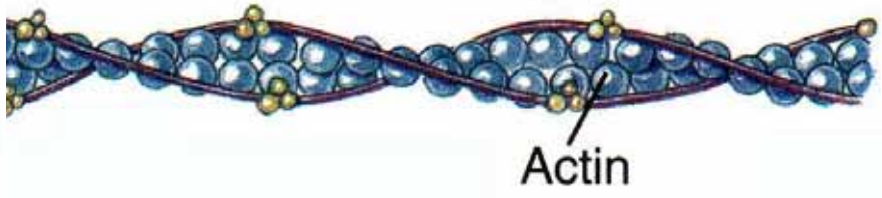
Hypertrophy: Increased Number of Myofibrils



Thick & Thin Filaments

Myosin & Actin Molecules

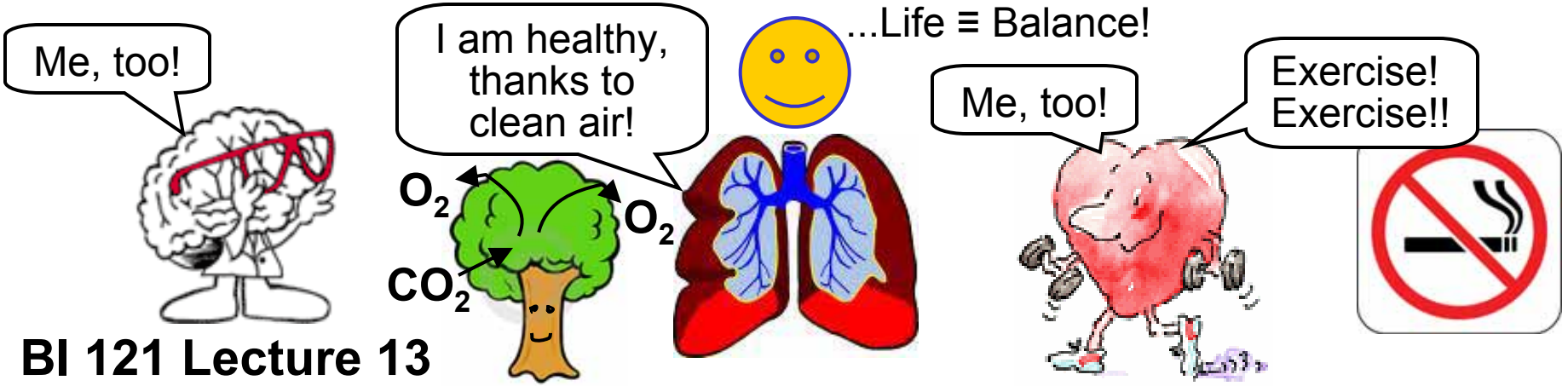




Characteristics of Skeletal Muscle Fibers

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



BI 121 Lecture 13

I. ***Announcements*** **Optional notebook check today. Discussion-Review followed by final exam tomorrow. Q?**

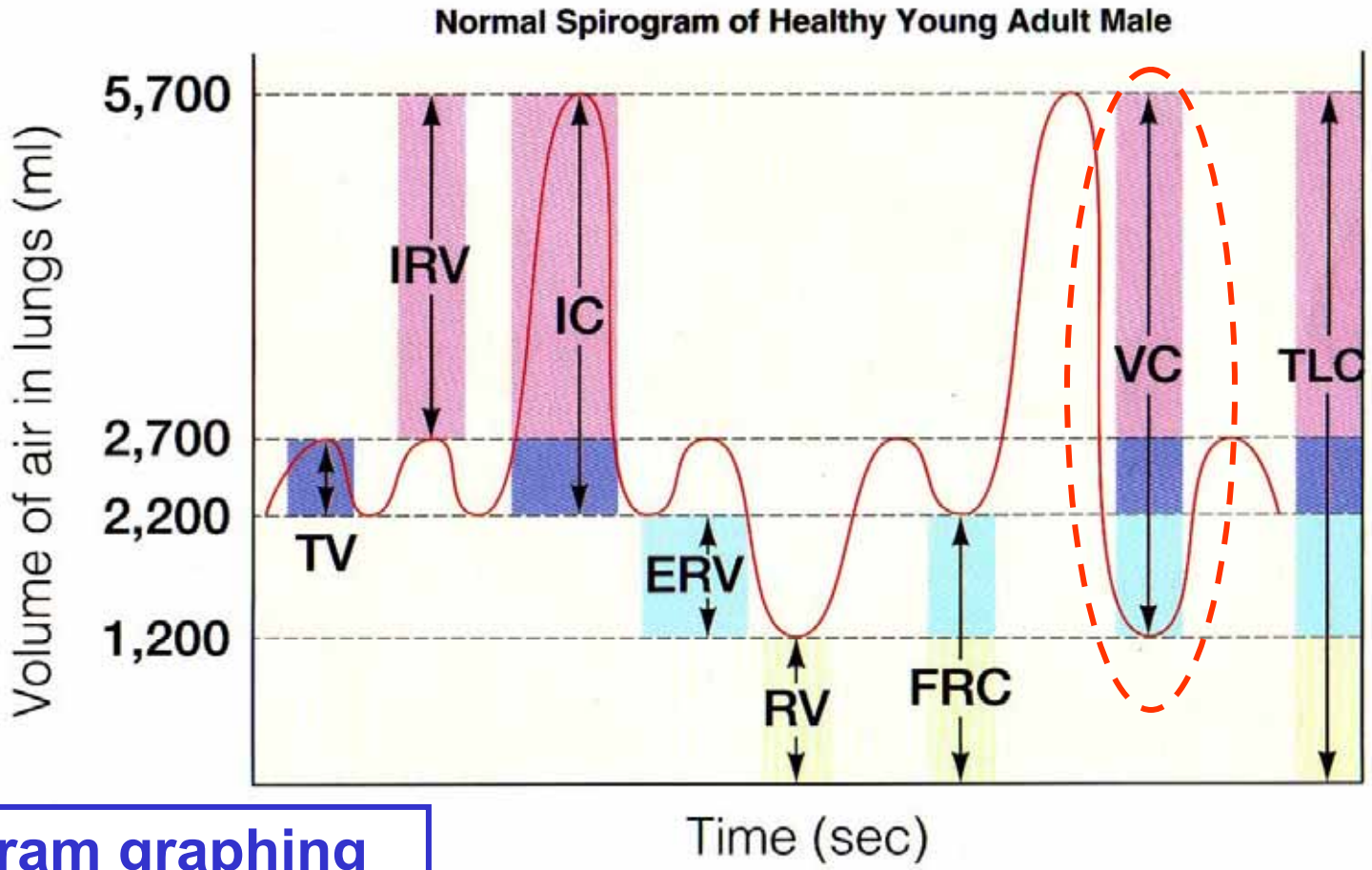
II. ***Introduction to PFT Lab 6*** **Pulmonary Function Testing**

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

- **A. Steps of respiration? External *vs.* cellular/internal? LS fig 12-1 pp 345-7**
- **B. Respiratory system anatomy LS fig 12-2 p347, DC, SI Fox +...**
- **C. Histology LS fig 12-4 pp 347-9, DC**
- **D. How do we breathe? LS fig12-12, fig12-25 pp 349-56, 373-8**
- **E. Gas exchange LS fig 12-19 pp 362-5**
- **F. Gas transport LS tab 12-3 pp 365-70**

IV. ***Physiology of Cigarette Smoking***

- **A. ANS, autonomic nerves & nicotine? Route of chemicals,...**
- **B. Emphysema? 2nd-hand smoke?... p 356, 365**
- **C. UO Smoke-Free since Fall 2012! Help is available!**



Spirogram graphing complete *PFT* from computer simulation.

TV = Tidal volume (500 ml)
IRV = Inspiratory reserve volume (3,000 ml)
IC = Inspiratory capacity (3,500 ml)
ERV = Expiratory reserve volume (1,000 ml)
RV = Residual volume (1,200 ml)
FRC = Functional residual capacity (2,200 ml)
VC = Vital capacity (4,500 ml)
TLC = Total lung capacity (5,700 ml)

Lombo's simplified steps!

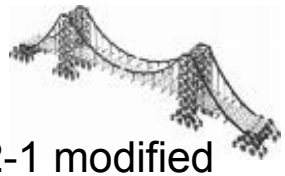
1. **Breathe in & out!**

2. **Cross membranes!**

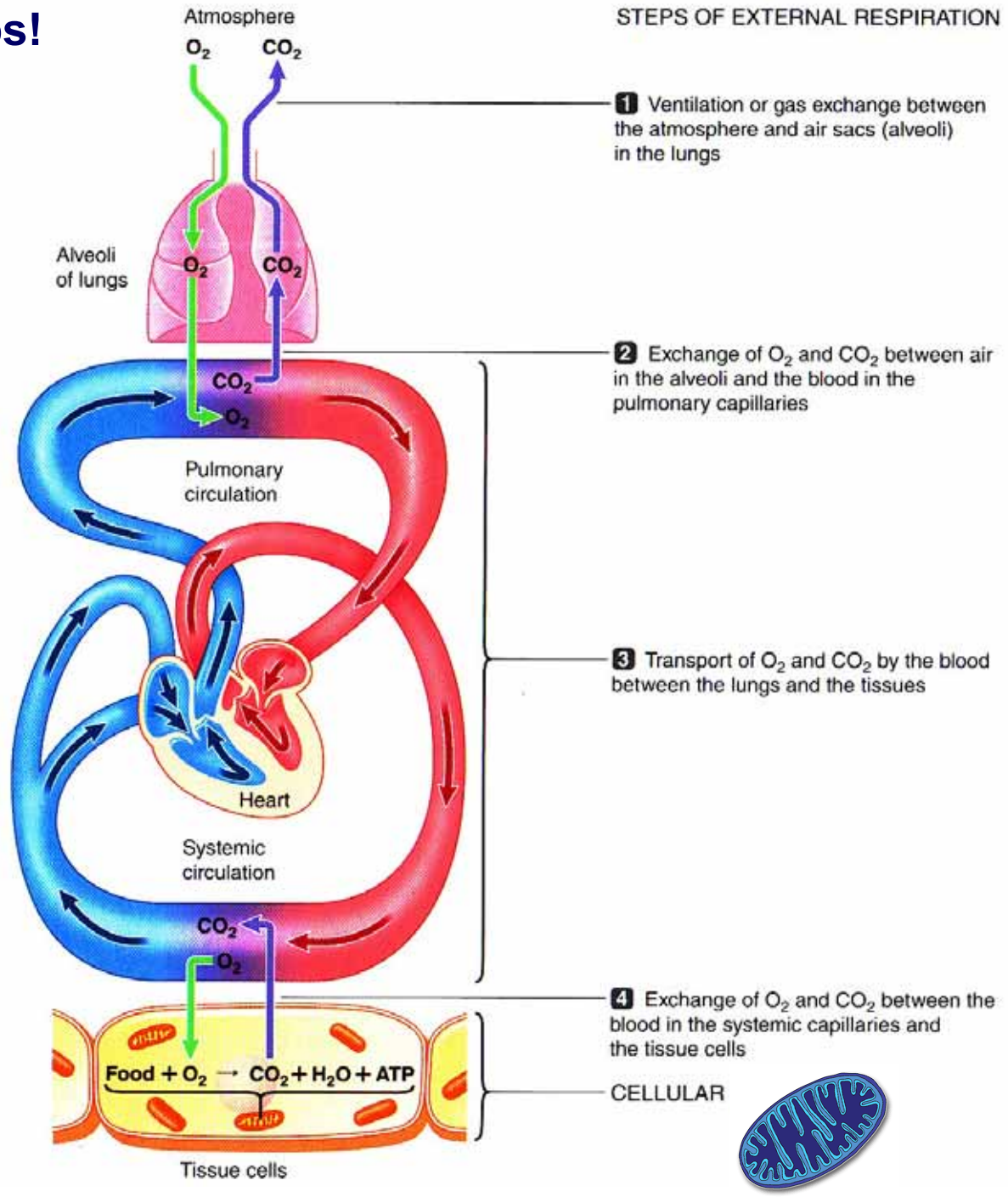
3. **Move with blood!**

Go with the flow!

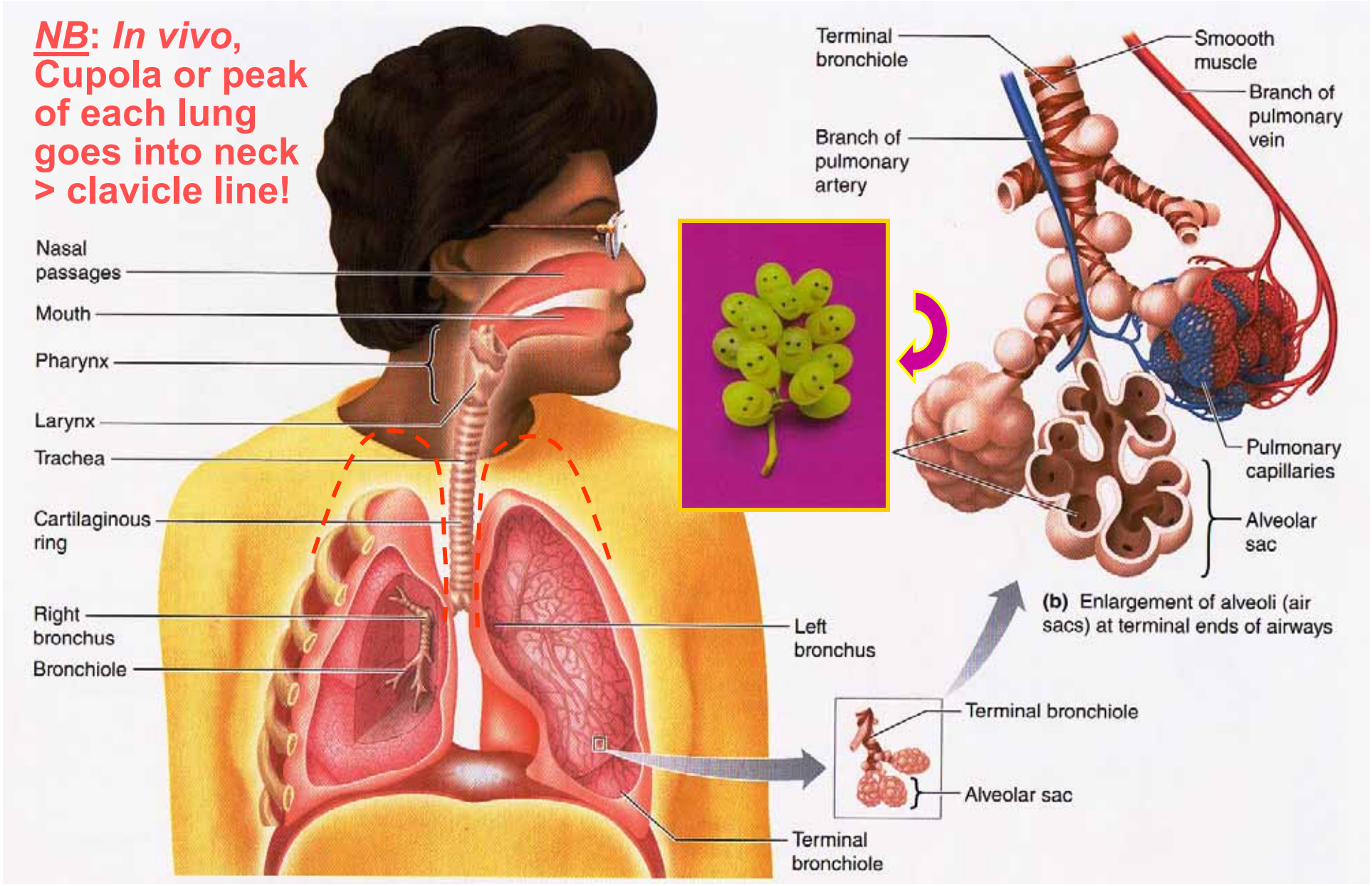
4. **Cross membranes!**



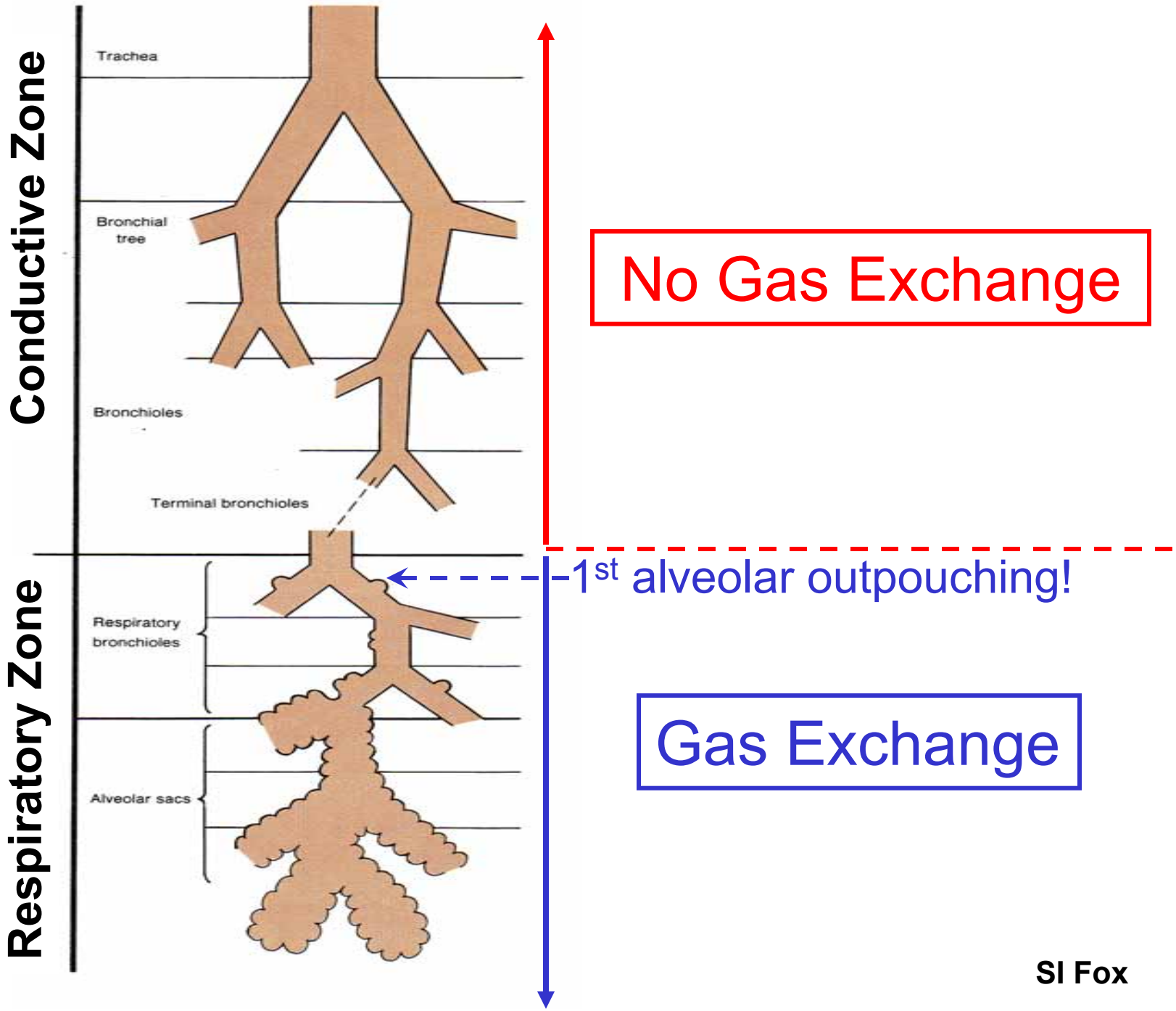
LS 2012 fig 12-1 modified



Respiratory System Anatomy



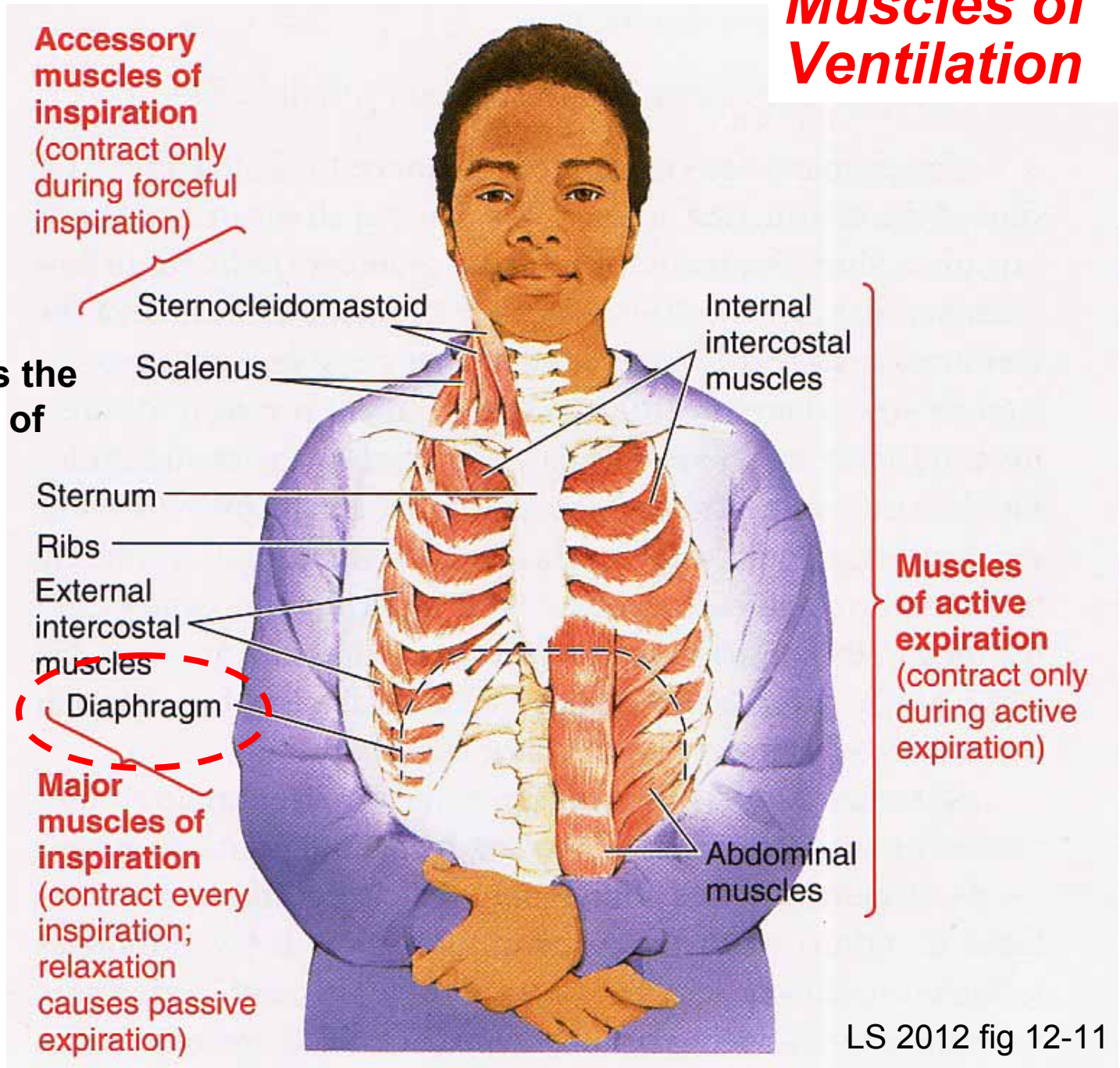
LS 2012 fig 12-2


Conductive Zone
Respiratory Zone
Trachea
Bronchial tree
Bronchioles
Terminal bronchioles
Respiratory bronchioles
Alveolar sacs
No Gas Exchange
1st alveolar outpouching!
Gas Exchange

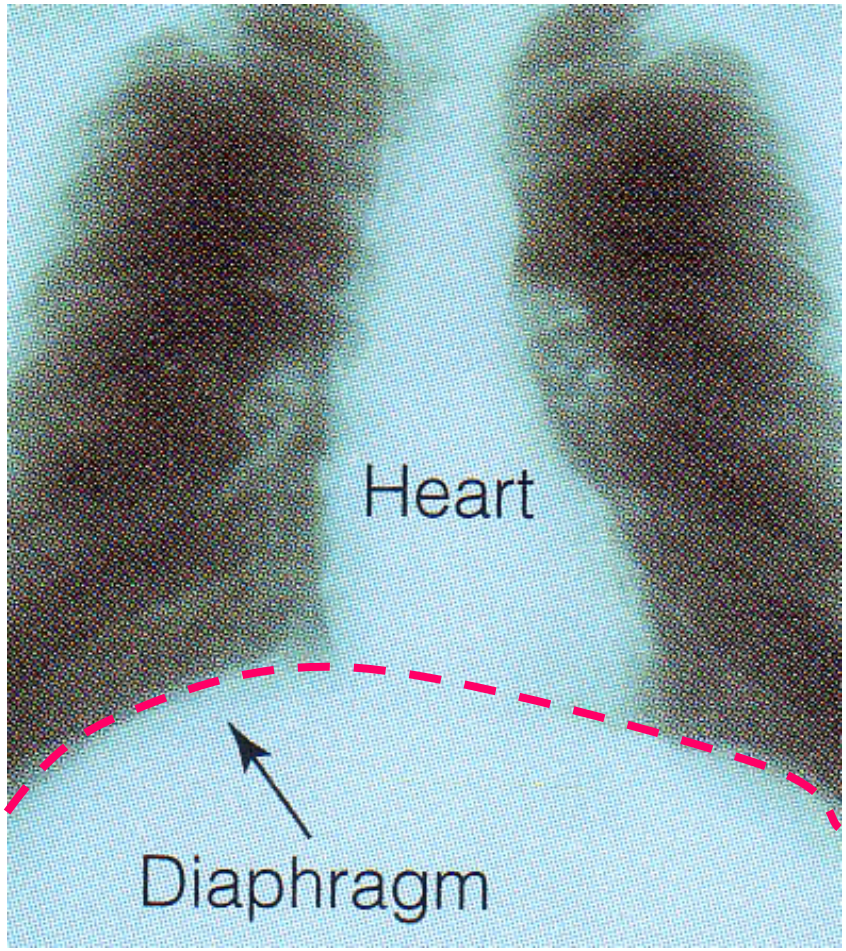
SI Fox

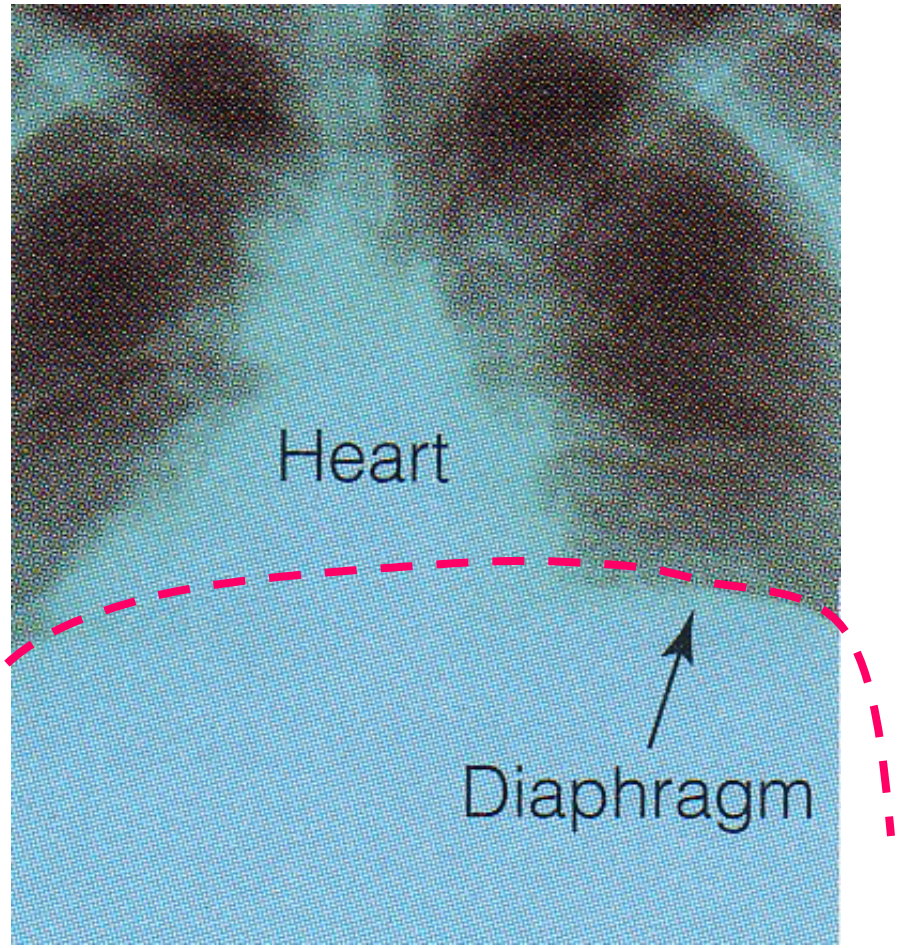
Muscles of Ventilation

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



LS 2012 fig 12-11





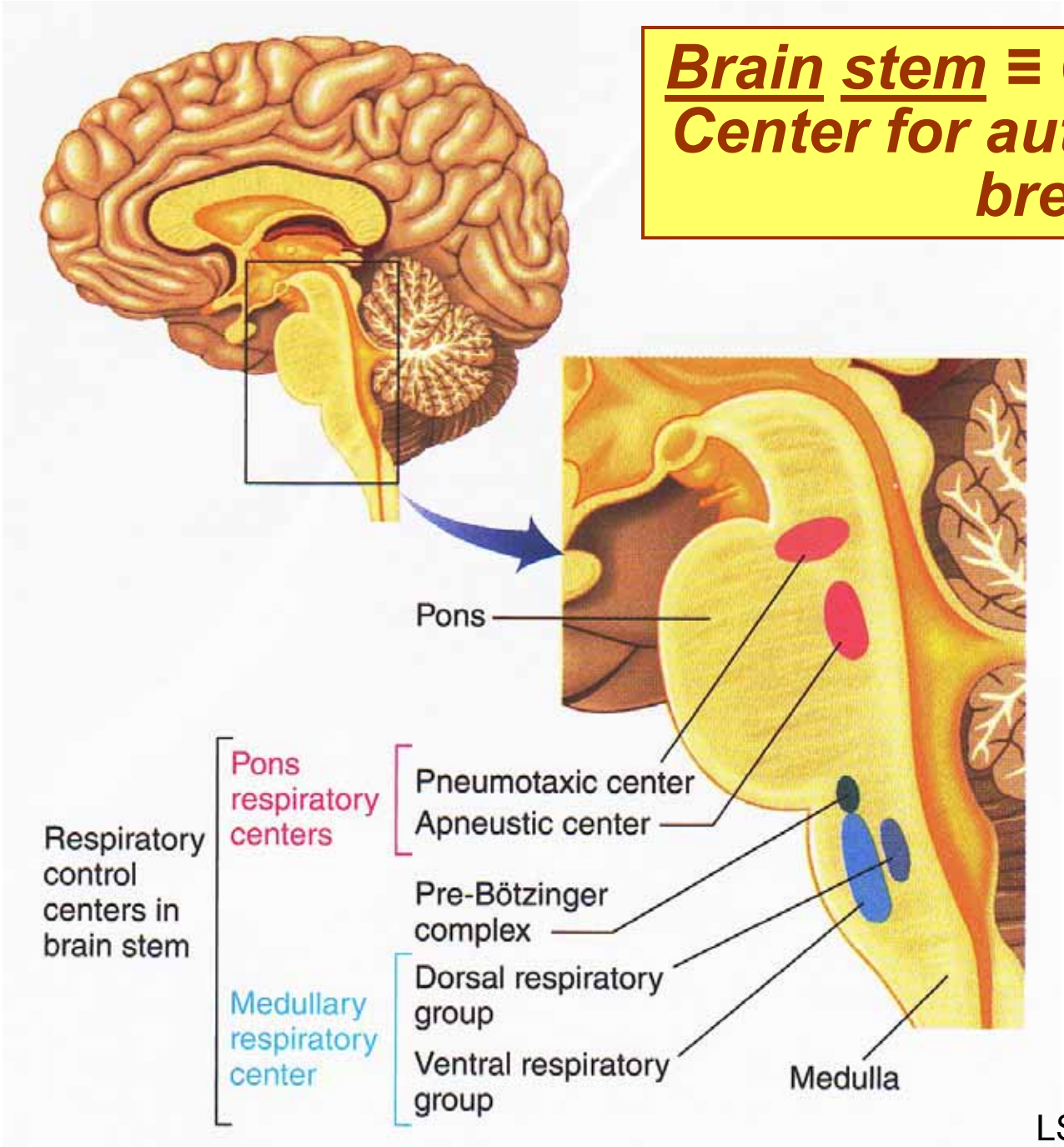
<u>Inhale</u> (active)

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

<u>Contract</u> & flatten diaphragm

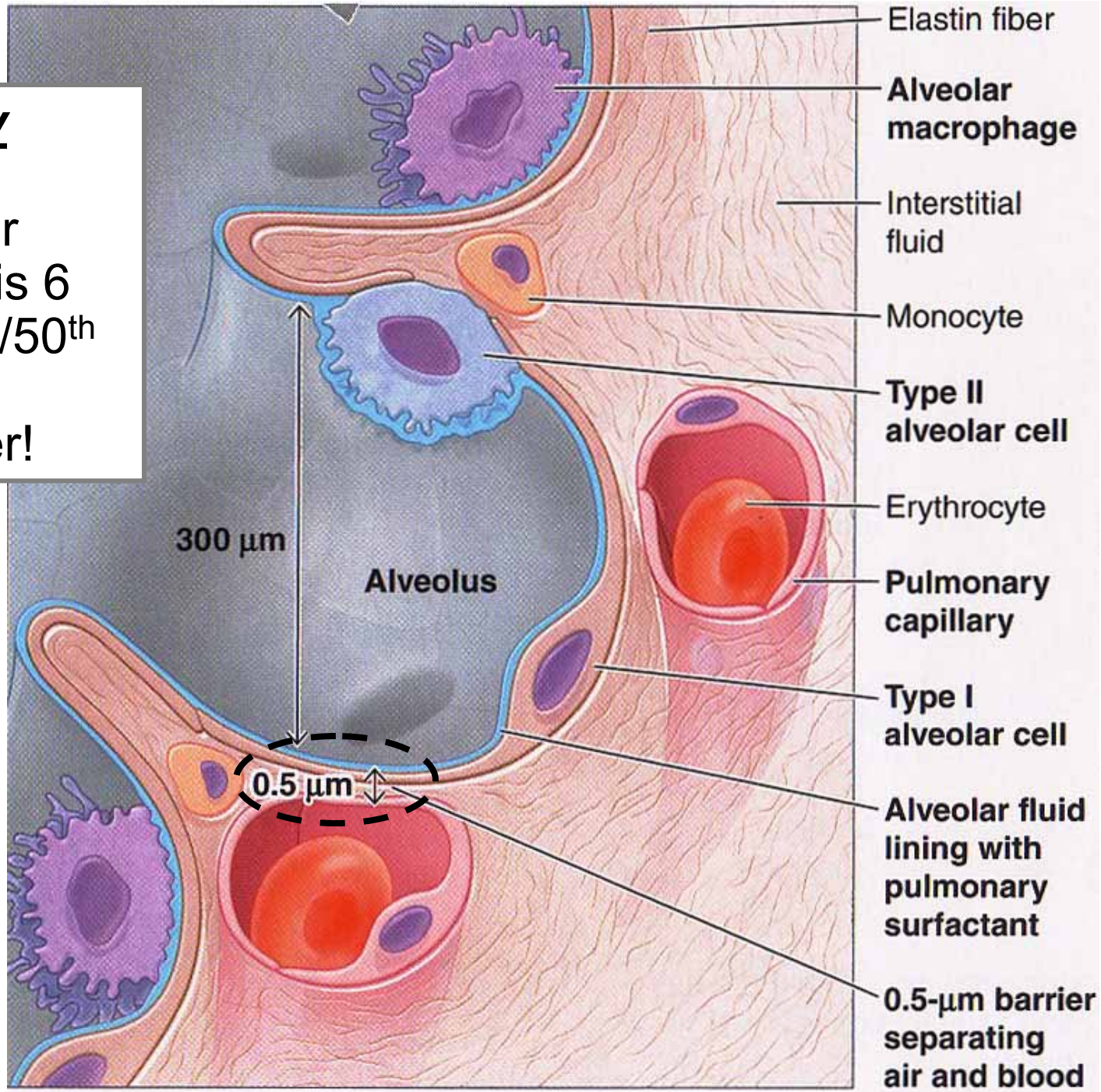
<u>Relax</u> & pouch up diaphragm!

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!

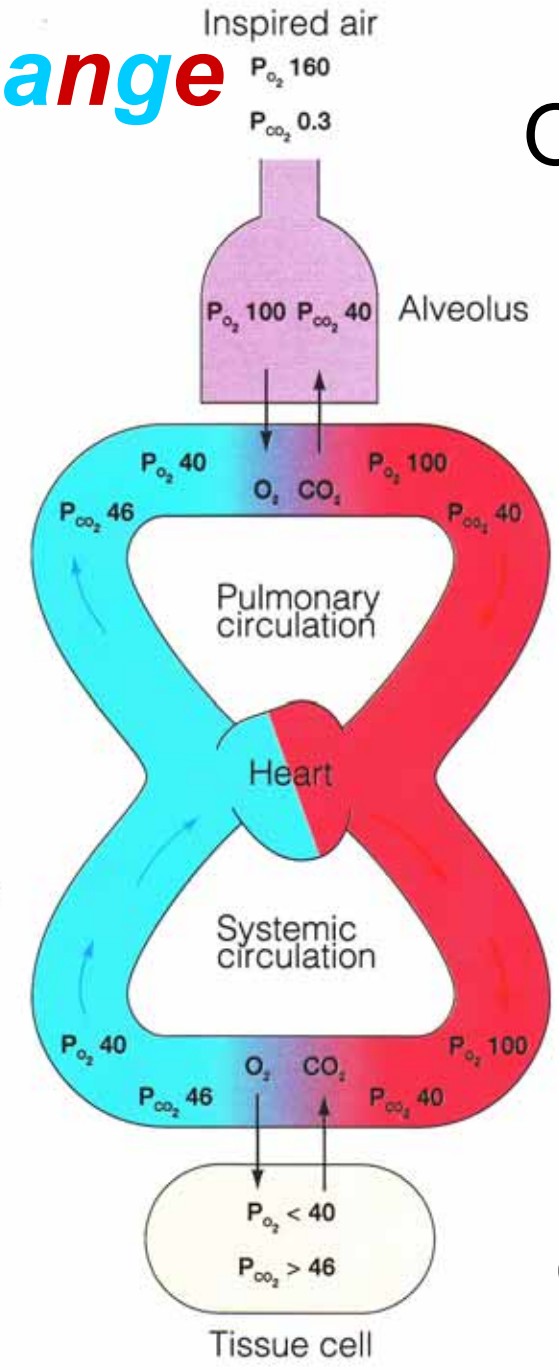


LS 2012 fig 12-4a

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)

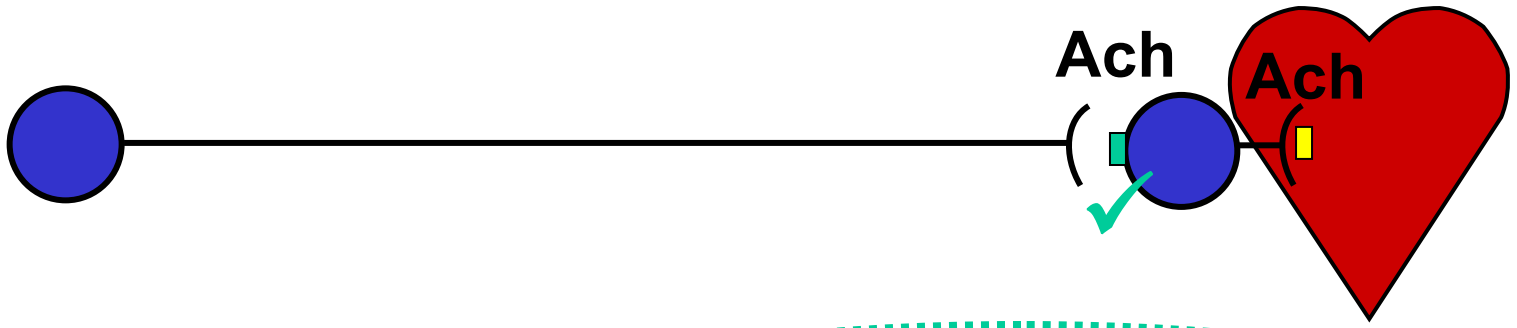
Numbers are mm Hg pressure.

CO_2 HIGH

O_2 LOW

cf: LS 2012 fig 12-19

Parasympathetic

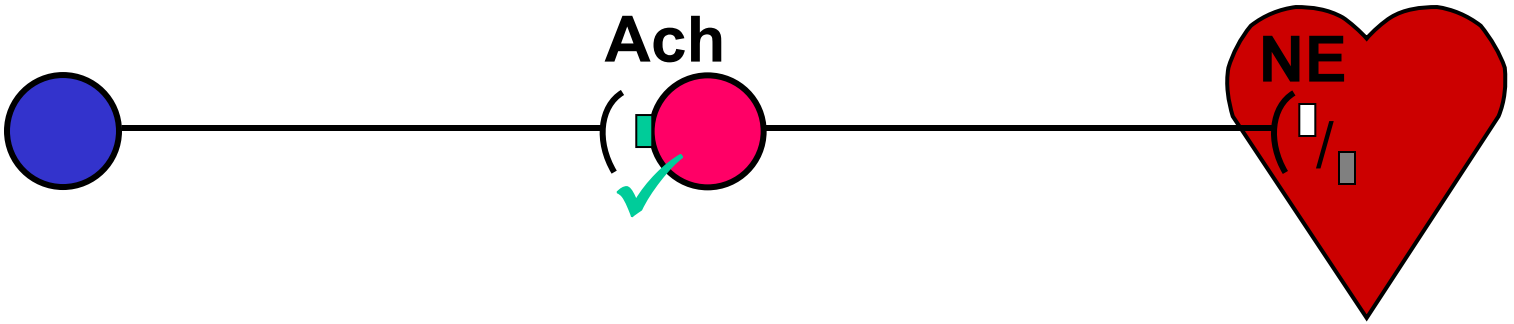


Ach = Acetylcholine

= Nicotinic Receptor

= Muscarinic Receptor

Sympathetic



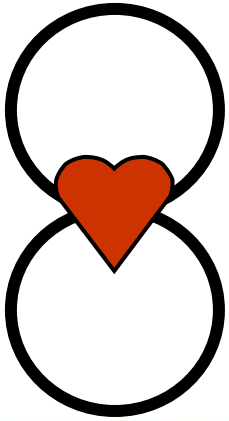
NE = Norepinephrine

= α Receptor (α_1 , α_2)

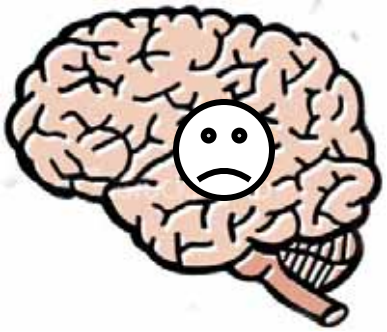
= β Receptor (β_1 , β_2)

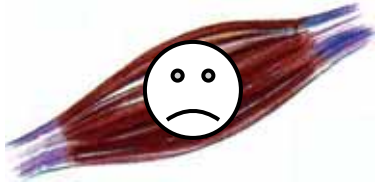
Cigarettes ≡ Patient-Assisted Drug-Delivery System
Inhaling Bypasses the Systemic Circulation
& Is Powerfully Reinforcing!

Pulmonary



Systemic





Tracing the Route of Cigarette Smoke
Puff to Brain Time 5 to 8 seconds!!

Mouth

↓

Pharynx

↓

Larynx

↓

Trachea

↓

Bronchi

↓

Bronchioles

↓

Alveoli

Blood

Pulmonary Veins

↓

Left Atrium

↓

Left Ventricle

↓

Aorta

↓

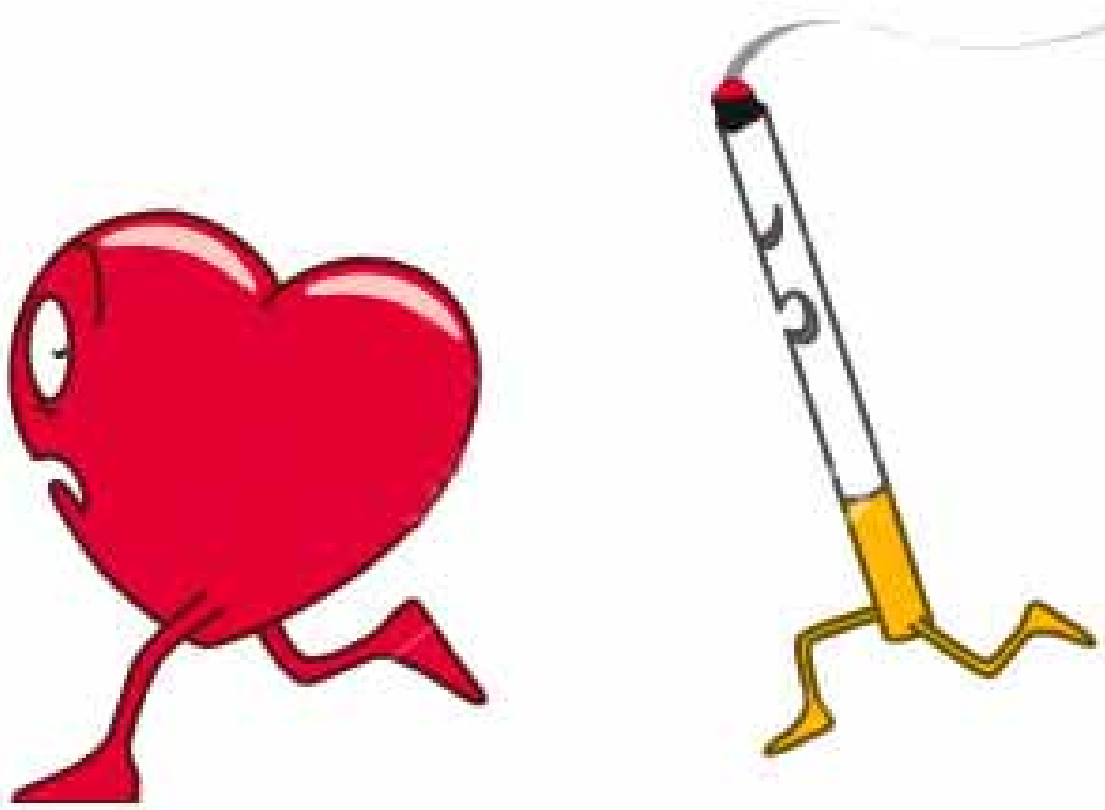
Heart

Brain

Systemic Circulation

Respiratory Membrane

Not only the Lungs, but the Heart, Brain & 100s of Other Tissues & Organs Adversely Affected!



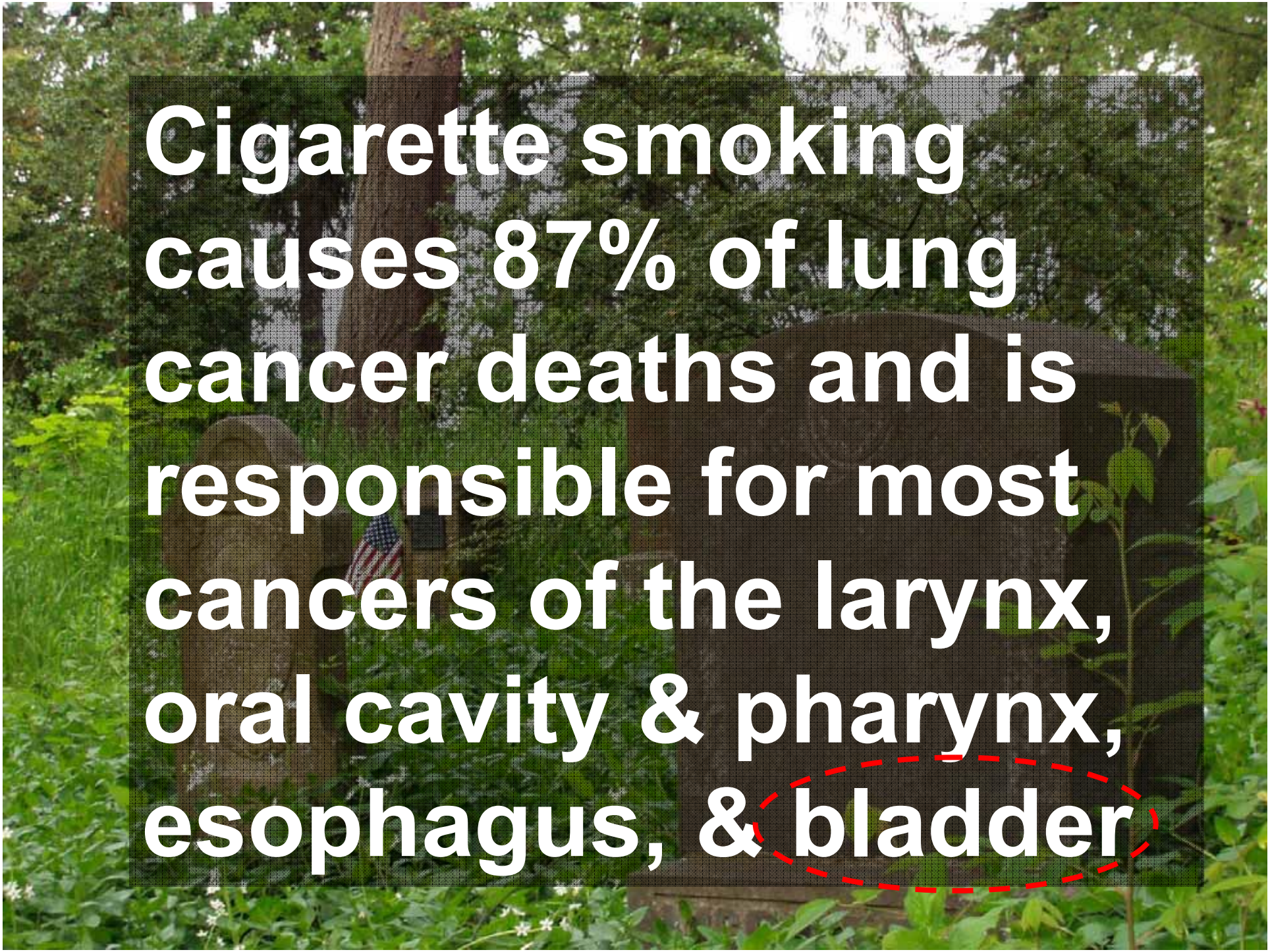
Tobacco smoke = Deadly mix of > 7000 chemicals!

http://www.cdc.gov/tobacco/data_statistics/sgr/2010/consumer_booklet/chemicals_smoke/

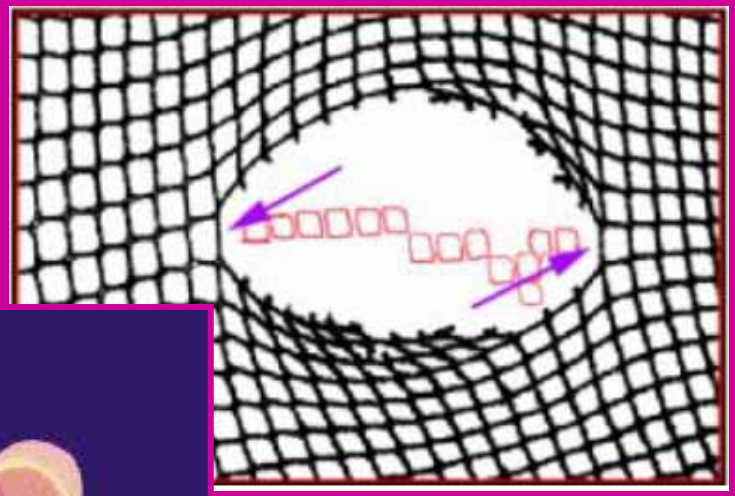
Keep it Basic?

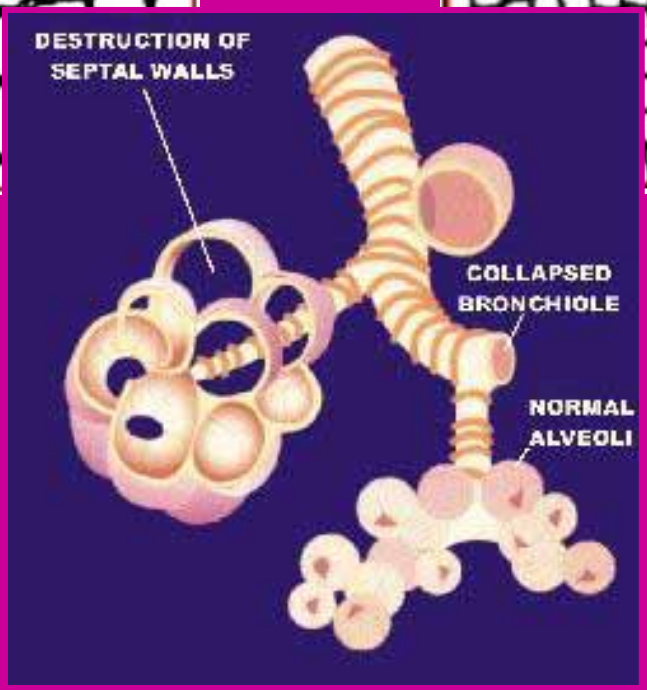
Cigarette smoking is the most important preventable cause of premature death in the U.S. accounting for 443,000 annual deaths.

http://www.cdc.gov/tobacco/data_statistics/fact_sheets/health_effects/tobacco_related_mortality/#cigs


Cigarette smoking causes 87% of lung cancer deaths and is responsible for most cancers of the larynx, oral cavity & pharynx, esophagus, & bladder

Emphysema ≡ Corrosion of Alveolar Walls with ↓ SA & Labored Breathing





Internet Journal of Pathology
Mayo Clinic Health

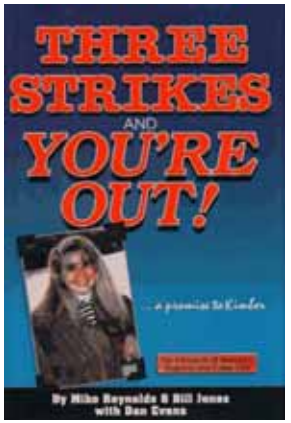
On the Pill & Smoke?

Increased Risk of:

1. Blood Clots

2. Heart Attack

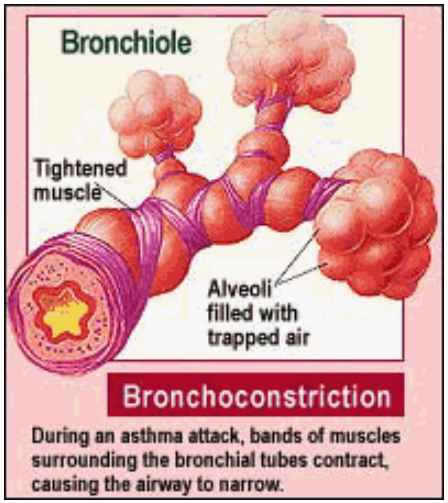
3. Strokes!



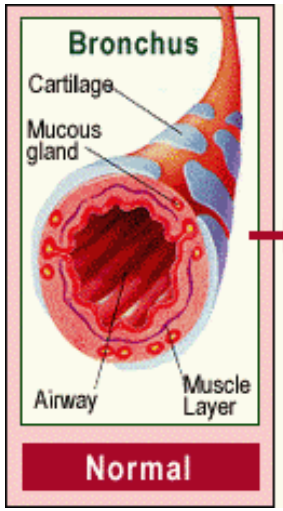
2nd-hand smoke is the 3rd leading preventable cause of death in the US!

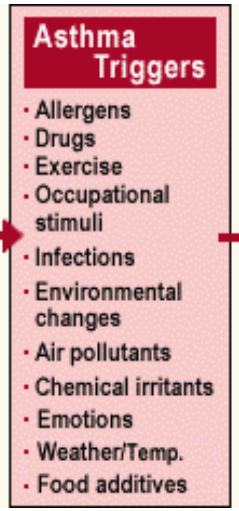
Each year 53,000 Americans die due to 2nd-hand smoke exposure!

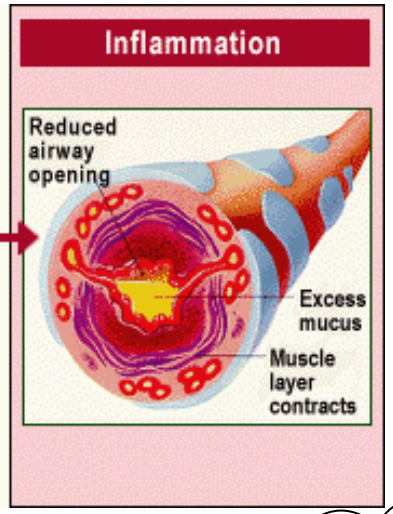
SMOKING ≡ ASTHMA?



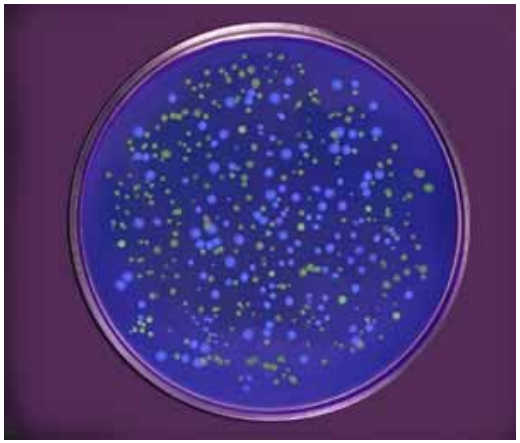
+







=



Petri-dish Effect




freebase nicotine!!

Ammonia converts nicotine, the addictive agent in tobacco, into a more volatile form, Pankow said. "Ammonia is the thing that helps tobacco companies hook the smoker by providing a means of delivering the nicotine."

Last October a former tobacco industry employee revealed that secret industry documents indicated that ammonia was added to tobacco to double the impact of nicotine. The Oregon Graduate Institute study confirms the contention that

Nicotine Addiction & Help Quitting Smoking

http://www.cancer.org/healthy/stayawayfromtobacco/guidetoquittingsmoking/guide-to-quitting-smoking-help-phys-nrt

2nd-Hand Smoke or ETS & 3rd-Hand Smoke?

http://www.cancer.org/cancer/cancercauses/tobaccocancer/secondhand-smoke

2nd-Hand Smoke Addictive?

http://www.ncbi.nlm.nih.gov/pubmed?term=2nd%20hand%20smoke%20addictive

http://www.ncbi.nlm.nih.gov/pubmed/20211642
http://www.ncbi.nlm.nih.gov/pubmed/19936715
http://www.ncbi.nlm.nih.gov/pubmed/21840504