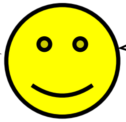
BI 121 Lecture 12



I. ***Announcements*** **Thanks for your help with blood lab! Great job! No lab this week. Study for Exam II, Dec 8, Mon!**

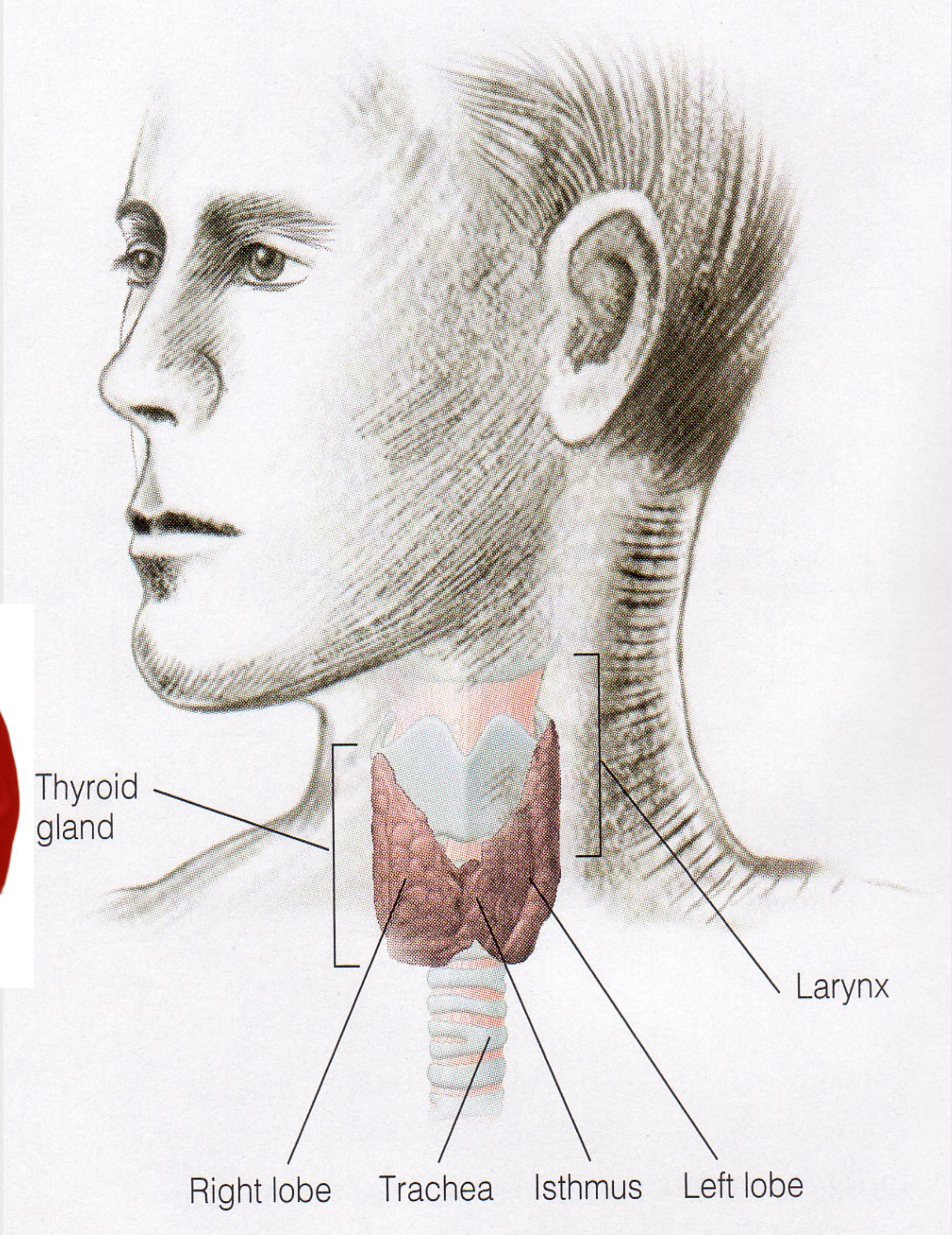
II. ***Endocrine Connections*** **Thyroid + Adrenals/Suprarenals** **LS pp 513-25 fig 17-18, 17-19; DC p 109-113 +…**

III. ***Introduction to the Nervous System*** **LS ch 5, DC Module 9**

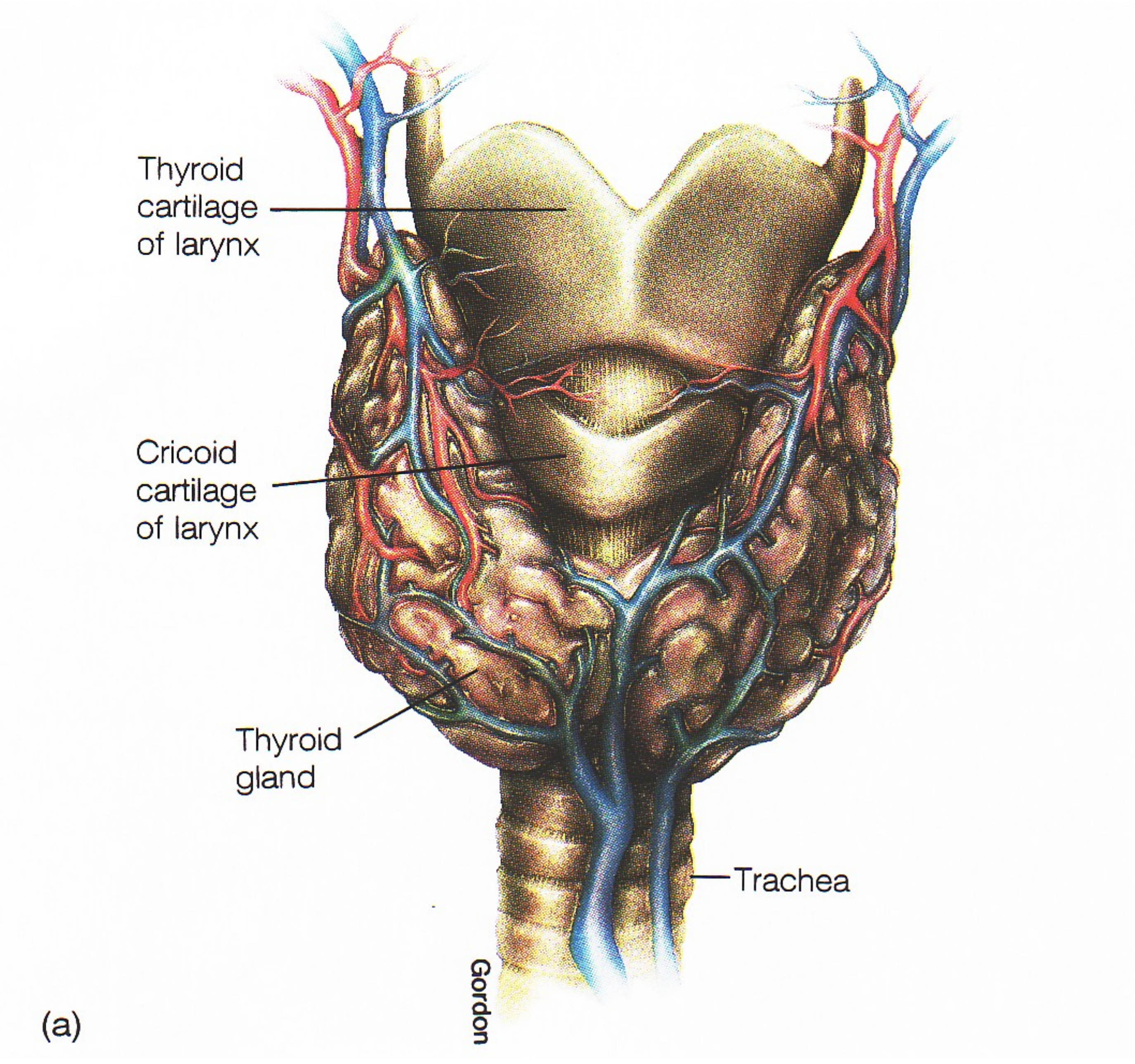
- **A. How is the nervous system organized?** **LS fig 5-1 DC p 67**
- **B. Neurons? What kind? Classes? Velocity?** **LS fig 5-2, 5-4**
- **C. What's myelin? How does it help?** **DC fig 9-3, LS pp 83-5**
- **D. Brain structure & function** **DC fig 9-6 thru 9-10 pp 71-5 +…**
- **E. Protect your head with a helmet! Bicycle head injury statistics, *NHTSA* & *BHSI* from 2011, the most recent yr**

IV. ***Autonomic Nervous System*** **LS ch 7 pp 178-85+...**

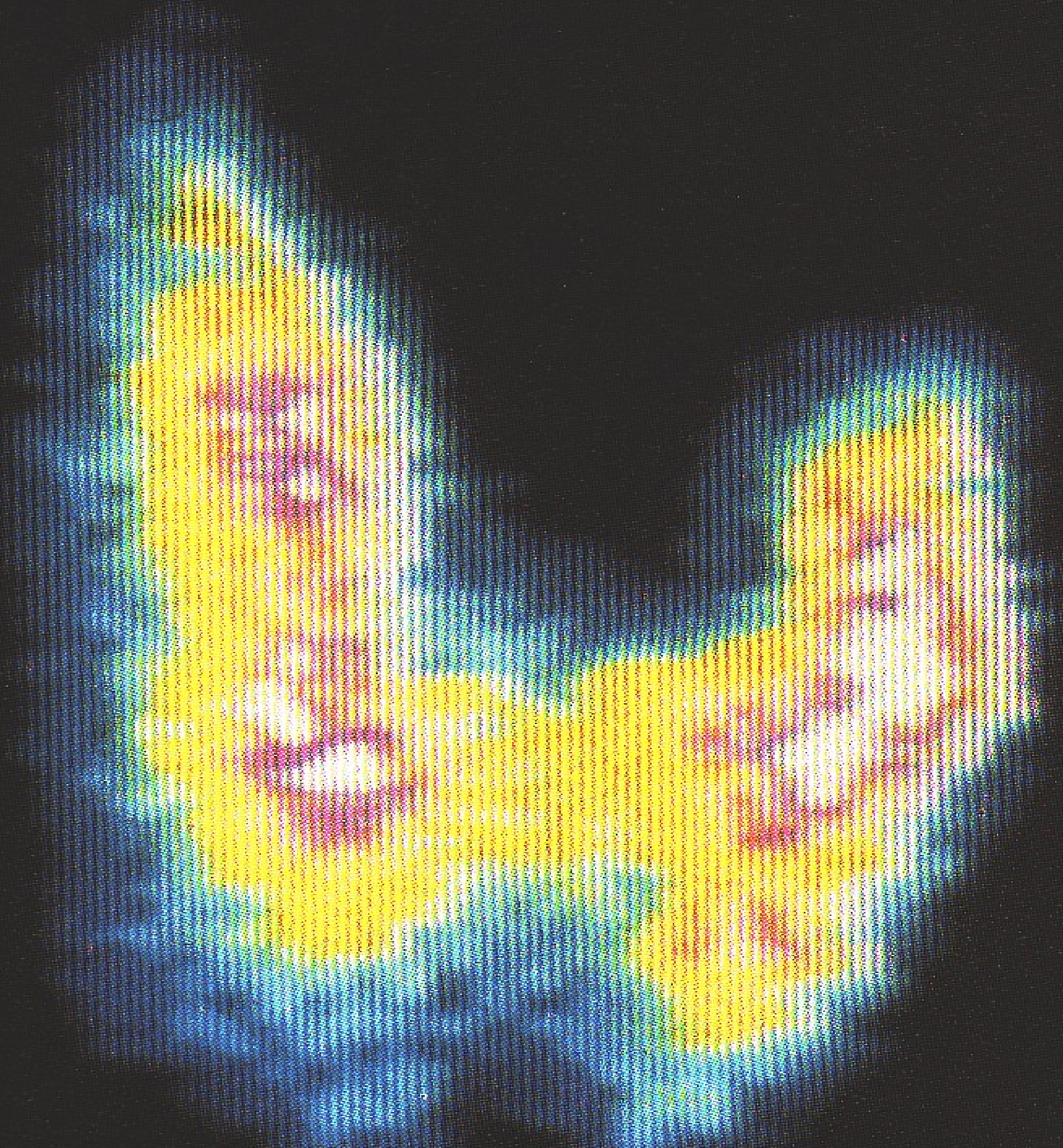
- **A. Sympathetic *vs* Parasympathetic branches** **LS fig 7-3**
- **B. Neurotransmitters & receptors** **LS fig 7-1 & 7-2, tab 7-2**
- **C. Actions** **LS tab 7-1**
- **D. Fight-or-flight stories!**



DC 2003


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

DC 2003



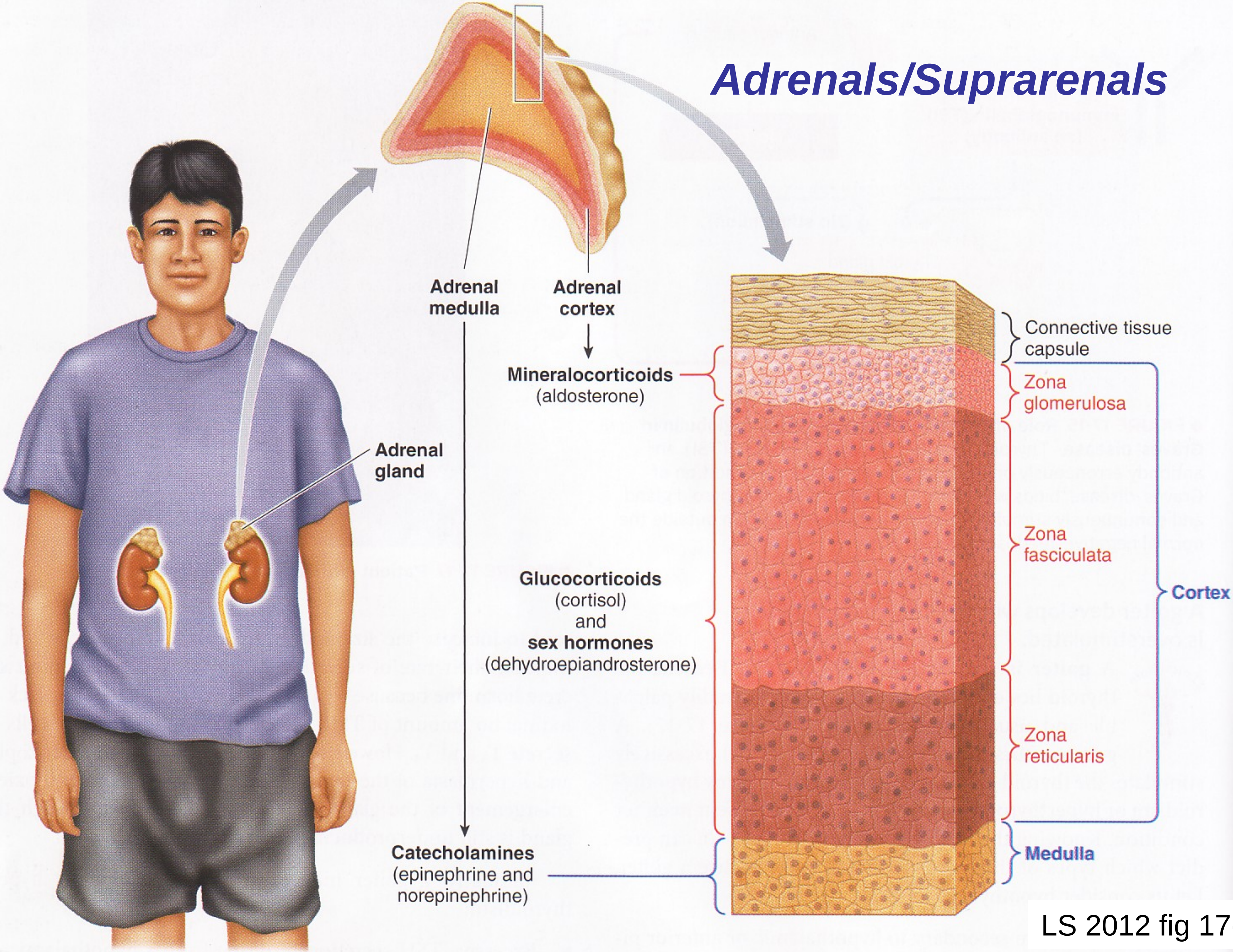
DC 2003

LS 2012 fig 17-16

LS 2012 fig 17-17

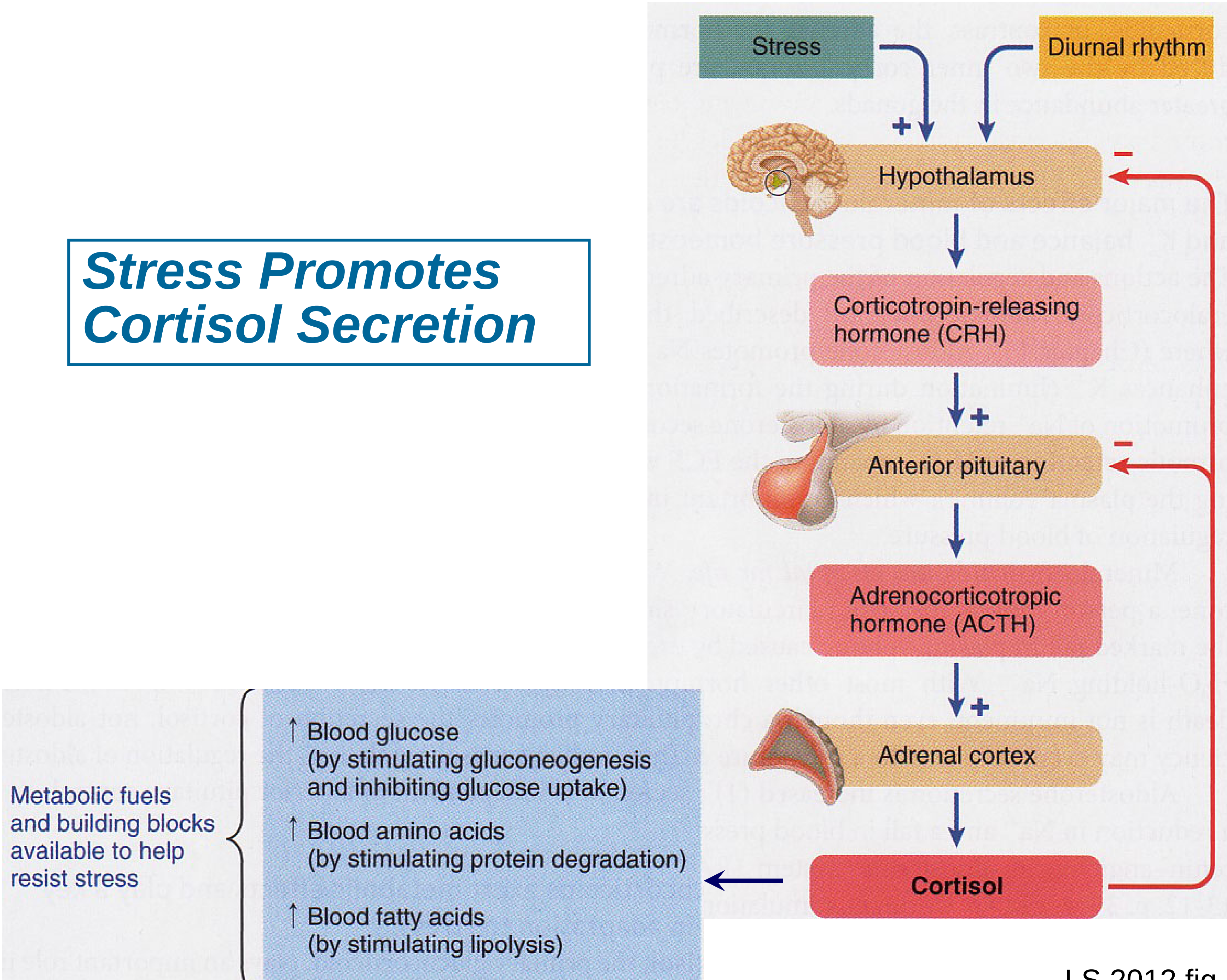

Guyton & Hall 2000

Adrenals/Suprarenals



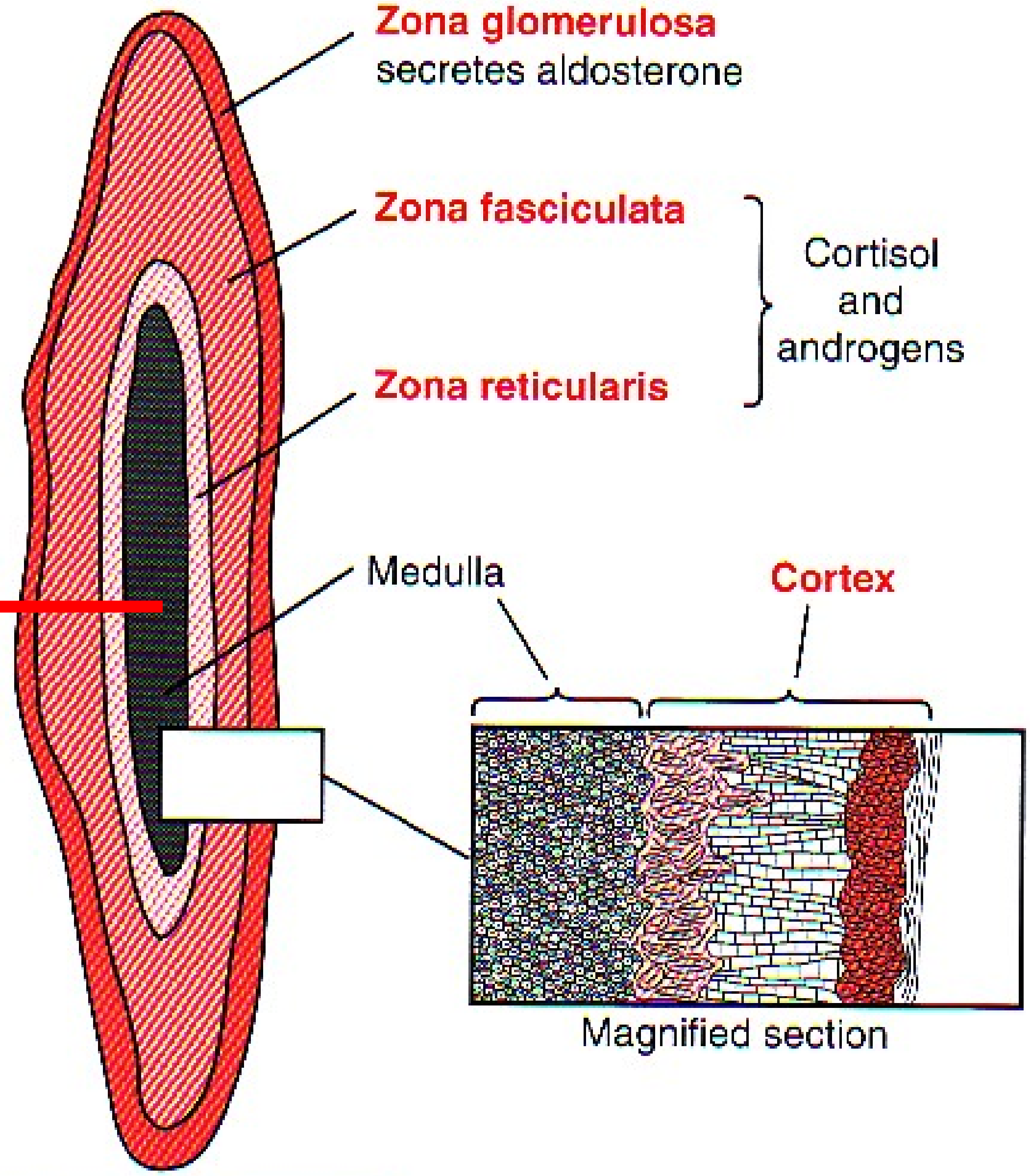
LS 2012 fig 17-18

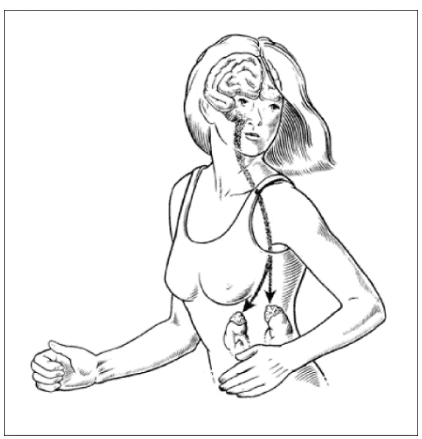
Stress Promotes Cortisol Secretion



LS 2012 fig 17-19

Epinephrine
80%
Norepinephrine
20%



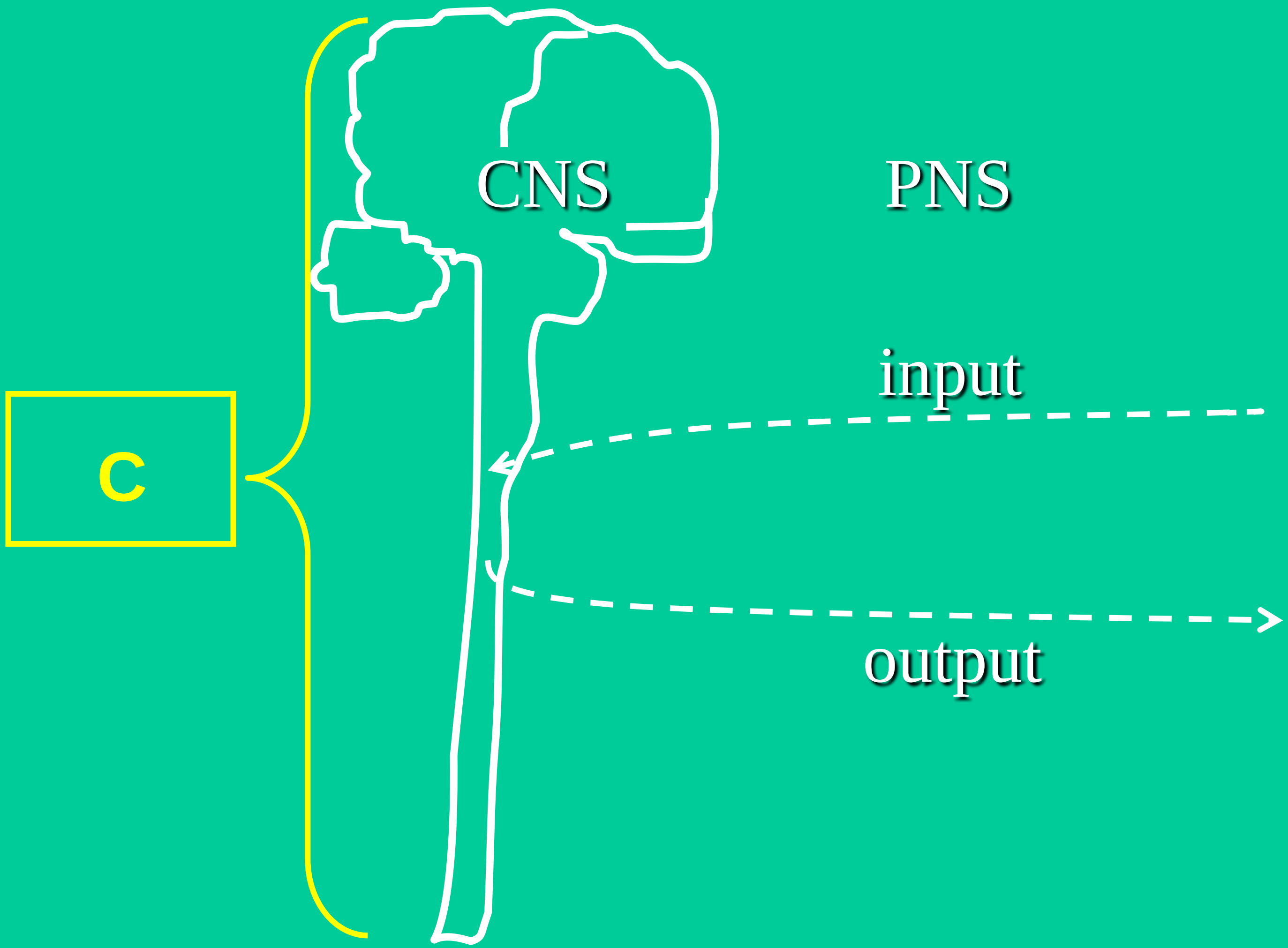


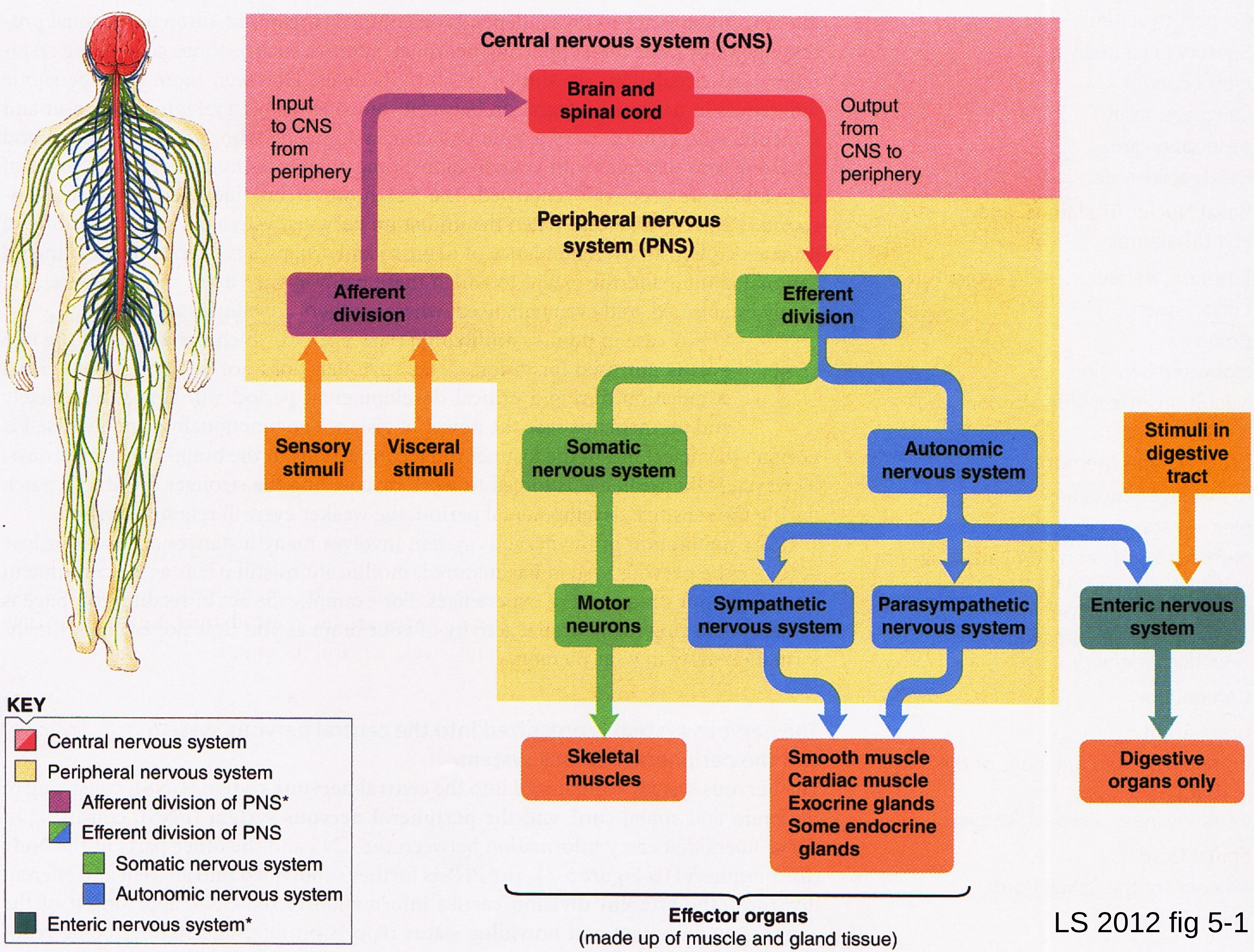
Guyton & Hall 2000

FIGURE 77-1

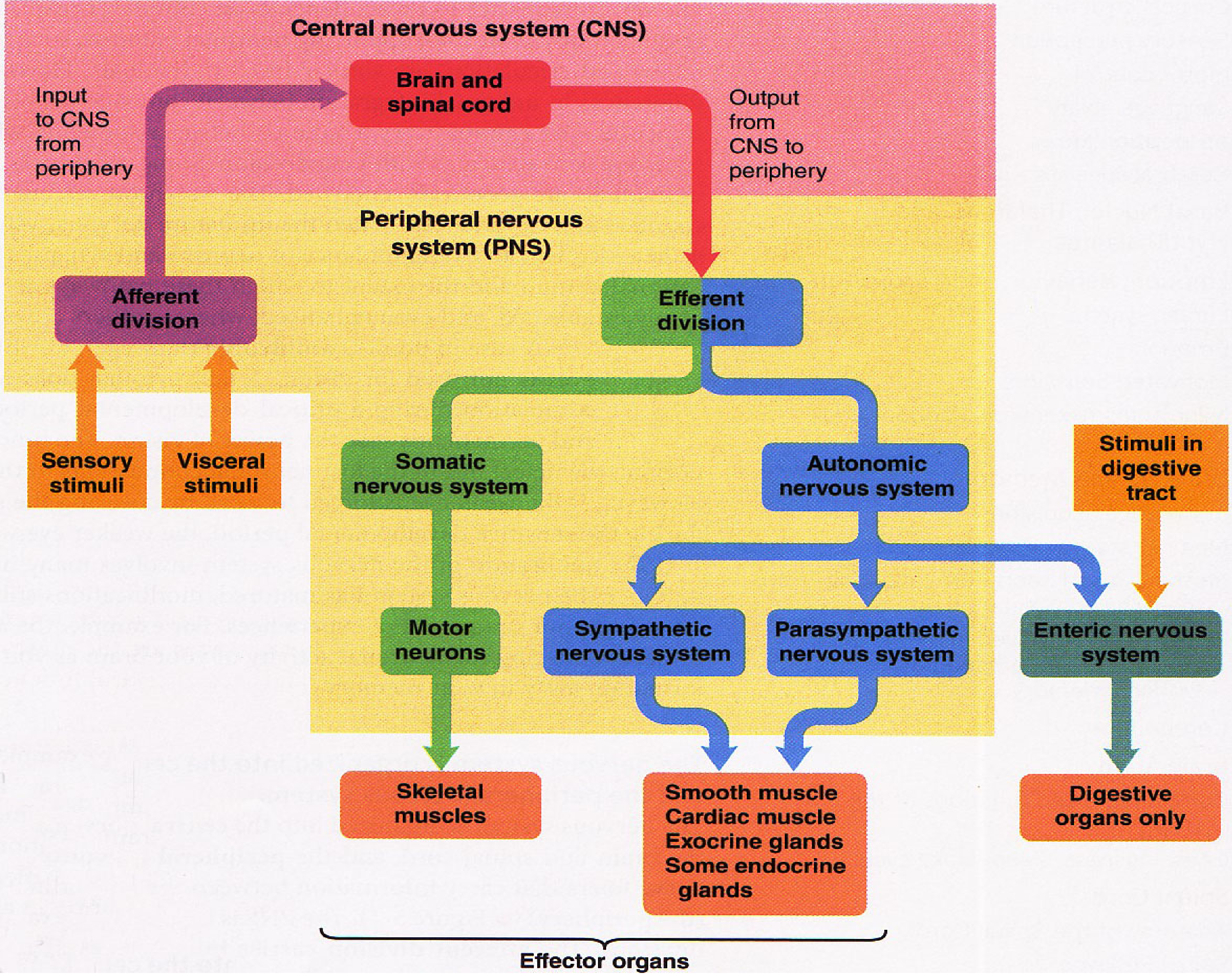
Secretion of adrenocortical hormones by the different zones of the adrenal cortex.

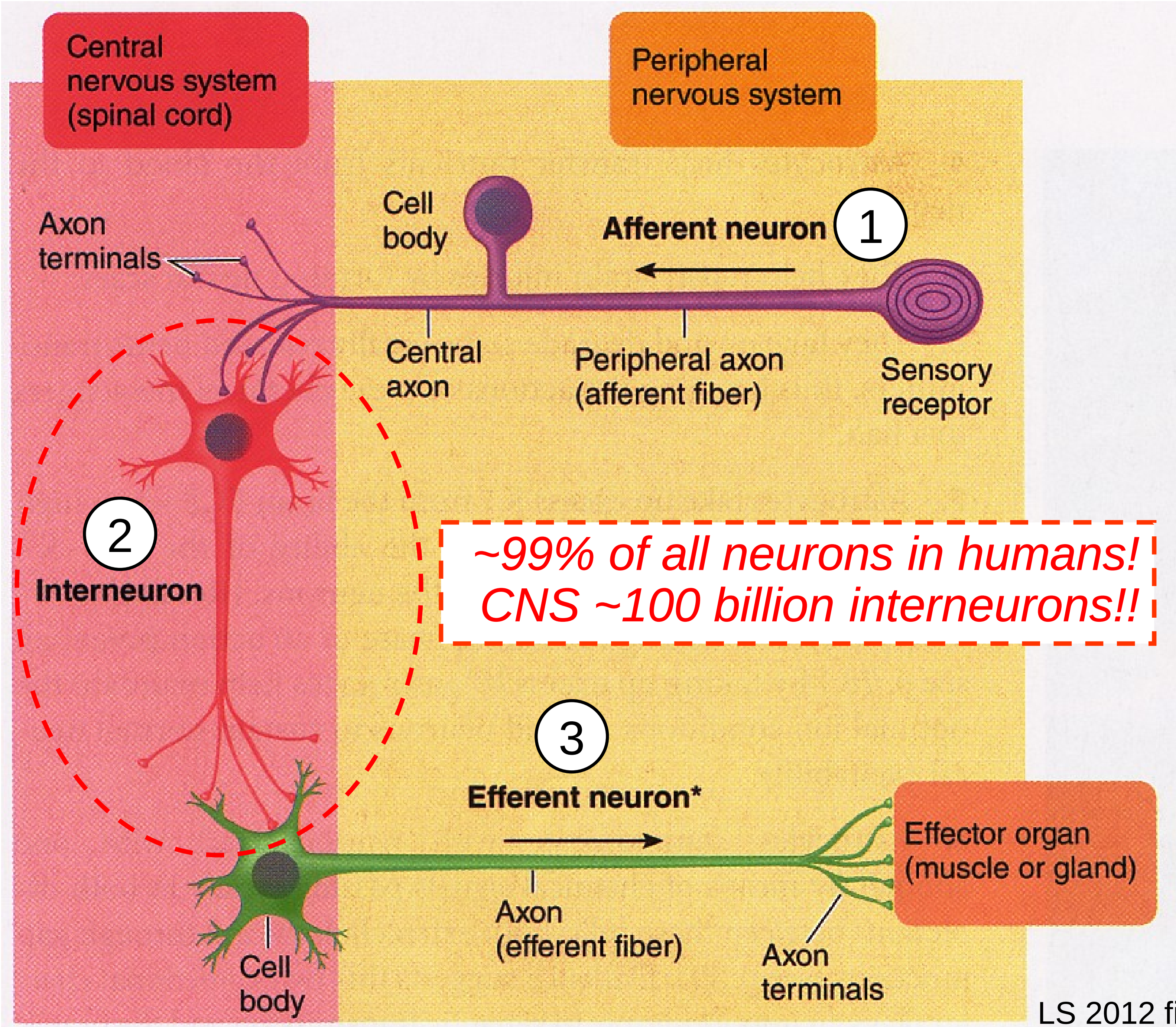
Nervous System





LS 2012 fig 5-1

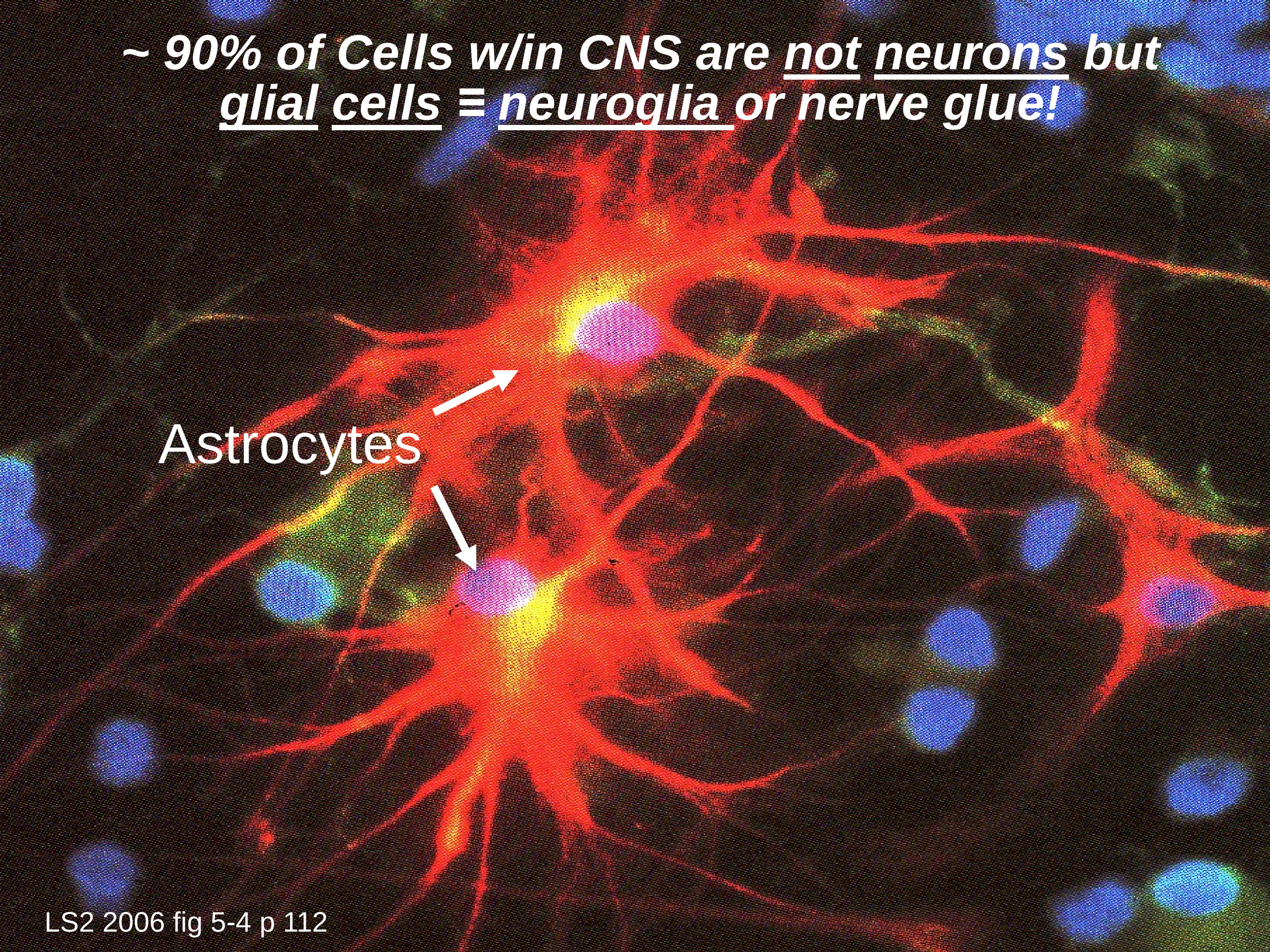

Central nervous system (CNS)
Brain and spinal cord
Input to CNS from periphery
Output from CNS to periphery
Peripheral nervous system (PNS)
Afferent division
Efferent division
Sensory stimuli
Visceral stimuli
Somatic nervous system
Autonomic nervous system
Stimuli in digestive tract
Motor neurons
Sympathetic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



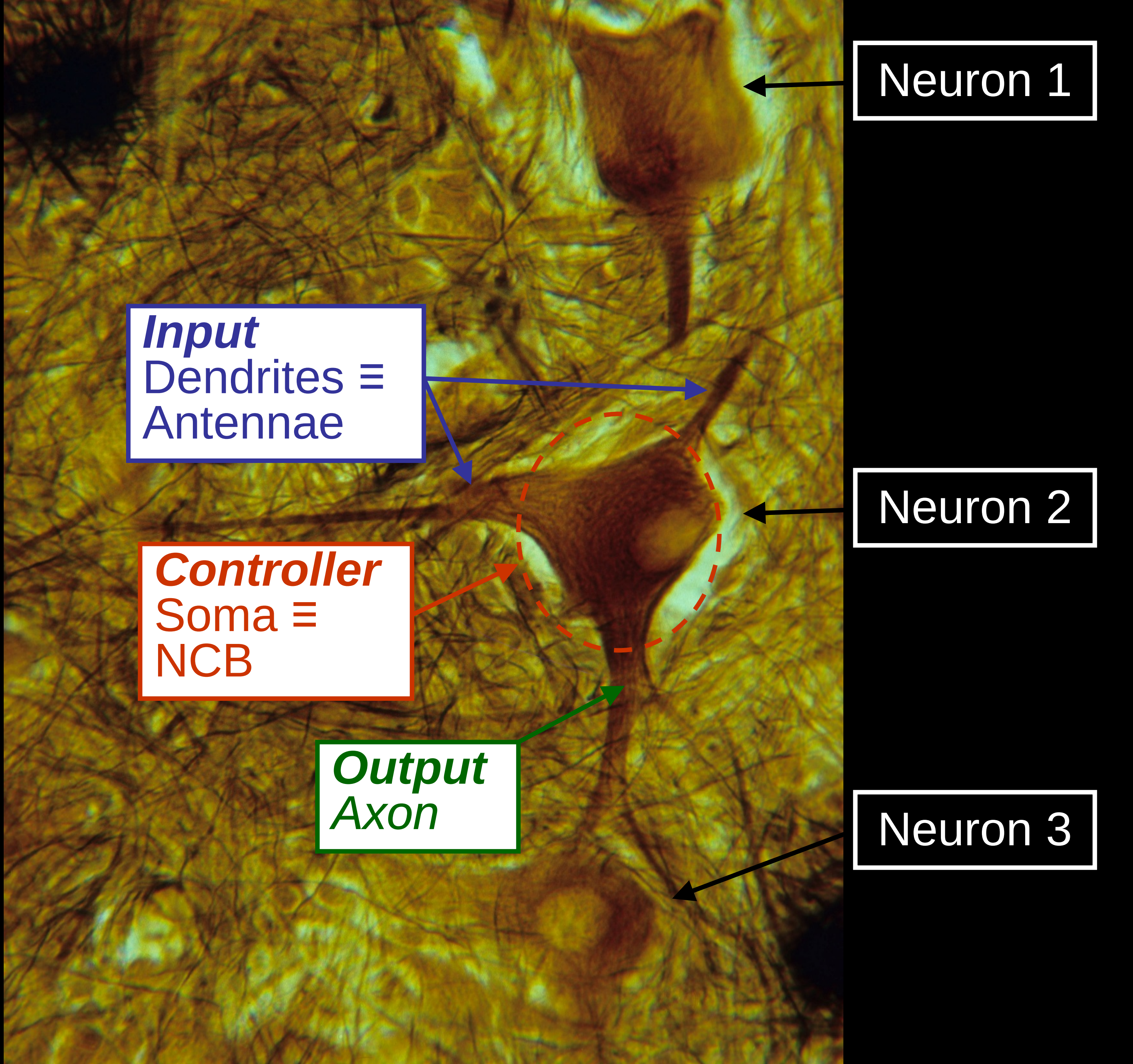
~99% of all neurons in humans!
CNS ~100 billion interneurons!!

LS 2012 fig 5-2

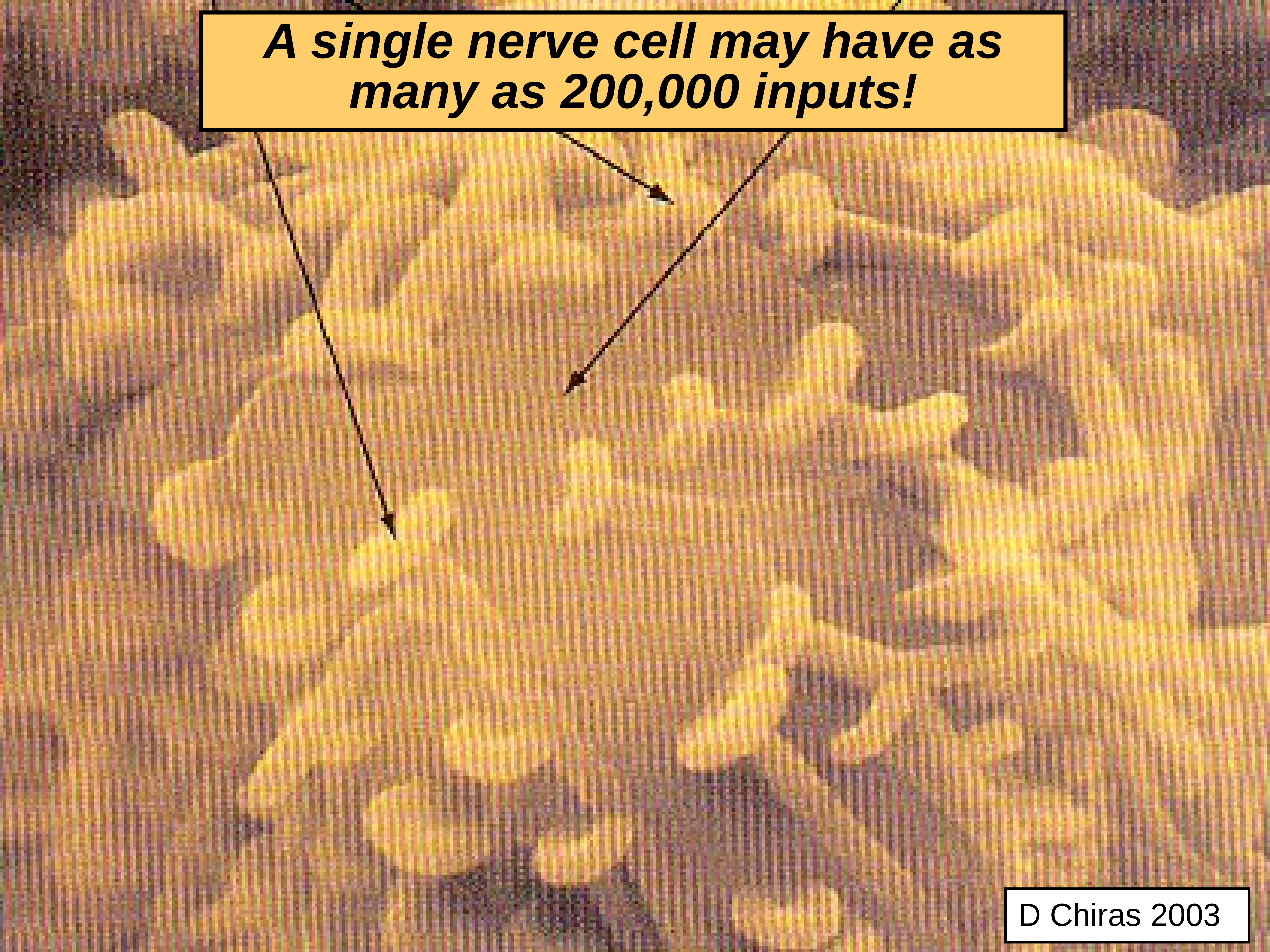
~ 90% of Cells w/in CNS are not neurons but glial cells ≡ neuroglia or nerve glue!



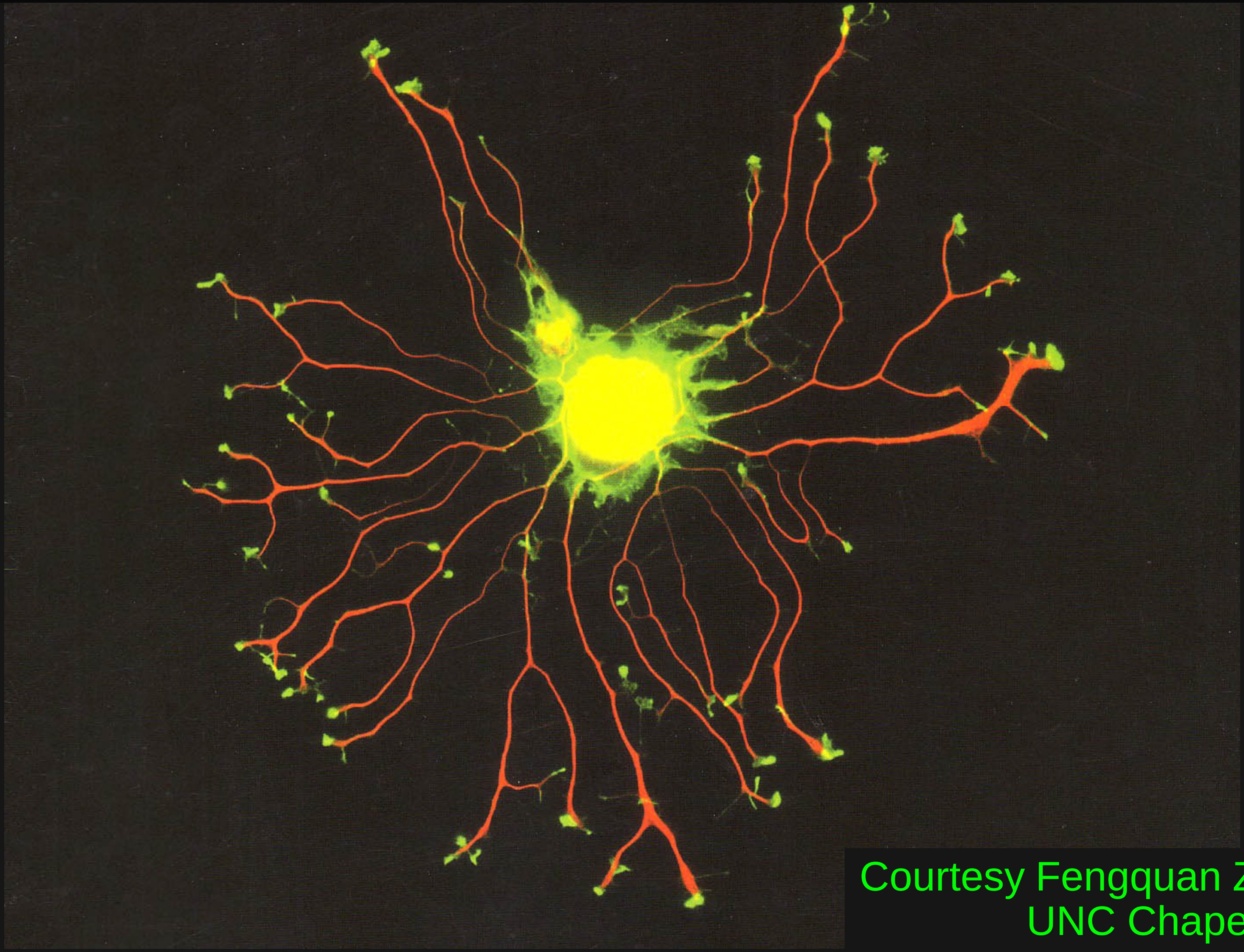
LS2 2006 fig 5-4 p 112



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

Sensory nerves especially, come in all shapes & sizes!

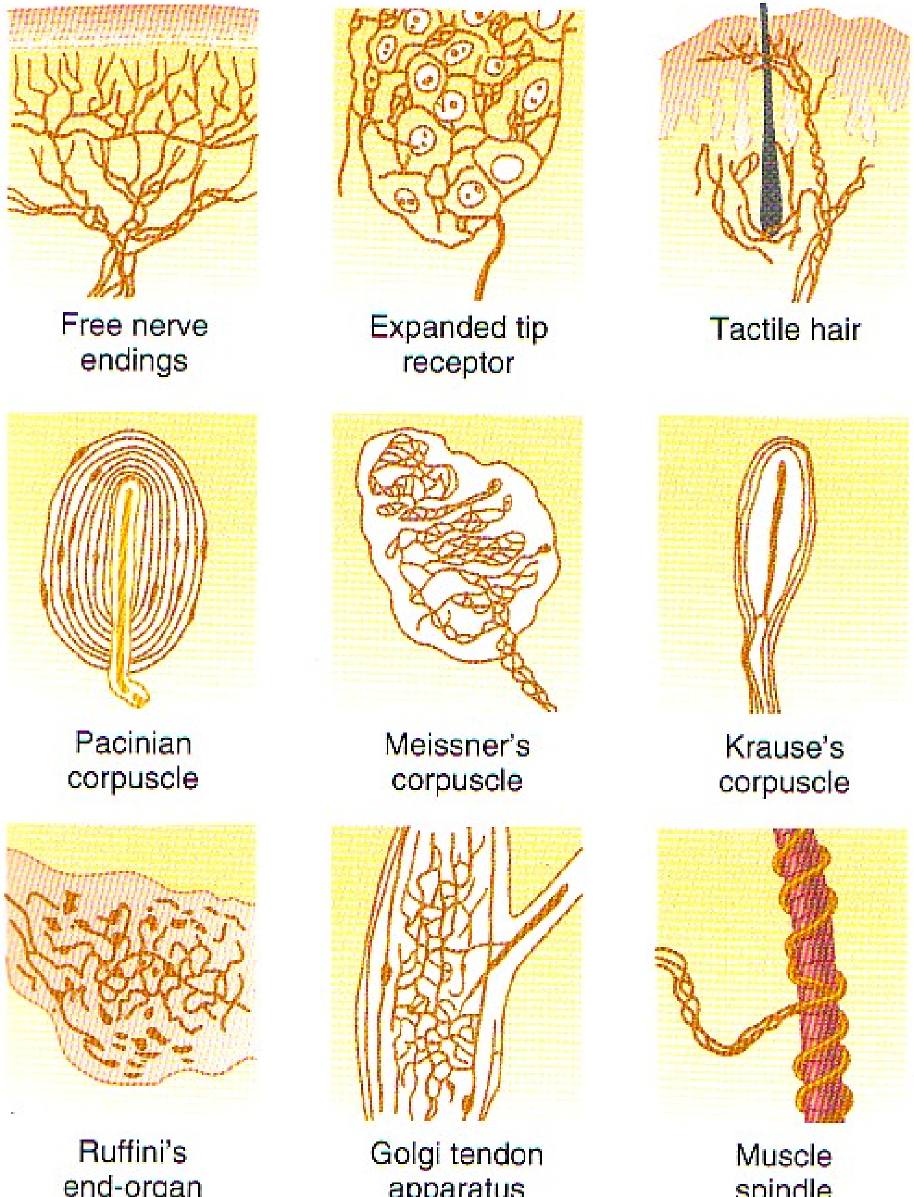


Figure 46–1

Several types of somatic sensory nerve endings.

Guyton & Hall 2011

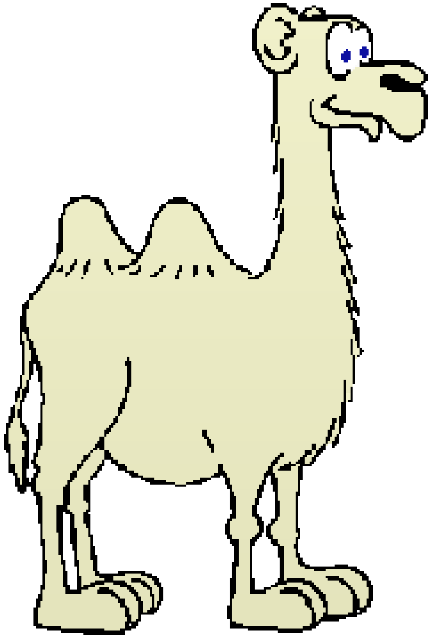
Nerve Extremes: Far ends of the Continuum

A = Large to medium myelinated, up to 120 m/sec

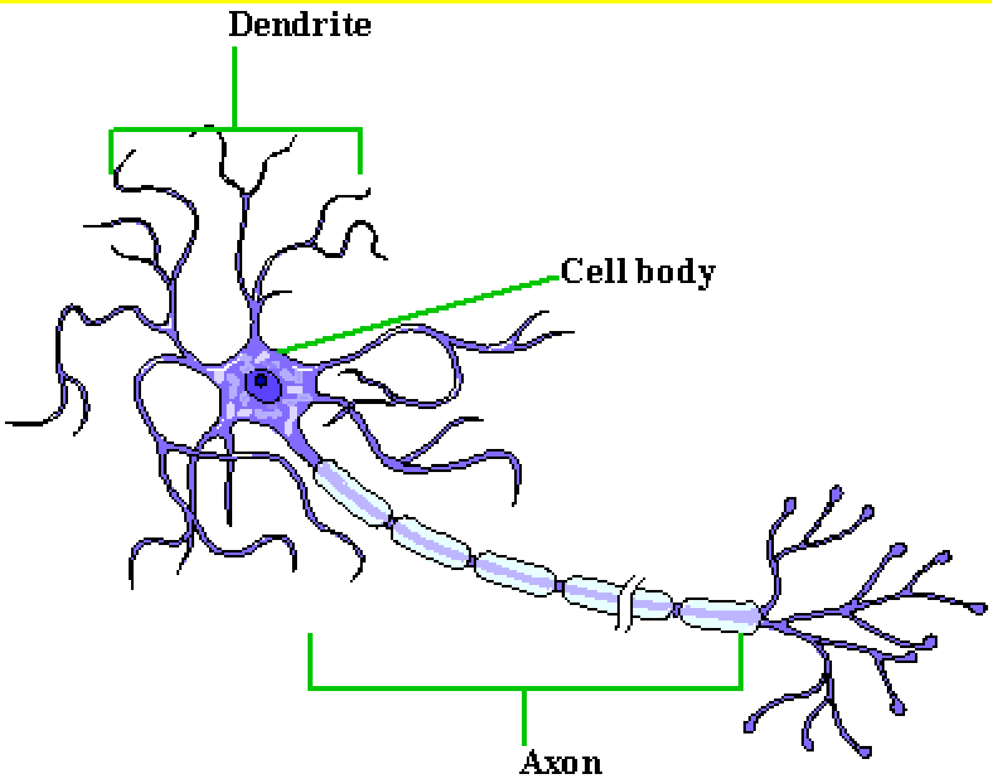
α,β, γ, δ

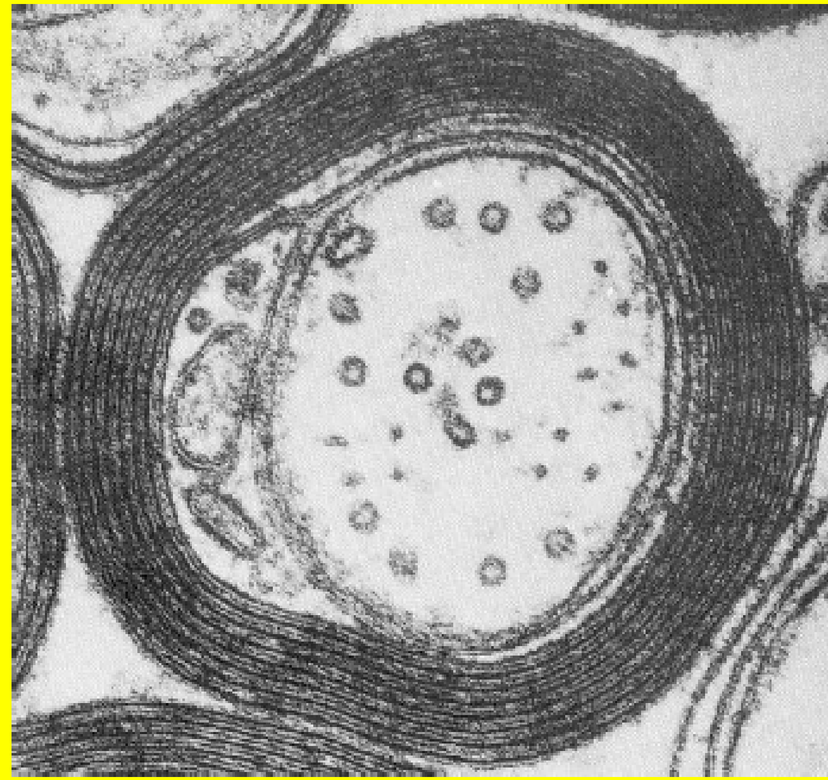
C = Small unmyelinated, 0.25 m/sec

IV



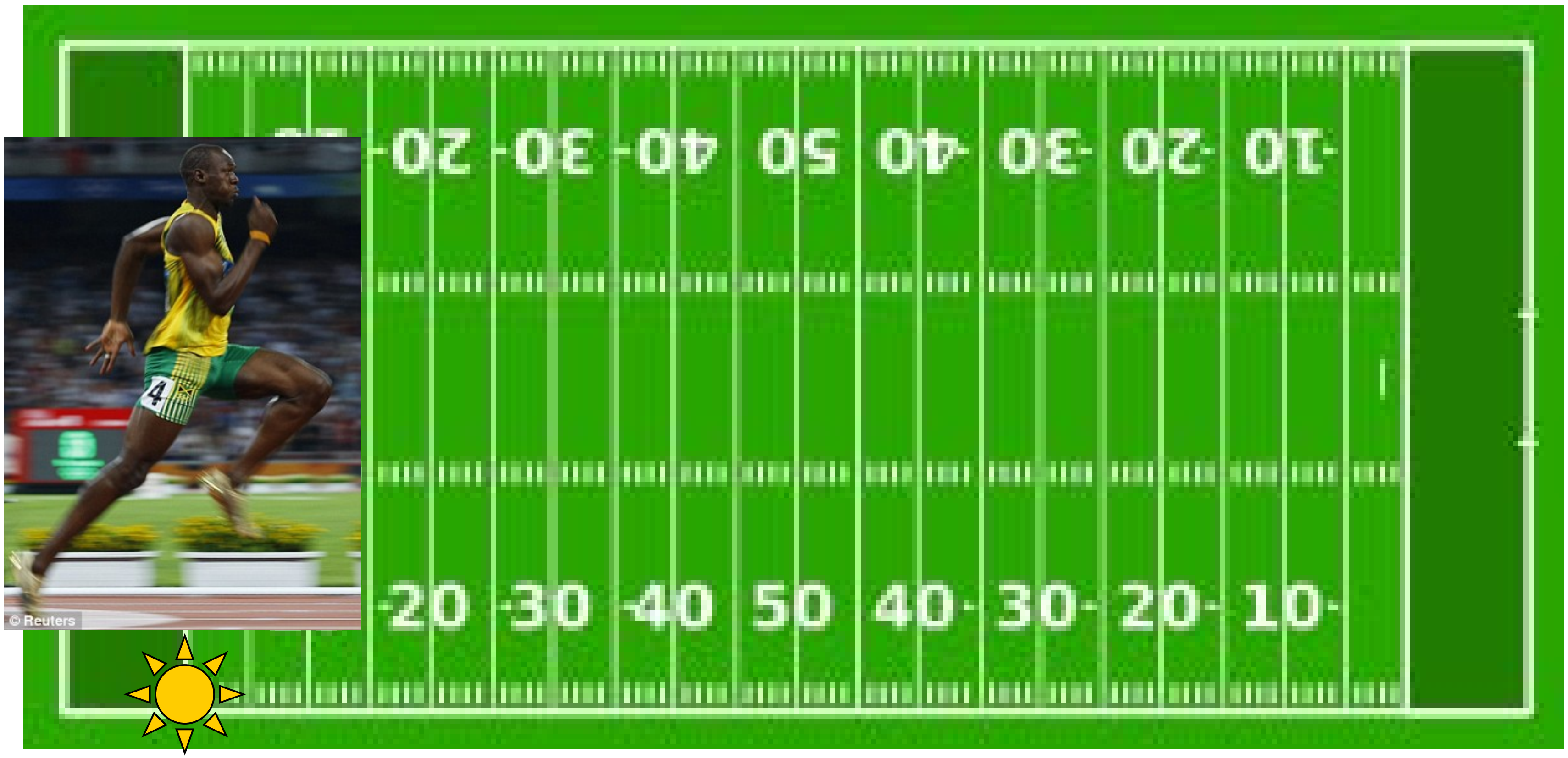
What is myelin?
Why is it important?



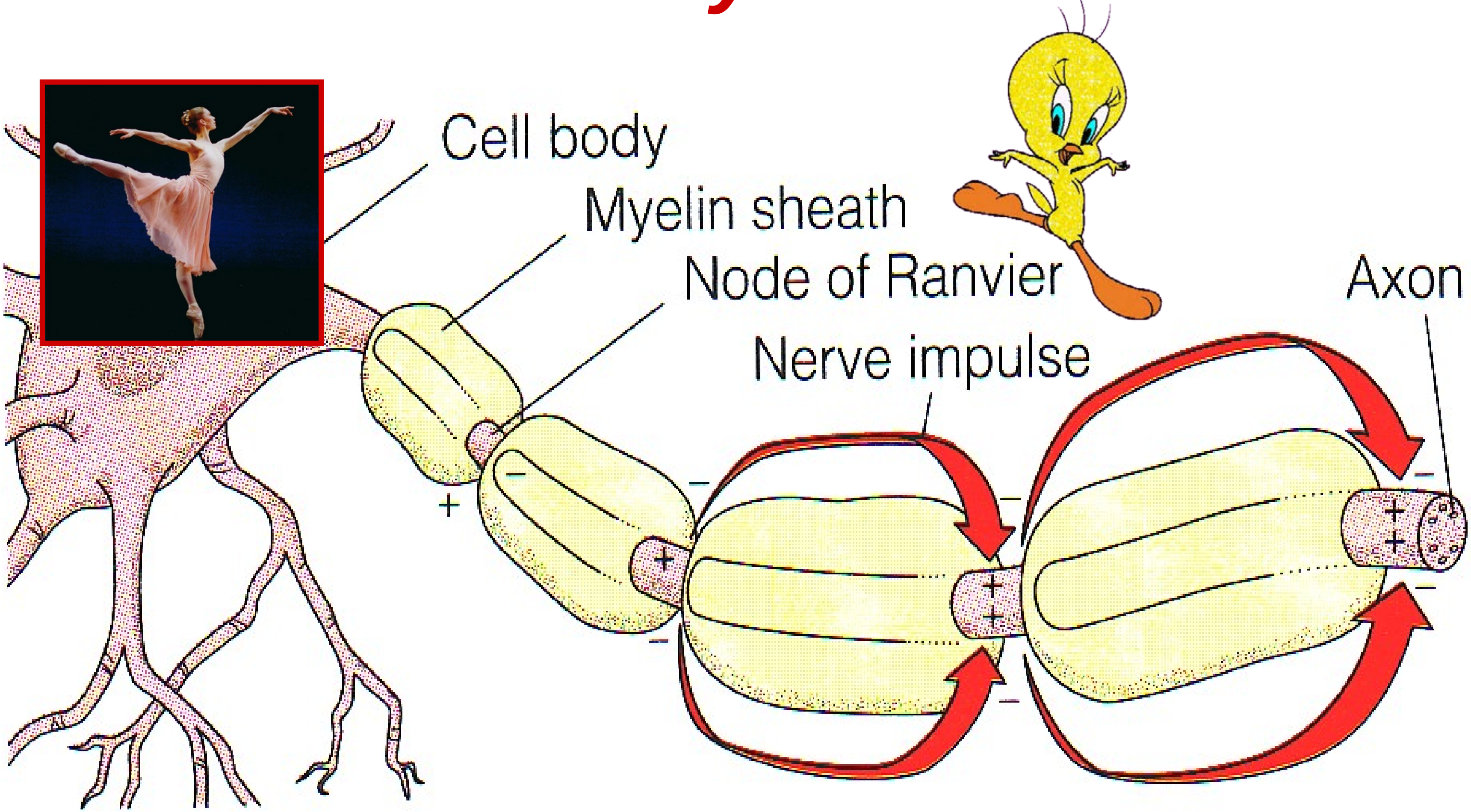


Lipid insulative coat
↑ $\vec{v}$, conserves ions & ATP

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

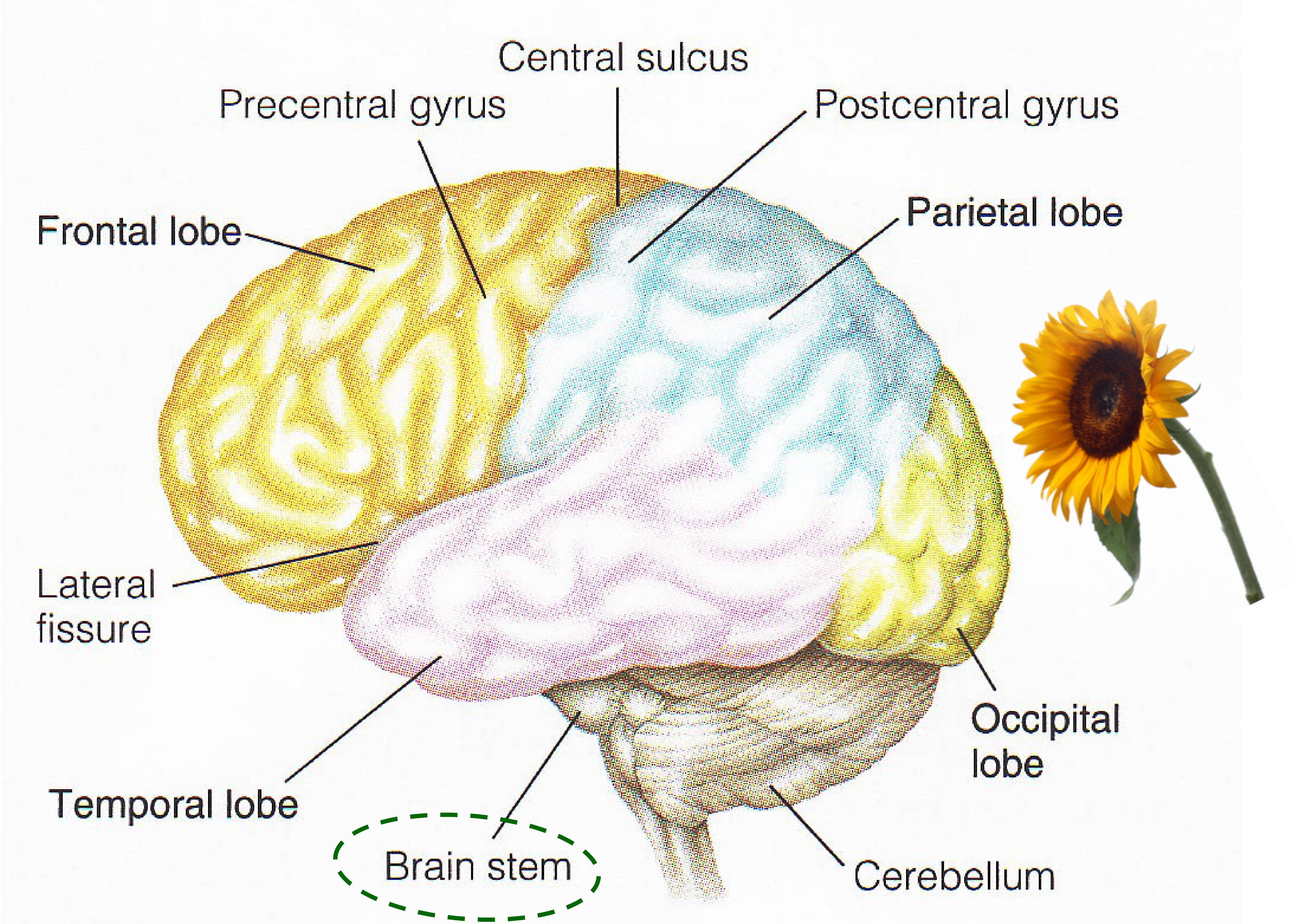


Saltatory/Leaping Conduction!
Crucial Sensory & Motor Nerves

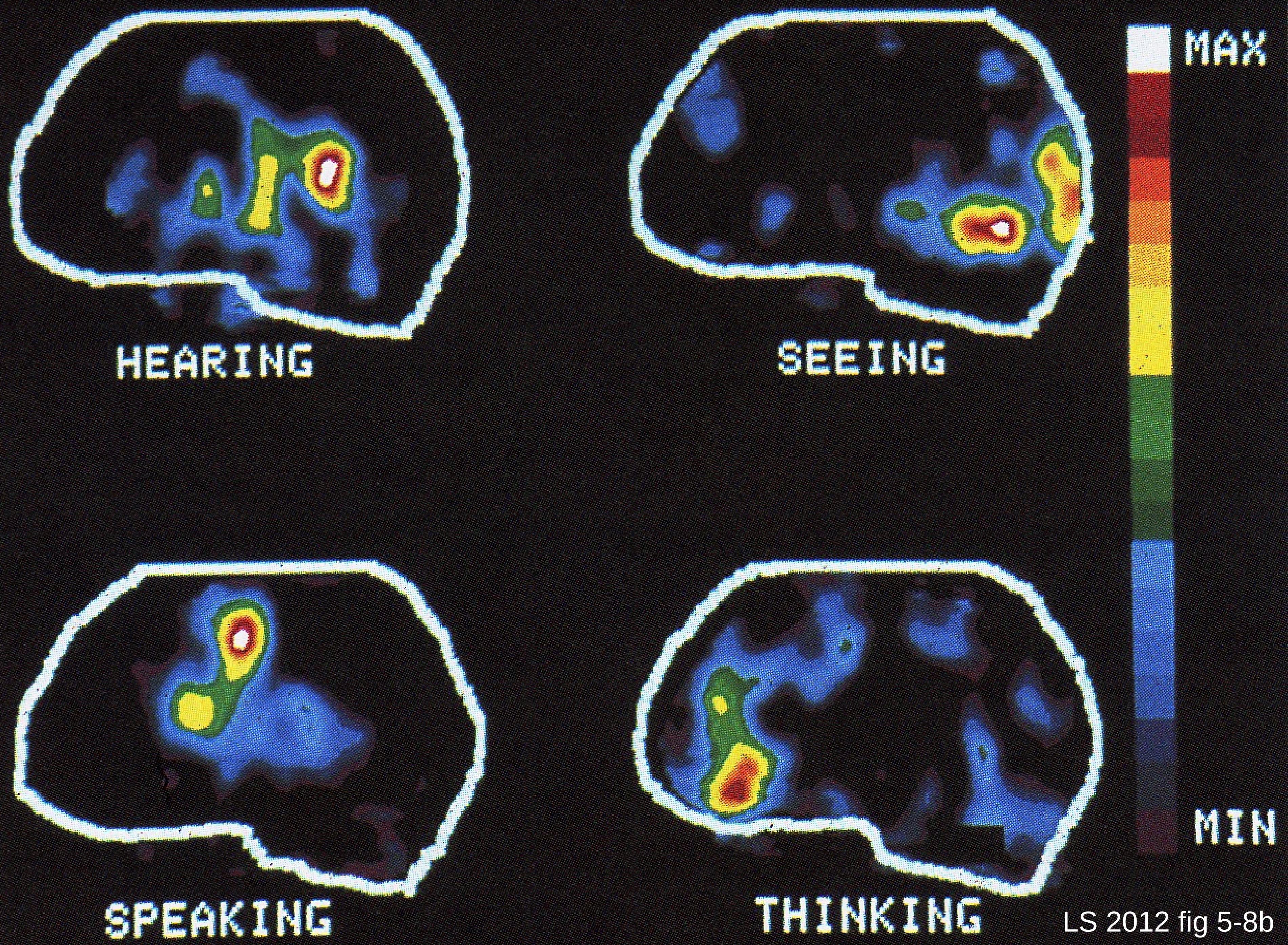


L. saltare to hop or leap! Fr. salt, sautier, sauté, leap, high air, vault

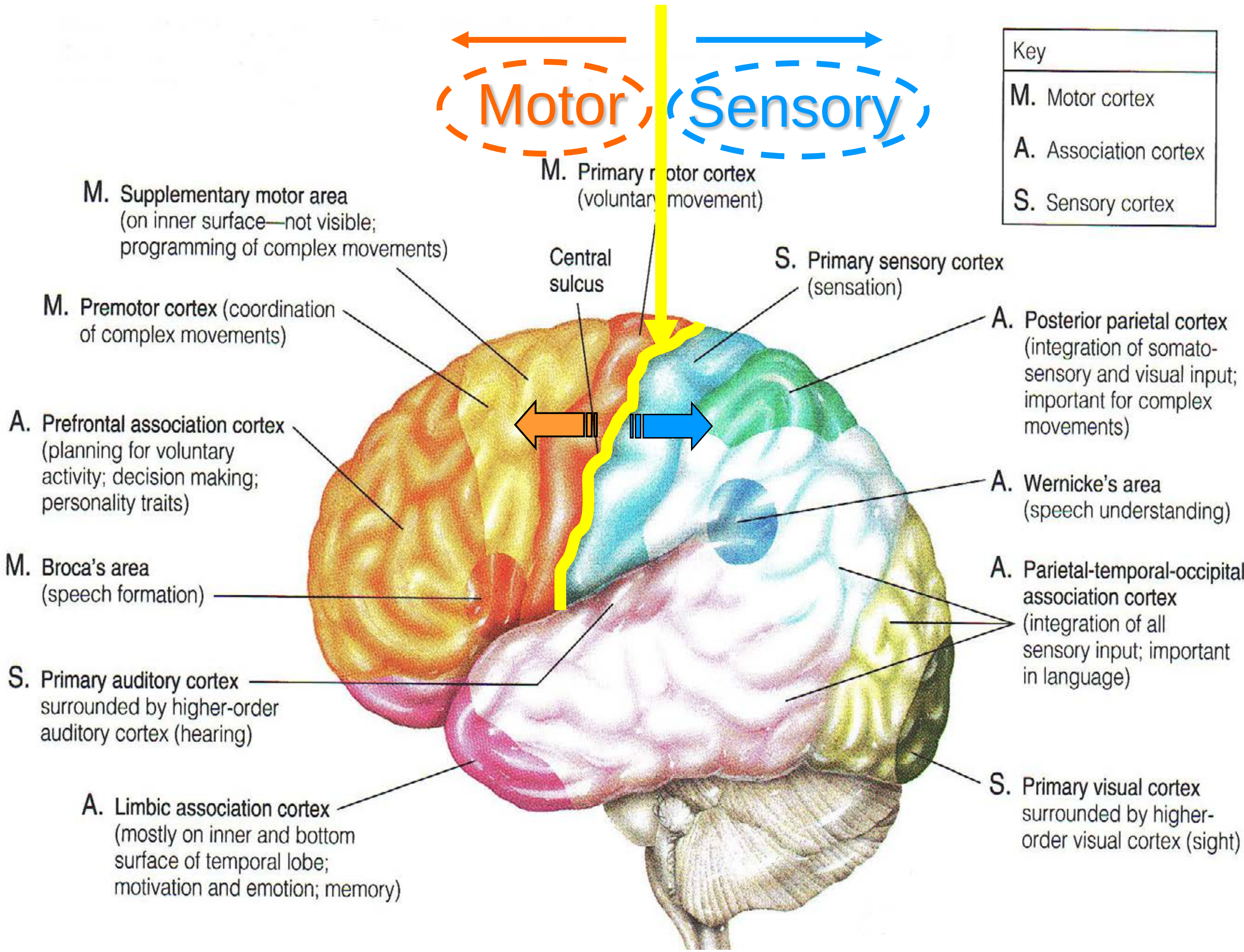
DC 2003



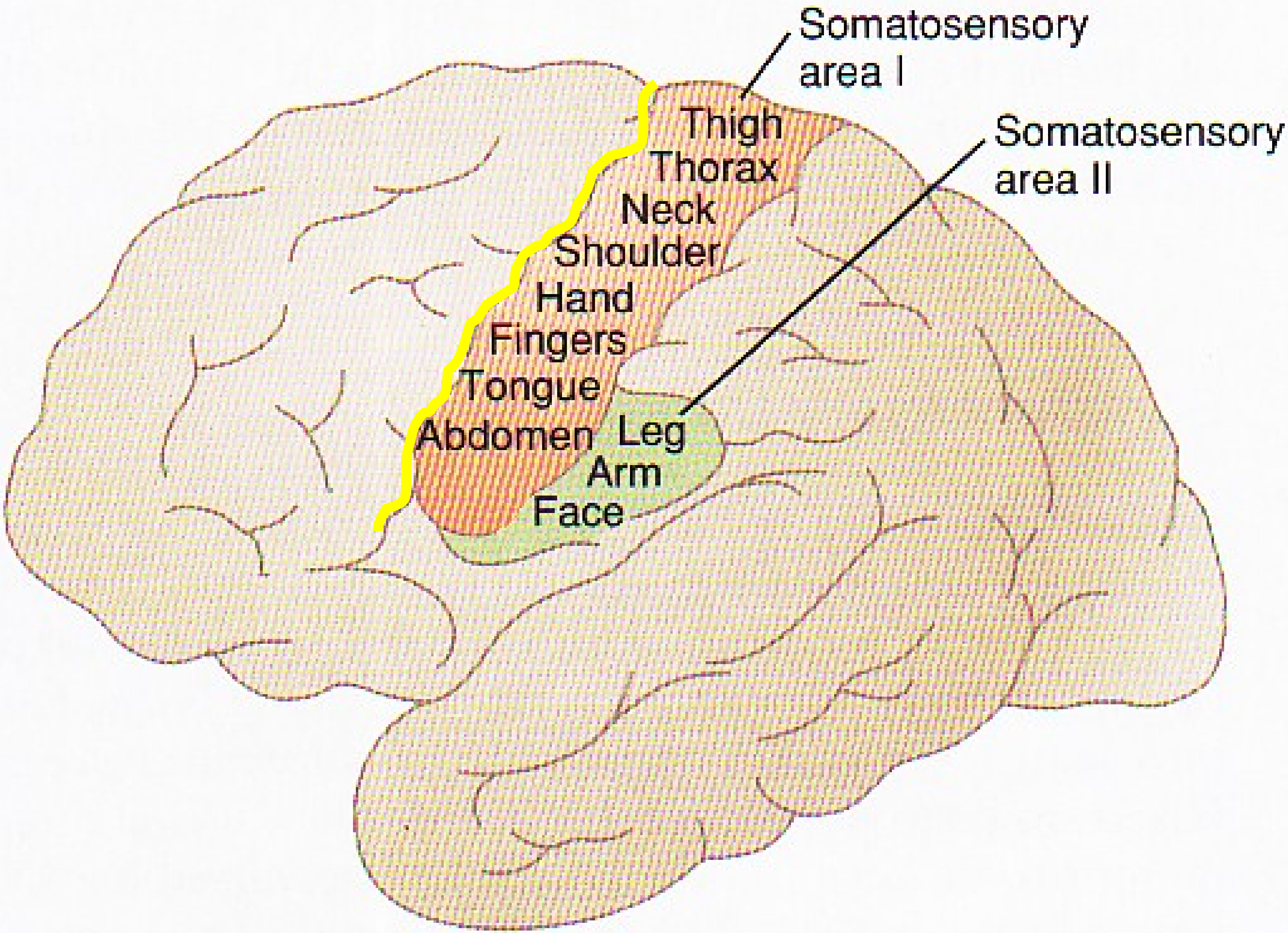
LS 2012 fig 5-7



LS 2012 fig 5-8b



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

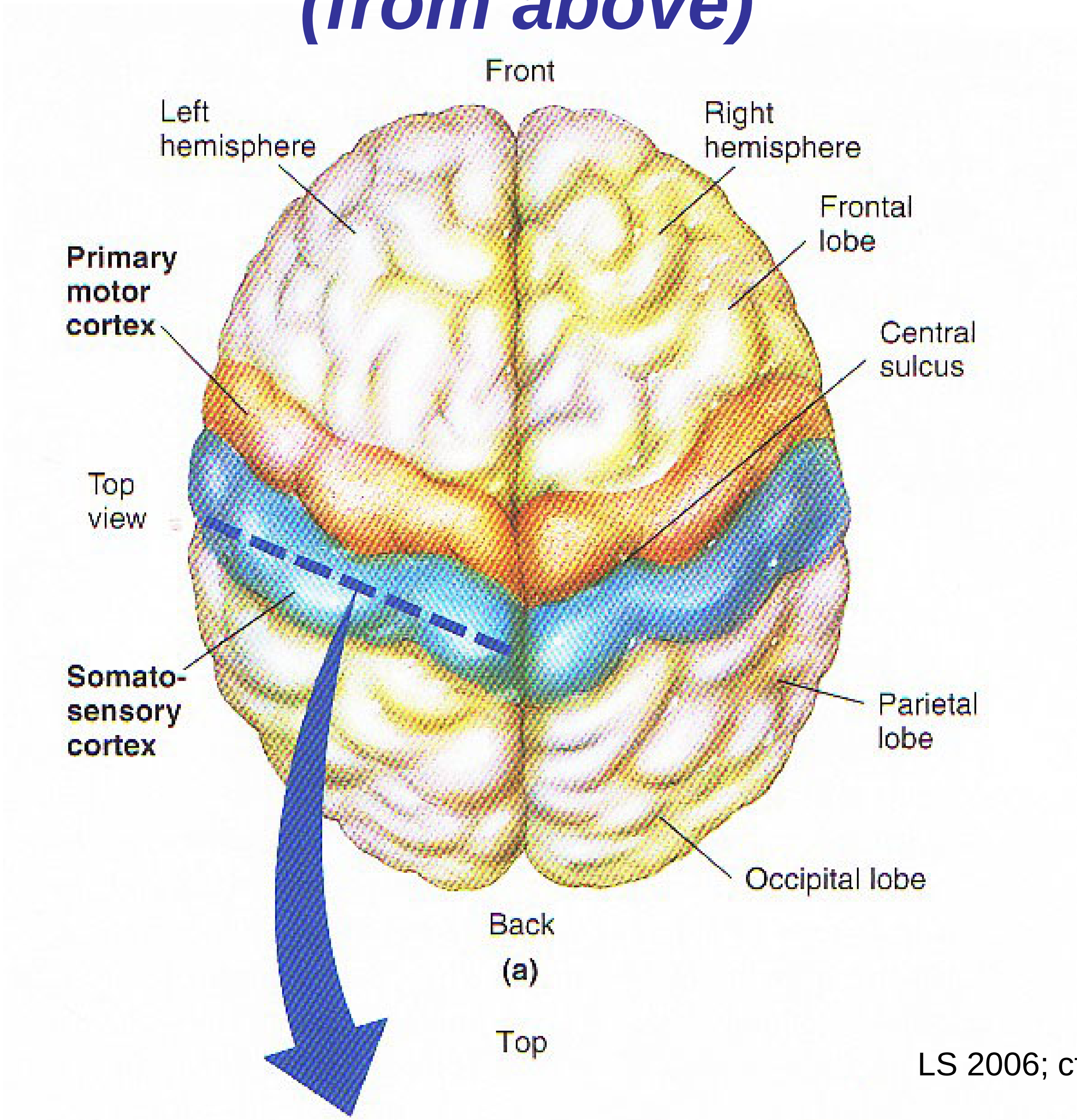


Guyton & Hall 2011

Figure 47–6

Two somatosensory cortical areas, somatosensory areas I and II.

Section Human Brain (from above)



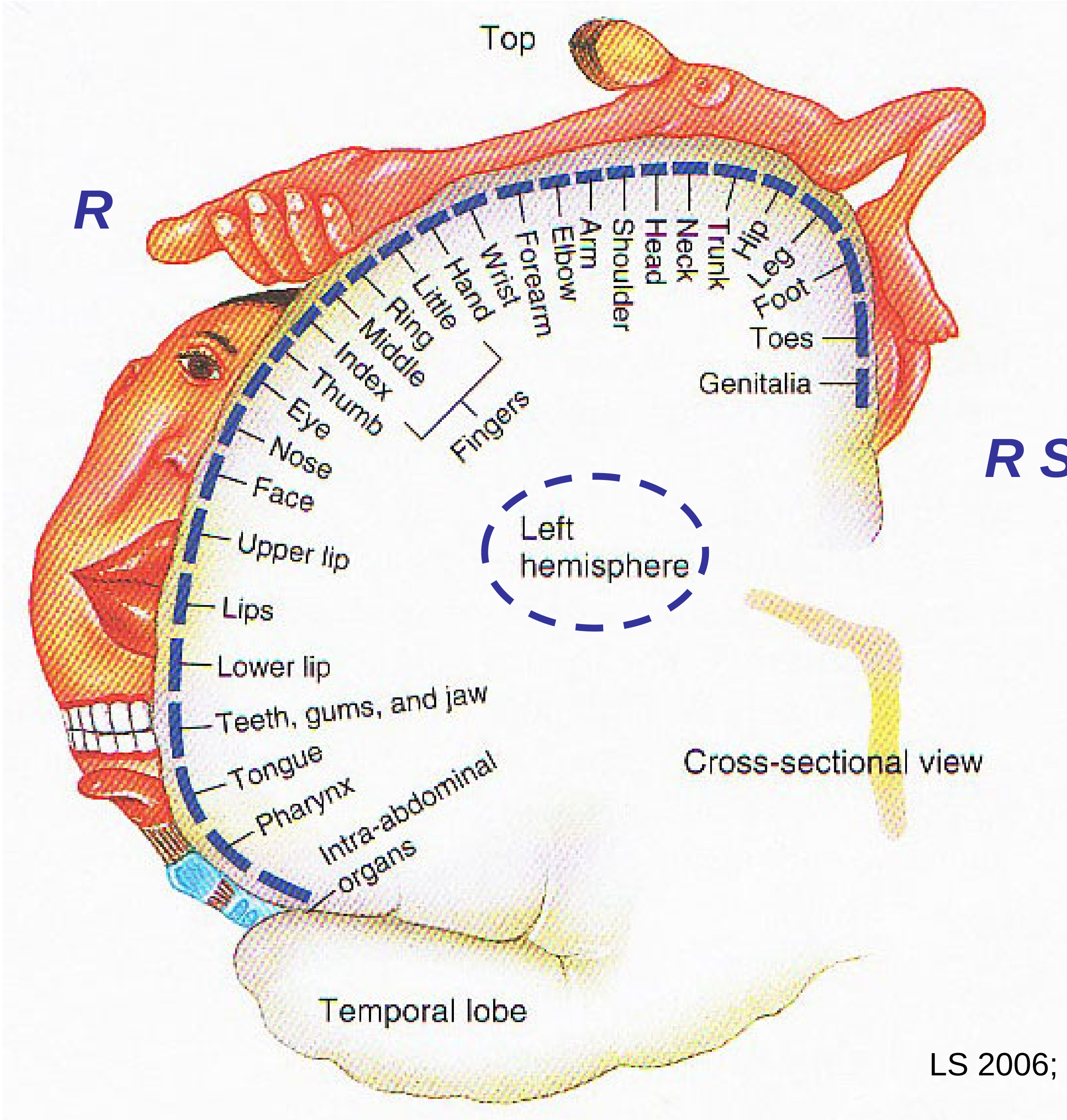
LS 2006; cf: LS 2012 fig 5-9

Sensory Homunculus

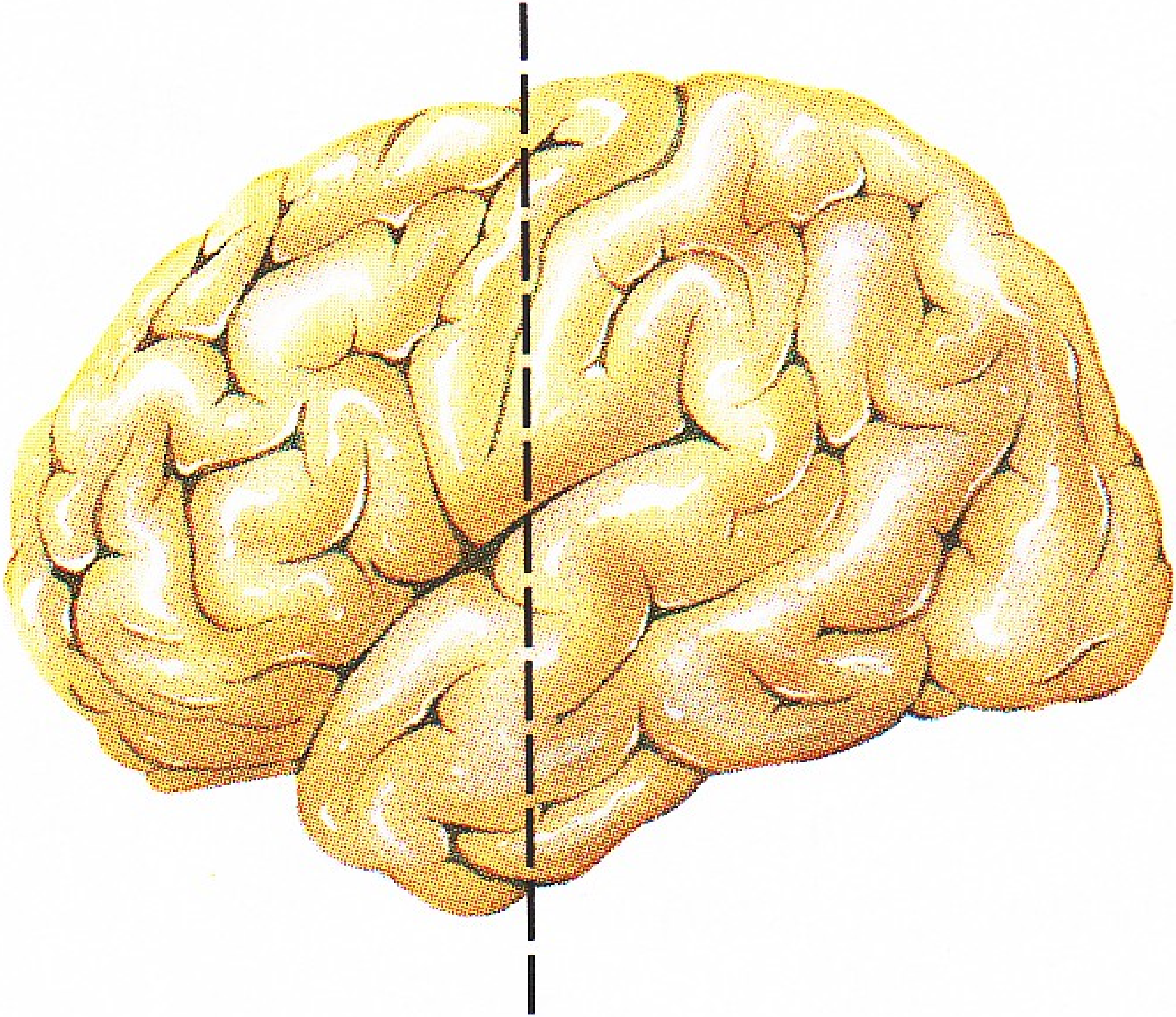
R

L Brain

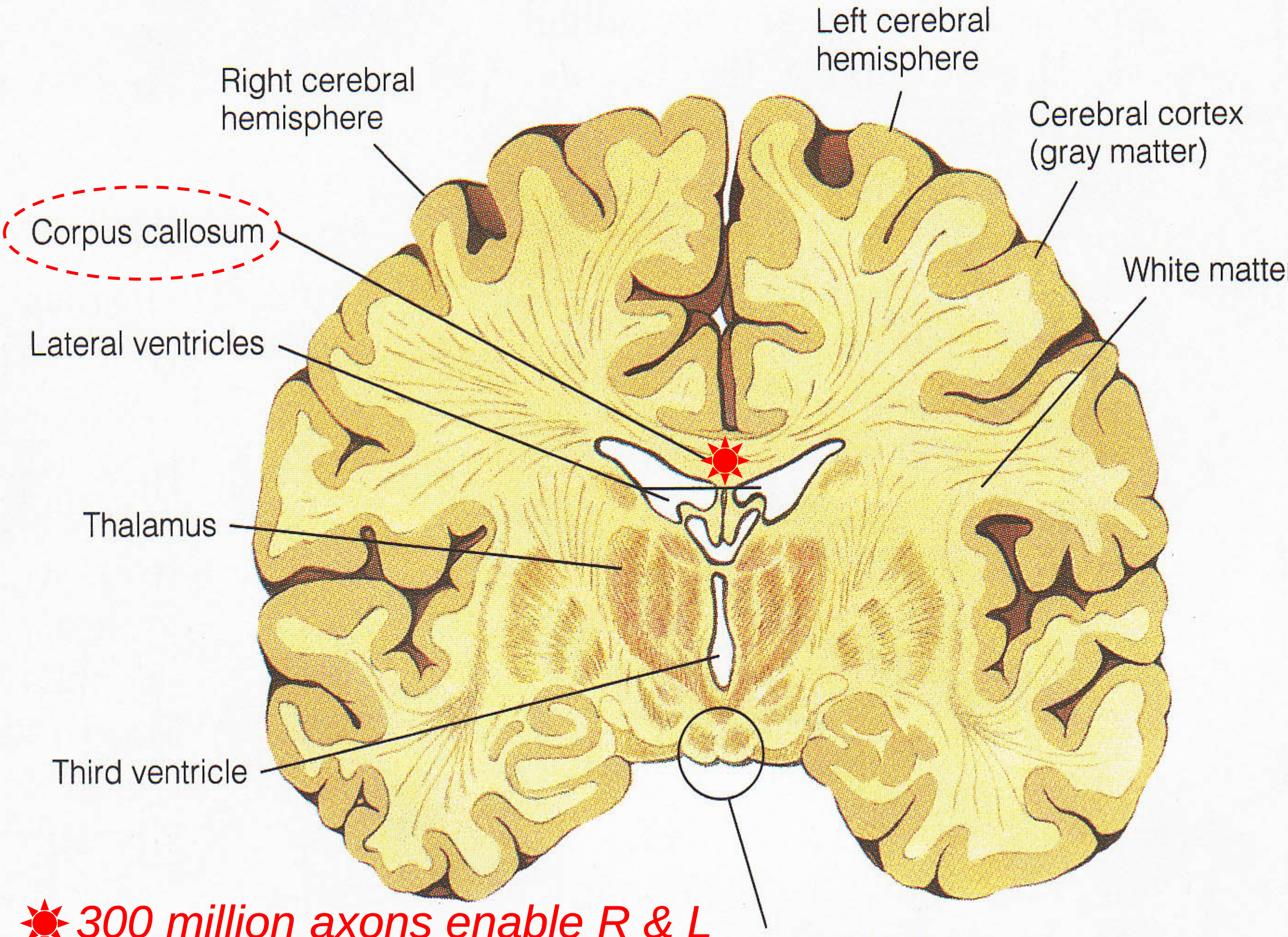
R Sensation



LS 2006; cf: LS 2012 fig 5-9

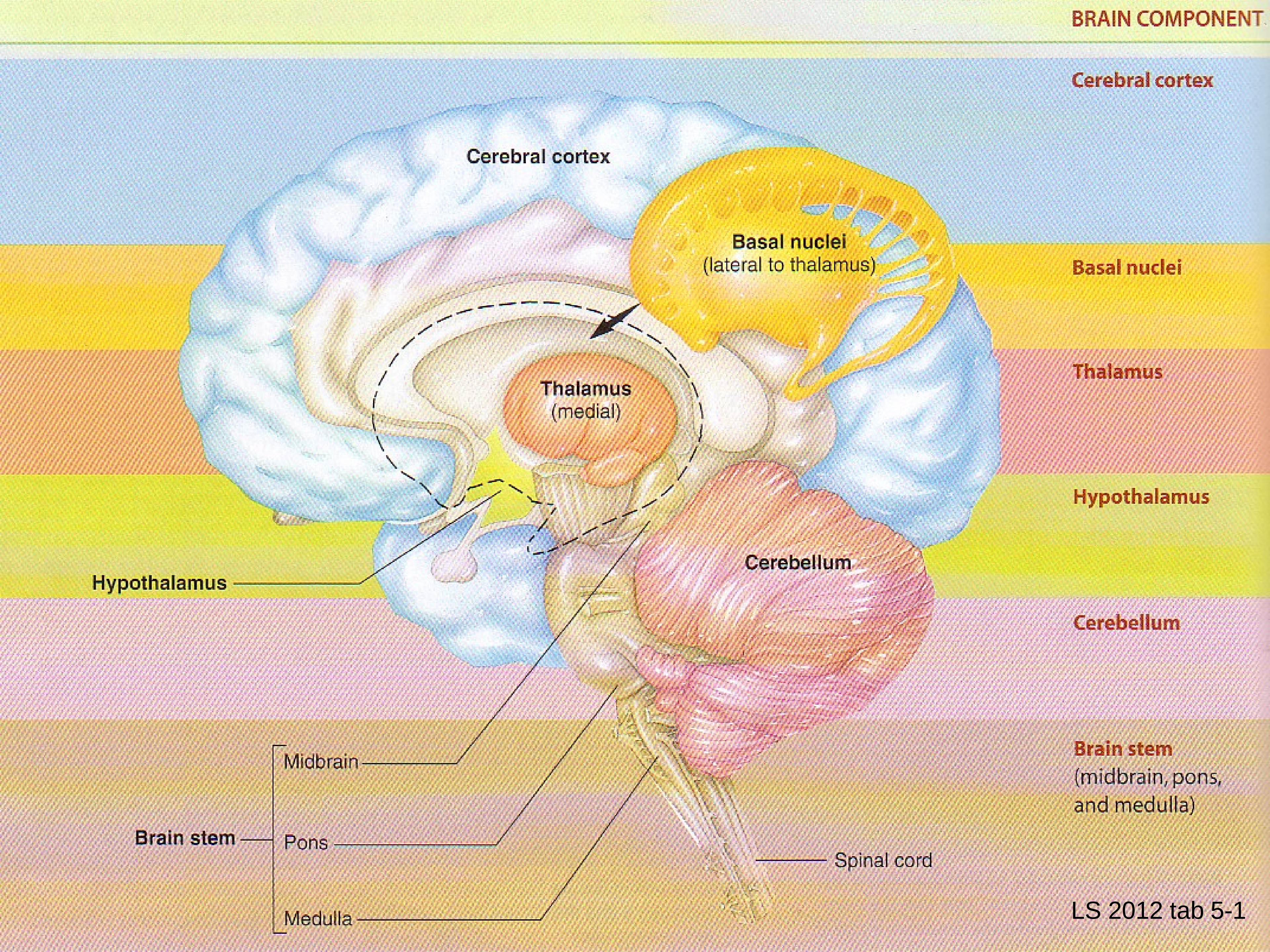


DC 2003; cf: LS 2012 fig 5-6

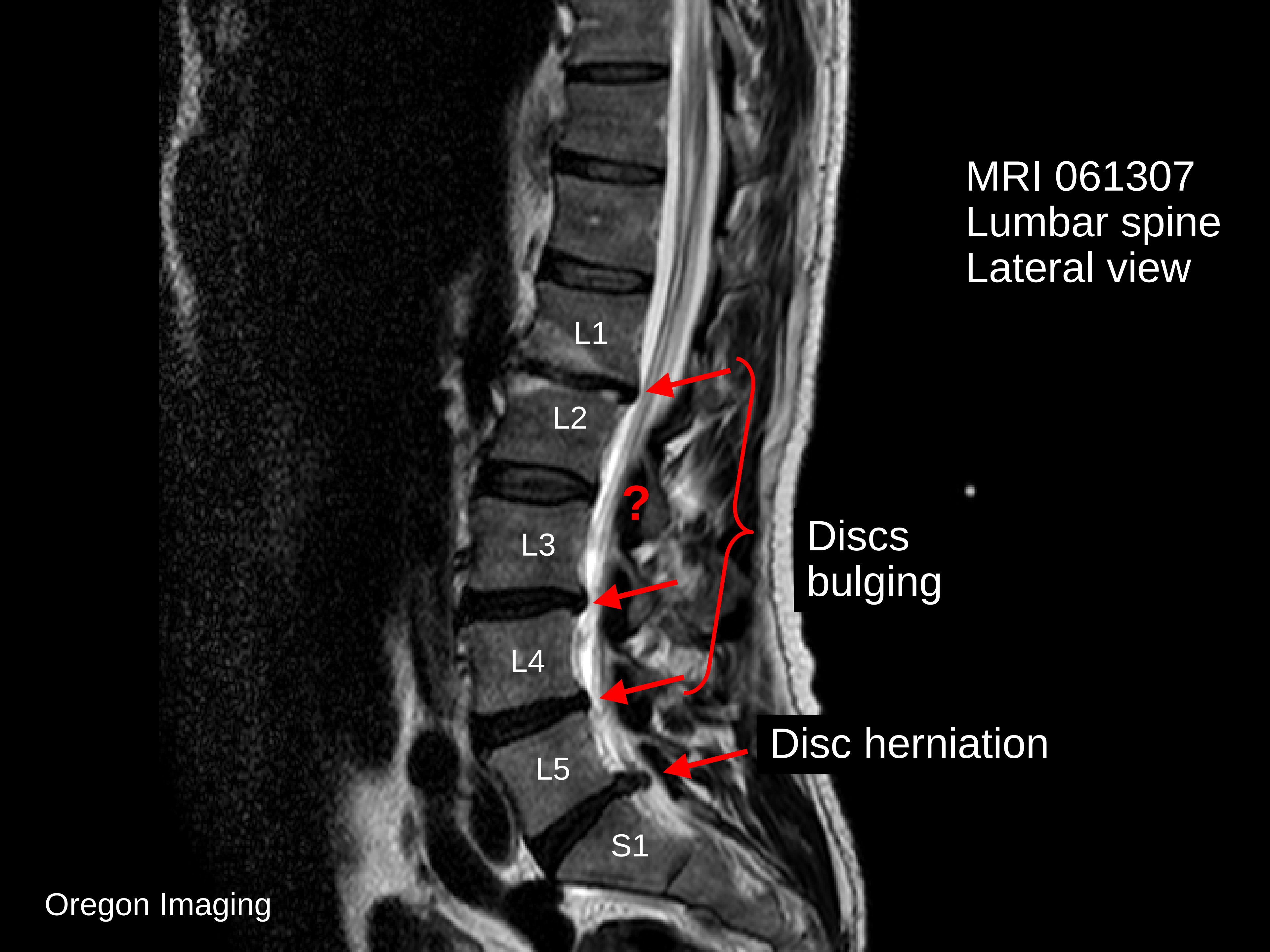


☀ *300 million axons enable R & L hemisphere cross-talk!!*

DC 2003



LS 2012 tab 5-1

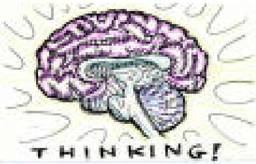

MRI 061307
Lumbar spine
Lateral view
L1
L2
L3
L4
L5
S1
?
Discs
bulging
Disc herniation
Oregon Imaging

MRI 061307
Lumbar spine
Axial view

Oregon Imaging

9.4 x 8.1 mm
Protrusion

Helmets Cheap, Brains Expensive!!
Use Your Head, Get a Helmet!!
http://www-nrd.nhtsa.dot.gov/Pubs/811743.pdf
http://www.bhsi.org/stats.htm



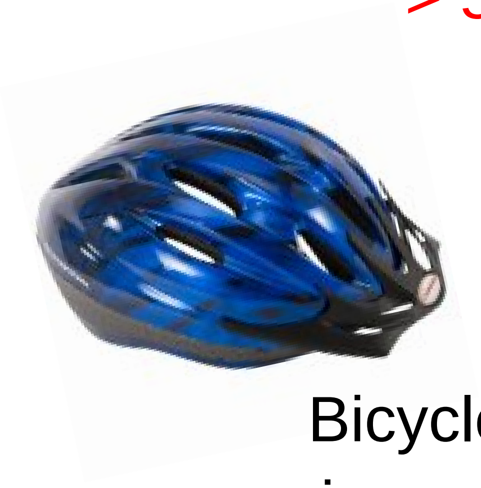
~540,000 bicyclists/yr visit emergency rooms

67,000 head injuries, 1 in 8 brain injuries

677 cyclists died in 2011 ≡ 2% of all traffic fatalities

9% of deaths children ≤ 14 yr, 69% ♂

> 54,000 cyclists have died since 1932



As of 2012, the population of

Albany, OR 51,322

Corvallis, OR 54,998

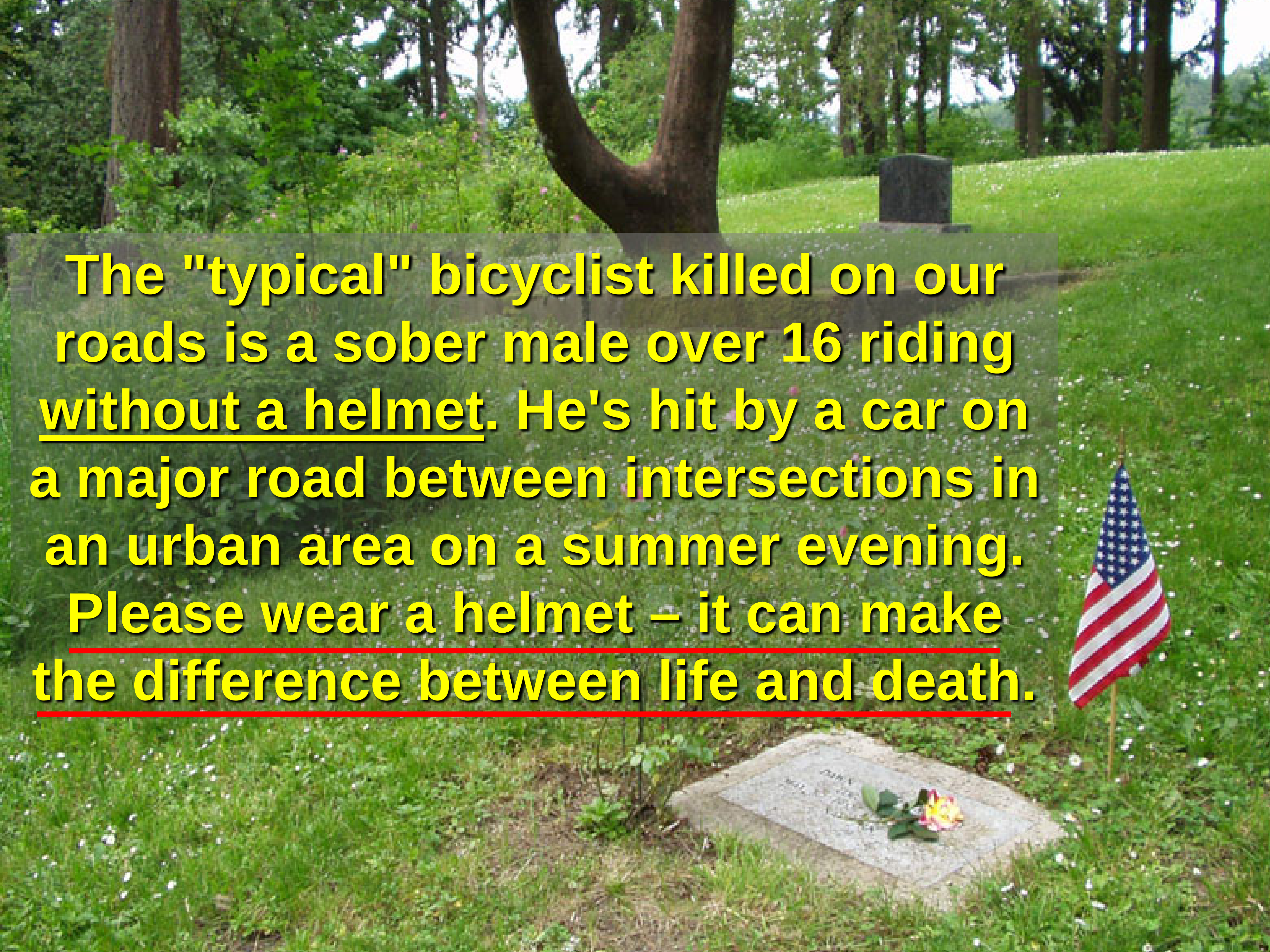
Springfield, OR 59,869

Bicycle crashes & injuries are under reported,

since majority not serious enough for ER visits.

Helmets may reduce head & brain injury risk by 66-88%!

~$81 million/yr = direct 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.

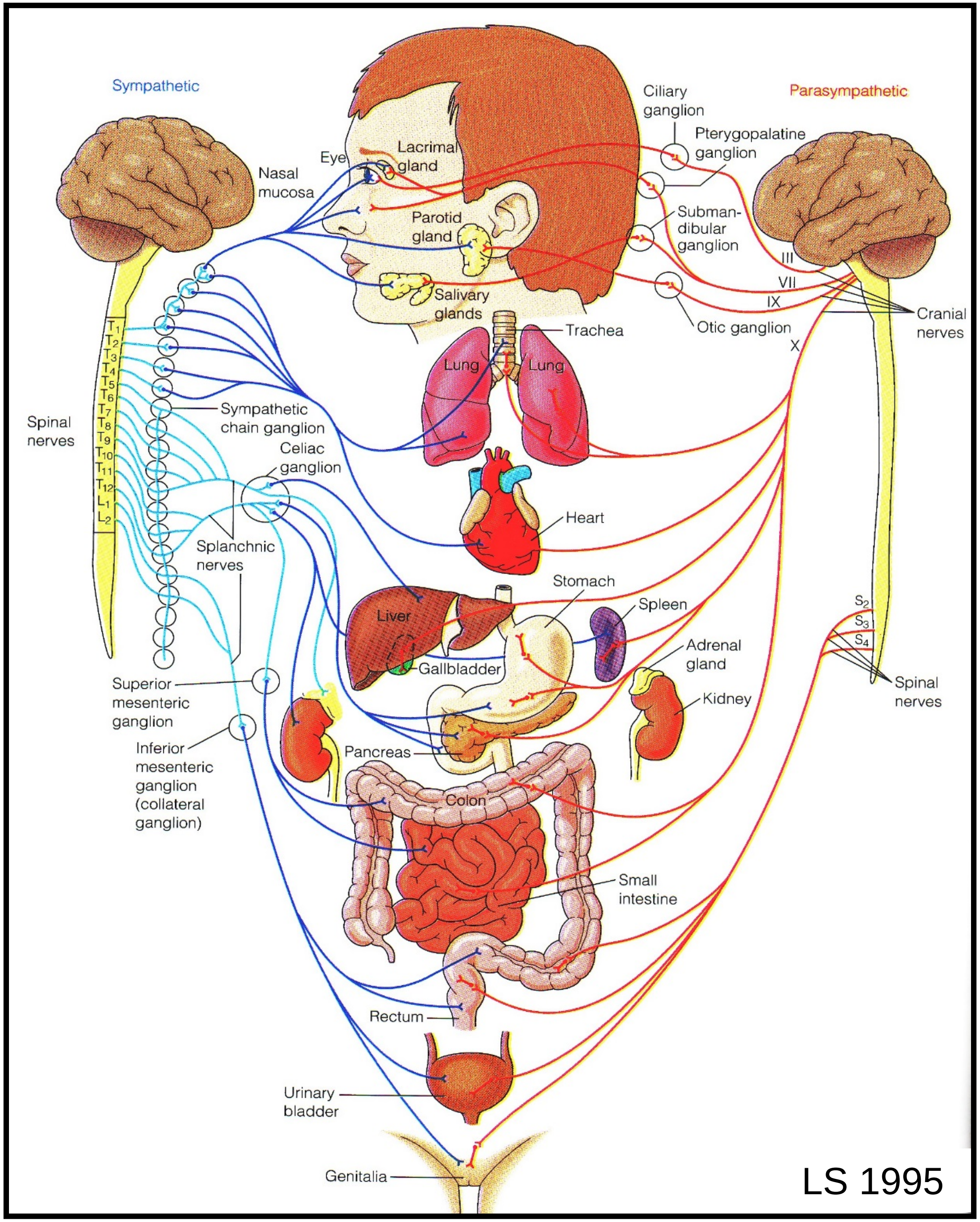
Stories, Discussion, Questions or Comments!

Autonomic Nervous System

Why overlap or dual innervation?

Fine-tune control & safety!

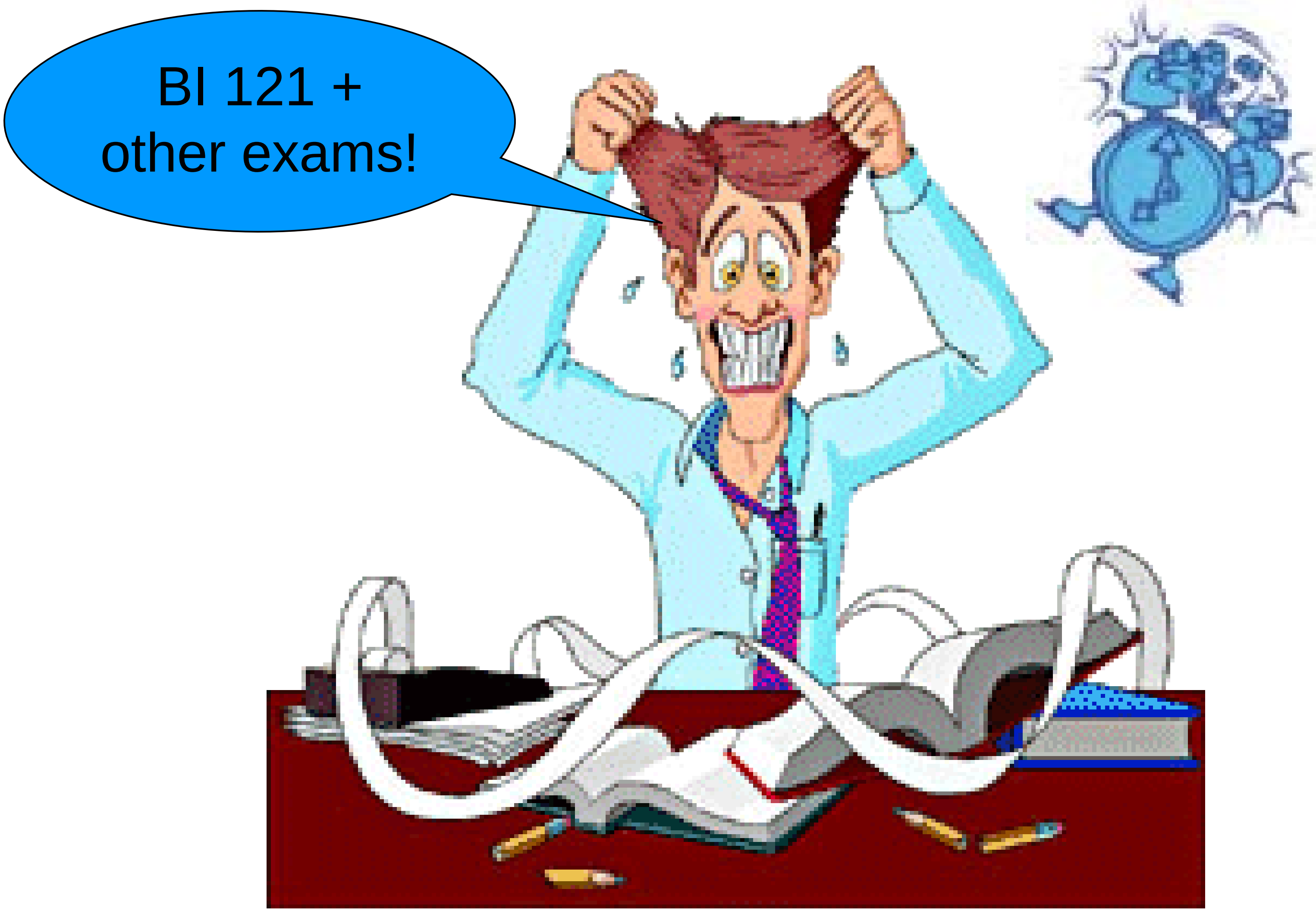
cf: LS 2012 fig 7-3



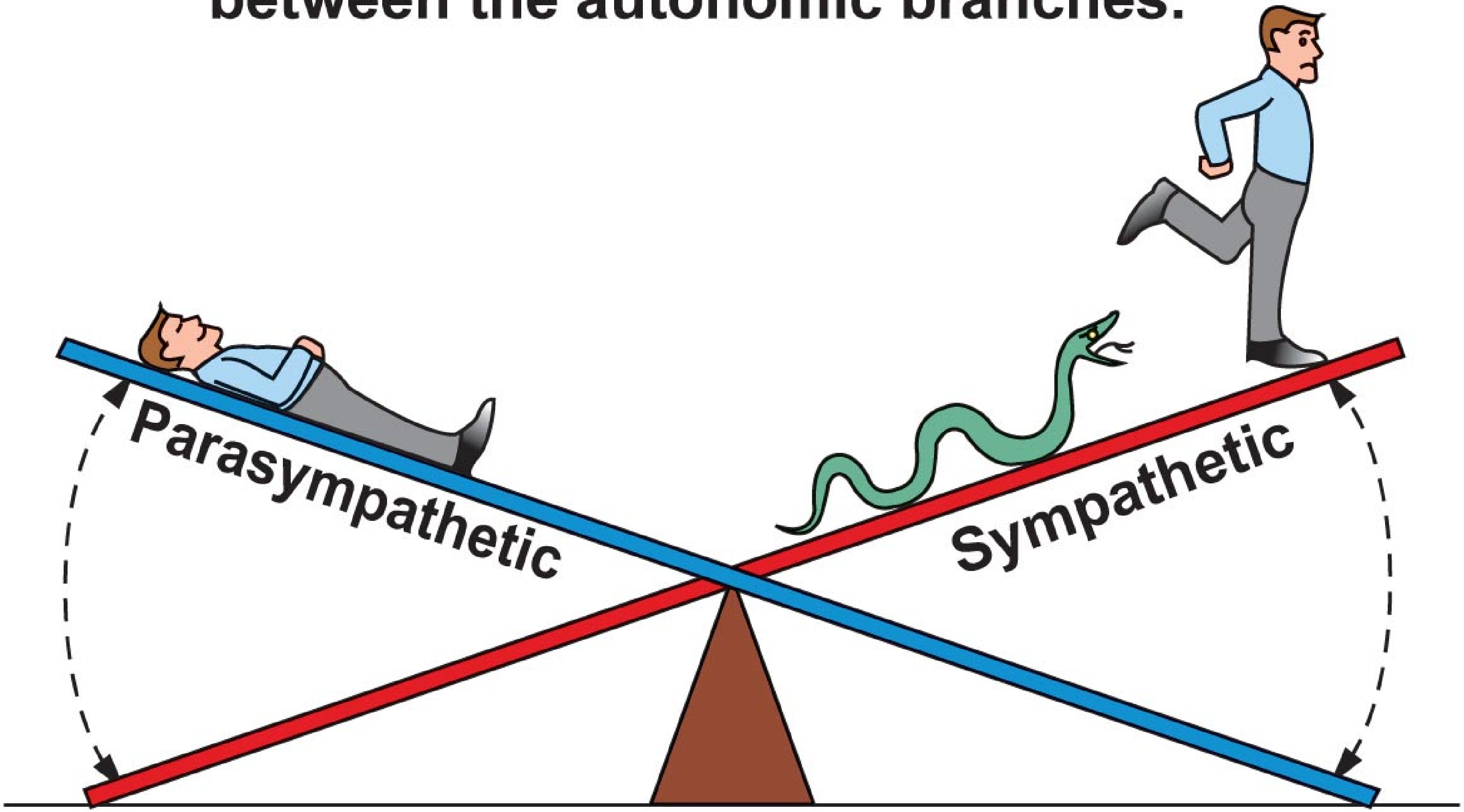
LS 1995


PARASYMPATHETIC = RESTING, DIGESTIVE,
HOUSEKEEPING FUNCTIONS

FIGHT/FLIGHT/ALARM REACTION!!



Homeostasis is a dynamic balance between the autonomic branches.

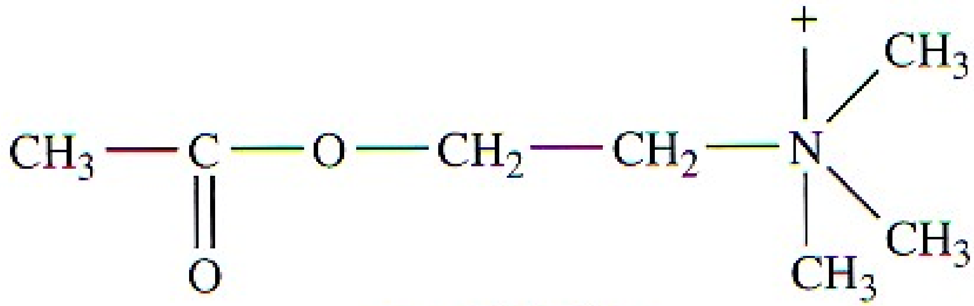


Rest-and-digest: Parasympathetic activity dominates.

Fight-or-flight: Sympathetic activity dominates.

D Silverthorn 2010

Autonomic Neurotransmitters & Receptors

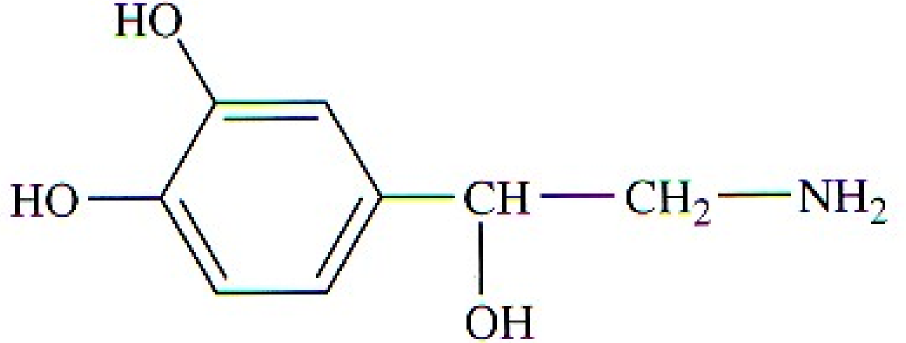


Acetylcholine

<u>*Cholinergic*</u>

Nicotinic

Muscarinic



Norepinephrine

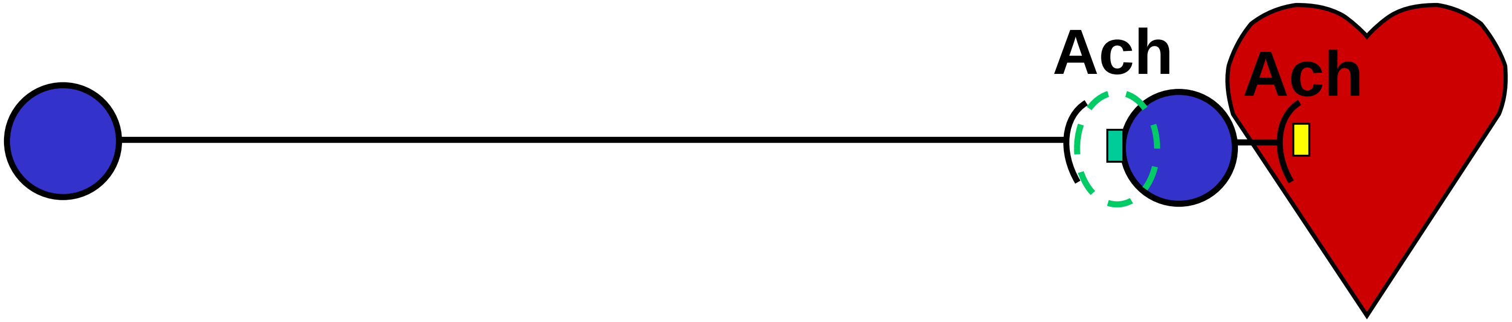
<u>*Adrenergic*</u>

α = Alpha

β = Beta

G&H 2011 p 731-3

Parasympathetic

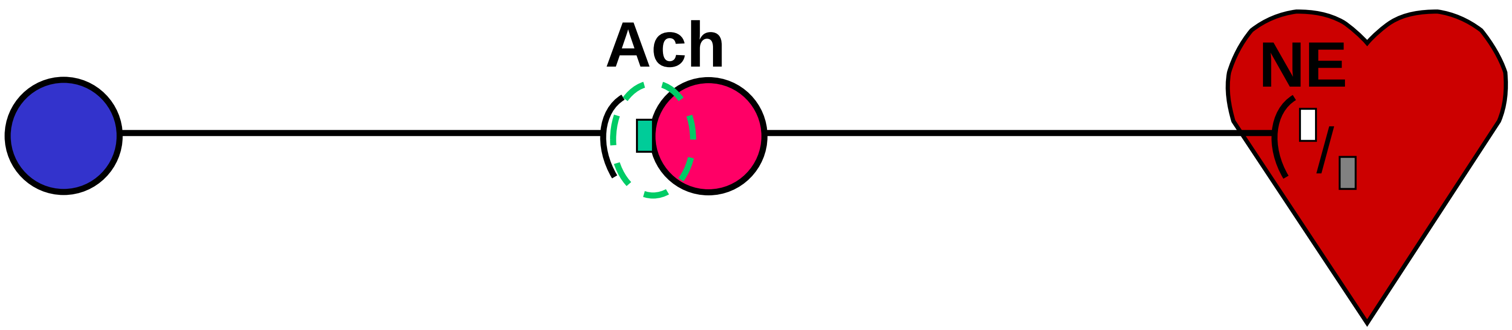


Ach = Acetylcholine

= Nicotinic Receptor

= Muscarinic Receptor

Sympathetic



NE = Norepinephrine

= α Receptor (α_1 , α_2)

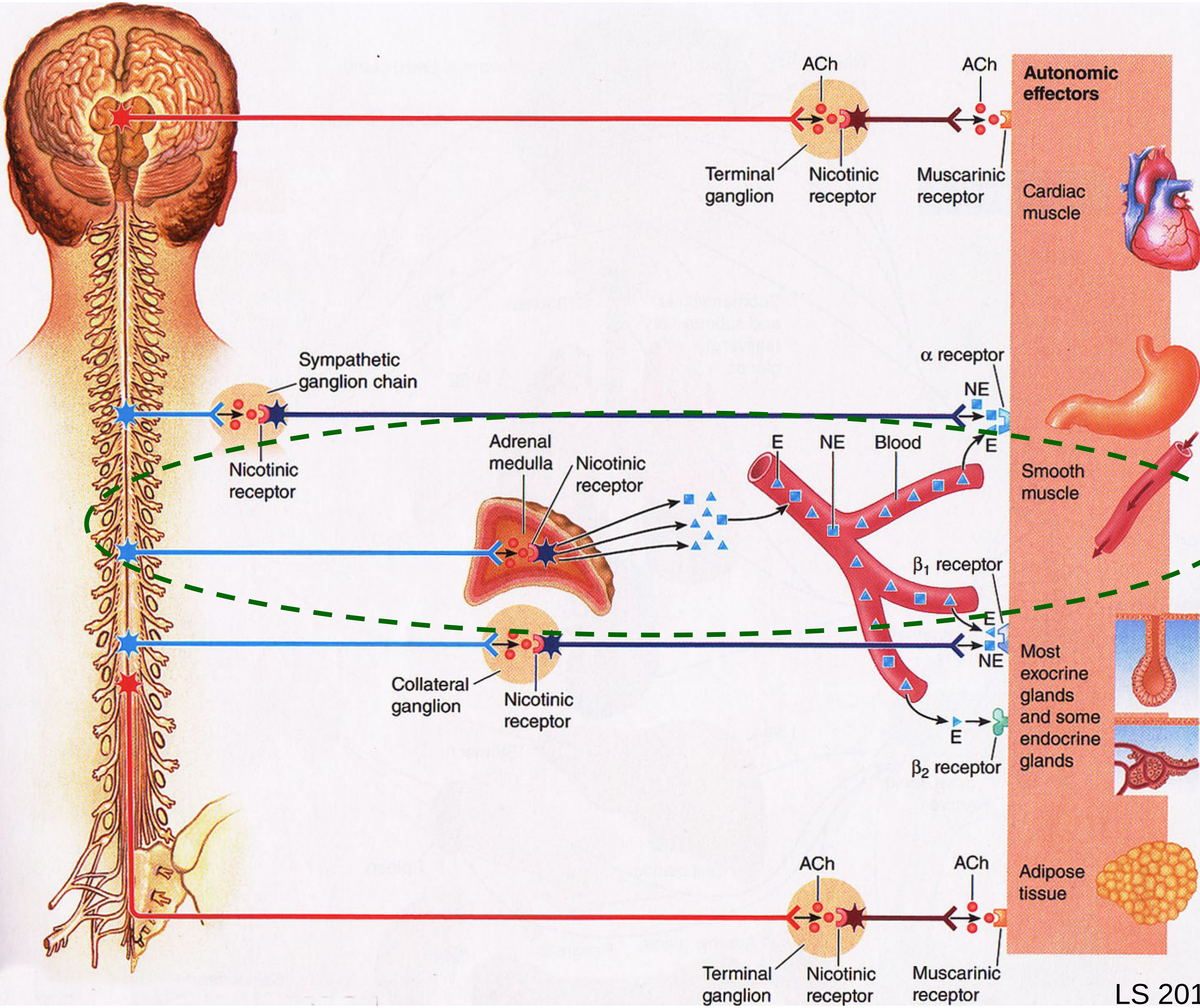
= β Receptor (β_1 , β_2)

Nicotine activates both Sympathetic & Parasympathetic post-ganglionic neurons!

Problem?

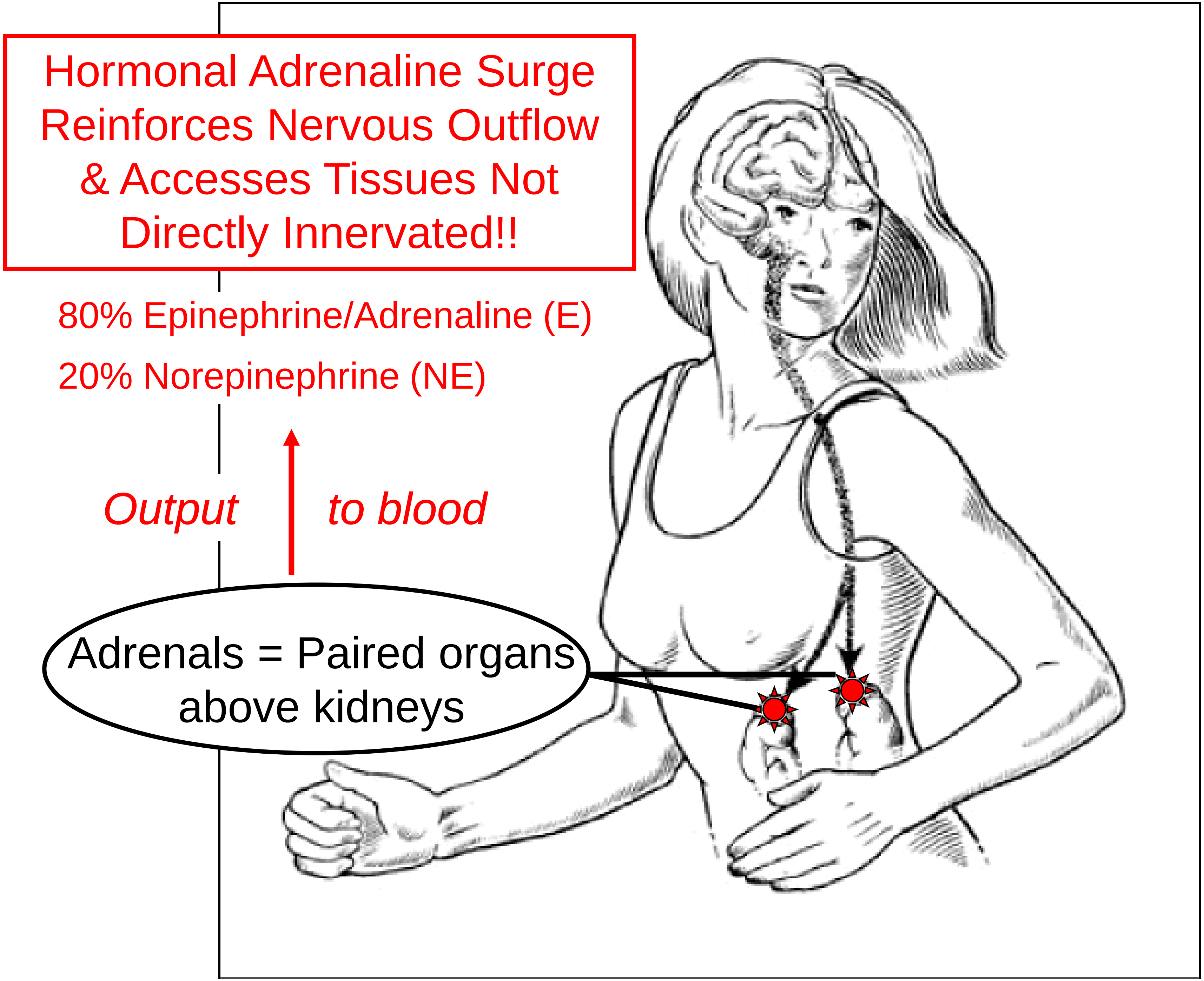
Like hammering the gas pedal & brake at the same time!!

Autonomic Nervous System Innervation

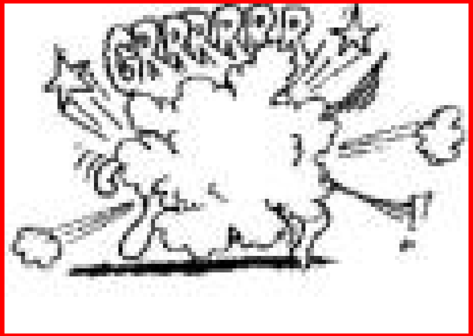


LS 2012 fig 7-2

In <u>Sympathetic Fight-or-Flight</u> why is it important to activate the adrenals?


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