# 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 Thurs. Q?

II. ***Endocrine Connections*** Peripheral endocrine organs
   A. Pancreas (insulin, glucagon, diabetes) B. Thyroid C. Adrenals
   DC Module 13 pp 109-13, LS pp 513-36

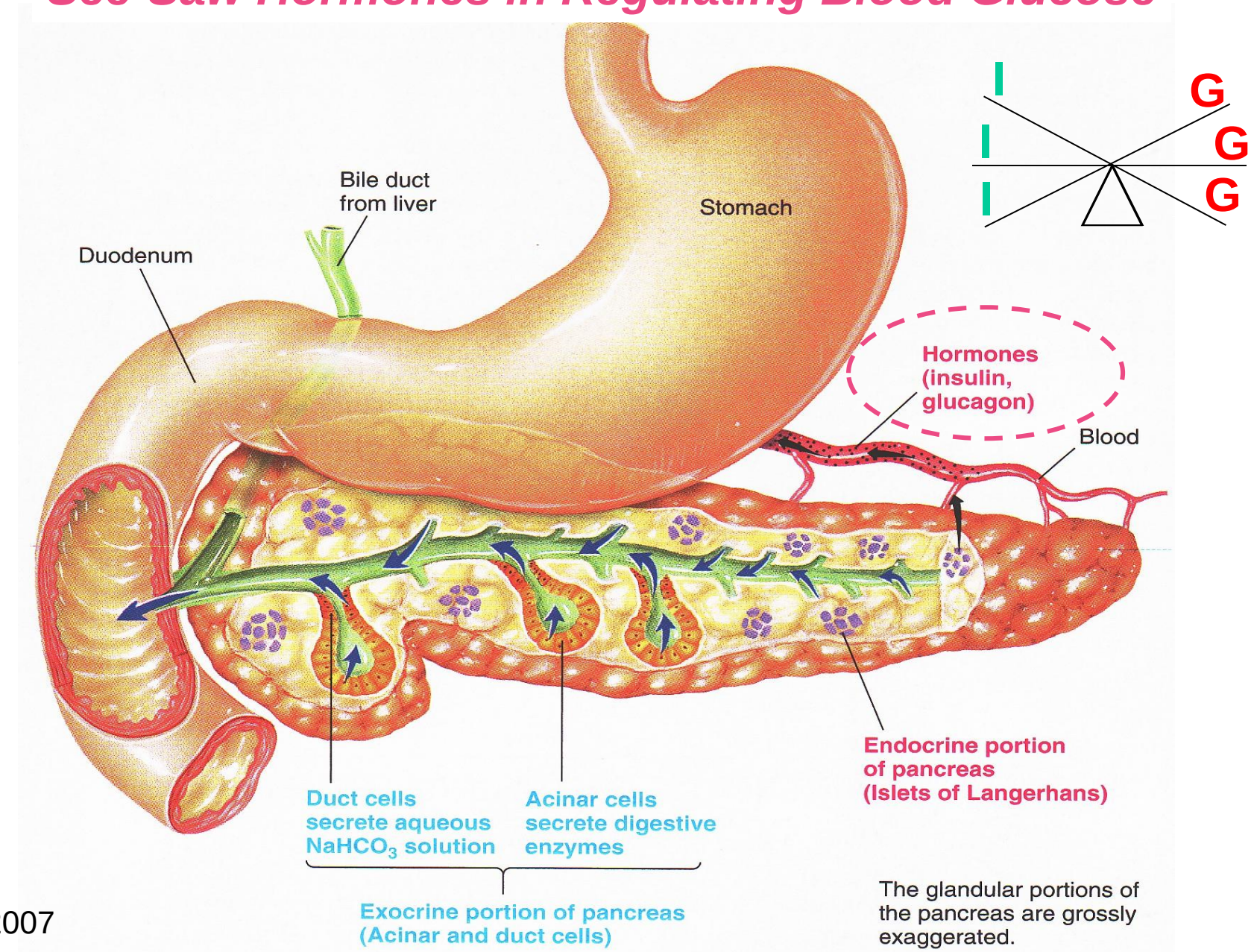
III. ***Nervous System & Excitable Cells*** DC Module 9, LS ch 5, 4, 7
   A. How is the nervous system organized? fig 5-1 p 108
   B. Neurons? What kind? fig 5-2 p 109
   C. Brain structure & function fig 5-7, 5-8 pp 116 – 7
   D. Protect your head with a helmet!
   Bicycle head injury statistics, NHTSA & BHSI

IV. ***Brain + Autonomic Nervous System Overview*** DC pp 71-77, LS pp 178 – 85, tab 7-1 p 183 + stories to remember ***fight-or-flight!***

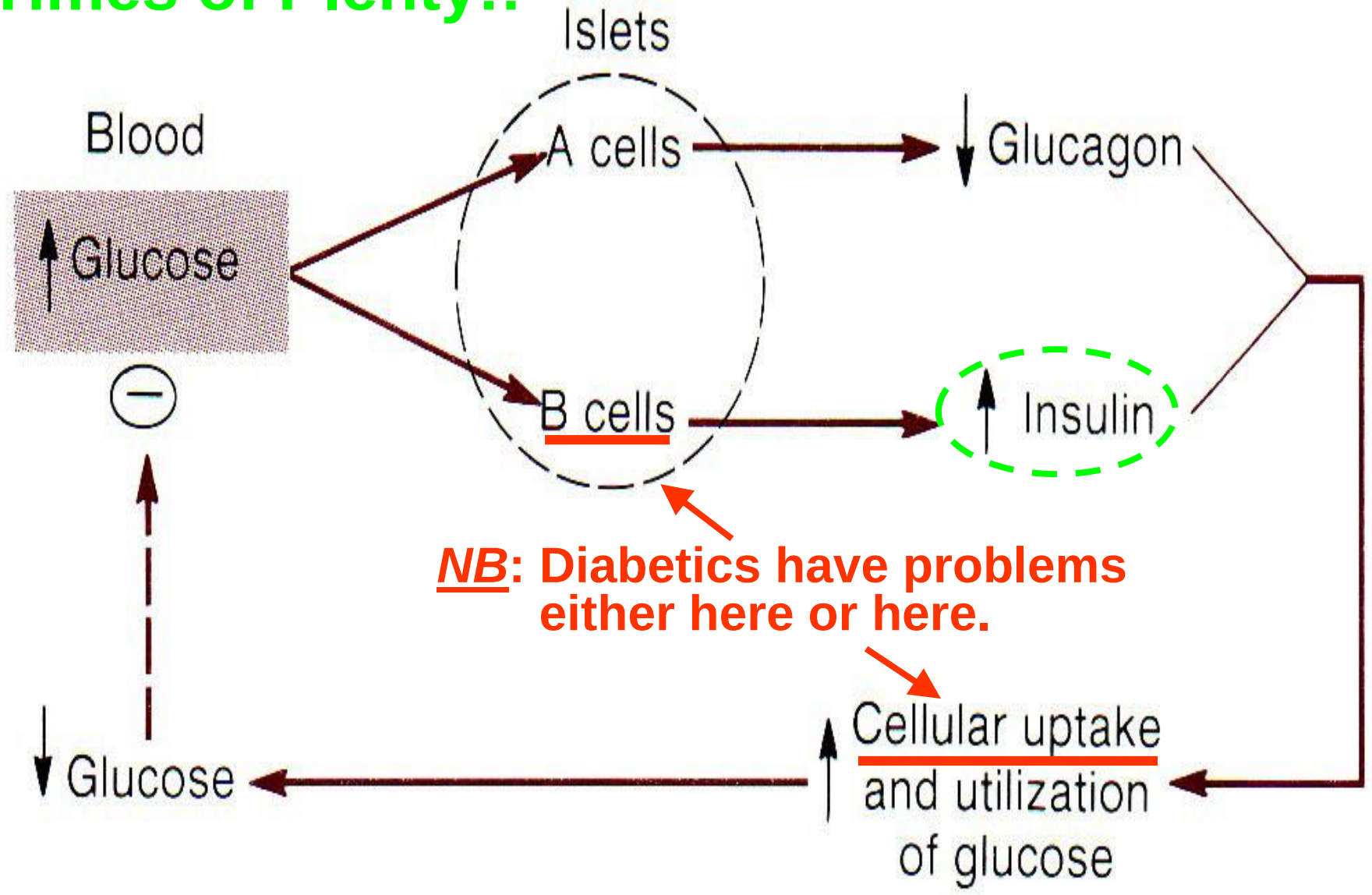
V. ***Neuromuscular Connections*** LS ch 7 pp 186-92, DC pp 69-71
   How does the signal cross the nerve-muscle gap? LS fig 7-5
   A. Normal function? Ca2+ for bones!…but what else? LS p 190
   B. What do black widow spider venom, botulism, curare & nerve gas have in common? Botox? LS p 189-91

VI. ***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

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



# Times of Plenty!!




Fox 1987

Store!

TABLE 4-7

# Warning Signs of Diabetes

These signs appear reliably in type 1 diabetes and, often, in the later stages of type 2 diabetes.

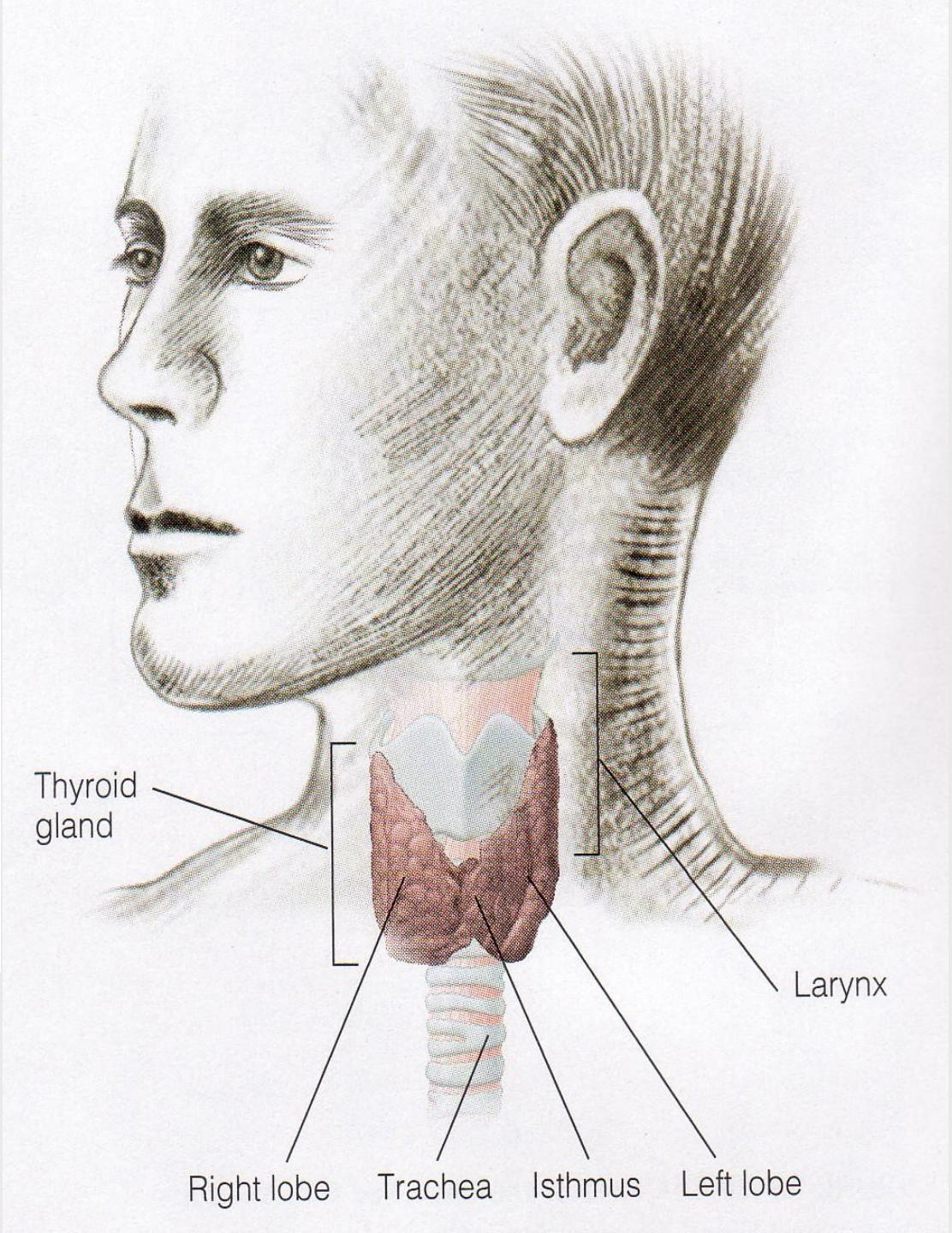
- Excessive urination and thirst
- Glucose in the urine
- Weight loss with nausea, easy tiring, weakness, or irritability
- Cravings for food, especially for sweets
- Frequent infections of the skin, gums, vagina, or urinary tract
- Vision disturbances; blurred vision
- Pain in the legs, feet, or fingers
- Slow healing of cuts and bruises
- Itching
- Drowsiness
- Abnormally high glucose in the blood

S&W 2011 tab 4-7 p 131

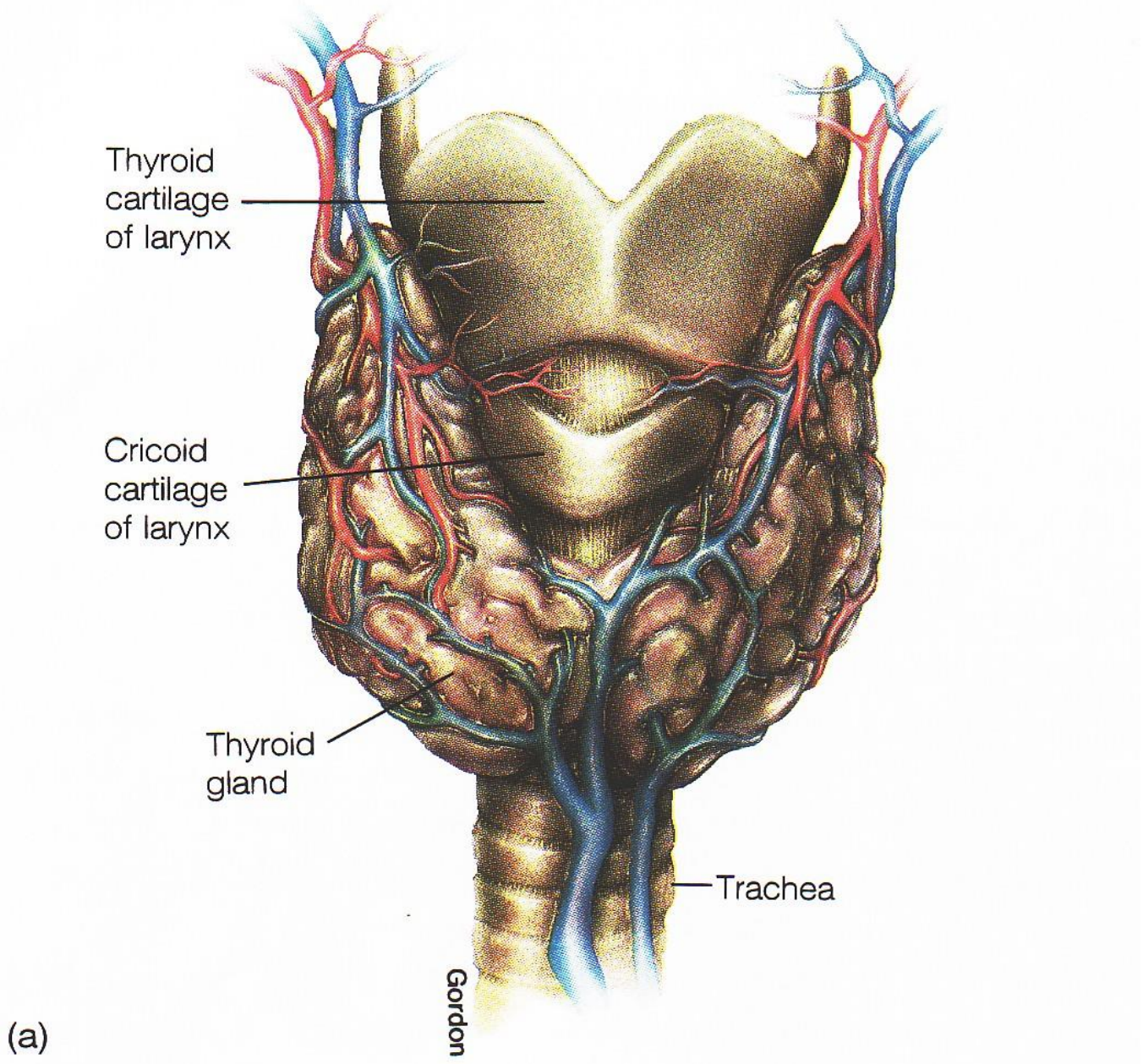
# *Diabetics must constantly juggle diet, exercise & medication to control blood glucose!*

# *Like others, diabetics benefit from whole grains, vegetables, fruits, legumes & non-/low-fat milk products!*

S&W p 133




DC 2003


Thyroid cartilage of larynx
Cricoid cartilage of larynx
Thyroid gland
Trachea
Gordon
(a)

DC 2003


DC 2003

LS 2012 fig 17-16

LS 2012 fig 17-17

Guyton & Hall 2000

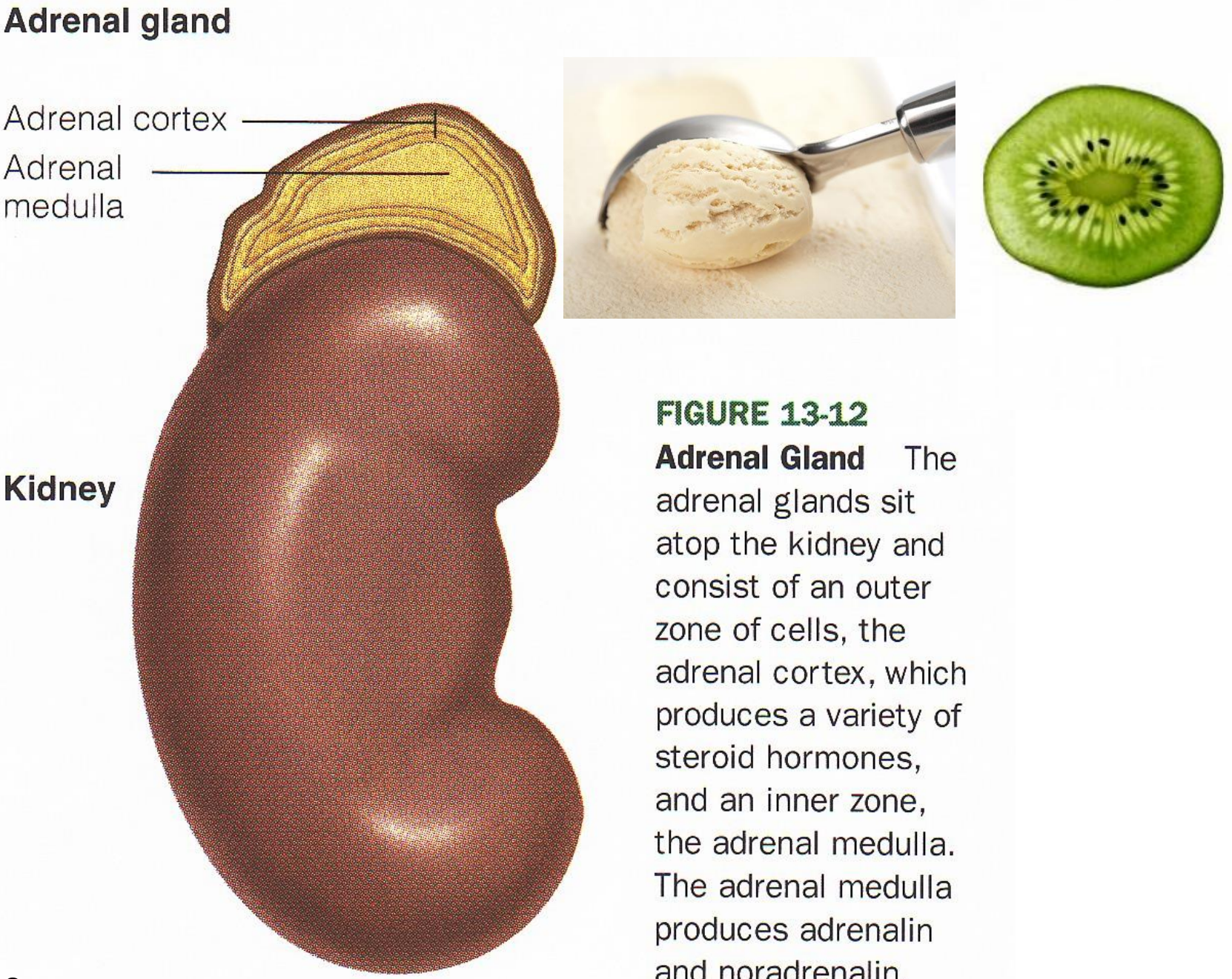
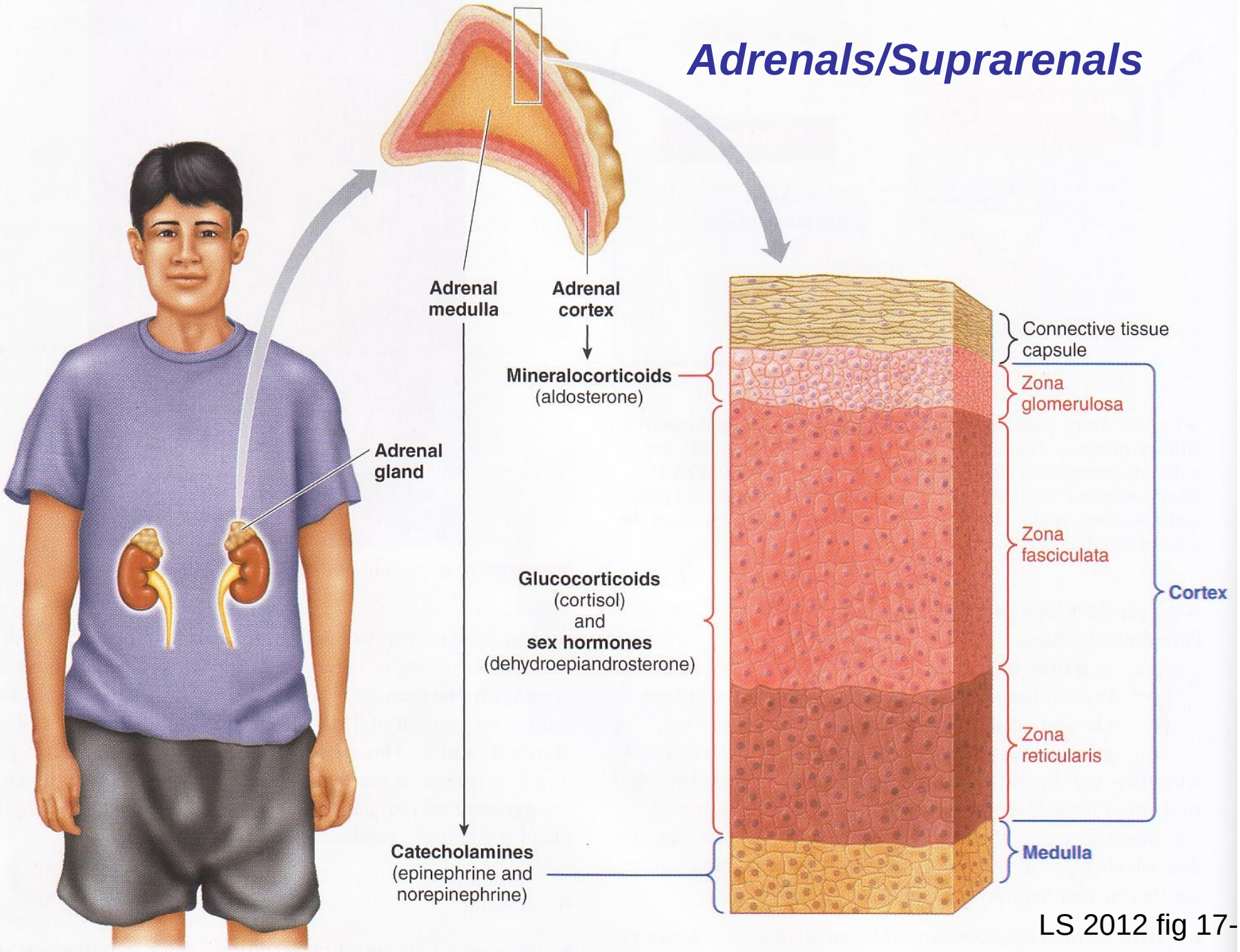


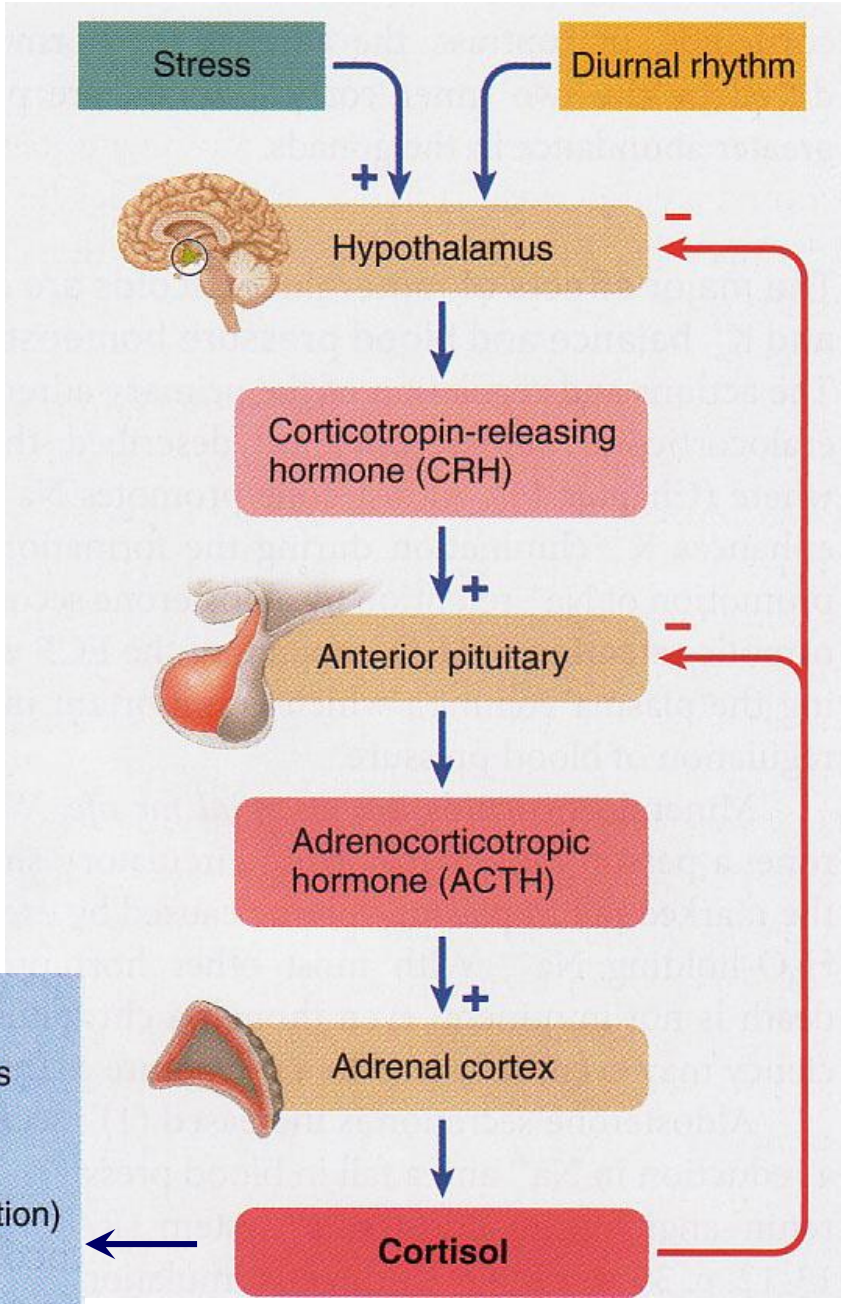

**FIGURE 13-12**
**Adrenal Gland** The adrenal glands sit atop the kidney and consist of an outer zone of cells, the adrenal cortex, which produces a variety of steroid hormones, and an inner zone, the adrenal medulla. The adrenal medulla produces adrenalin and noradrenalin.

# Adrenals/Suprarenals




LS 2012 fig 17-18

# Stress Promotes Cortisol Secretion

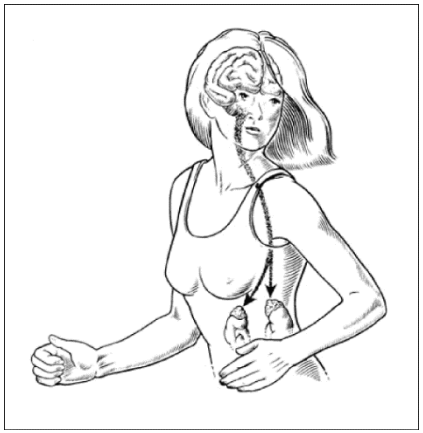



Metabolic fuels and building blocks available to help resist stress

- ↑ Blood glucose (by stimulating gluconeogenesis and inhibiting glucose uptake)
- ↑ Blood amino acids (by stimulating protein degradation)
- ↑ Blood fatty acids (by stimulating lipolysis)

LS 2012 fig 17-19


**Epinephrine 80%**
**Norepinephrine 20%**



Guyton & Hall 2000

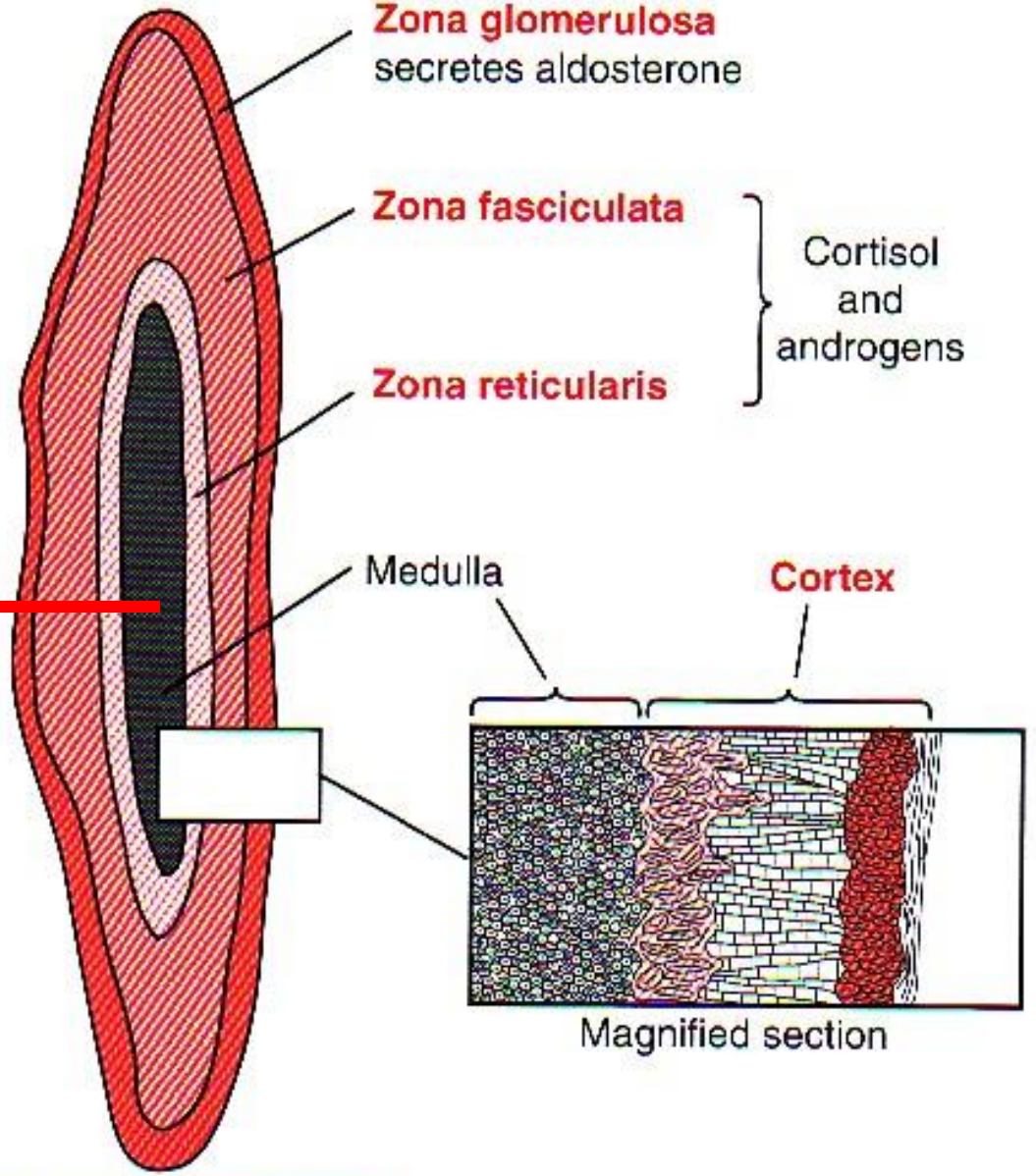
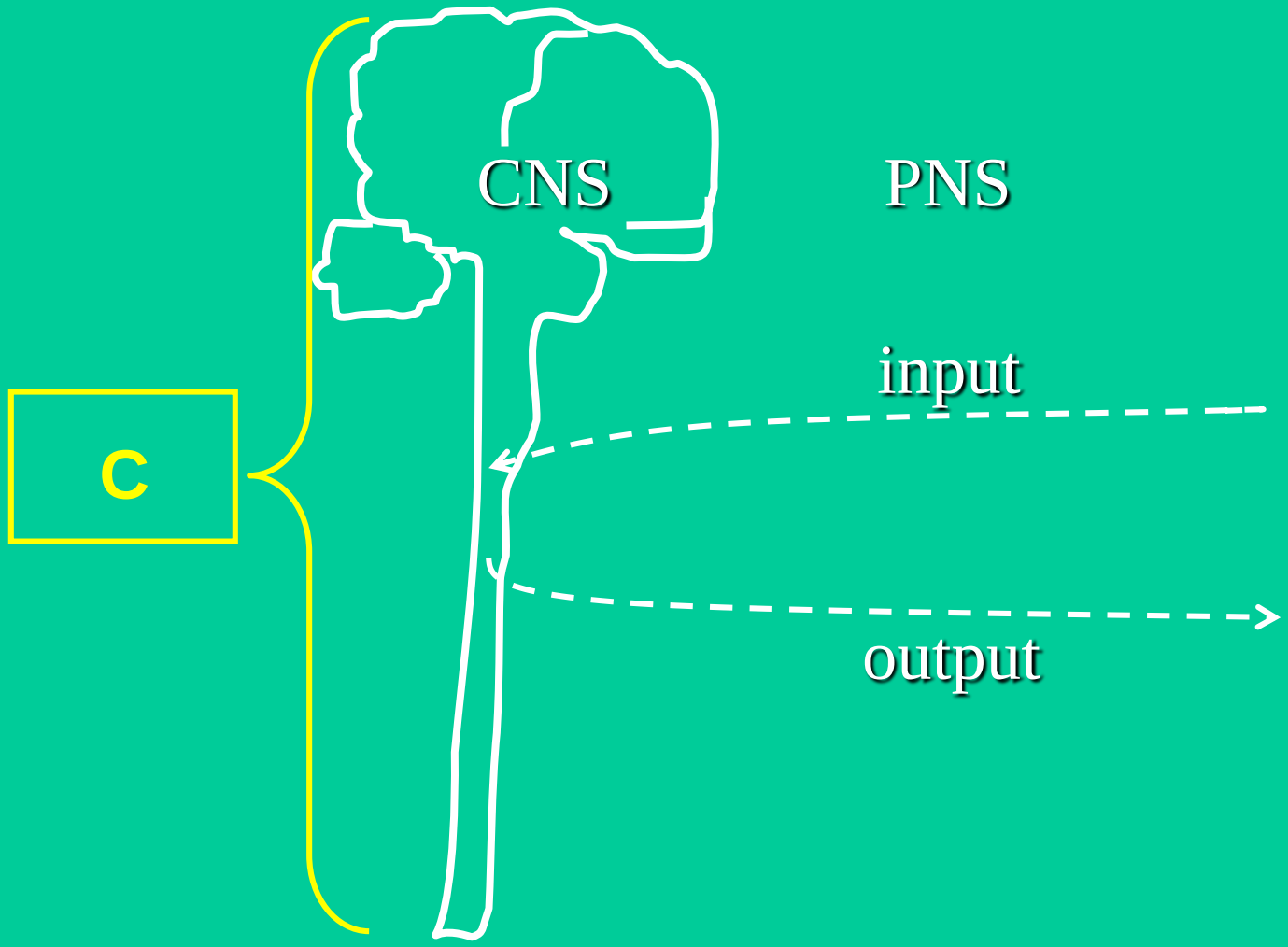
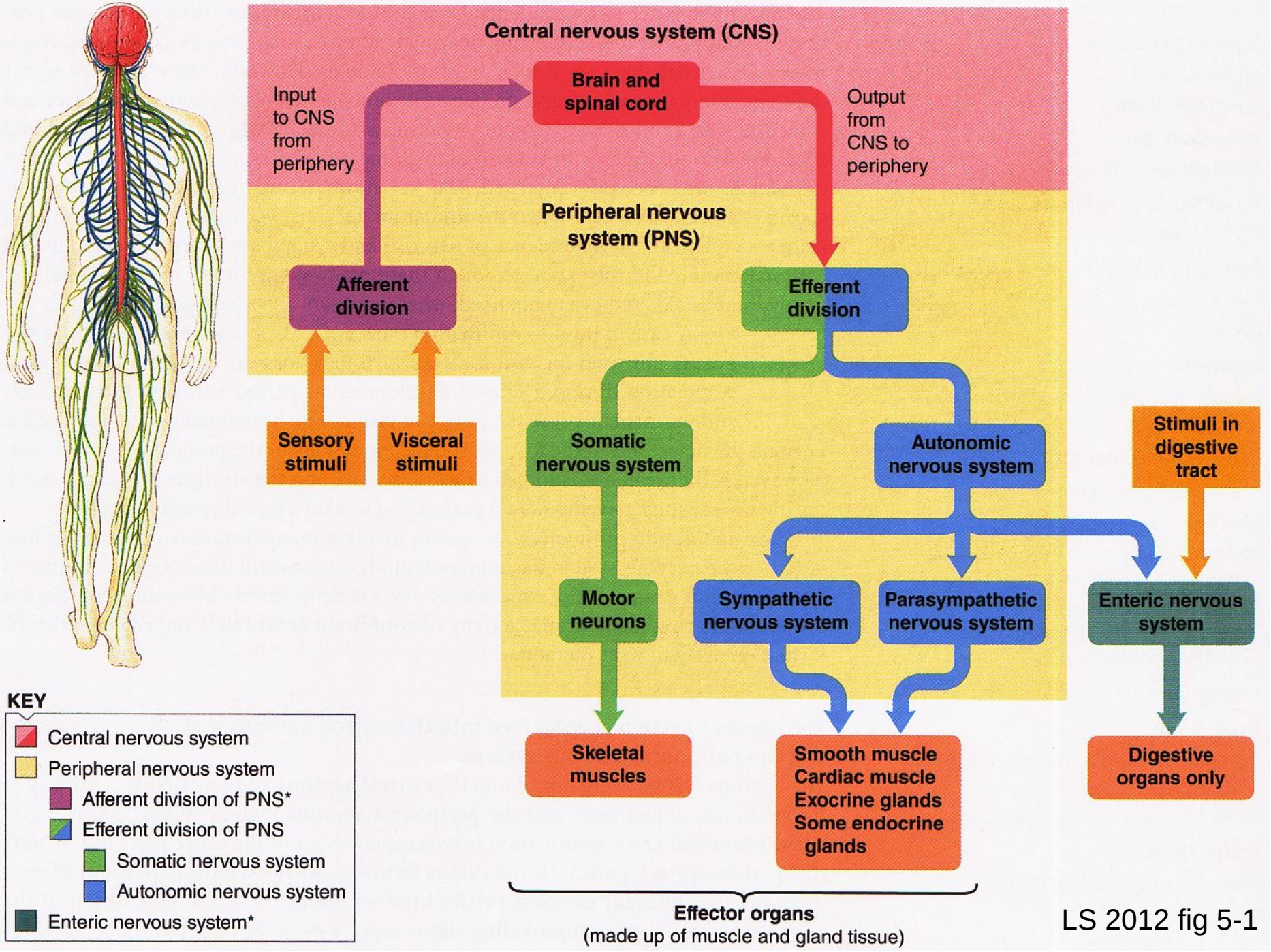



FIGURE 77-1

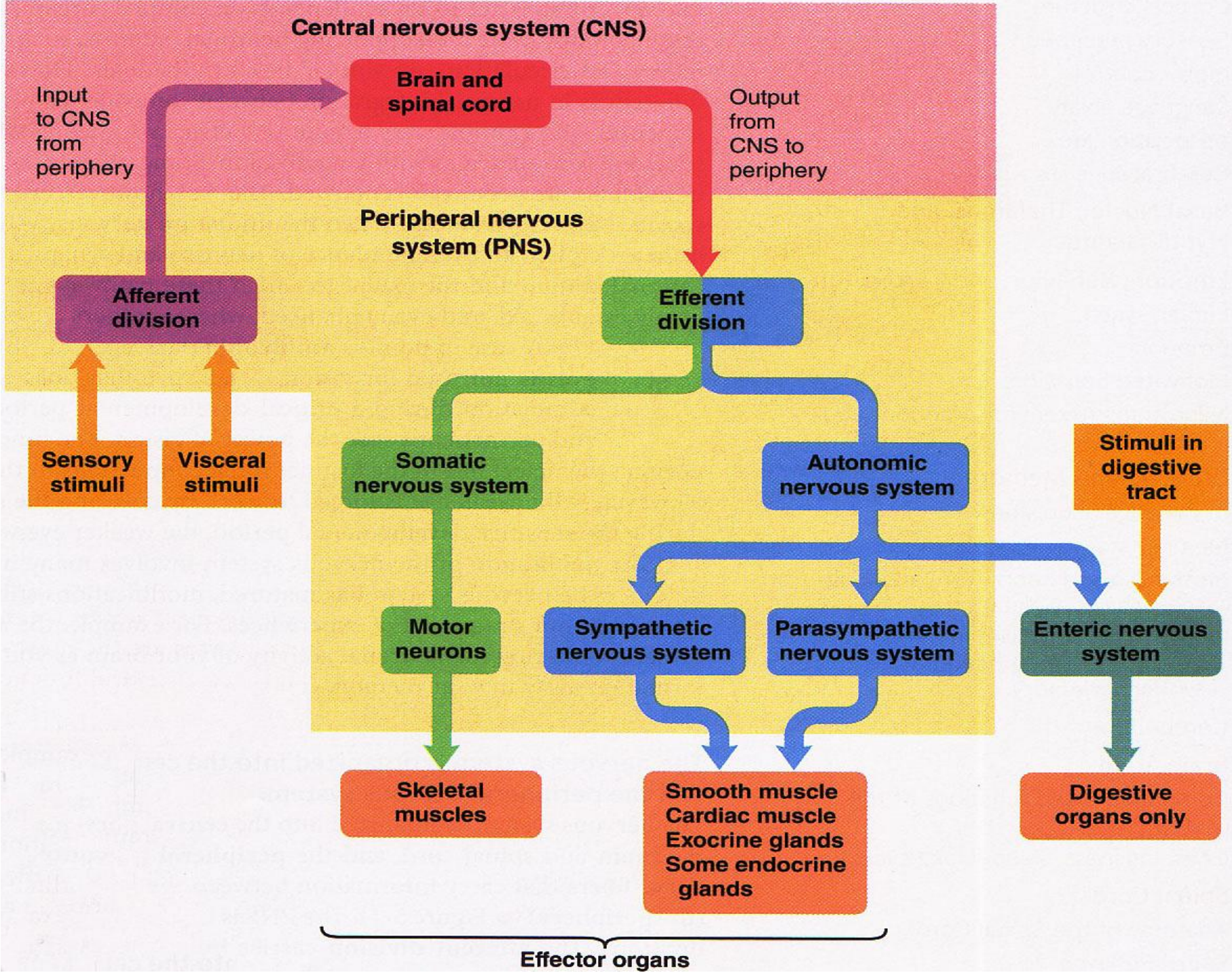
Secretion of adrenocortical hormones by the different zones of the adrenal cortex.

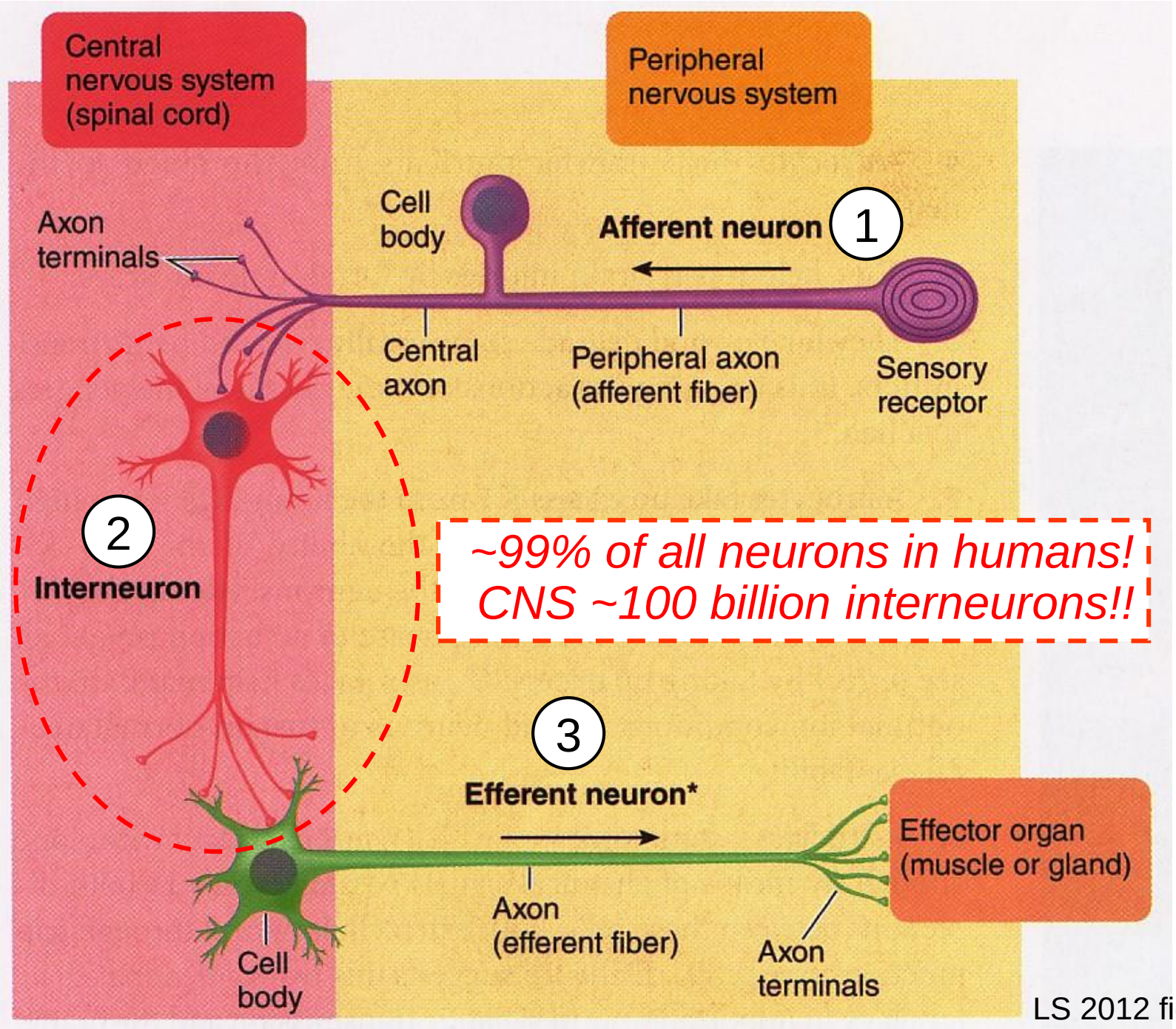
# Nervous System





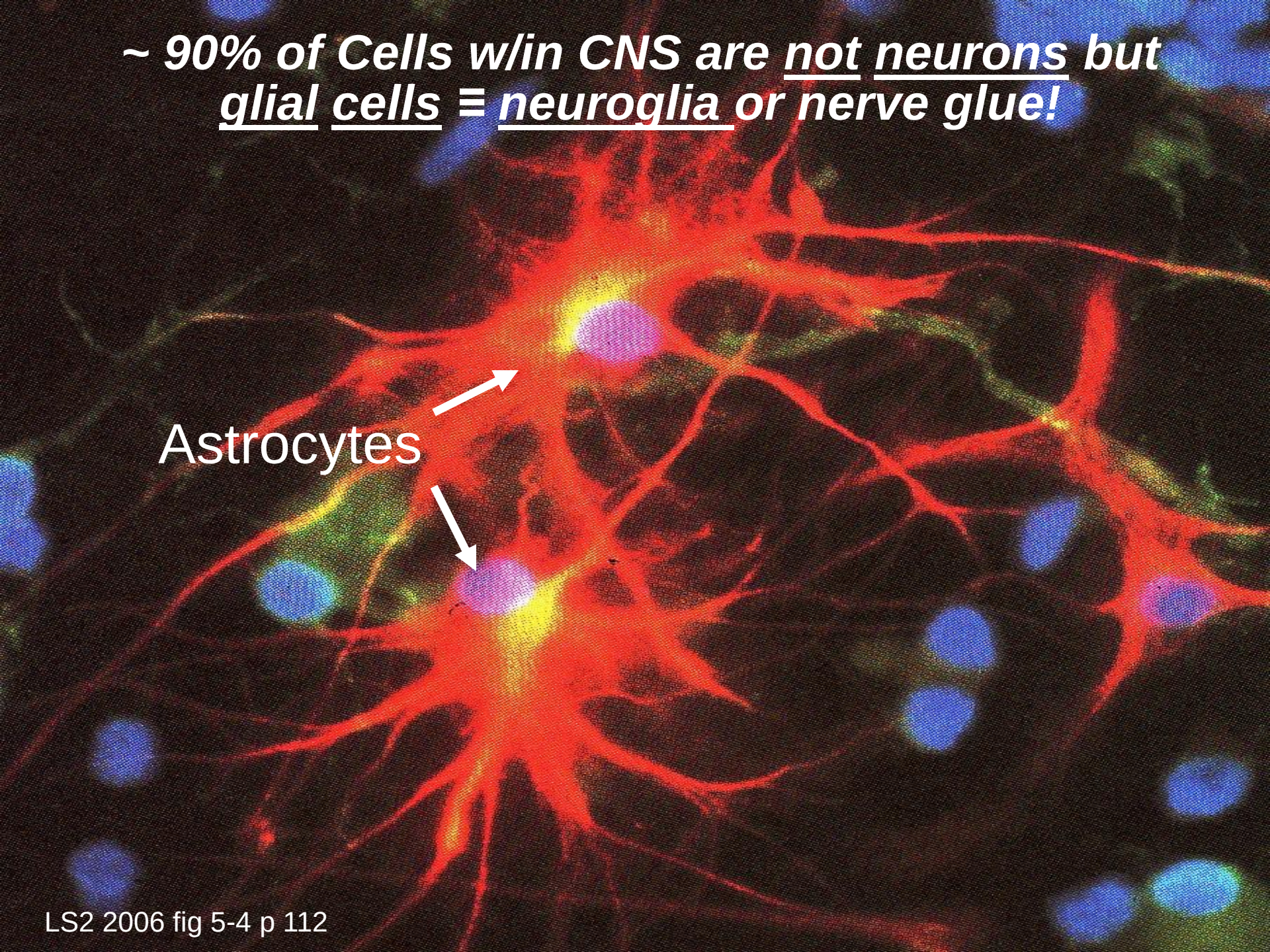

LS 2012 fig 5-1


Central nervous system (CNS)
Brain and spinal cord
Input to CNS from periphery
Output from CNS to periphery
Peripheral nervous system (PNS)
Afferent division
Efferent division
Sensory stimuli
Visceral stimuli
Somatic nervous system
Autonomic nervous system
Stimuli in digestive tract
Motor neurons
Sympathetic nervous system
Parasympathetic nervous system
Enteric nervous system
Skeletal muscles
Smooth muscle
Cardiac muscle
Exocrine glands
Some endocrine glands
Digestive organs only
Effector organs

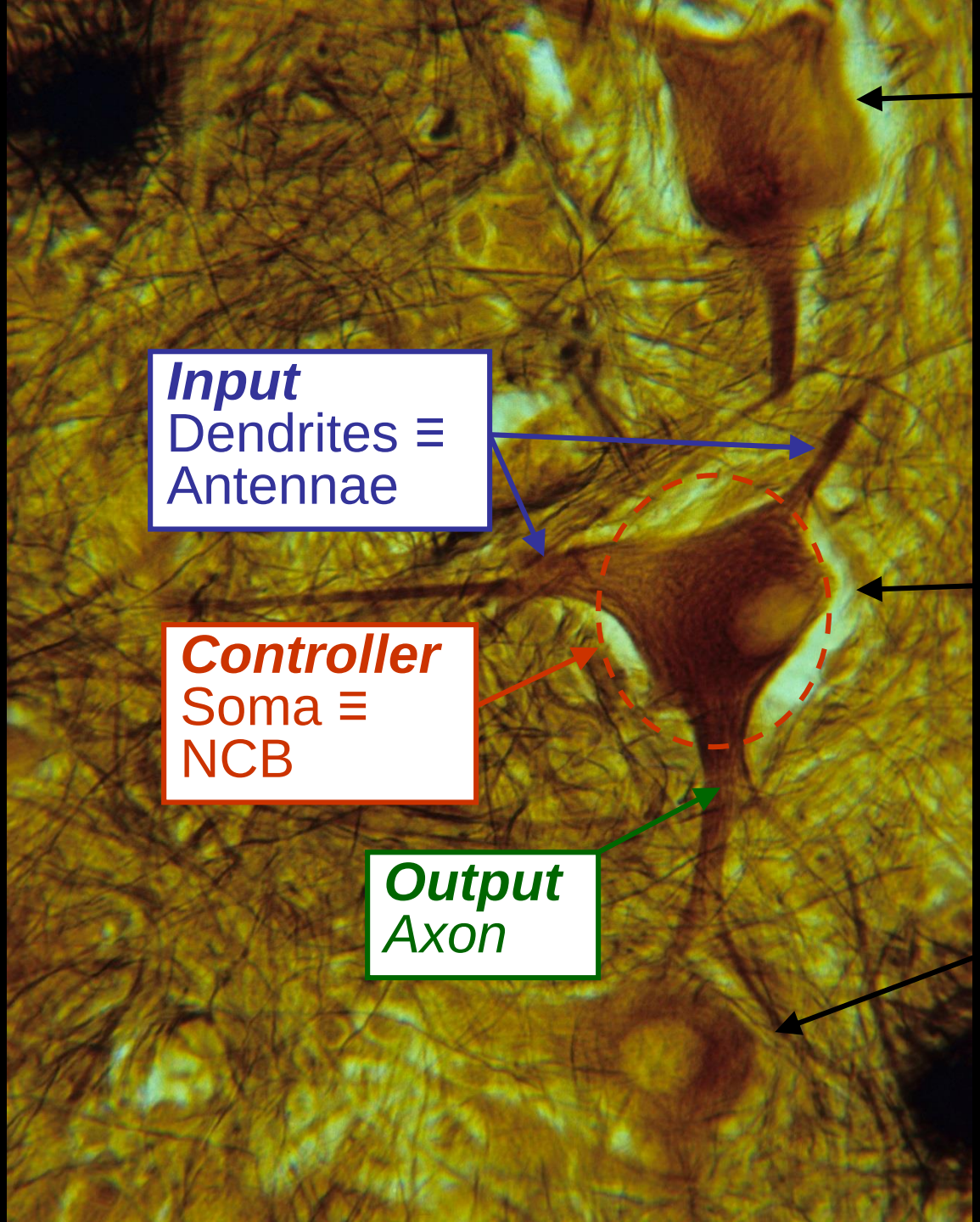



LS 2012 fig 5-2

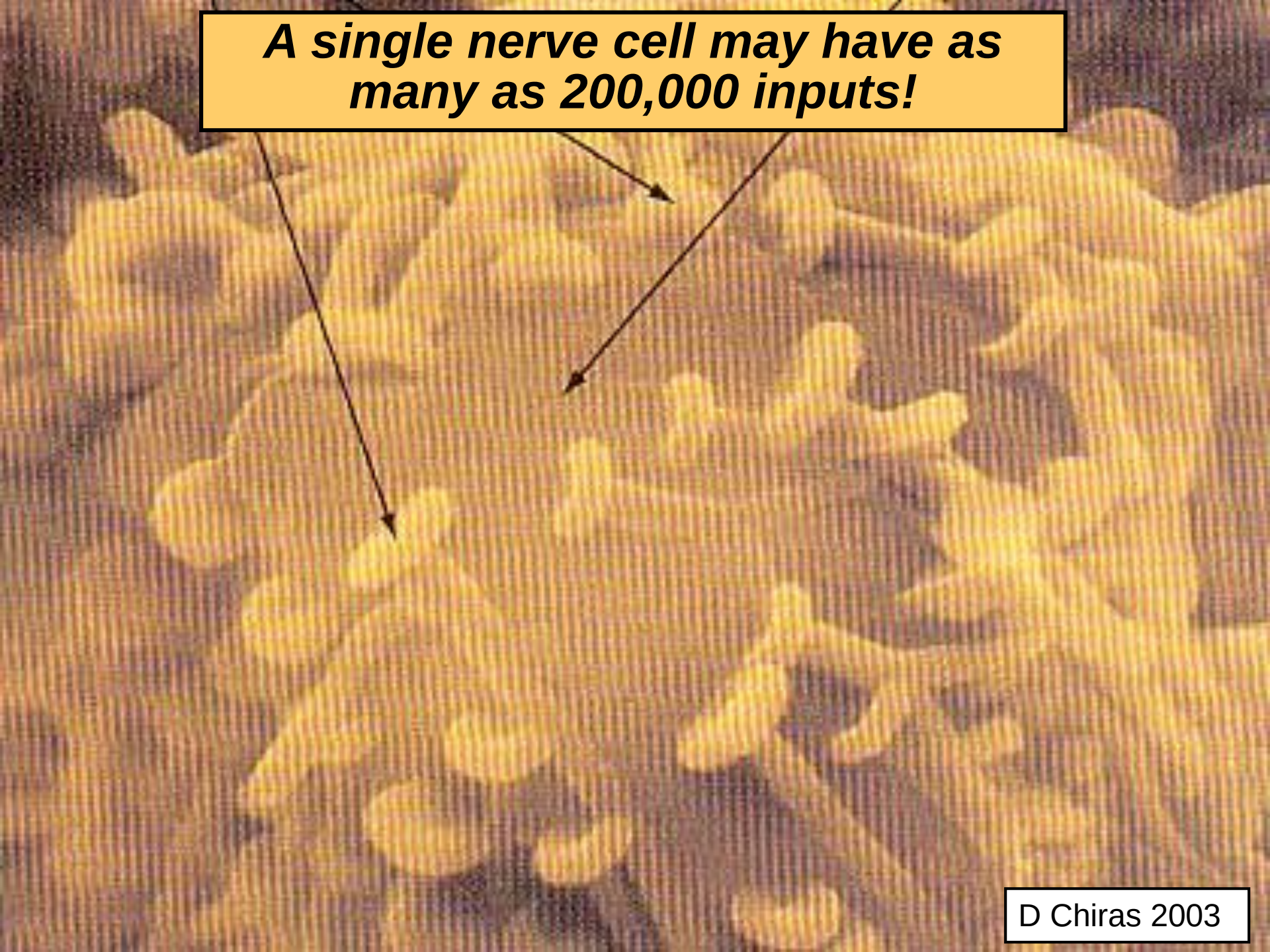
***~ 90% of Cells w/in CNS are <u>not</u> <u>neurons</u> but <u>glial</u> <u>cells</u> ≡ <u>neuroglia</u> or nerve glue!***



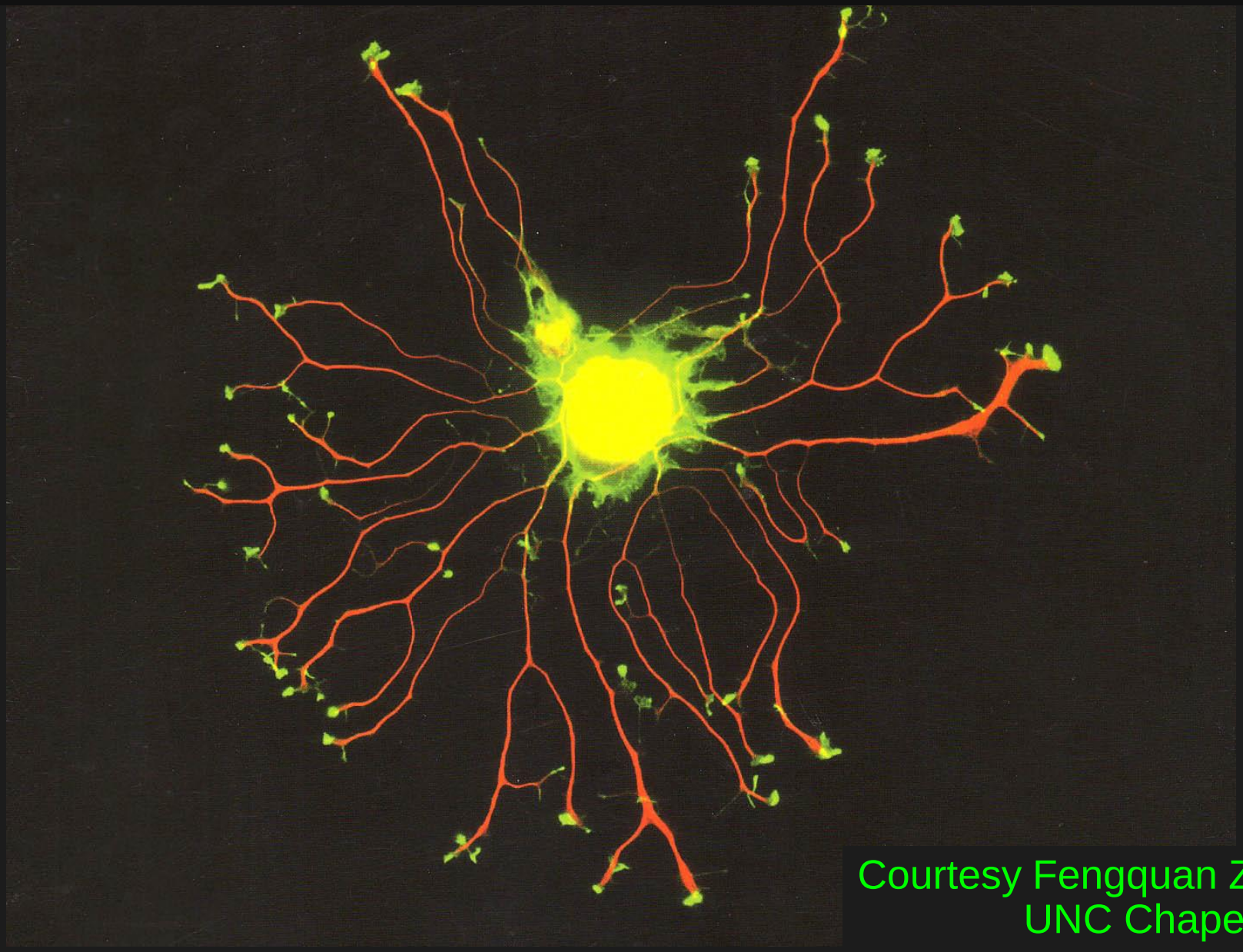

LS2 2006 fig 5-4 p 112




H. Howard 1980

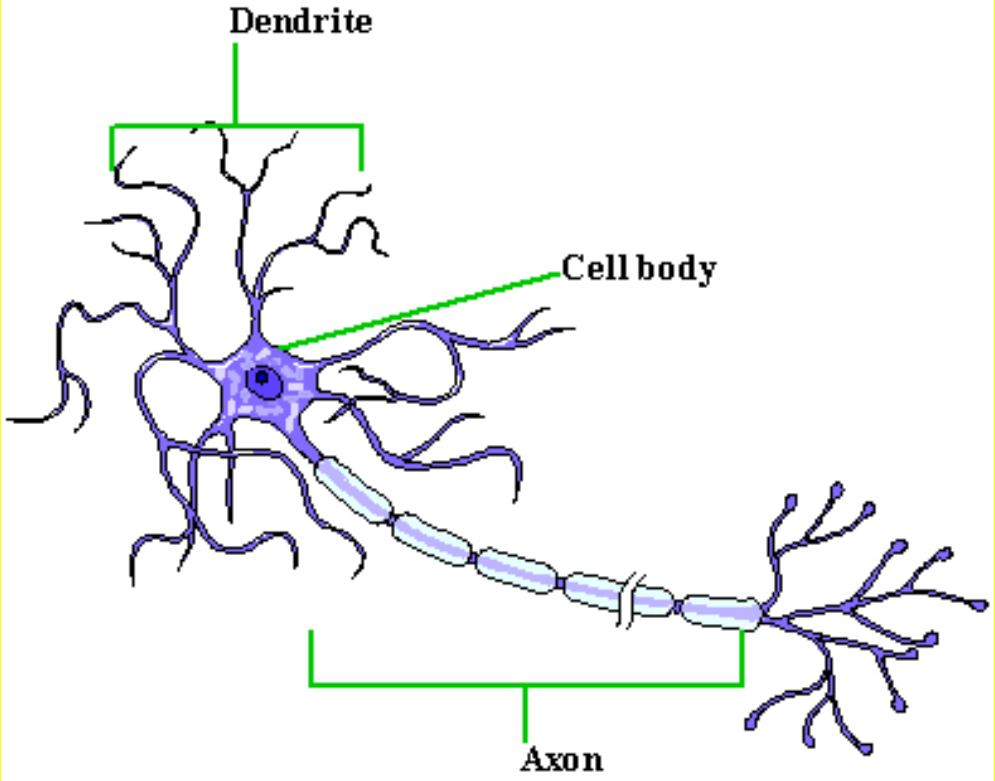

A single nerve cell may have as many as 200,000 inputs!
D Chiras 2003

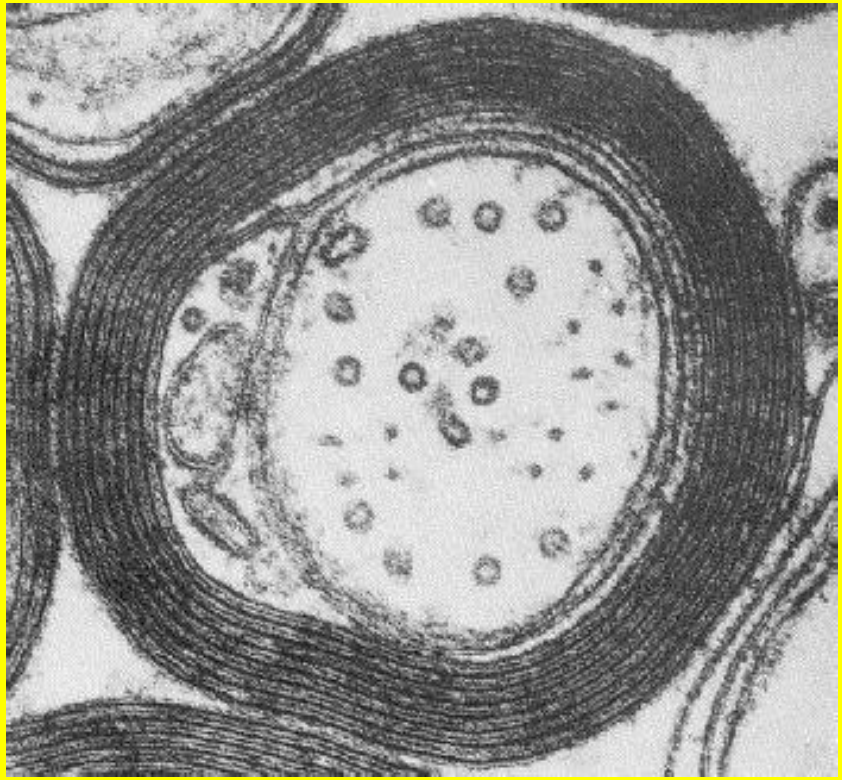
# *Nerve cell with multiple axons grown by adding a mitogen/neurogen ≡ nerve growth factor!*



Courtesy Fengquan Zhou
UNC Chapel Hill

# *What is myelin?*
# *Why is it important?*

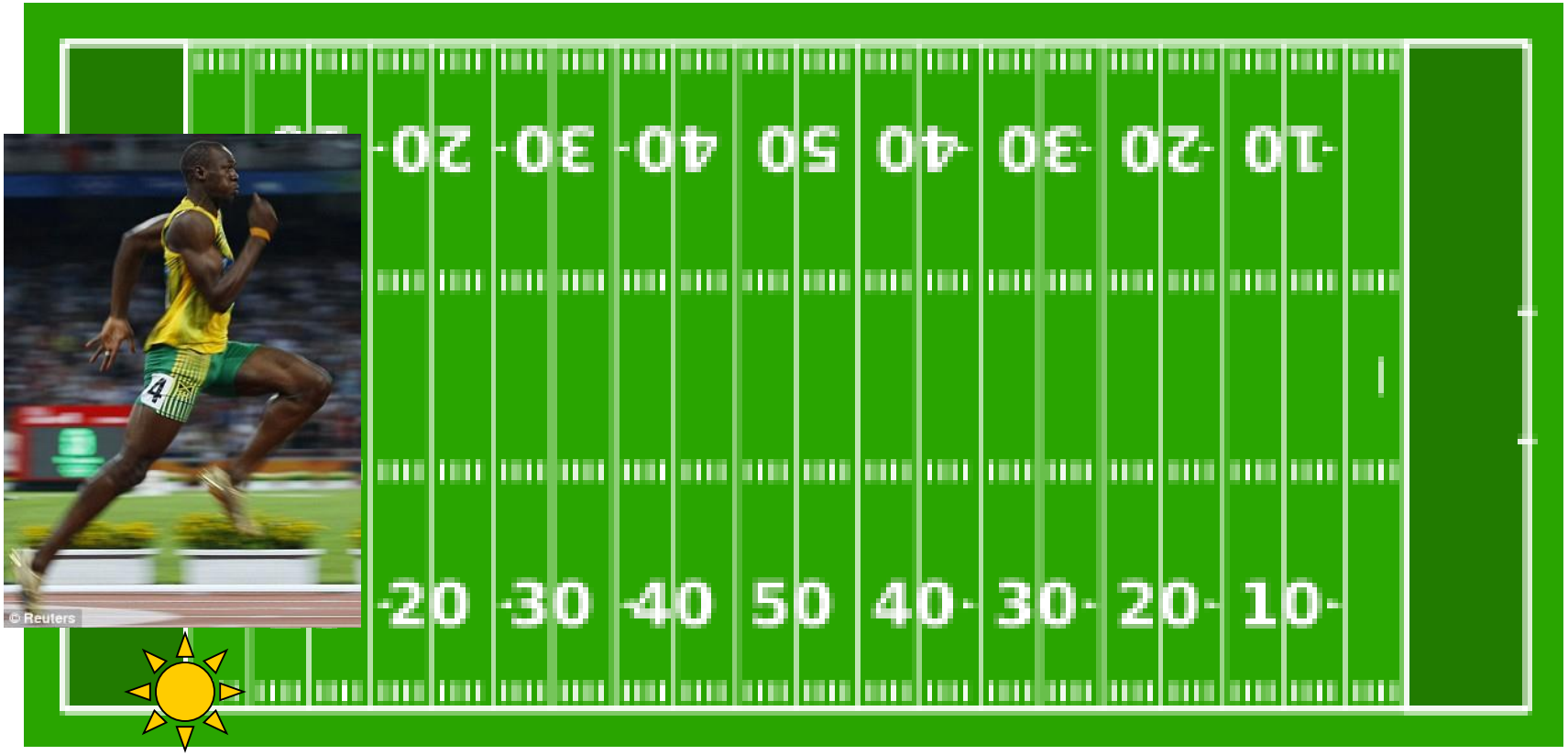


***Lipid insulative coat***

***↑ $\vec{v}$, conserves ions & ATP***

***A large myelinated "survival" nerve can conduct impulses the length of football field in < 1 second!***

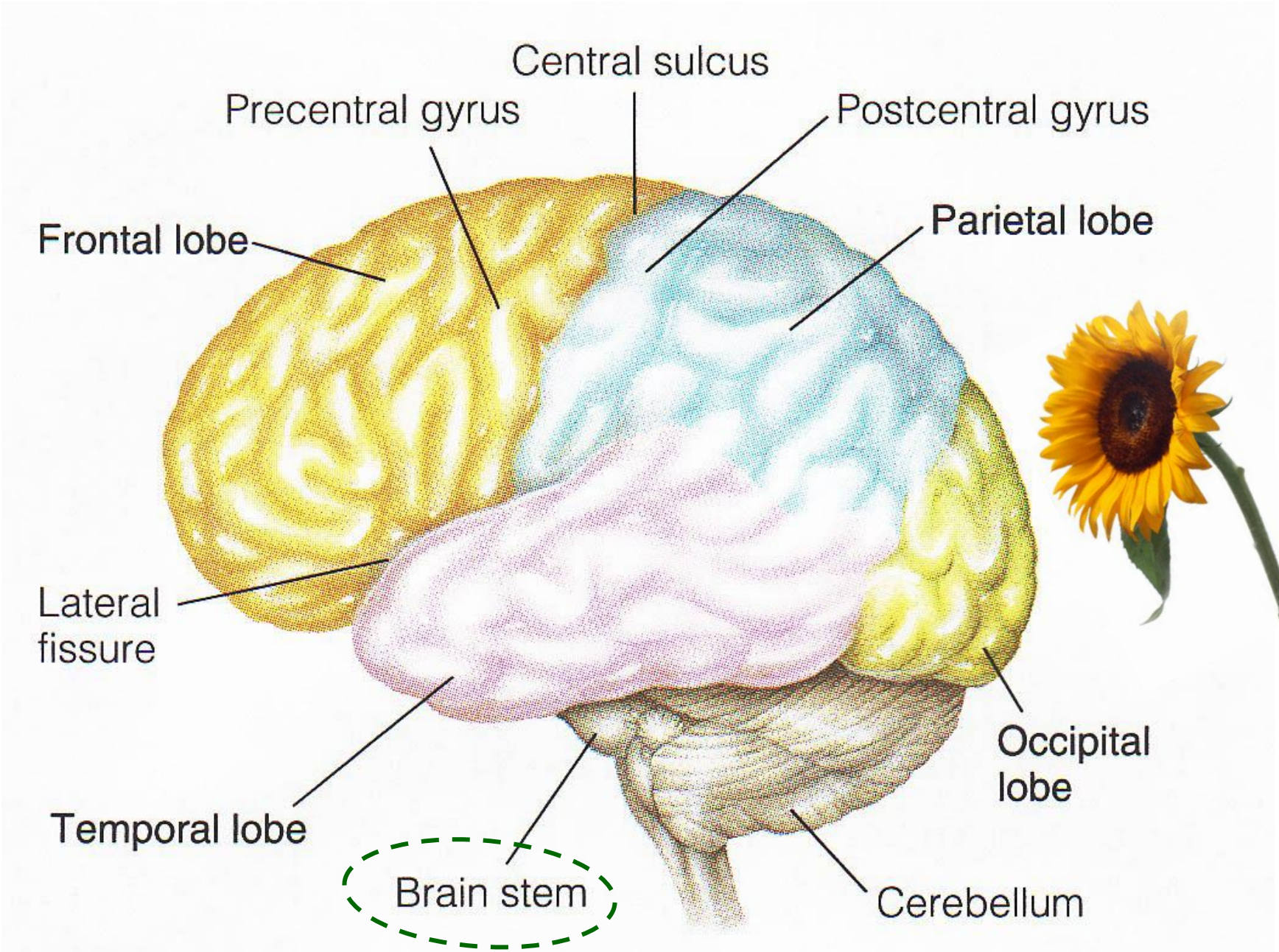


# ***Saltatory/Leaping Conduction! Crucial Sensory & Motor Nerves***

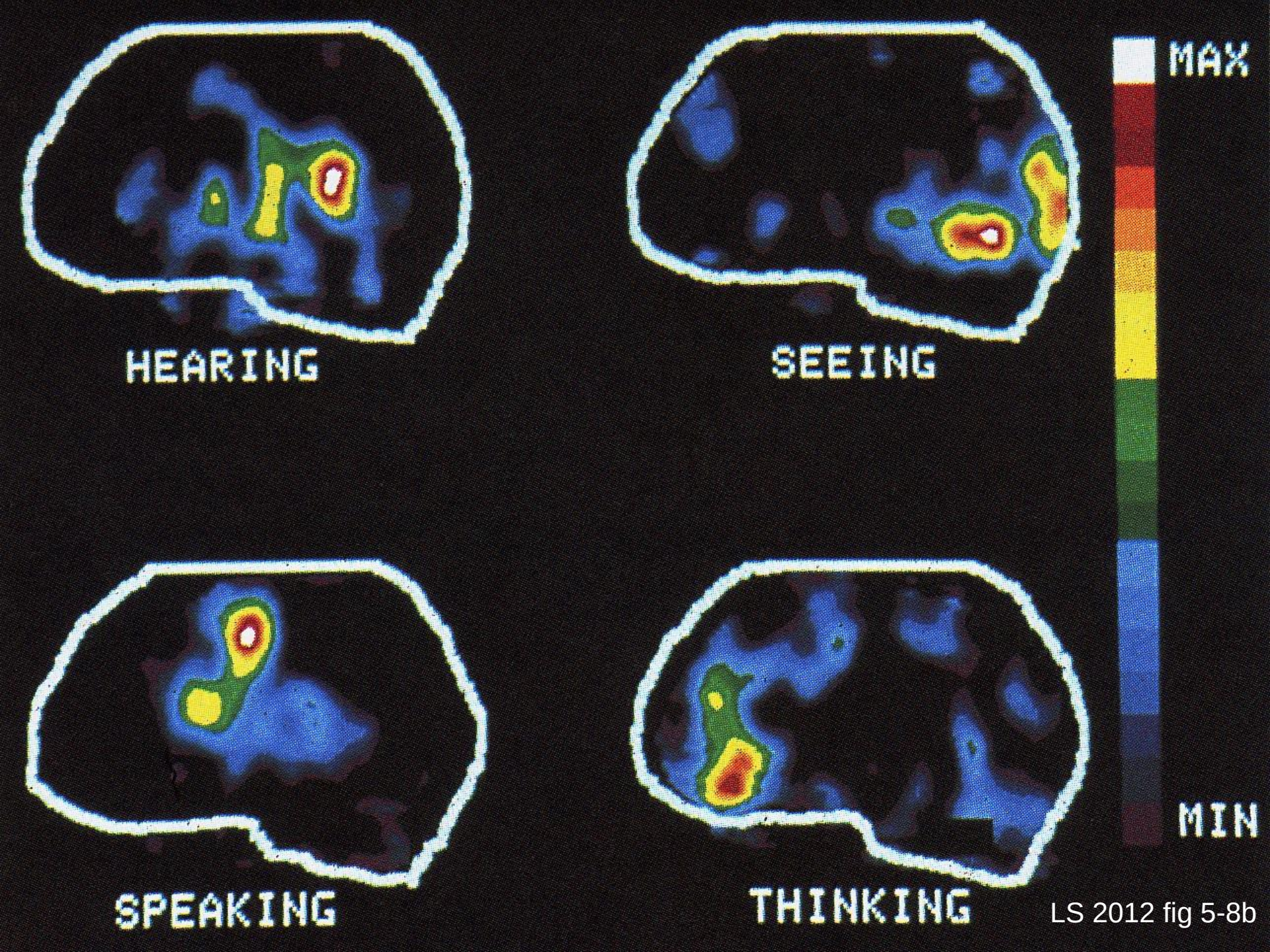



L. <u>salt</u>are to hop or leap! Fr. <u>salt</u>, sautier, sauté, leap, high air, vault

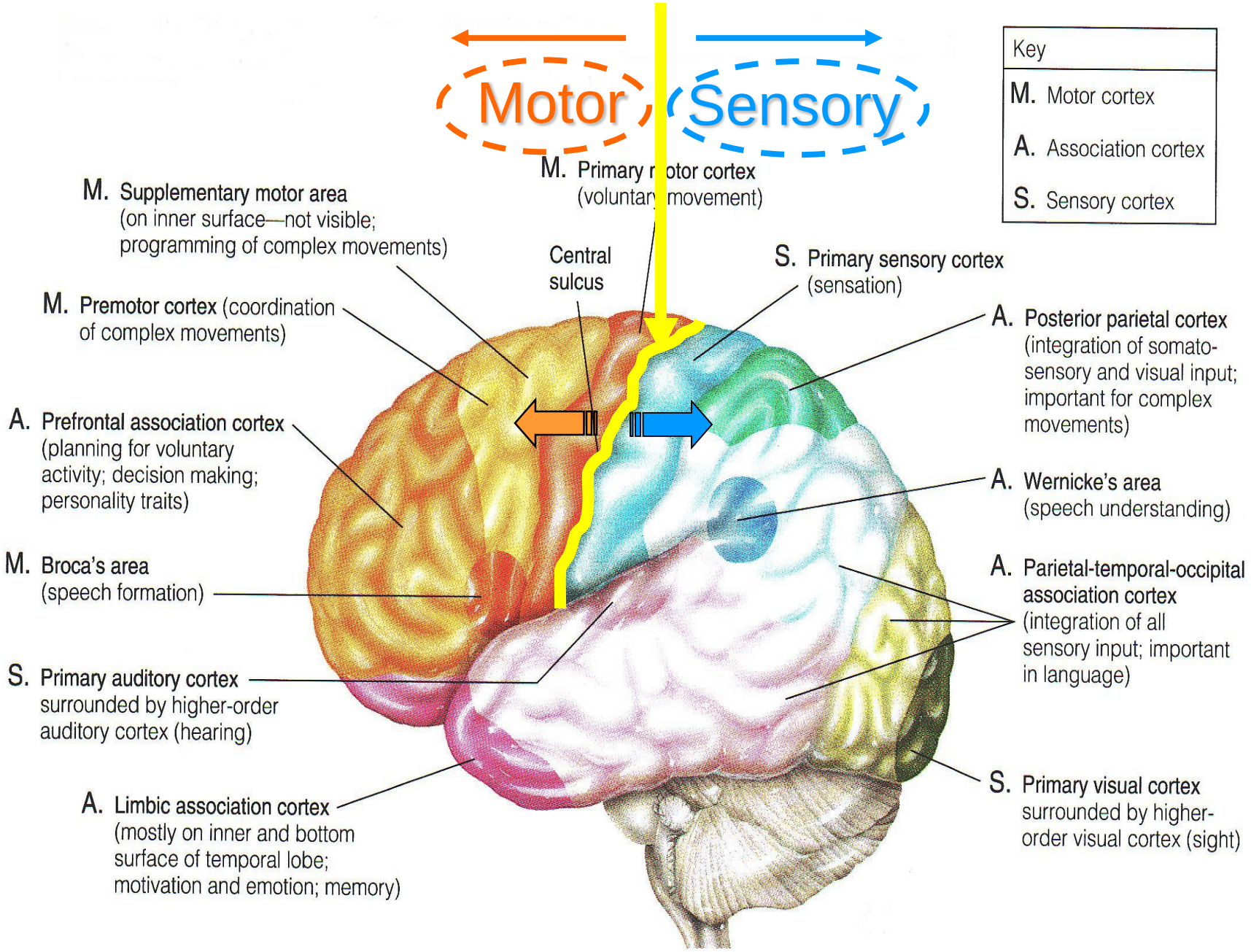
DC 2003




LS 2012 fig 5-7




LS 2012 fig 5-8b




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/812018.pdf***
***http://www.bhsi.org/stats.htm***

~ 500,000 bicyclists/yr visit emergency rooms

As of 2014, the population estimate of

State of Wyoming 584,153
Albany OR 51,980
Corvallis OR 54,953
Springfield OR 60,263

~ 26,000 traumatic brain injuries

743 of ~900 cyclist deaths, 2013 ≡ ~ 2% of all traffic fatalities

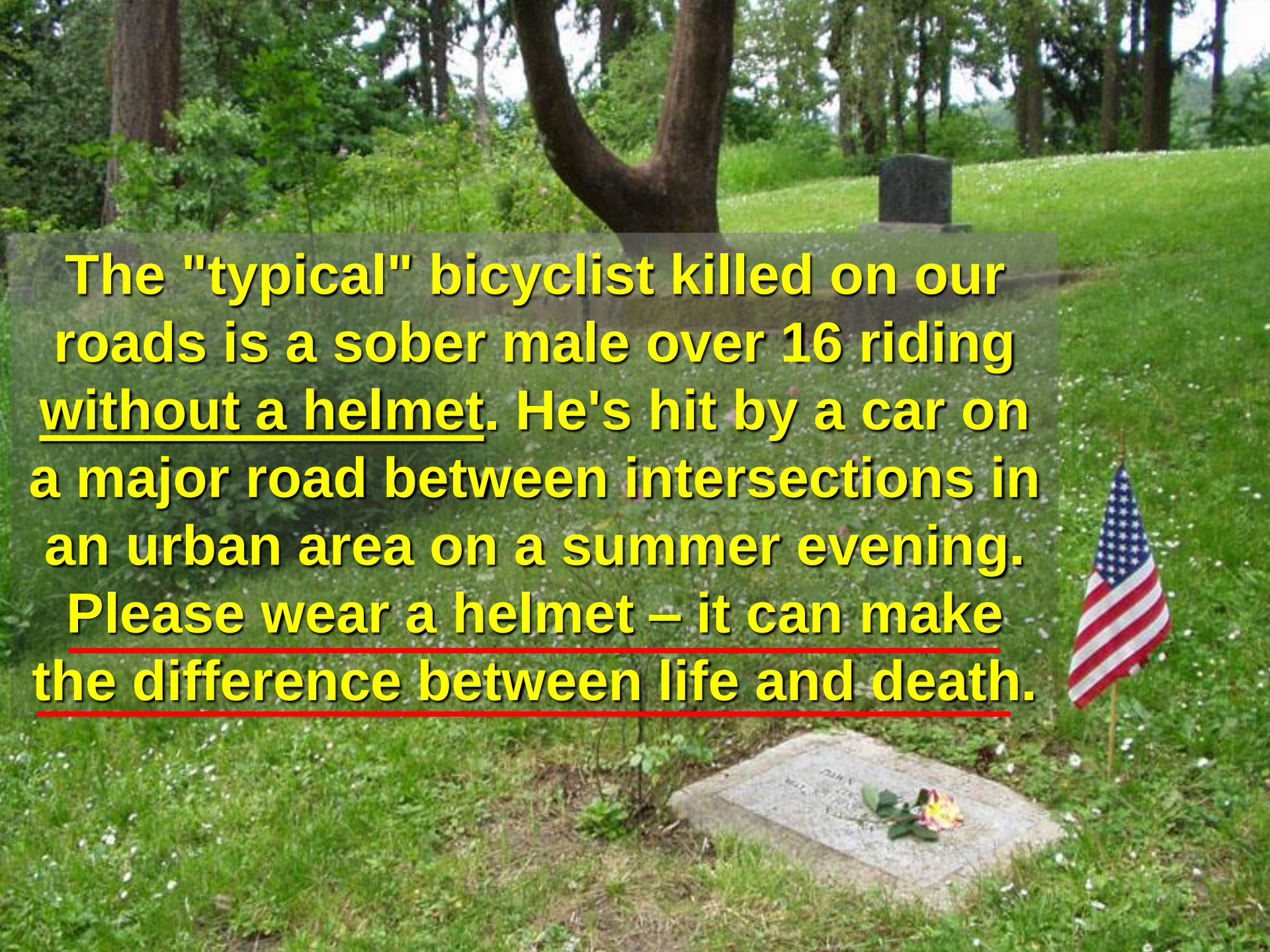
13% of deaths children ≤ 14 yr, 87% ♂

11% involved wrong-way riding!

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

Helmets may reduce head & brain injury risk by 85%!

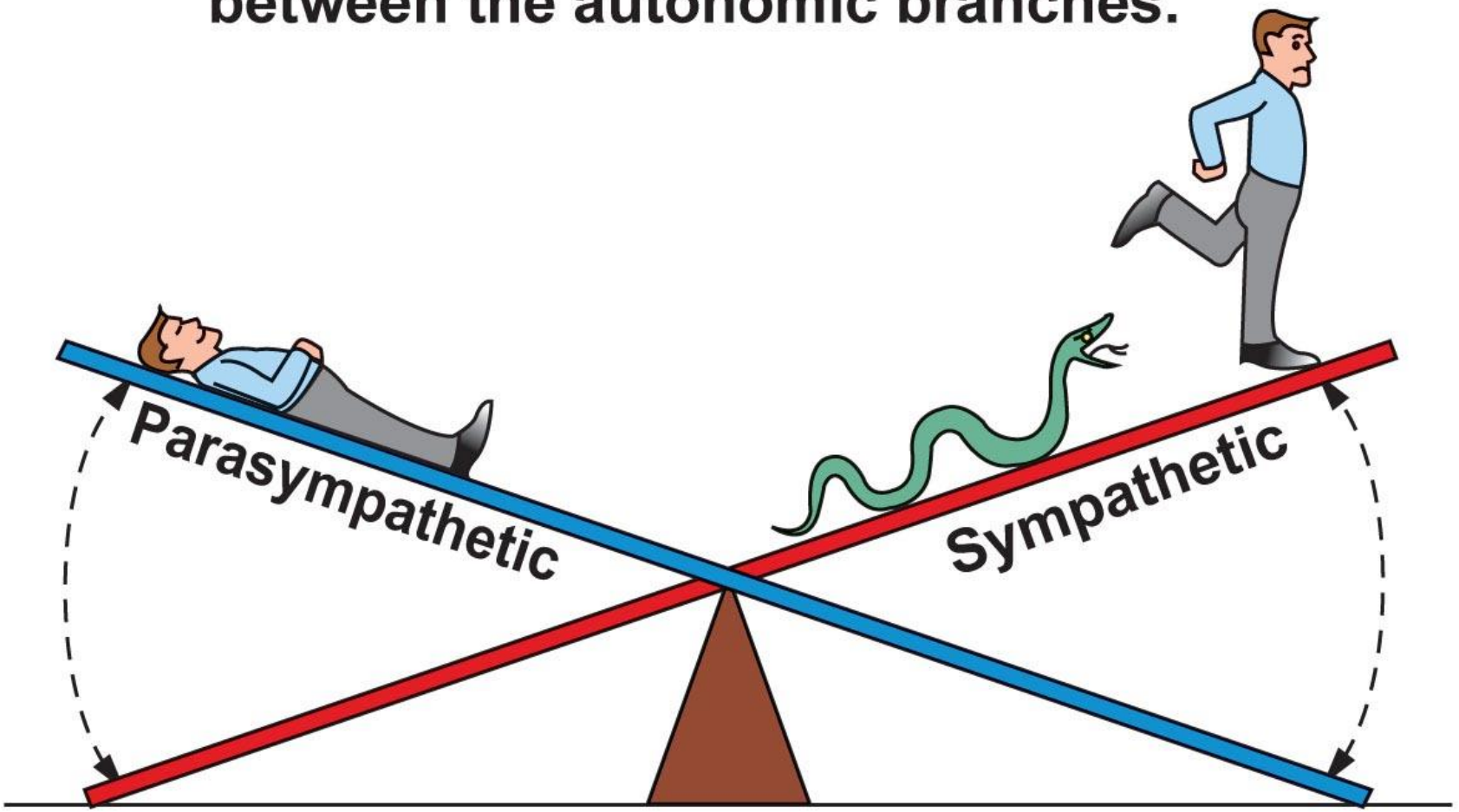
~$2.3 billion/yr = indirect injury costs from not using helmets!


The "typical" bicyclist killed on our roads is a sober male over 16 riding without a helmet. He's hit by a car on a major road between intersections in an urban area on a summer evening. Please wear a helmet – it can make the difference between life and death.

# *Hey, I'm alive because I wore a helmet!!*

# *Stories, Discussion, Questions or Comments!*

**Homeostasis is a dynamic balance between the autonomic branches.**




**Rest-and-digest: Parasympathetic activity dominates.**

**Fight-or-flight: Sympathetic activity dominates.**

Copyright © 2009 Pearson Education, Inc.

D Silverthorn 2010

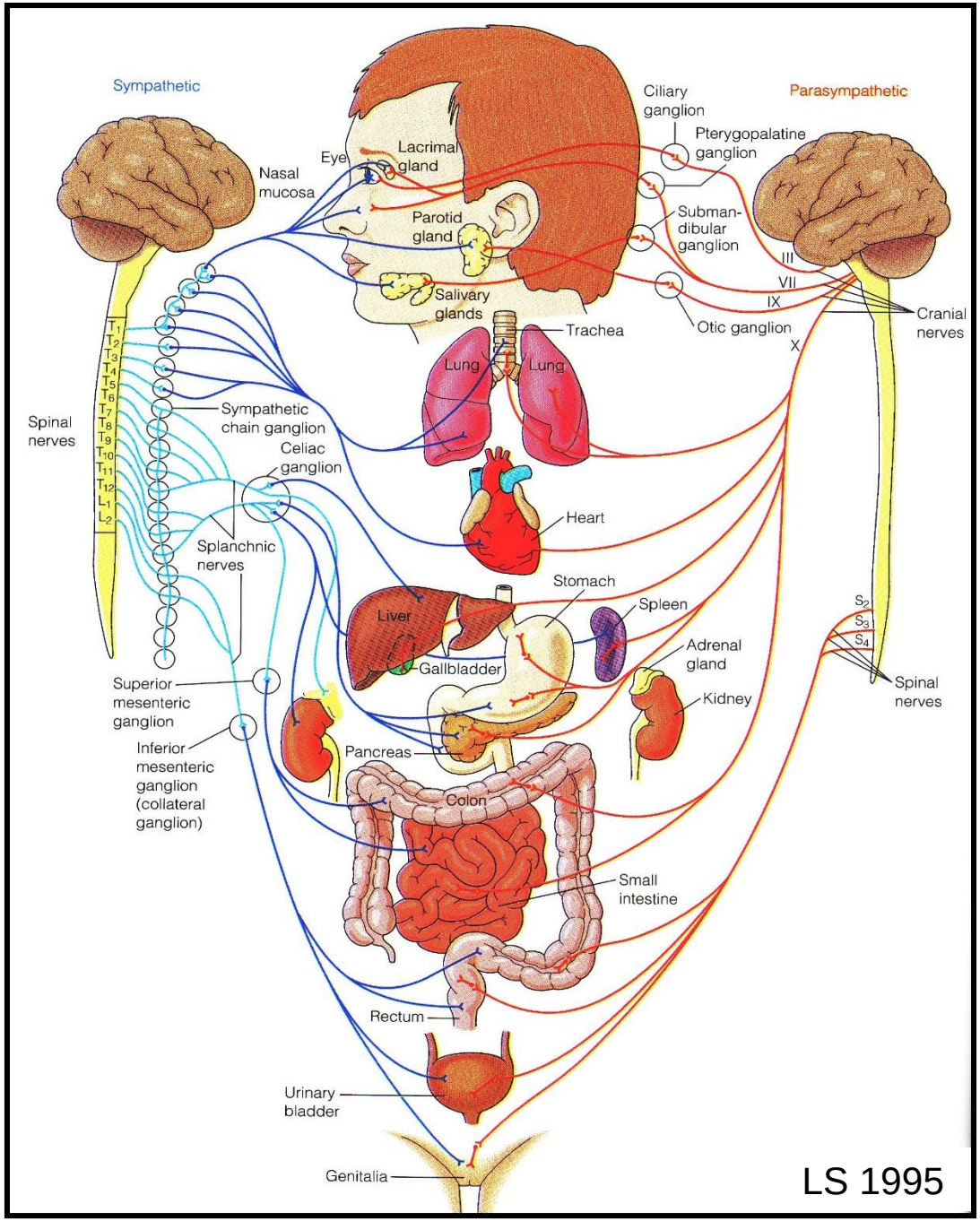

PARASYMPATHETIC = RESTING, DIGESTIVE, HOUSEKEEPING FUNCTIONS

# FIGHT/FLIGHT/ALARM REACTION!!

# Autonomic Nervous System

Why overlap or dual innervation?

*Fine-tune control & safety!*




cf: LS 2012 fig 7-3

# *Why adrenal activation & response important?*

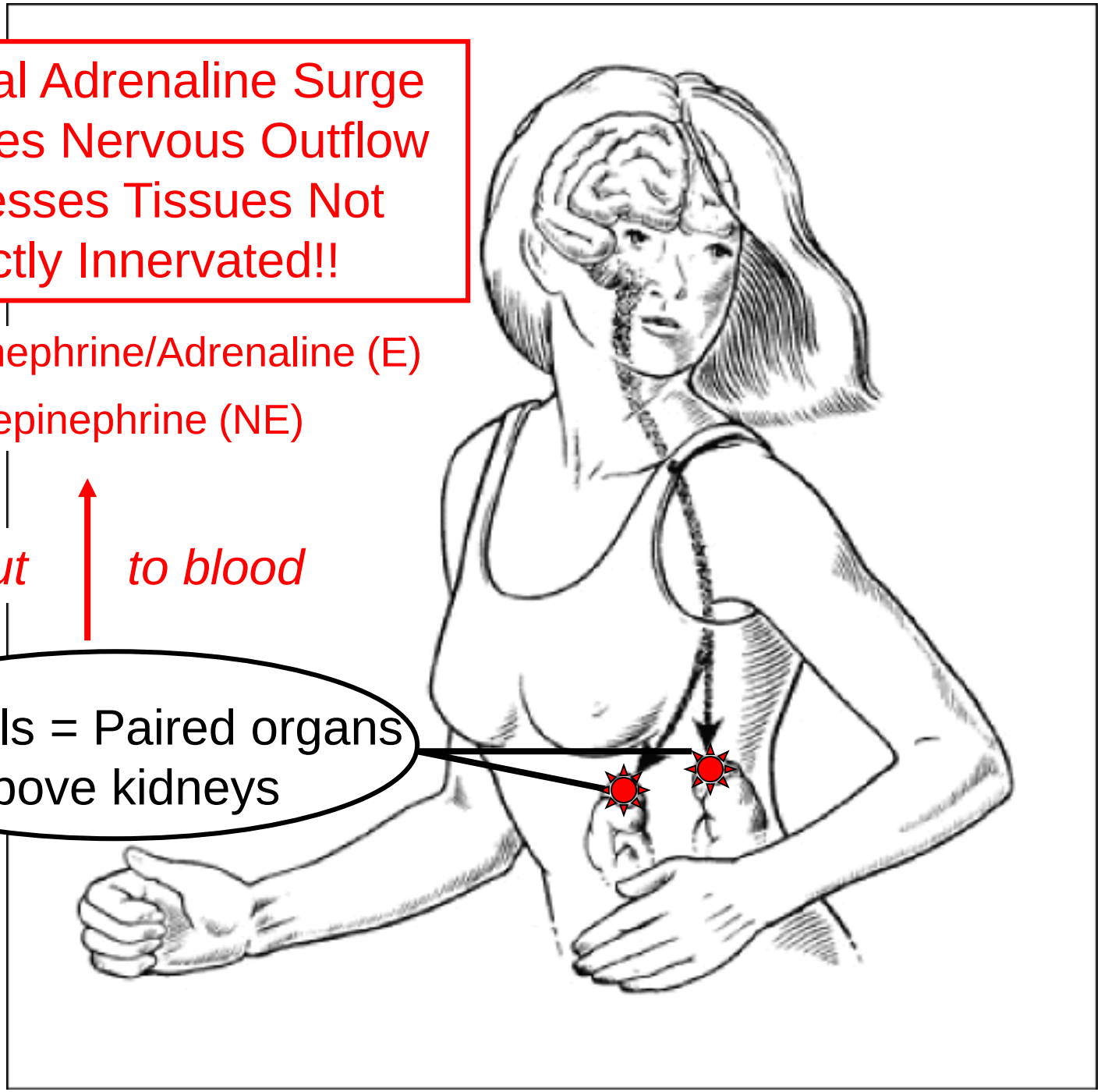
# Hormonal Adrenaline Surge Reinforces Nervous Outflow & Accesses Tissues Not Directly Innervated!!

80% Epinephrine/Adrenaline (E)

20% Norepinephrine (NE)

*Output* *to blood*

Adrenals = Paired organs above kidneys



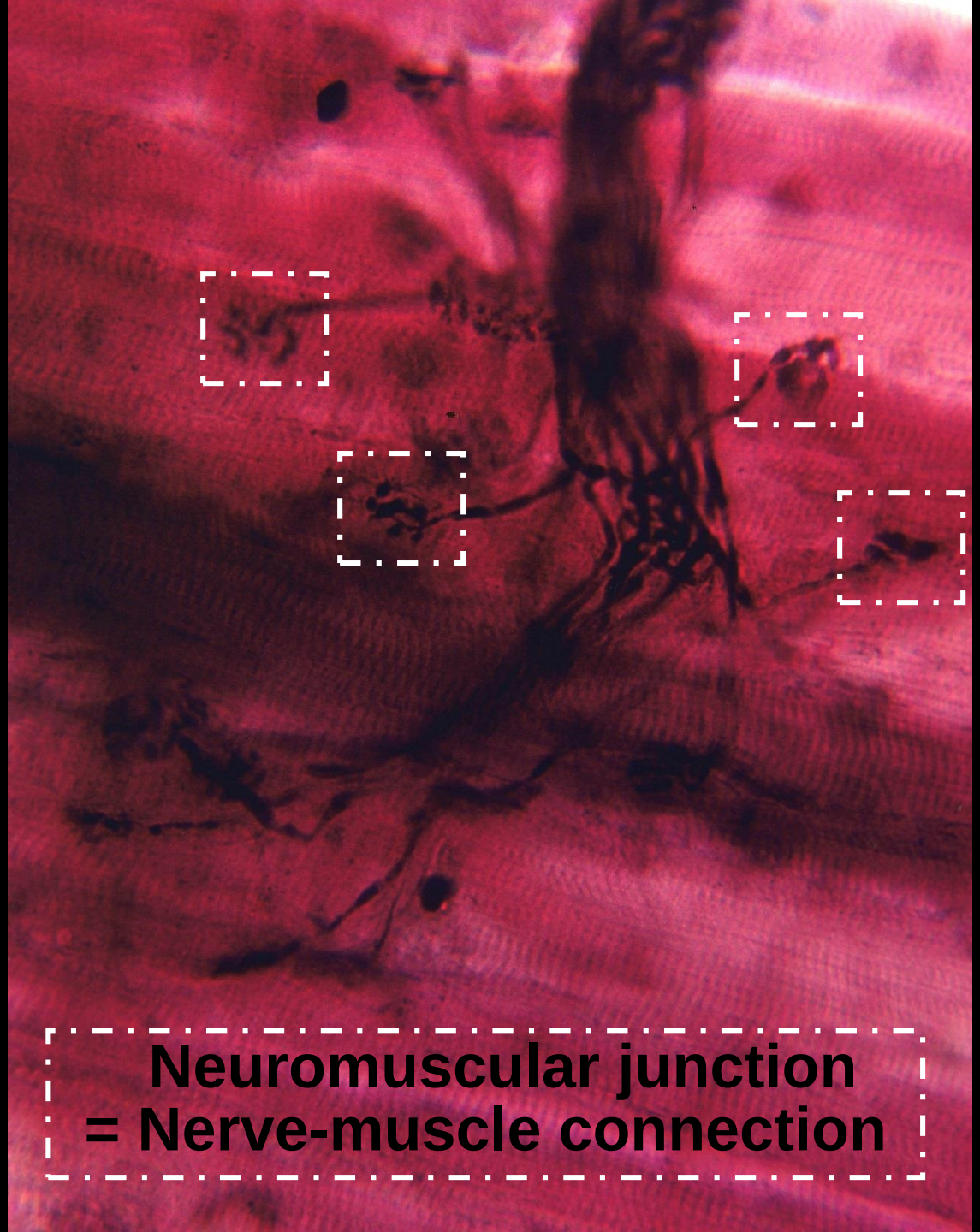
# Fight-or-Flight Stories!

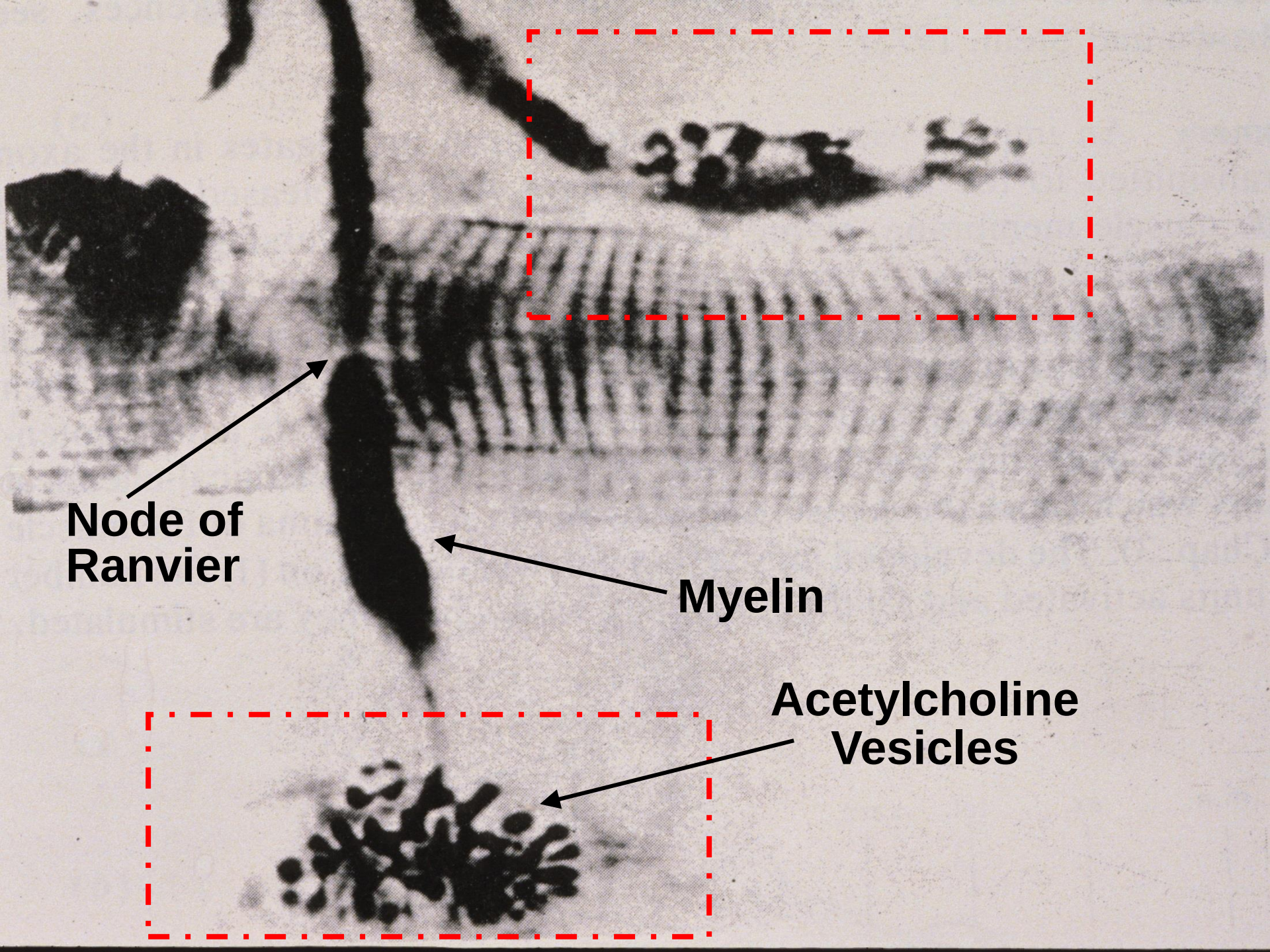

or

…choose this!!

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

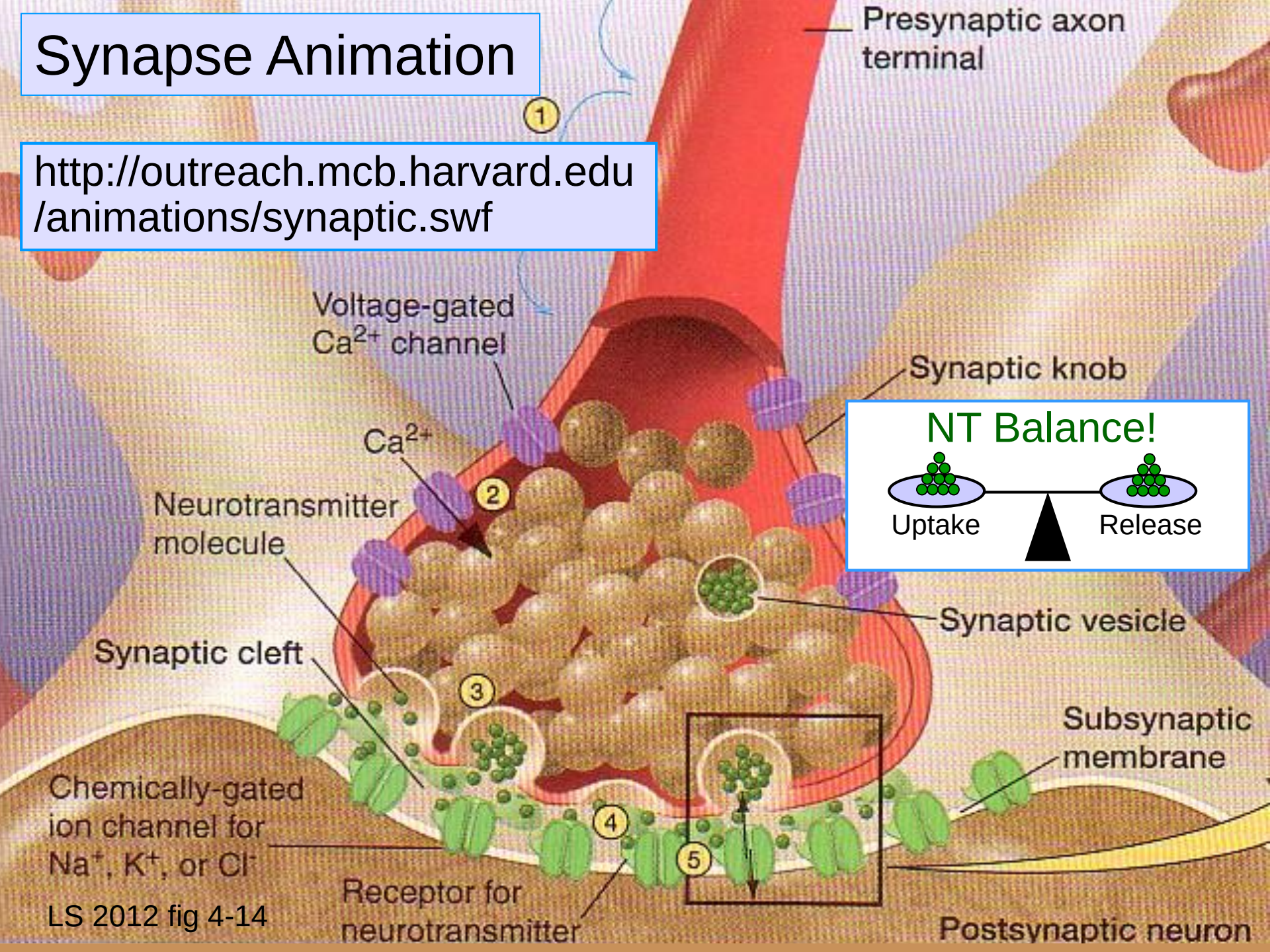
| Organ | Effect of Sympathetic Stimulation | Effect of Parasympathetic Stimulation |
|---|---|---|
| **Heart** | Increases heart rate and increases force of contraction of the whole heart | Decreases heart rate and decreases force of contraction of the atria only |
| **Blood Vessels** | Constricts | 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 |


Neuromuscular junction
= Nerve-muscle connection


Node of
Ranvier
Myelin
Acetylcholine
Vesicles

# Synapse Animation

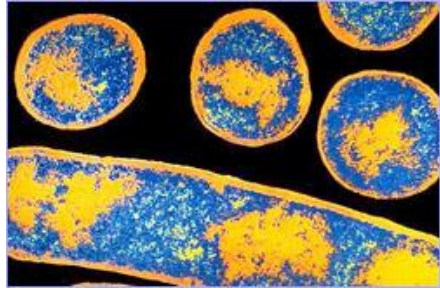
http://outreach.mcb.harvard.edu/animations/synaptic.swf




NT Balance!



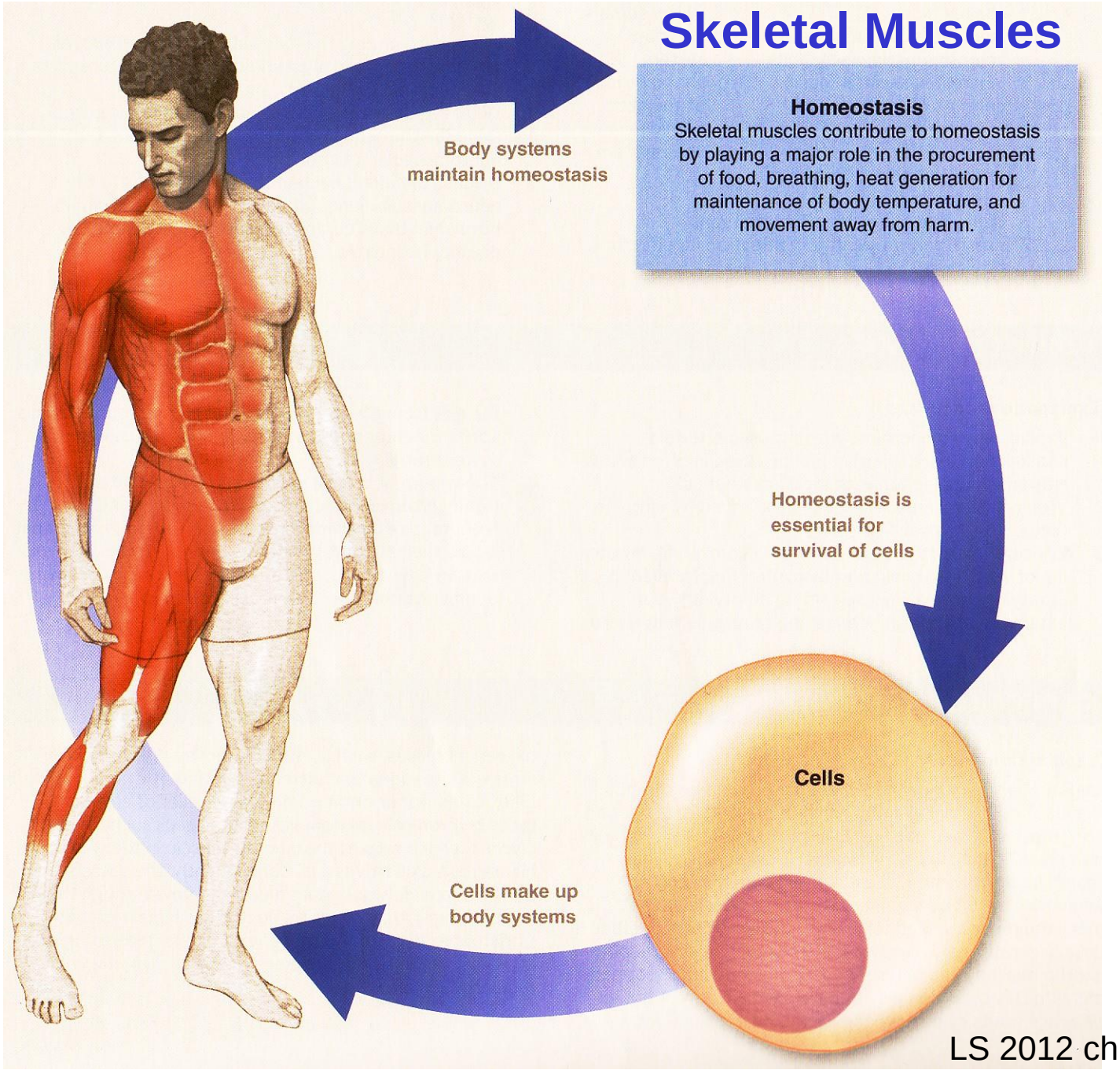

LS 2012 fig 4-14



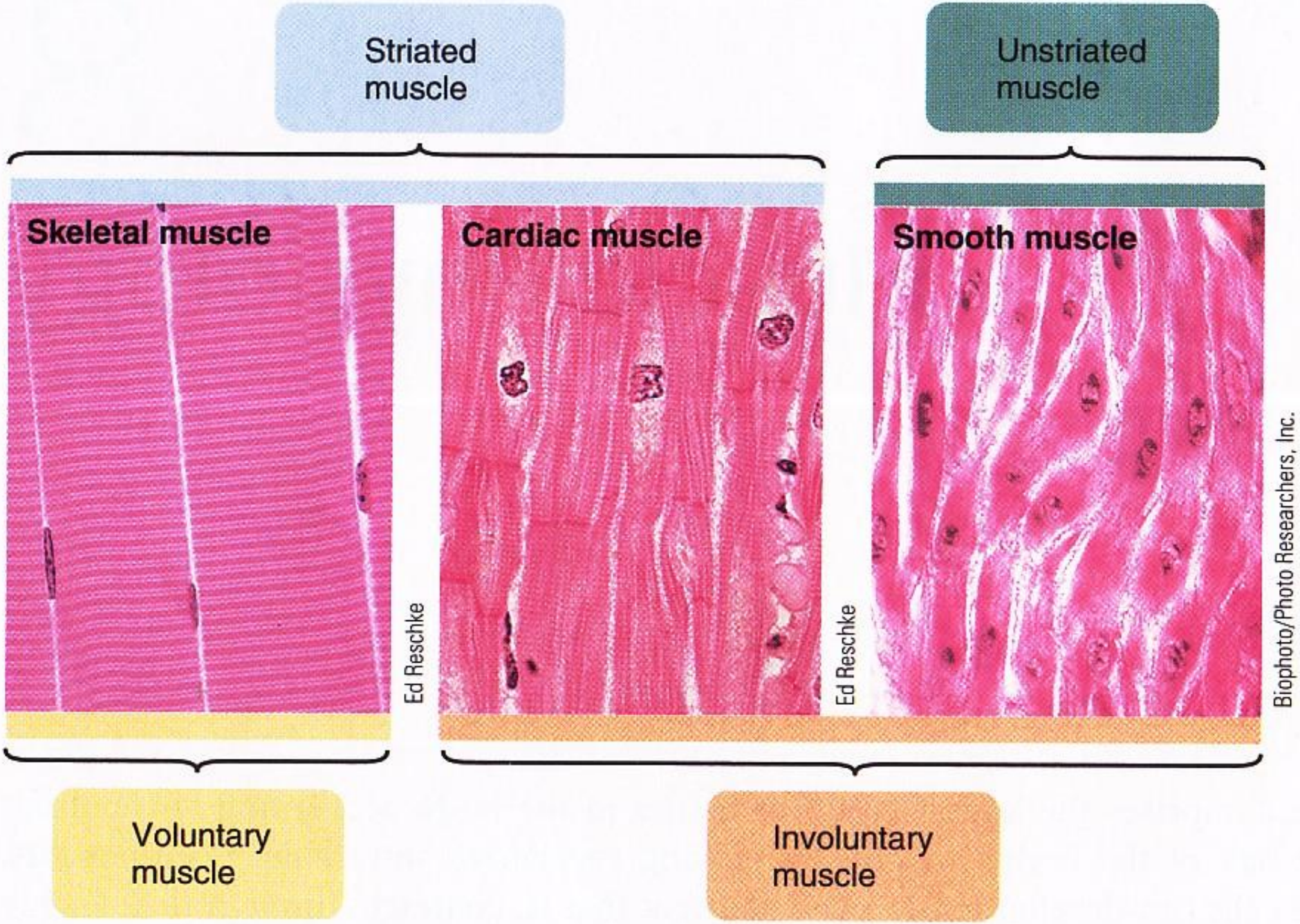

Campbell's
CLASSICS
BEAN
BACON


Axon of motor neuron
Myelin sheath
Action potential propagation in motor neuron
1
Axon terminal
Terminal button
Ca2+
Calcium channel
Vesicle of acetylcholine
2
Action potential propagation in muscle fiber
6
3
Muscle fiber
Plasma membrane of muscle fiber
4
K+
Acetylcholine receptor site
5
Na+
Cation channel
7
Local current flow between depolarized end plate and adjacent membrane
Acetylcholinesterase
Motor end plate
Contractile elements within muscle fiber

# Skeletal Muscles

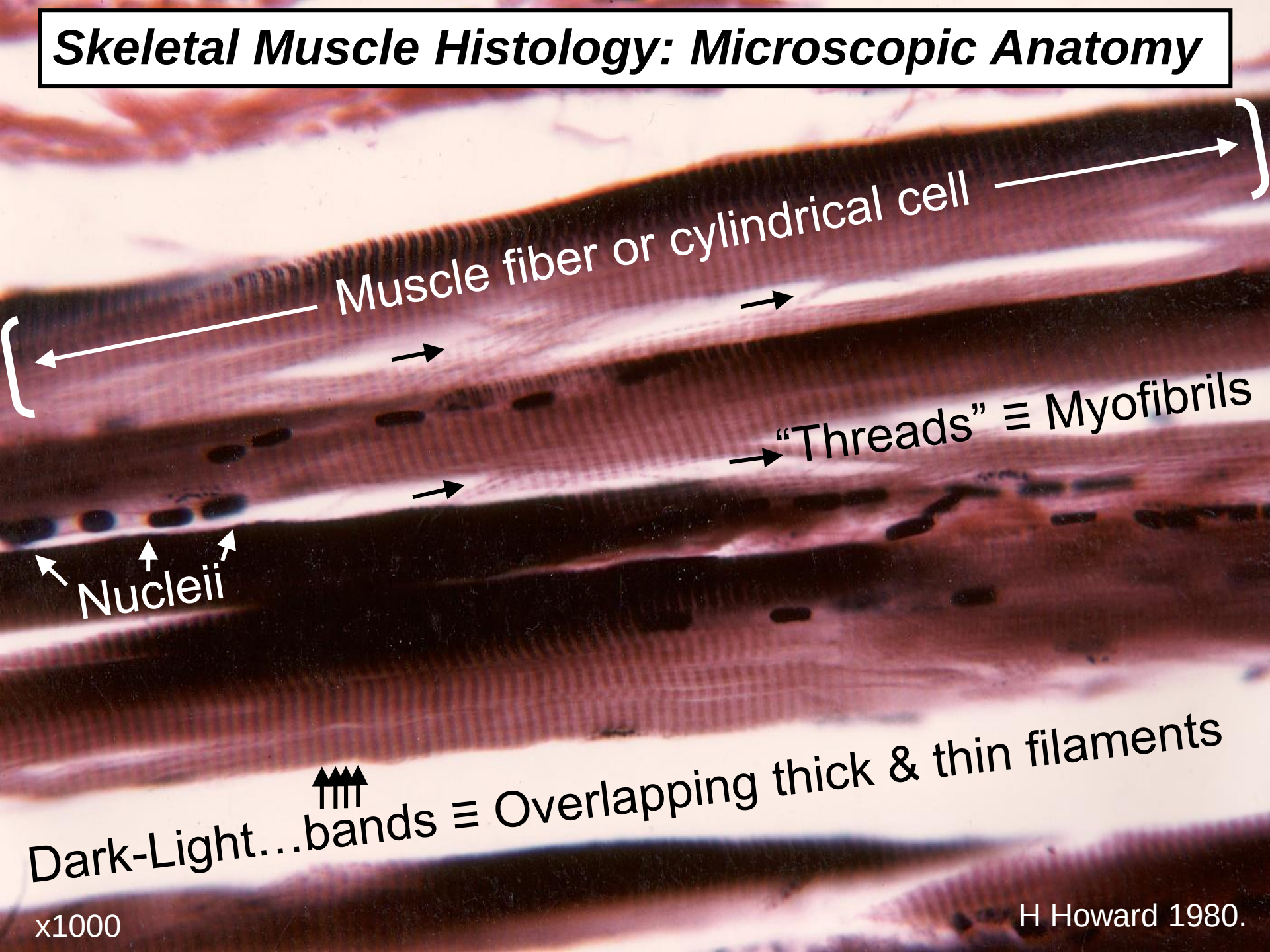



LS 2012 ch 8 vignette

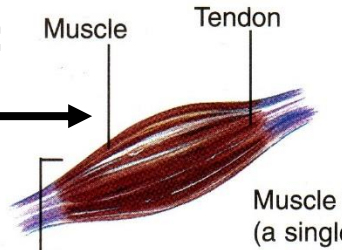



LS 2012 fig 8-1

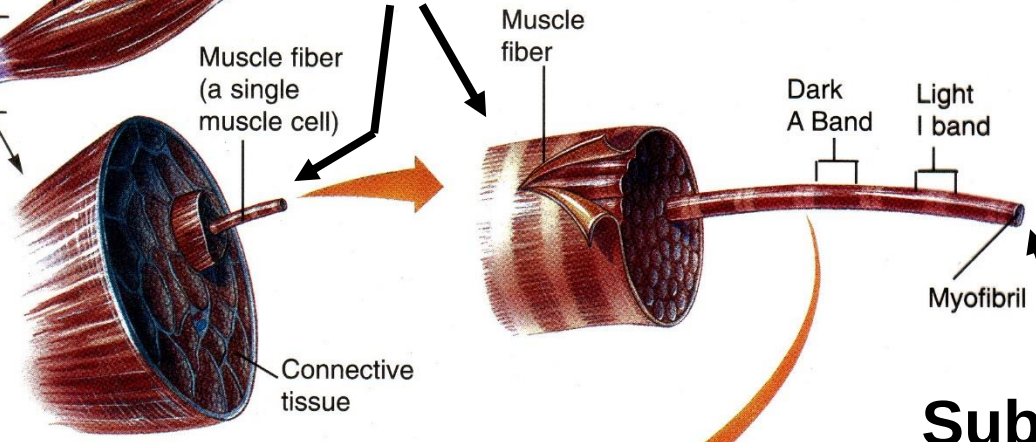
# *Skeletal Muscle Histology: Microscopic Anatomy*



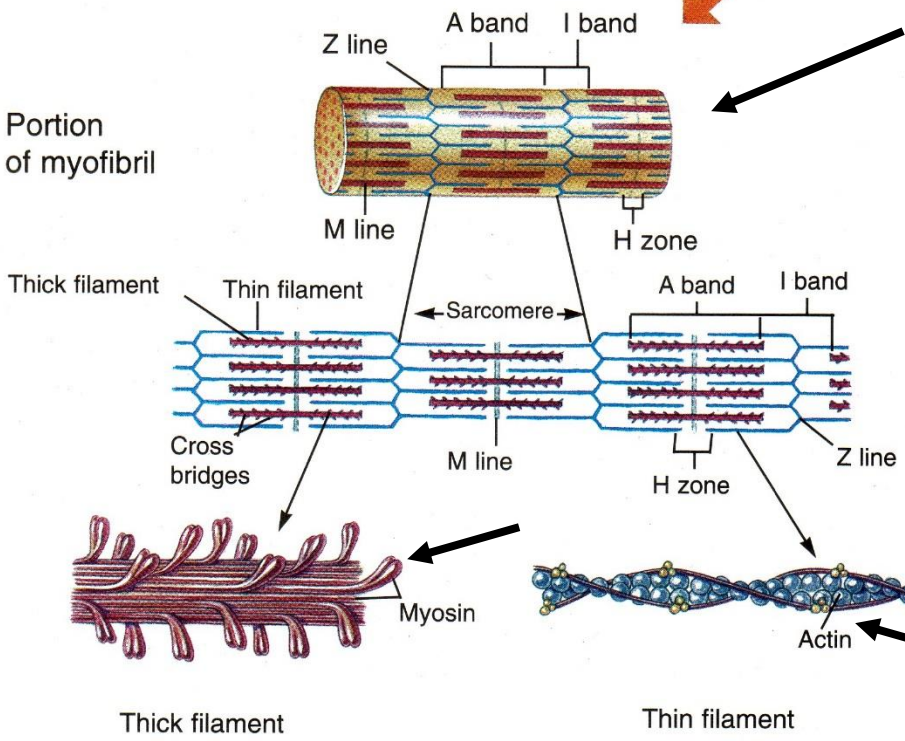
**Organ = Muscle**




**Cell = Myocyte = Fiber**




**Subcellular = Cytoskeleton**



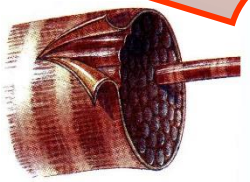

**Molecules = Actin & Myosin**

LS 2006, cf:
LS 2012 fig 8-2

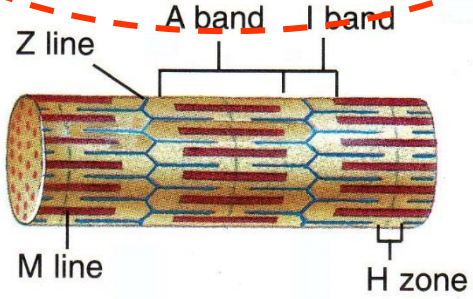
Whole Muscle

Organ

Myocyte or Muscle Fiber

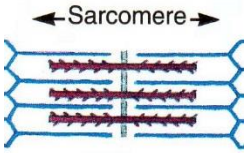


Cell

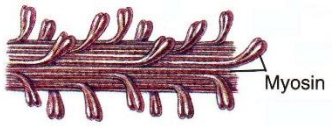



Myofibril

Cytoskeleton

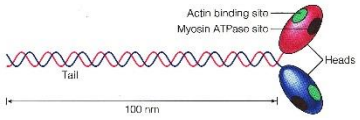


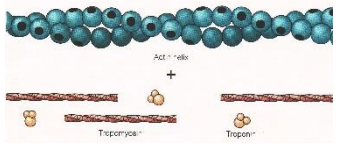

Thick & Thin Filaments



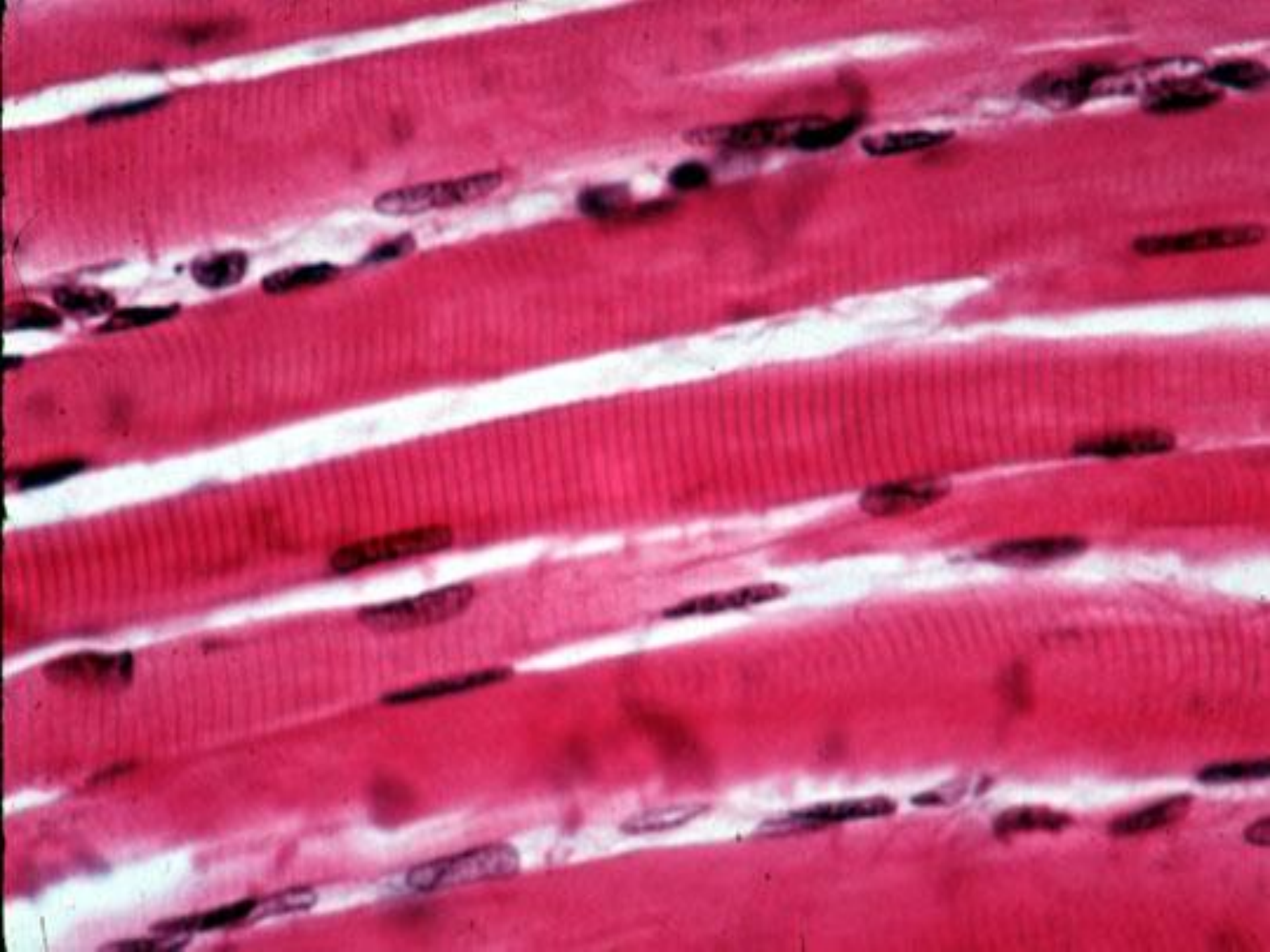


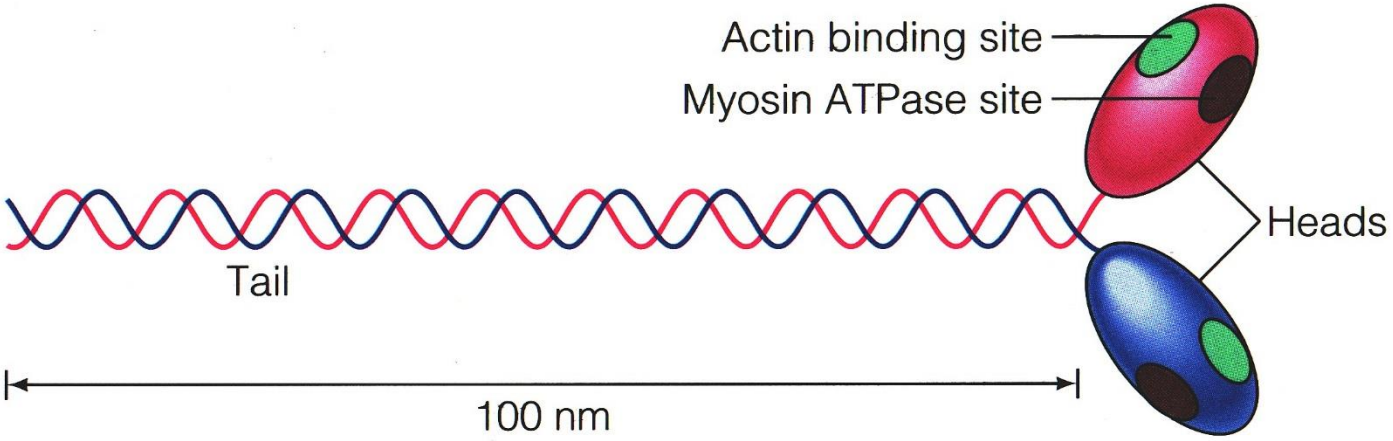
Myosin & Actin



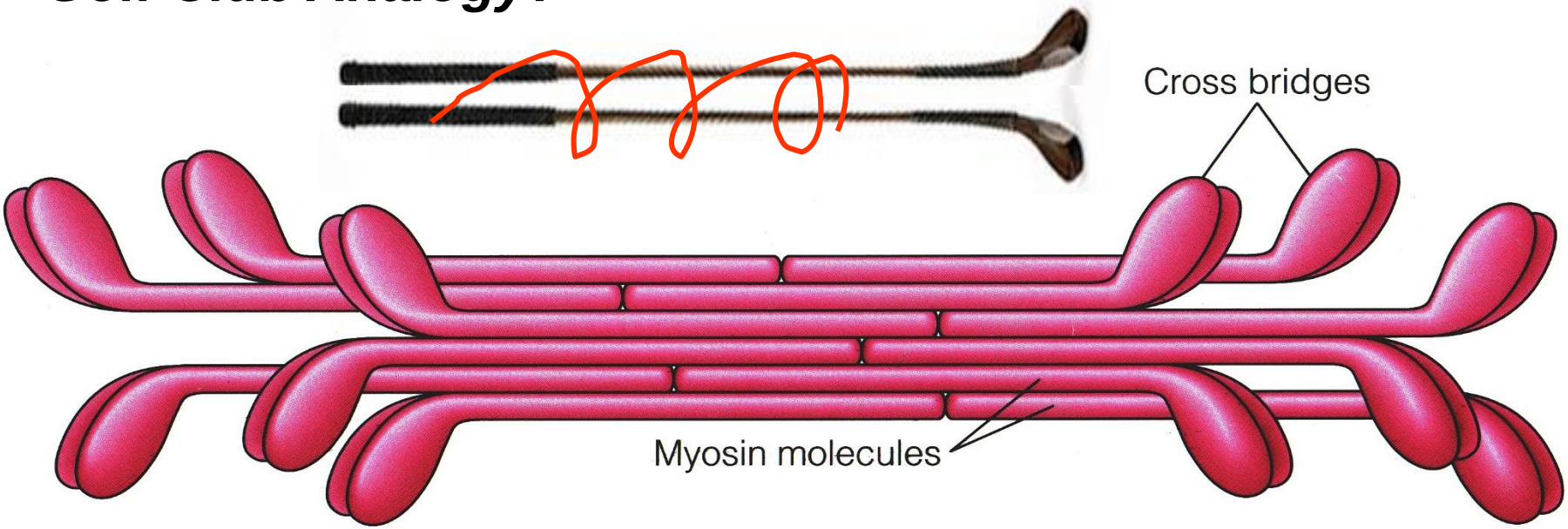
Molecules






(a)

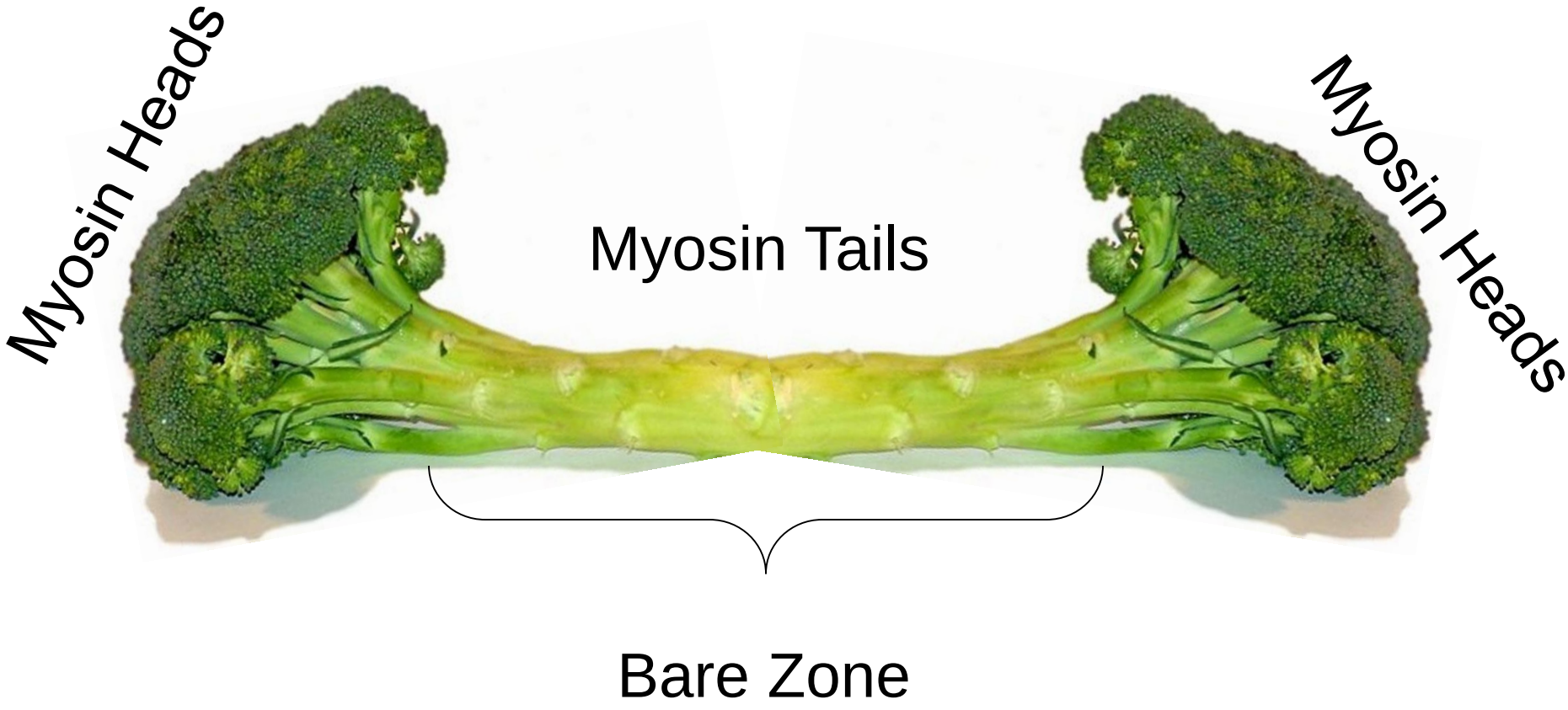
***Golf Club Analogy?***

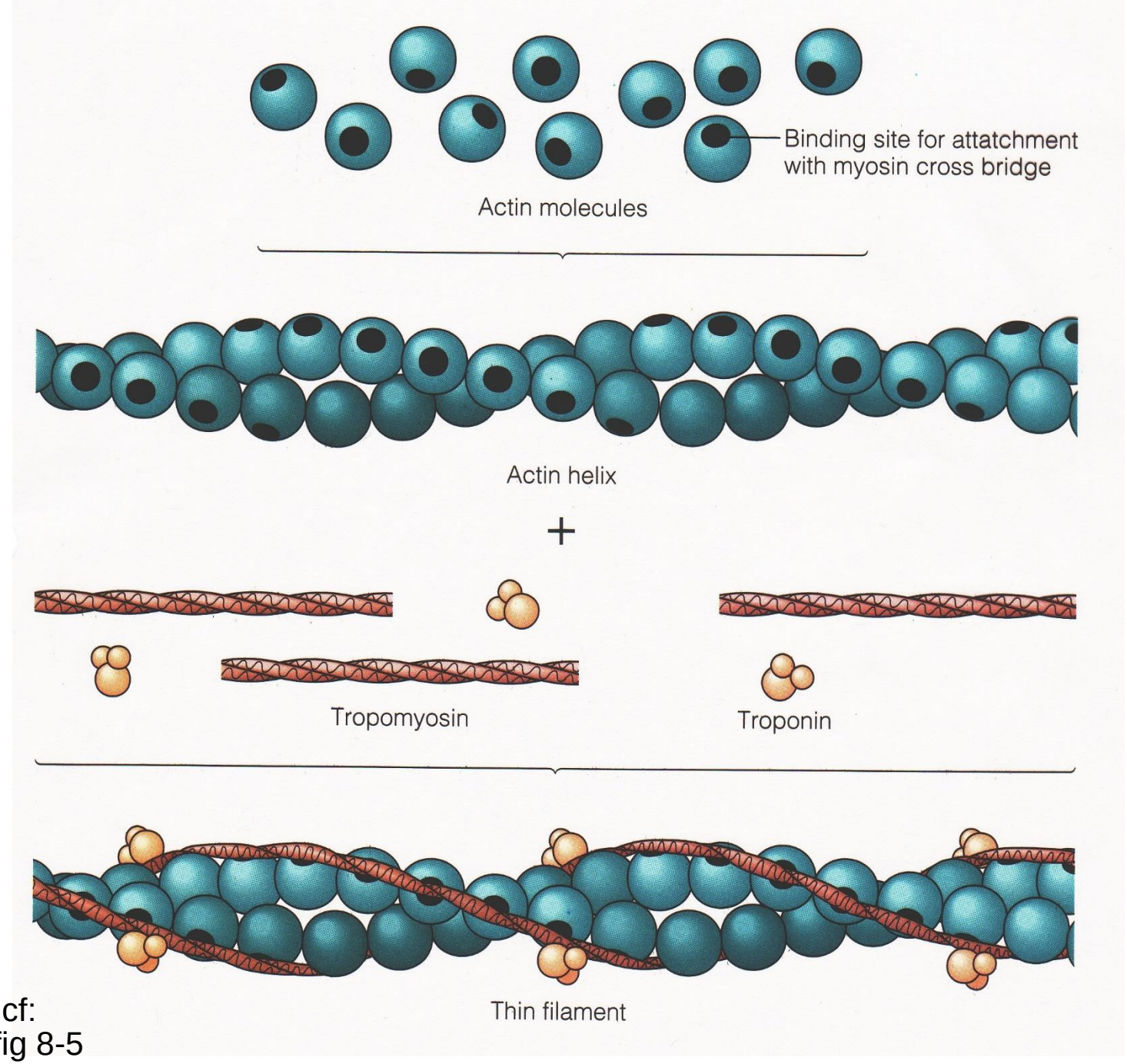



(b)

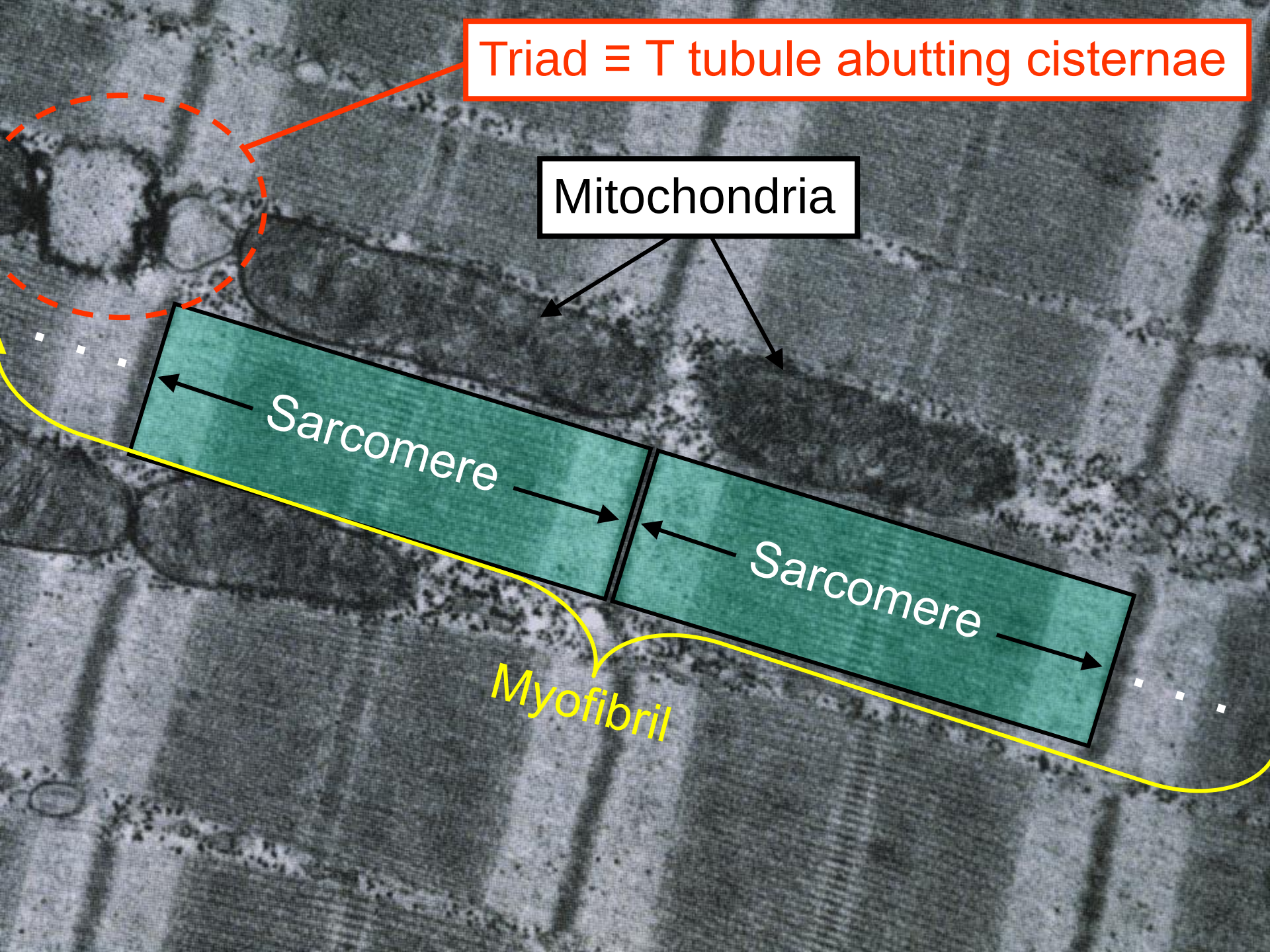
LS 2006, cf:
LS 2012 fig 8-4

# *Broccoli Analogy?*



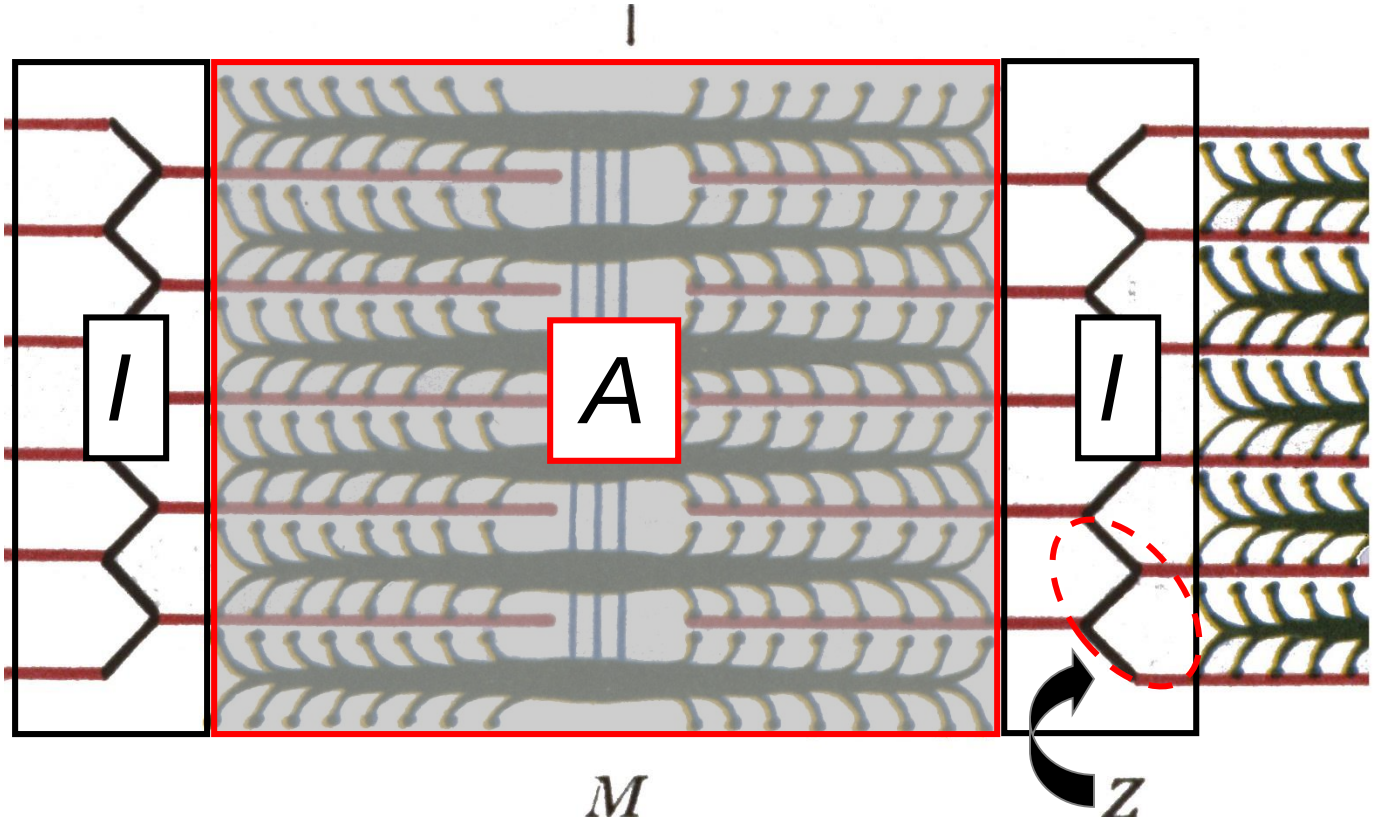



LS 2006, cf:
LS 2012 fig 8-5


Triad ≡ T tubule abutting cisternae
Mitochondria
Sarcomere
Sarcomere
Myofibril

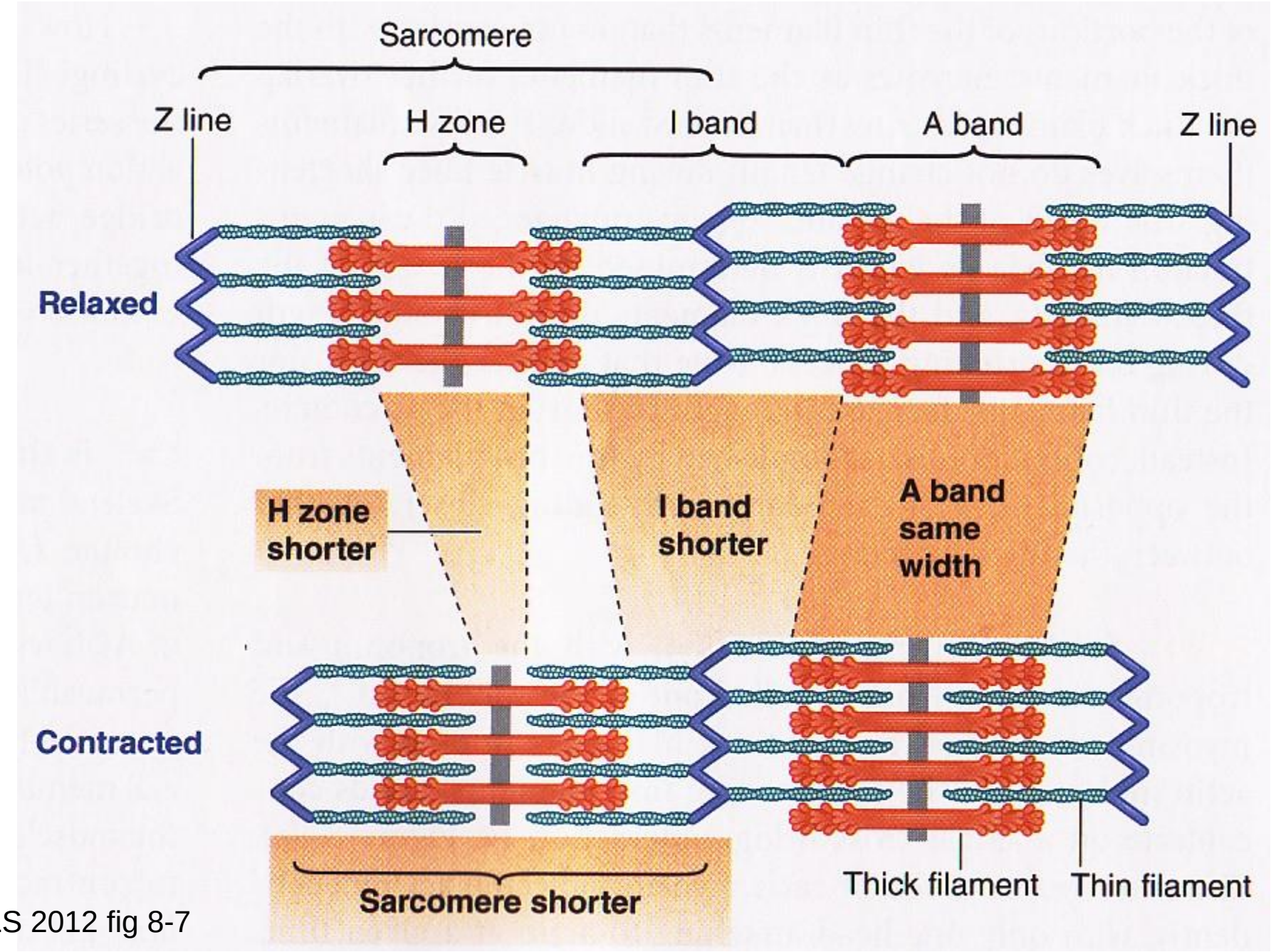
*A* Band = Dark Band

*A*nisotropic = Light Can't Shine Through




*I* Band = Light Band

*I*sotropic = Light Can Shine Through




LS 2012 fig 8-7