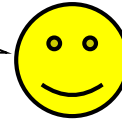


Thanks to you, Courtney, Eli,  
Nelson & Katie!

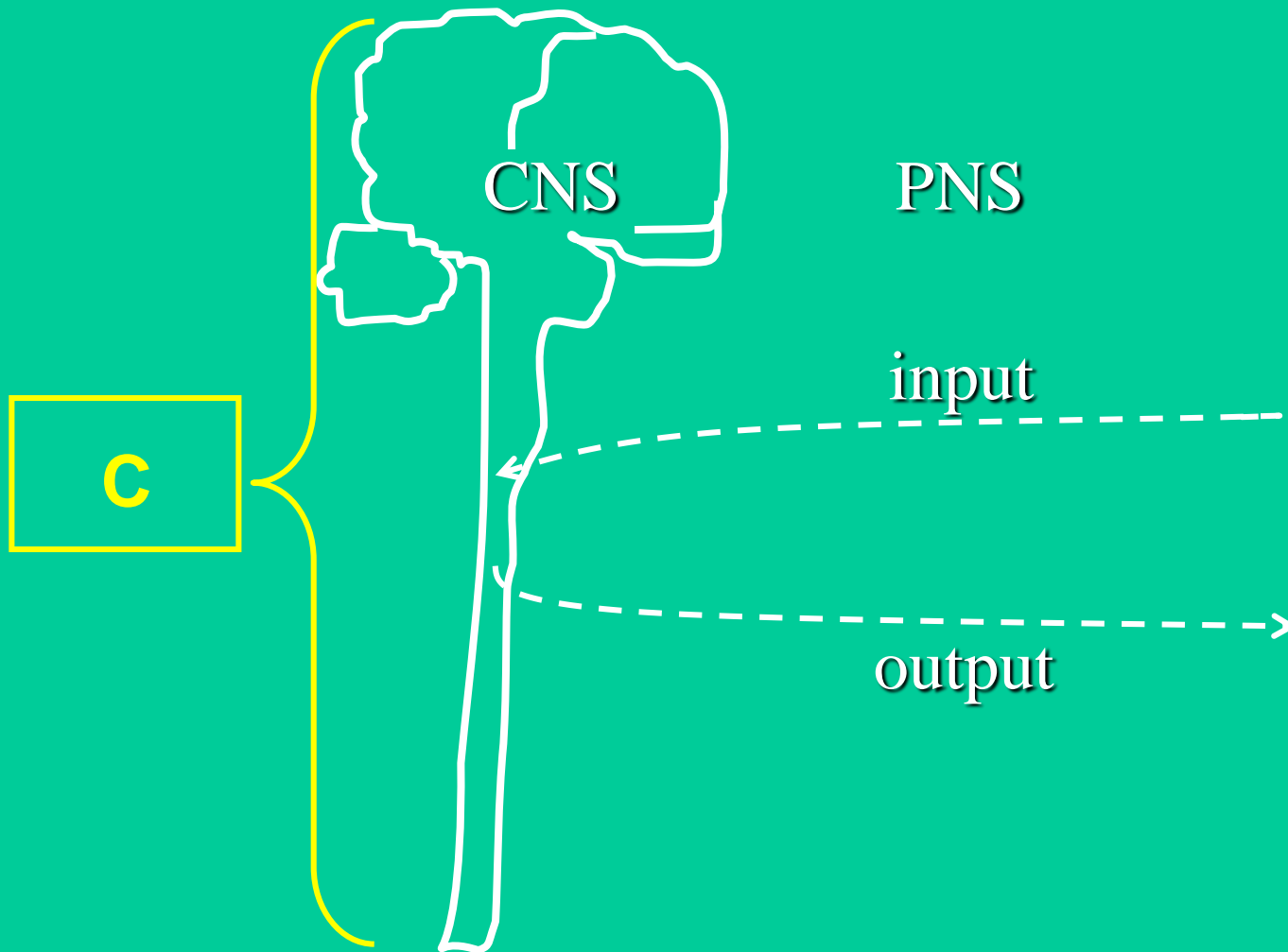


For your effort  
& your 🩸 !!

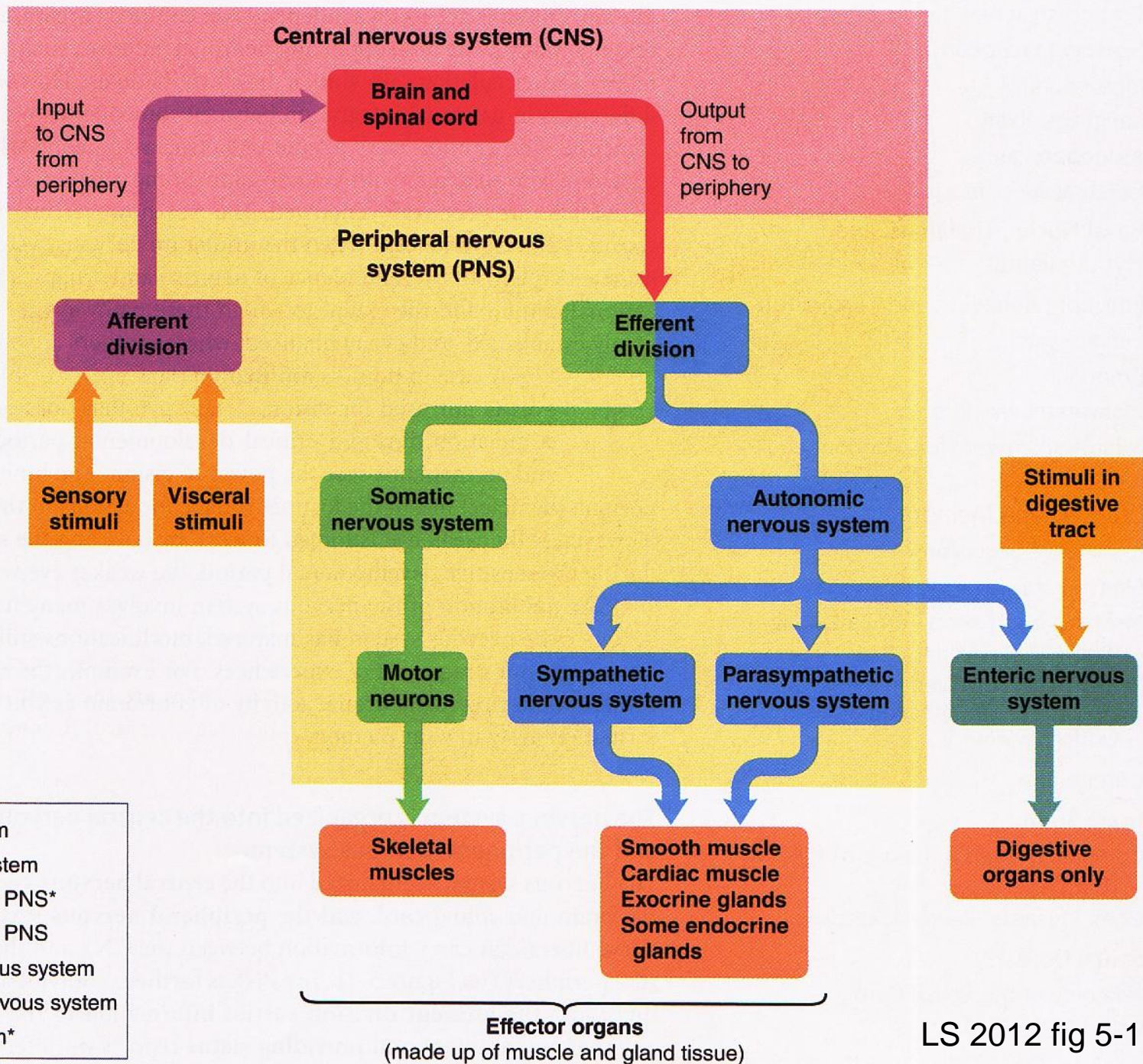
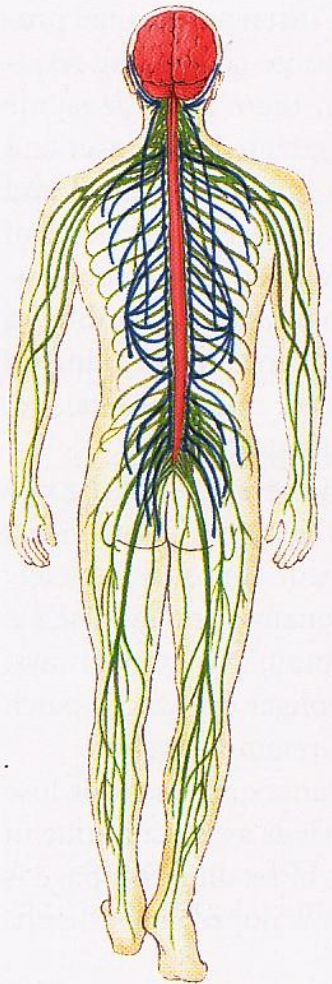
## BI 121 Lecture 12

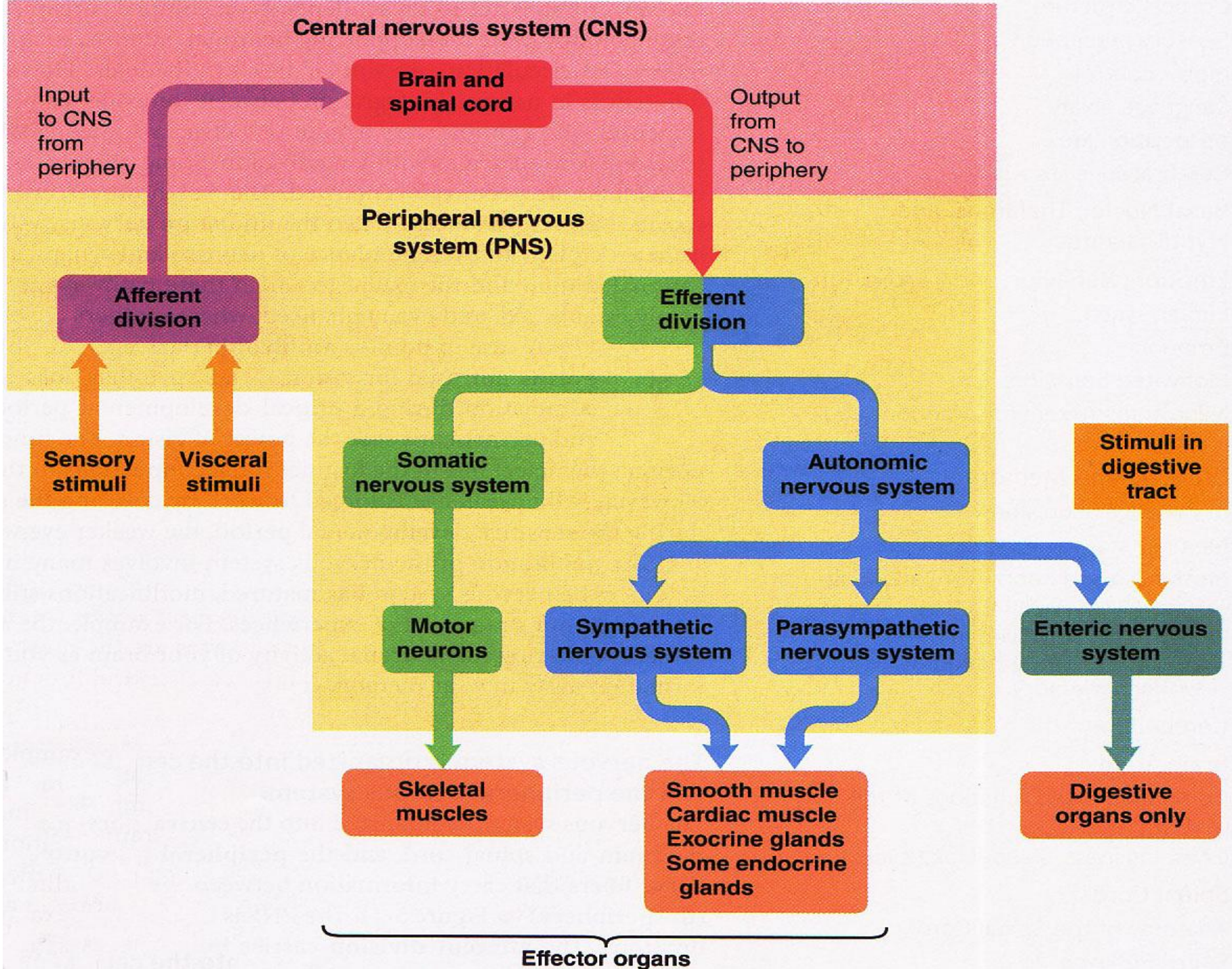
- I. **Announcements** Thanks for your help with blood lab! Great job! No lab this week. Study for Exam II, Dec 7, Friday, 8 am!
- II. **Introduction to the Nervous System** LS ch 5, DC Module 9
  - A. How is the nervous system organized? LS fig 5-1 DC p 67
  - B. Neurons? What kind? Classes? Velocity? 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 2013 & 2014
- III. **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!

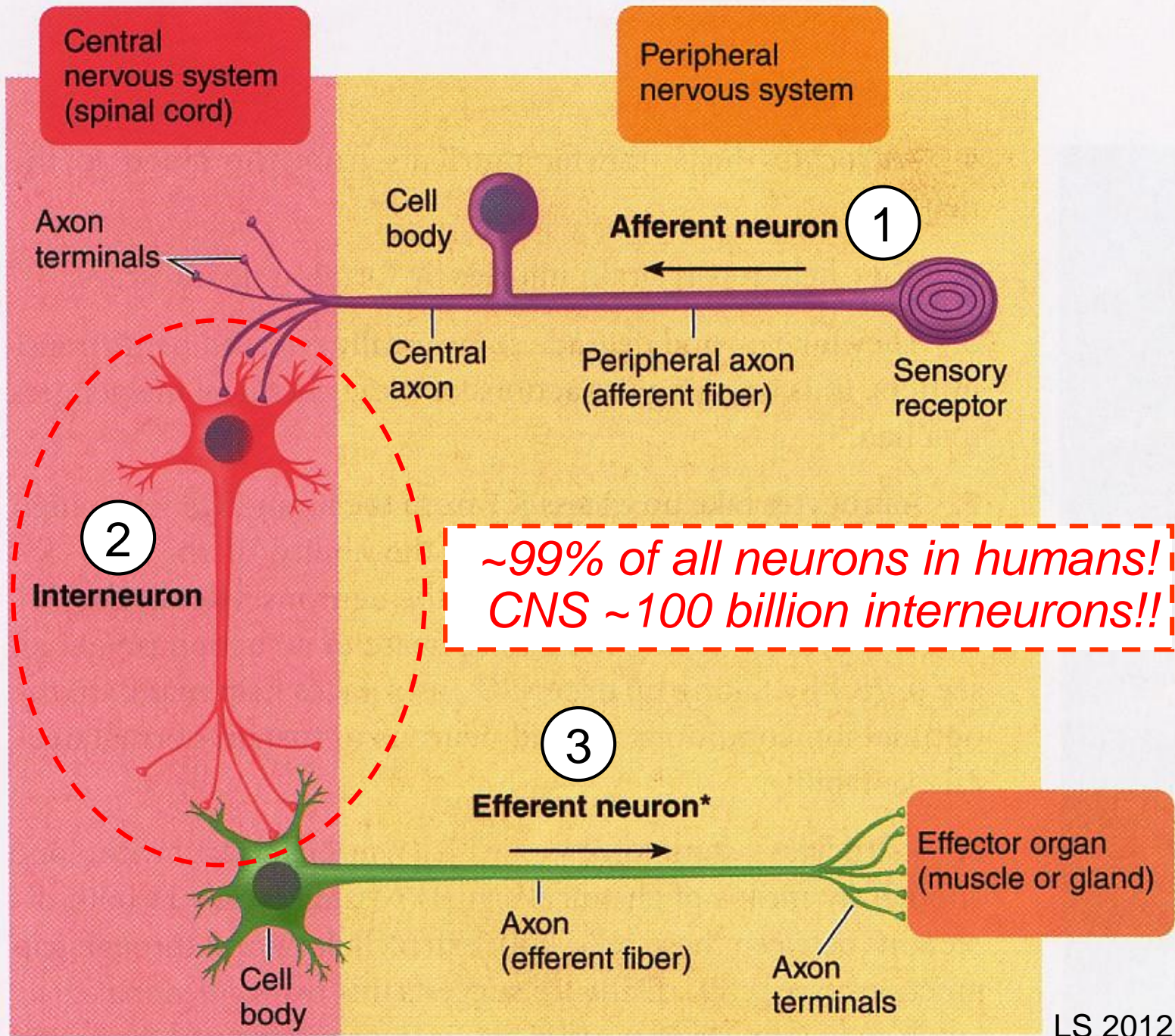
# Nervous System



[https://www.youtube.com/watch?v=uU\\_4uA6-zcE&vl=ko](https://www.youtube.com/watch?v=uU_4uA6-zcE&vl=ko)



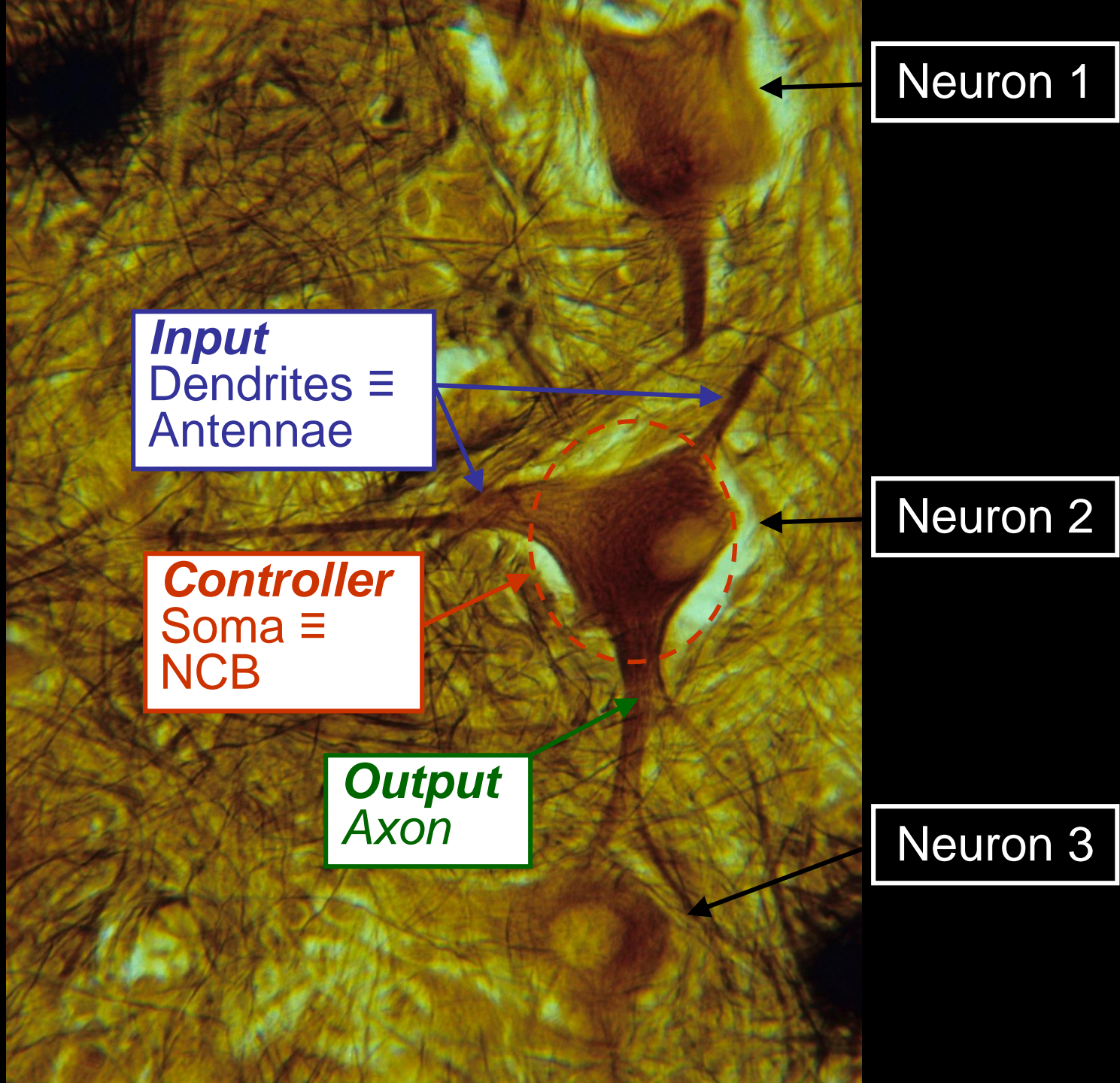




~ 90% of Cells w/in CNS are not neurons but glial cells  $\equiv$  neuroglia or nerve glue!

Astrocytes

A fluorescence micrograph showing several astrocytes. The cells are stained with a red dye that highlights their complex, branching cytoplasmic processes. The cell bodies are stained with a purple dye. The background is dark, with some blue-stained nuclei visible. Two white arrows point from the text 'Astrocytes' to two of the purple-stained cell bodies.



Neuron 1

**Input**  
Dendrites ≡  
Antennae

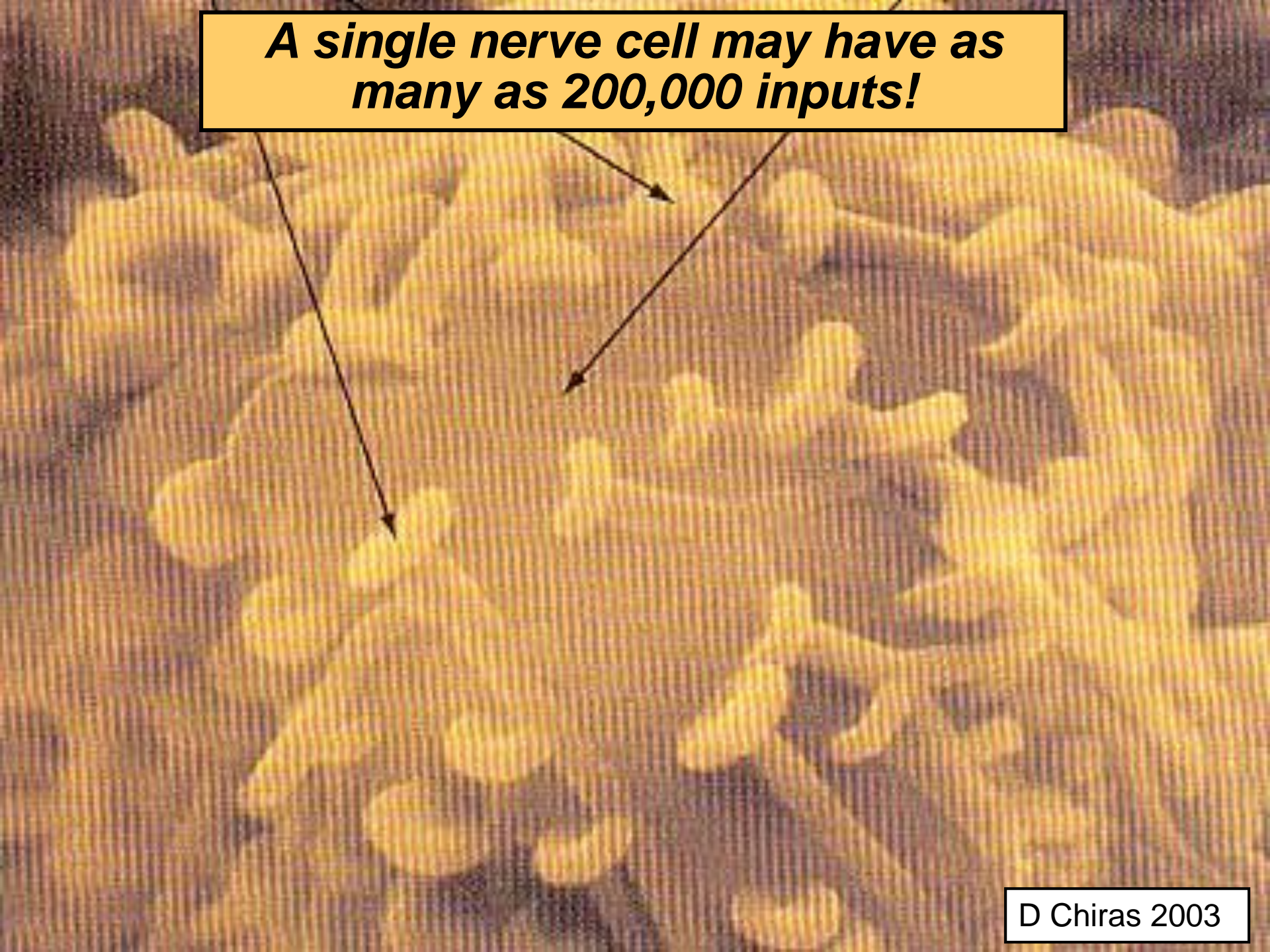
Neuron 2

**Controller**  
Soma ≡  
NCB

**Output**  
Axon

Neuron 3

***A single nerve cell may have as many as 200,000 inputs!***



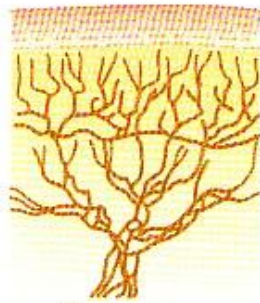


***Nerve cell with multiple axons grown by adding  
a mitogen/neurogen  $\equiv$  nerve growth factor!***



Courtesy Fengquan Zhou  
UNC Chapel Hill

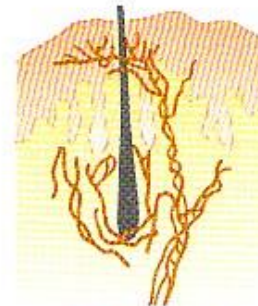
**Sensory nerves especially, come in all shapes & sizes!**



Free nerve endings



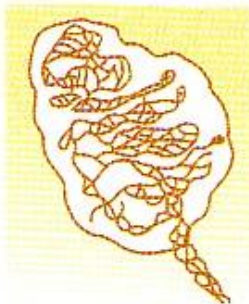
Expanded tip receptor



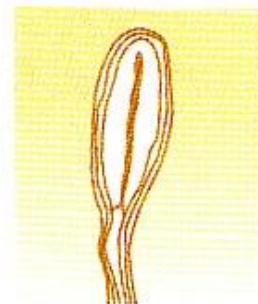
Tactile hair



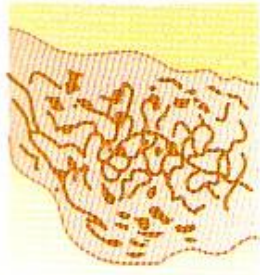
Pacinian corpuscle



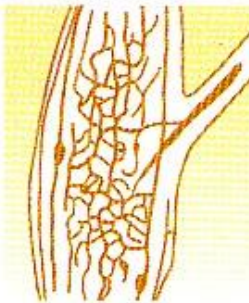
Meissner's corpuscle



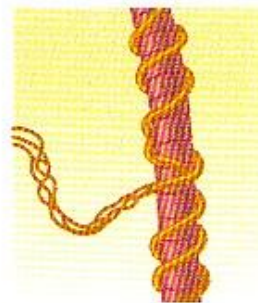
Krause's corpuscle



Ruffini's end-organ



Golgi tendon apparatus



Muscle spindle

**Figure 46-1**

Several types of somatic sensory nerve endings.

# Nerve Extremes: Far ends of the Continuum

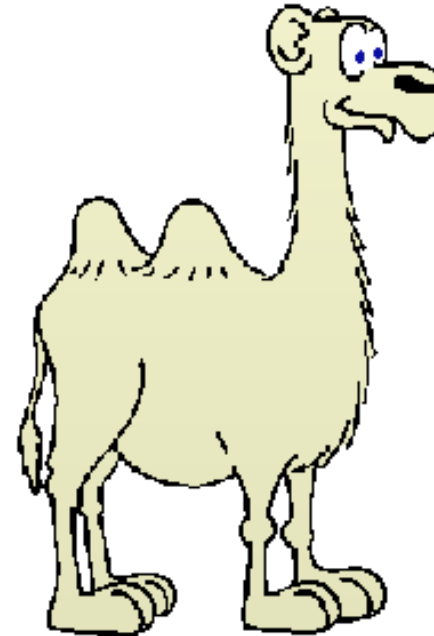
A = Large to medium  
myelinated, up to  
( 120 m/sec )

$\alpha, \beta, \gamma, \delta$

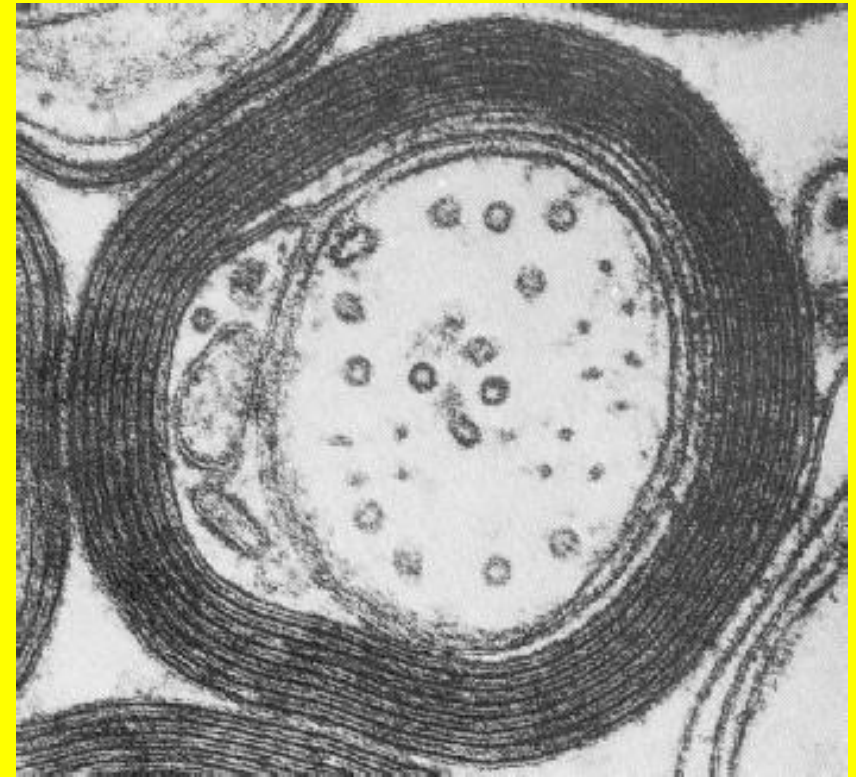
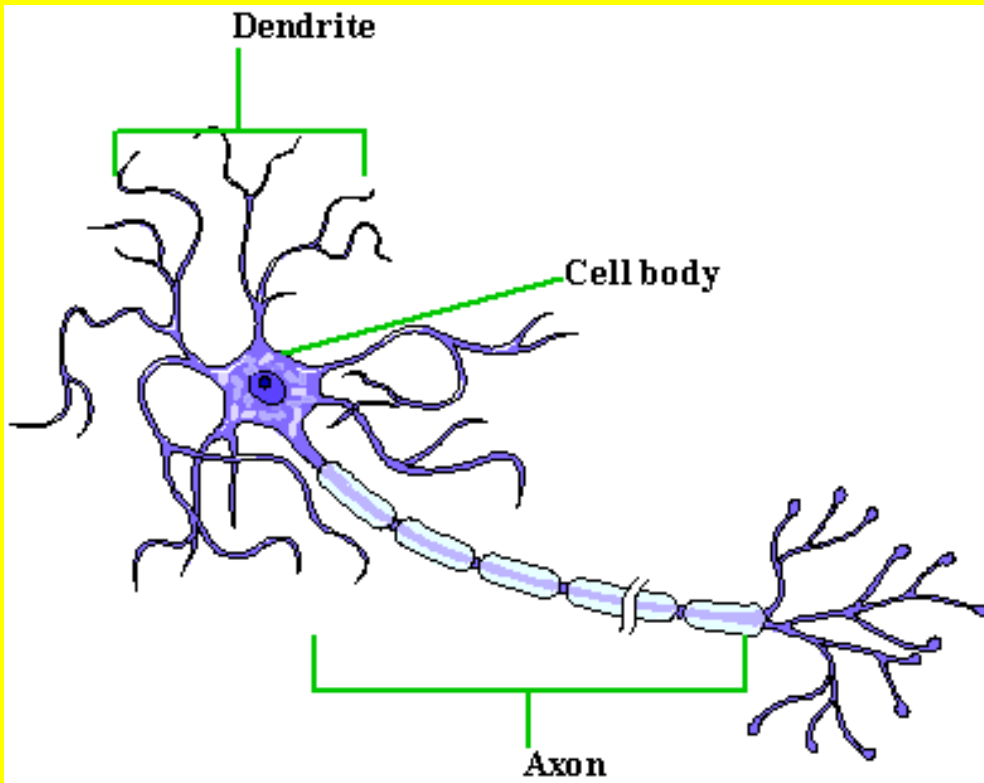


C = Small  
unmyelinated,  
( 0.25 m/sec )

IV

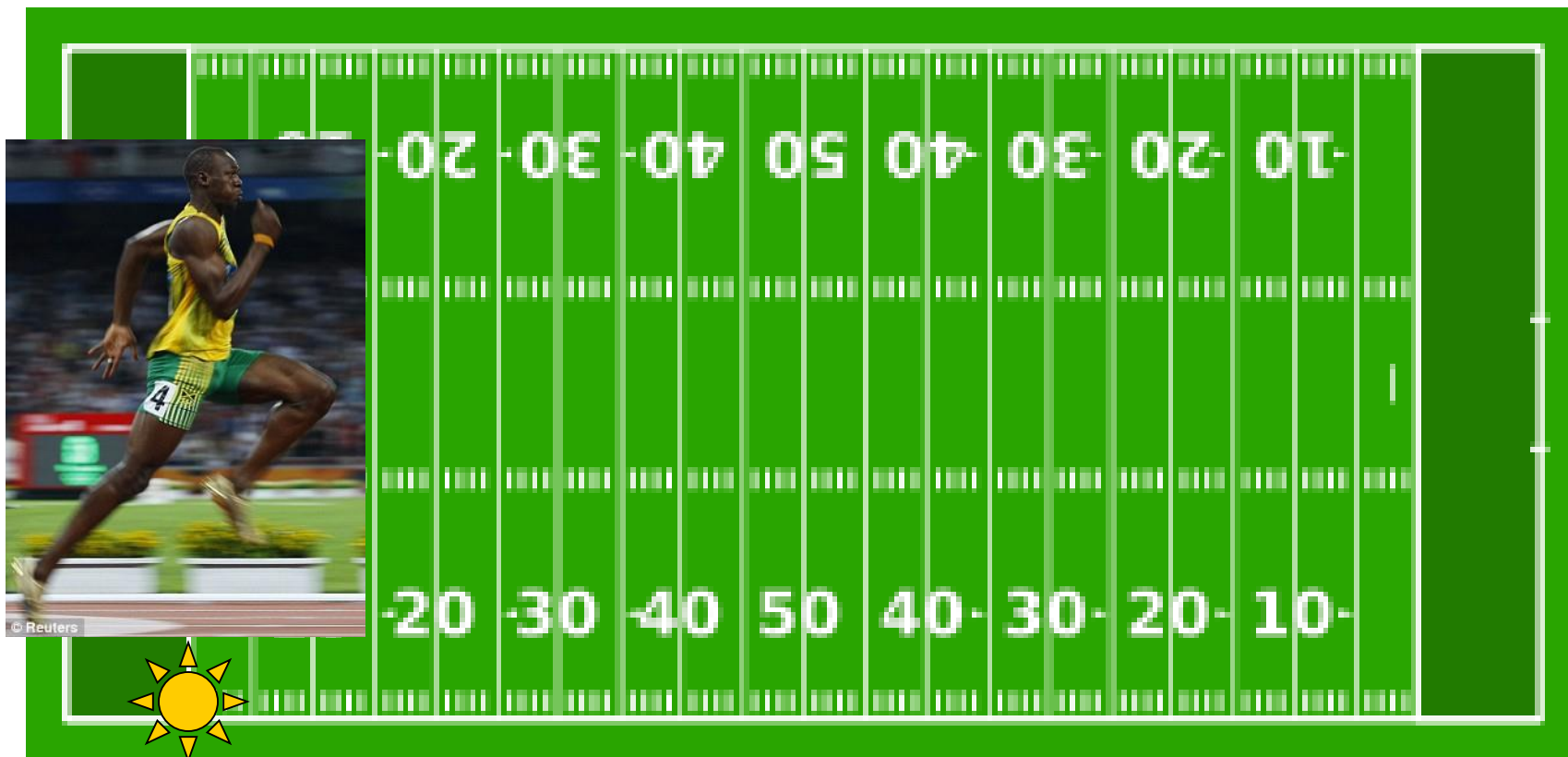


# *What is myelin? Why is it important?*

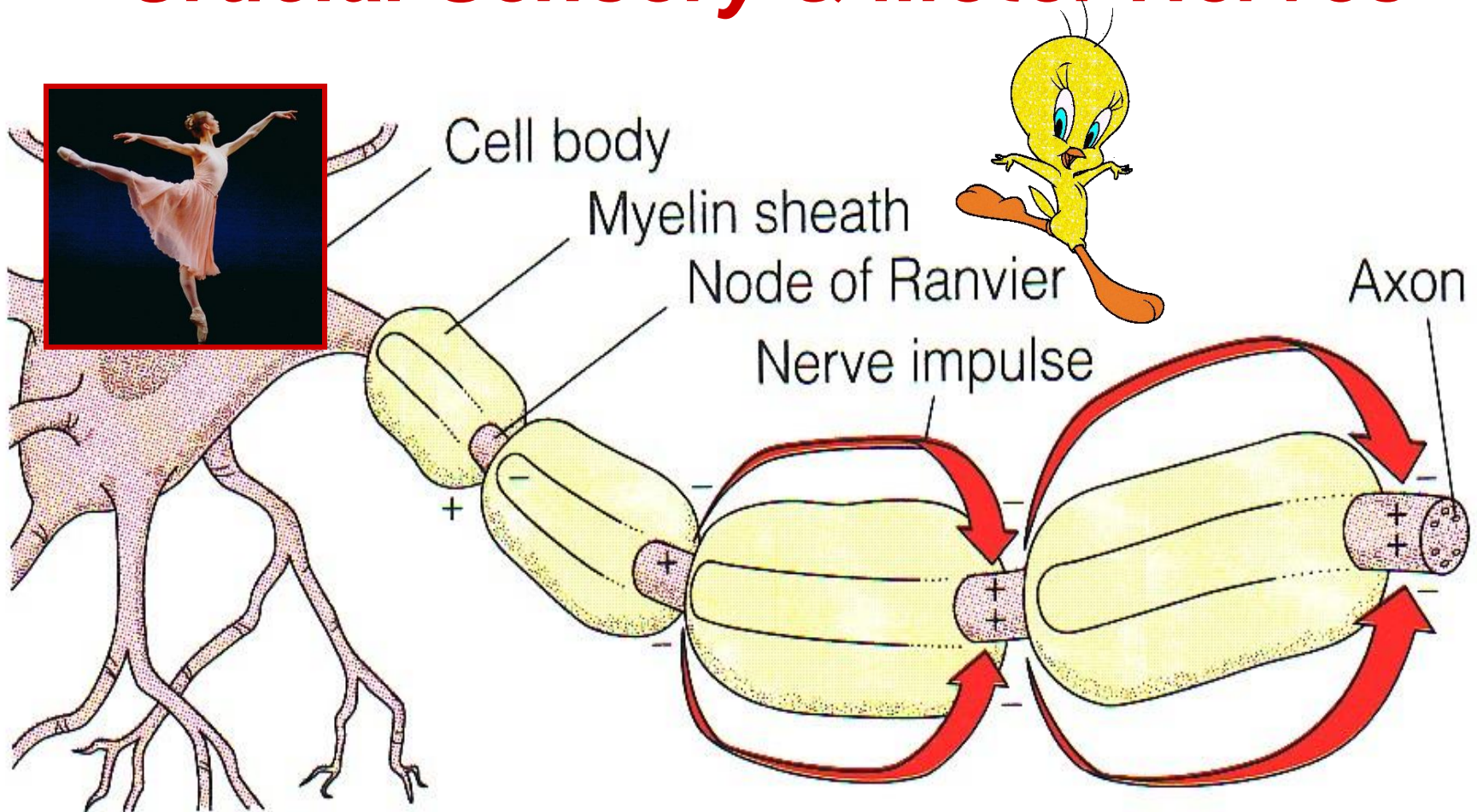


*Lipid insulative coat*  
 $\uparrow \vec{v}$ , *conserves ions & ATP*

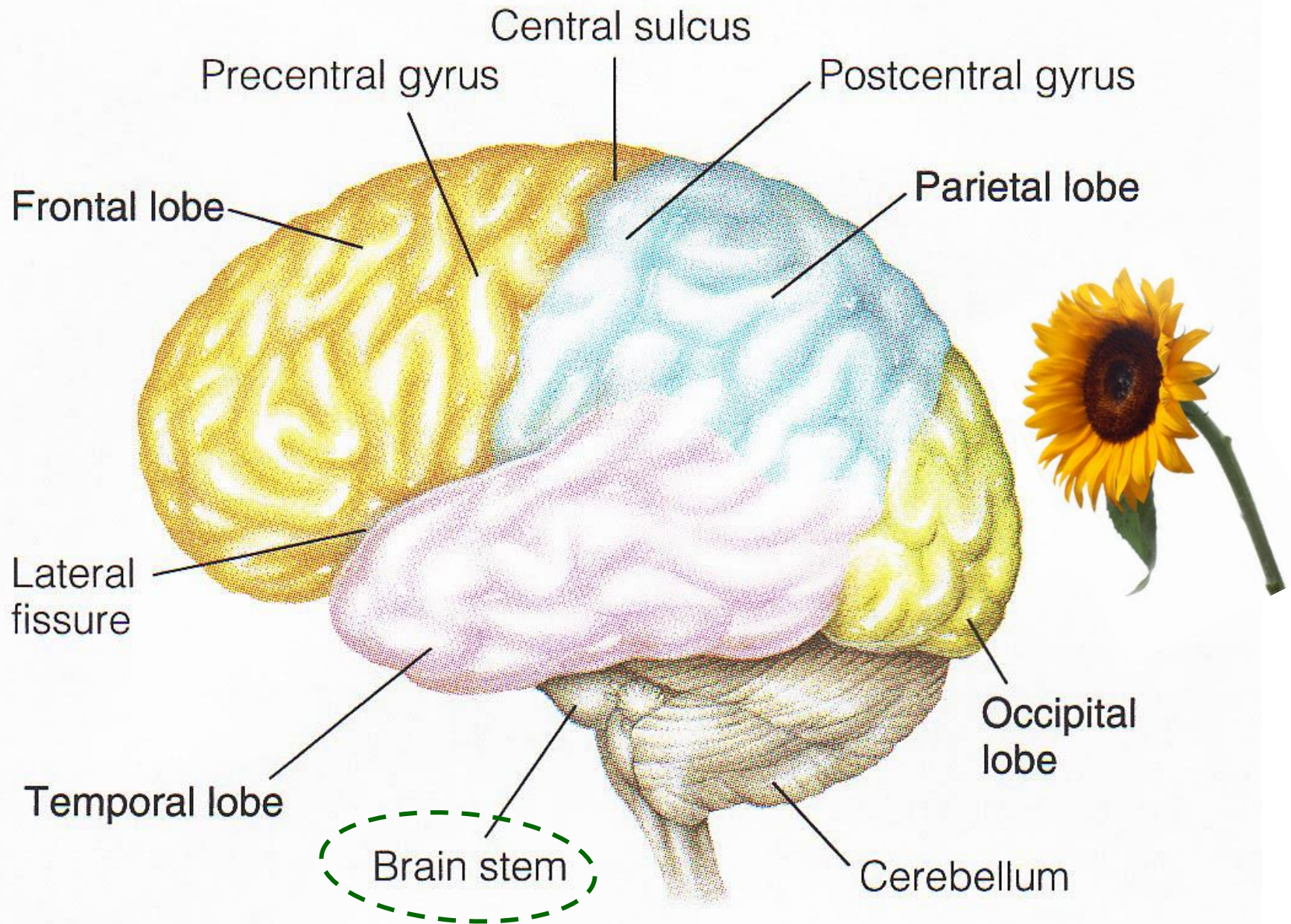
*A large myelinated "survival" nerve can conduct impulses the length of football field in < 1 second!*

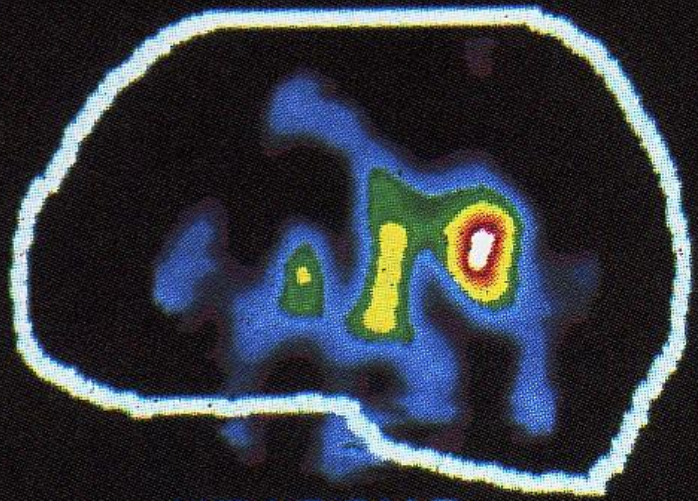


# Saltatory/Leaping Conduction! *Crucial Sensory & Motor Nerves*

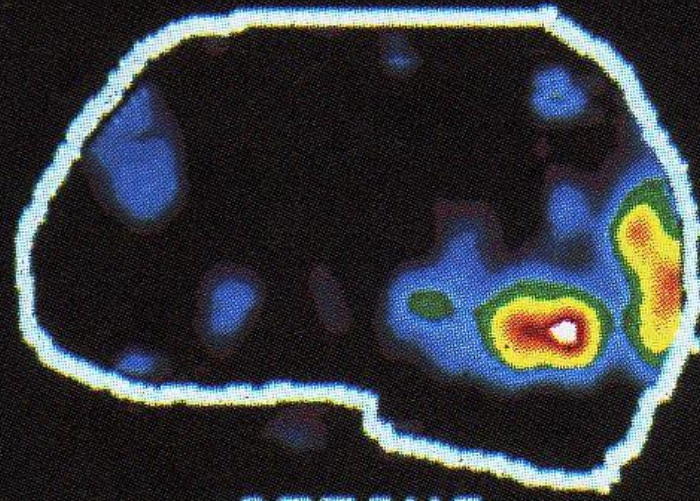


L. saltare to hop or leap! Fr. salt, sautier, sauté, leap, high air, vault

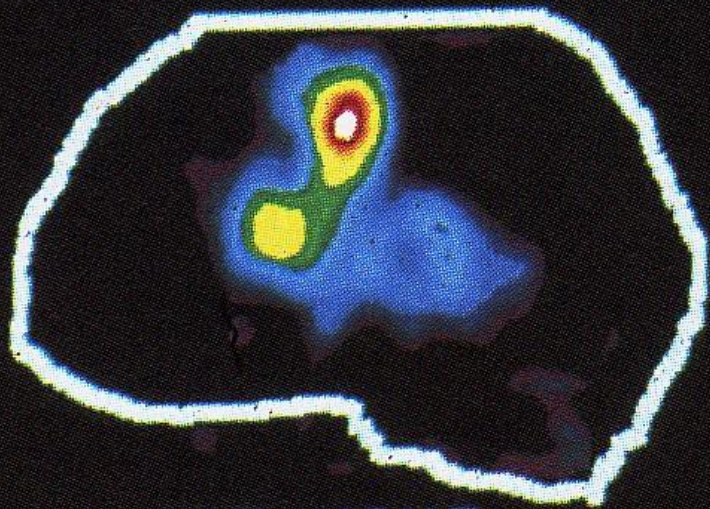




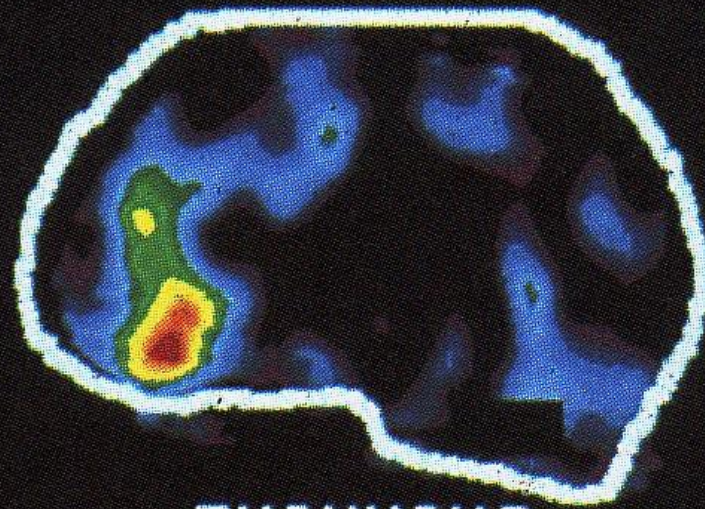
HEARING



SEEING



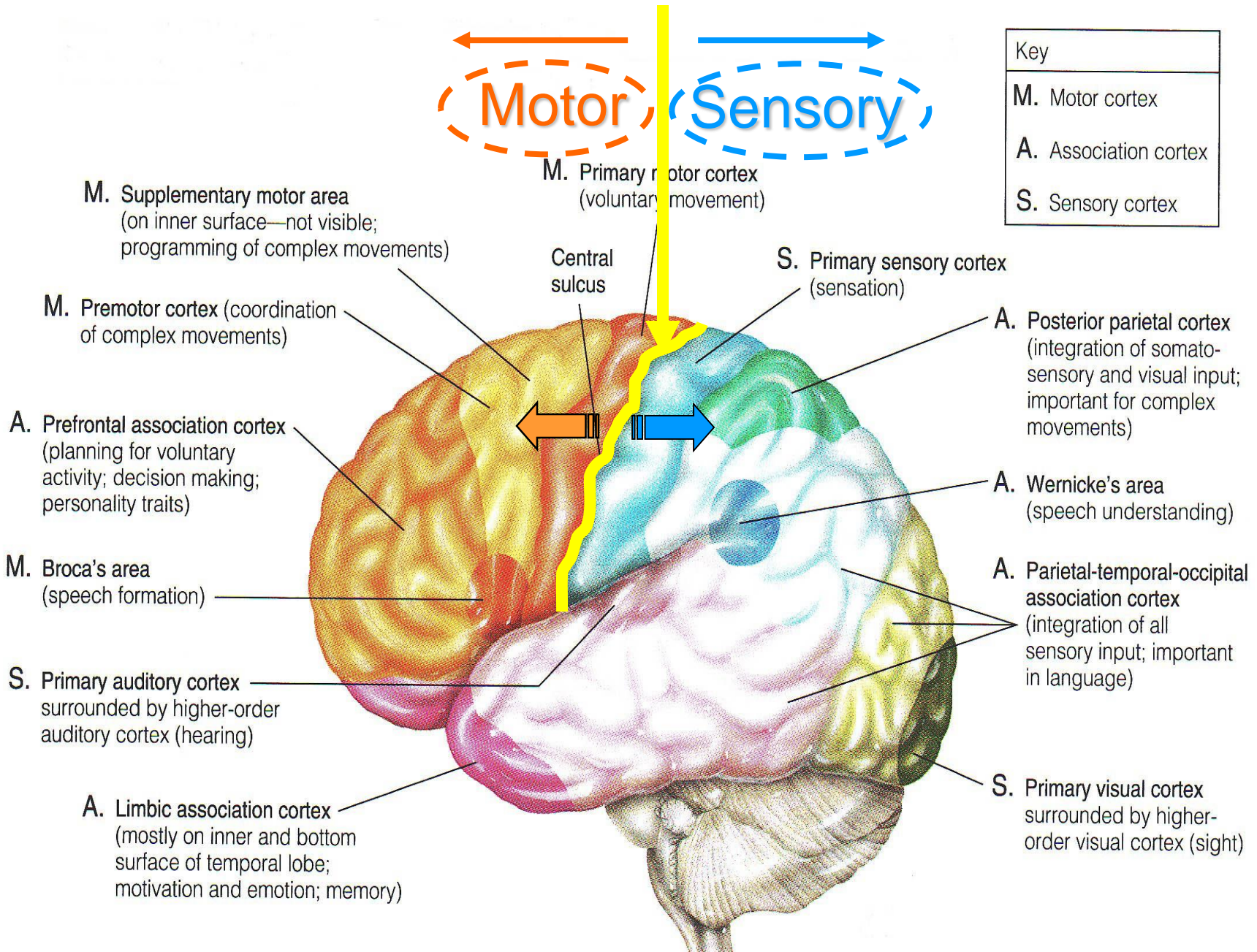
SPEAKING

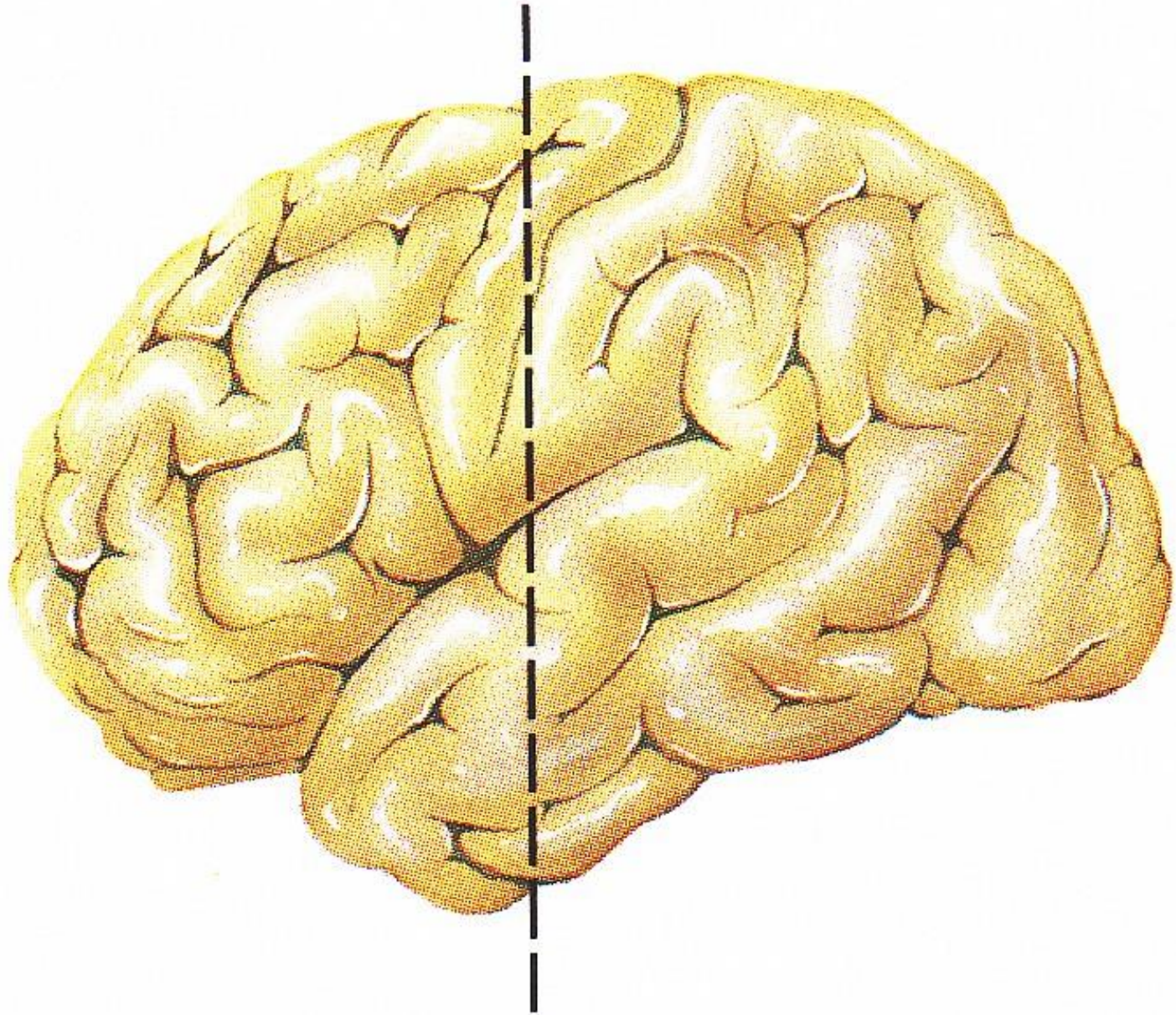


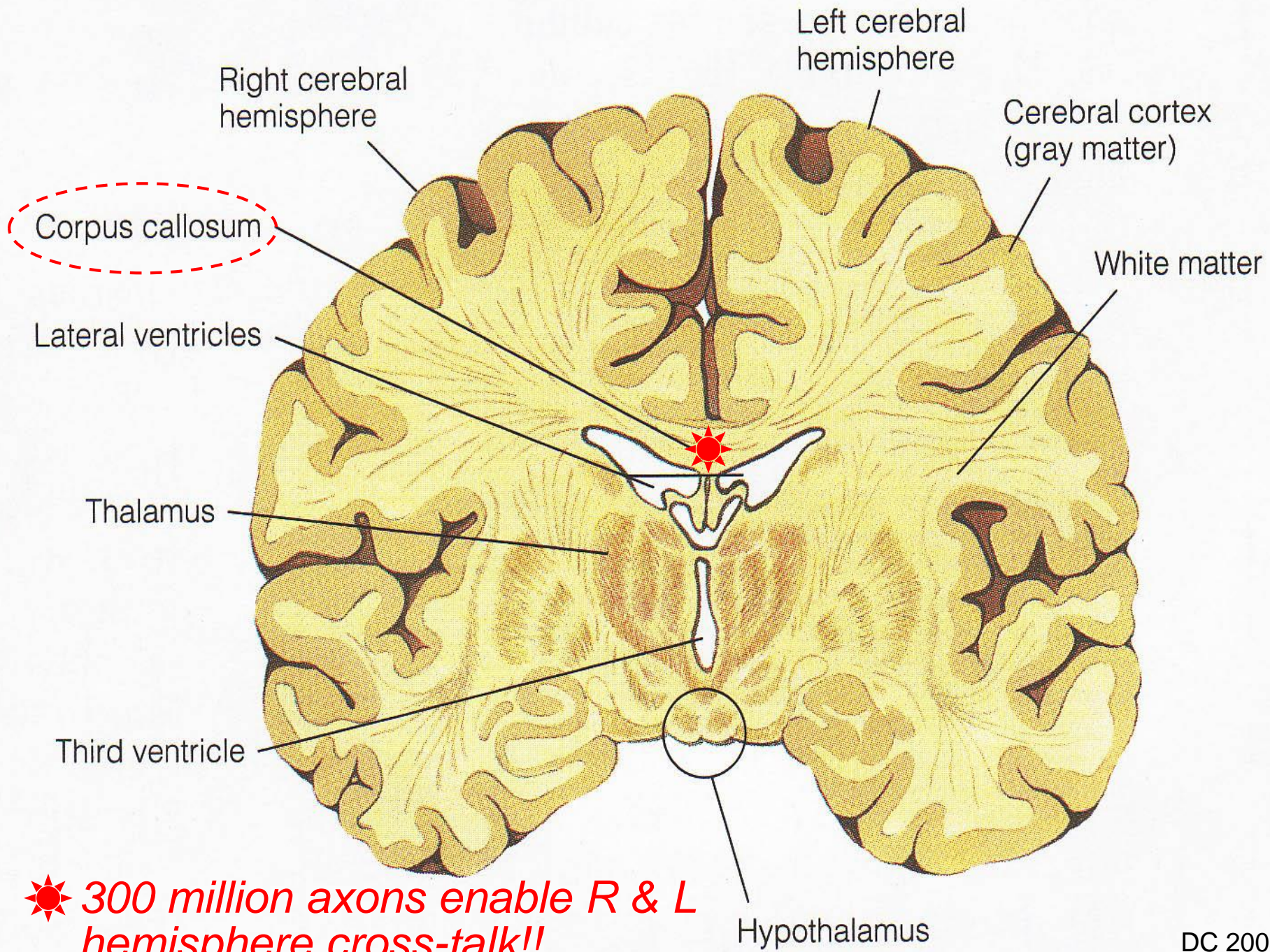
THINKING



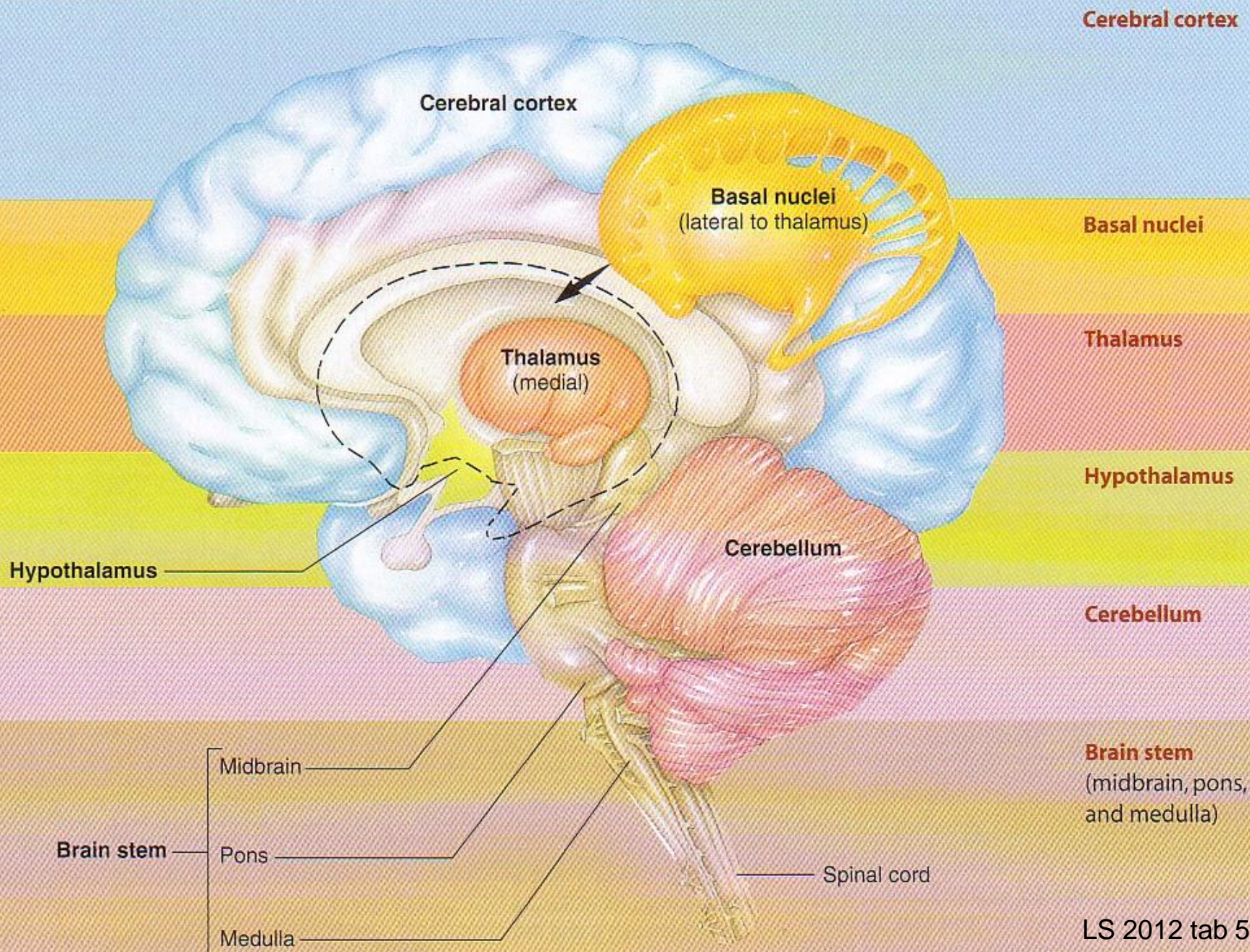








**★ 300 million axons enable R & L hemisphere cross-talk!!**



Cerebral cortex

Basal nuclei

Thalamus

Hypothalamus

Cerebellum

Brain stem  
(midbrain, pons,  
and medulla)

MRI 061307  
Lumbar spine  
Lateral view

L1

L2

L3

L4

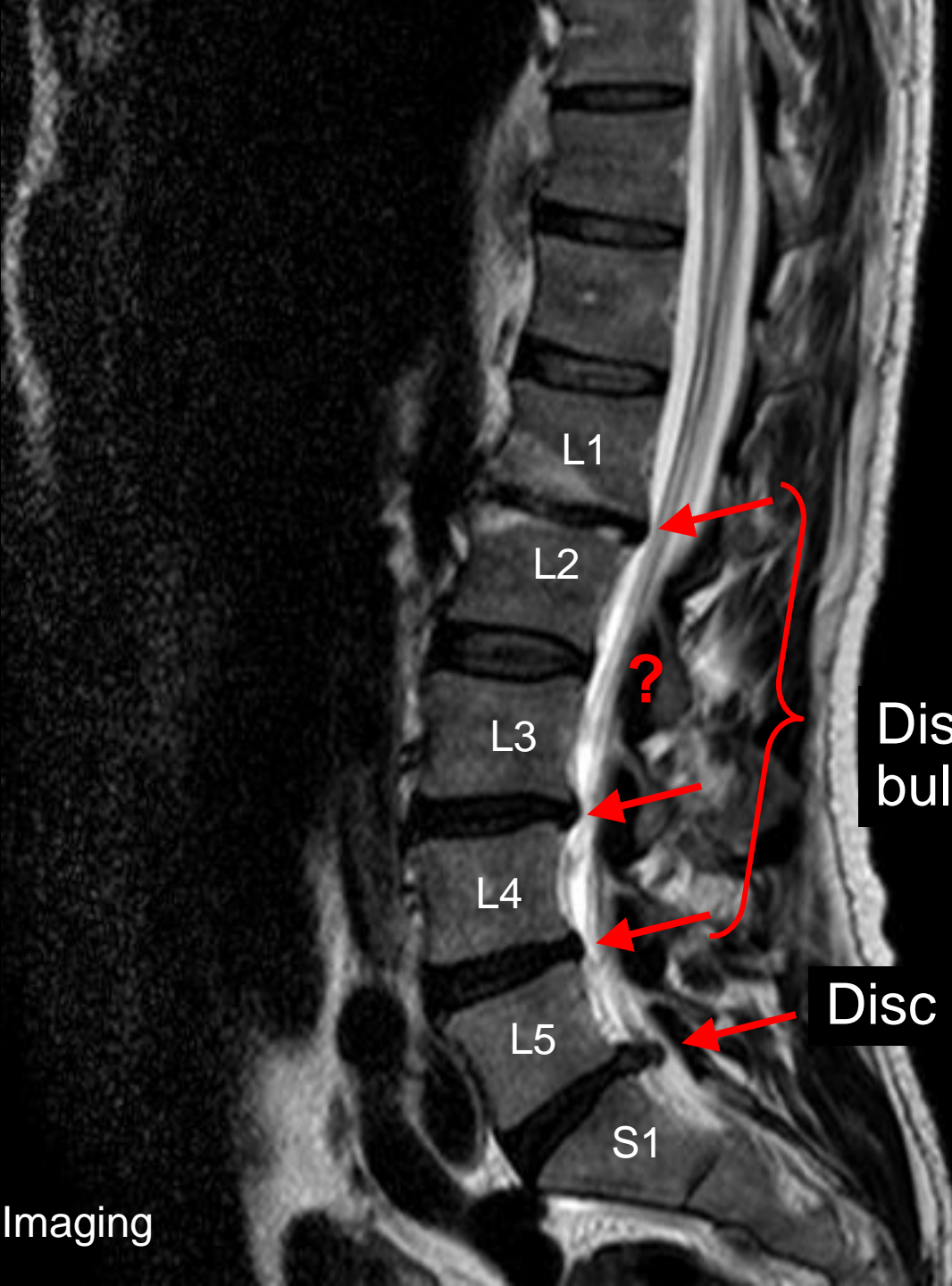
L5

S1

?

Discs  
bulging

Disc herniation





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/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  $\equiv$  ~ 2% of all traffic fatalities**

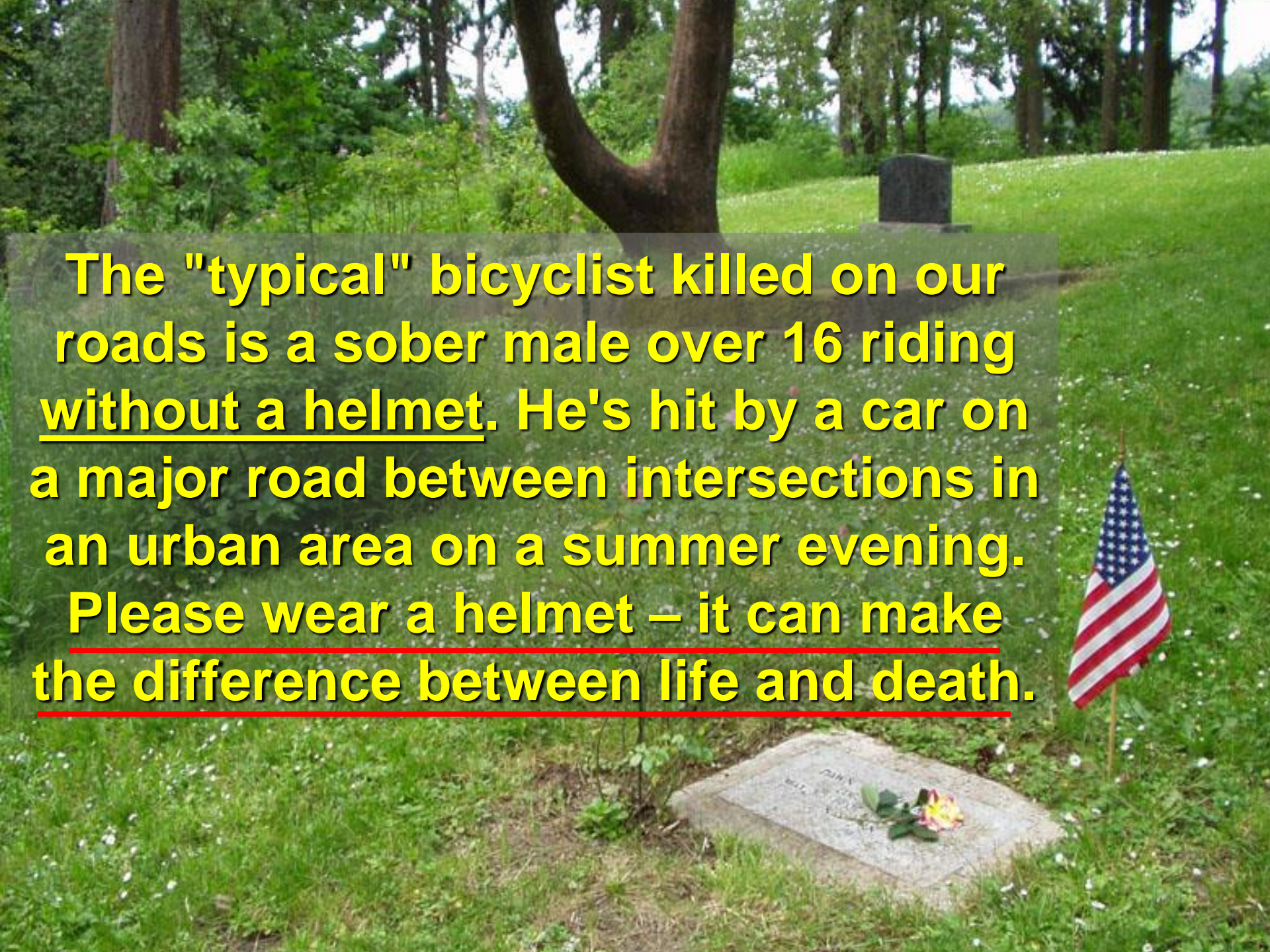
**13% of deaths children  $\leq$  14 yr, 87%  $\sigma$**

**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!**

A photograph of a cemetery. In the foreground, a large, dark tree trunk is on the left. To the right, a dark, rectangular gravestone stands on a grassy slope. In the lower right foreground, a small American flag is planted in the grass. A single rose lies on a flat, light-colored gravestone in the lower center. The background is filled with green trees and foliage under a bright sky.

**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.**



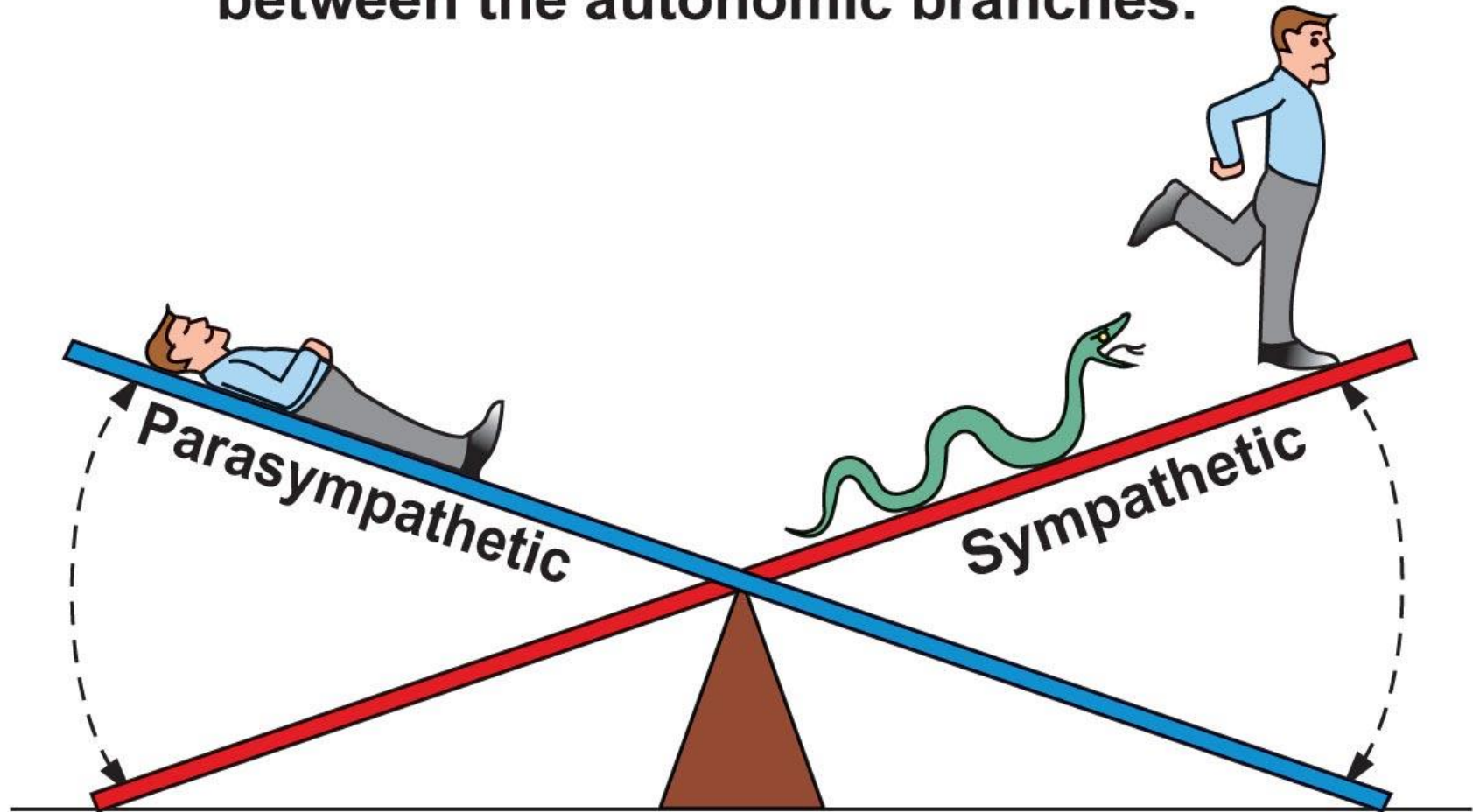
*Hey, I'm alive because I wore a helmet!!*



# *Stories, Discussion, Questions or Comments!*



Homeostasis is a dynamic balance between the autonomic branches.



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

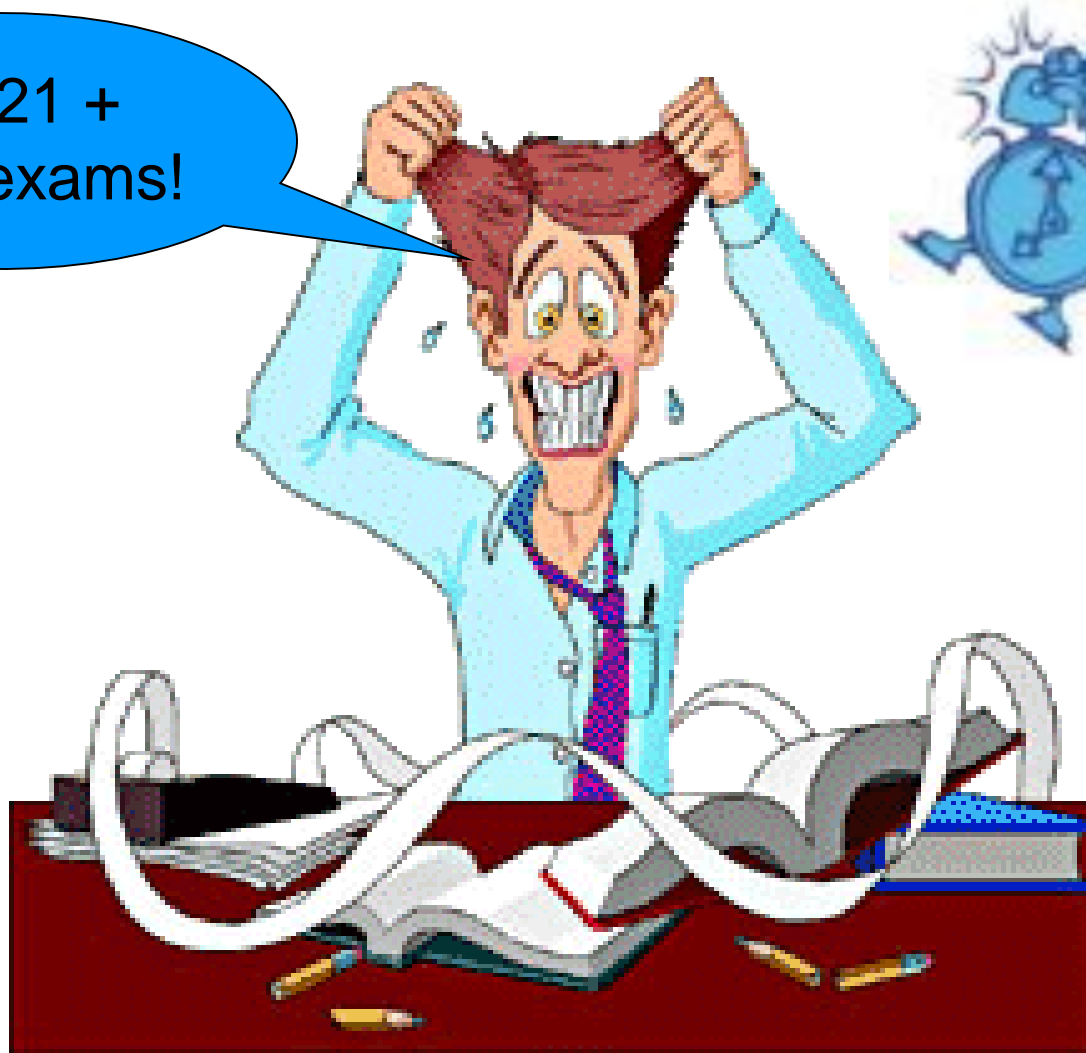
**Fight-or-flight:  
Sympathetic activity  
dominates.**

PARASYMPATHETIC = RESTING, DIGESTIVE,  
HOUSEKEEPING FUNCTIONS



# ***FIGHT/FLIGHT/ALARM REACTION!!***

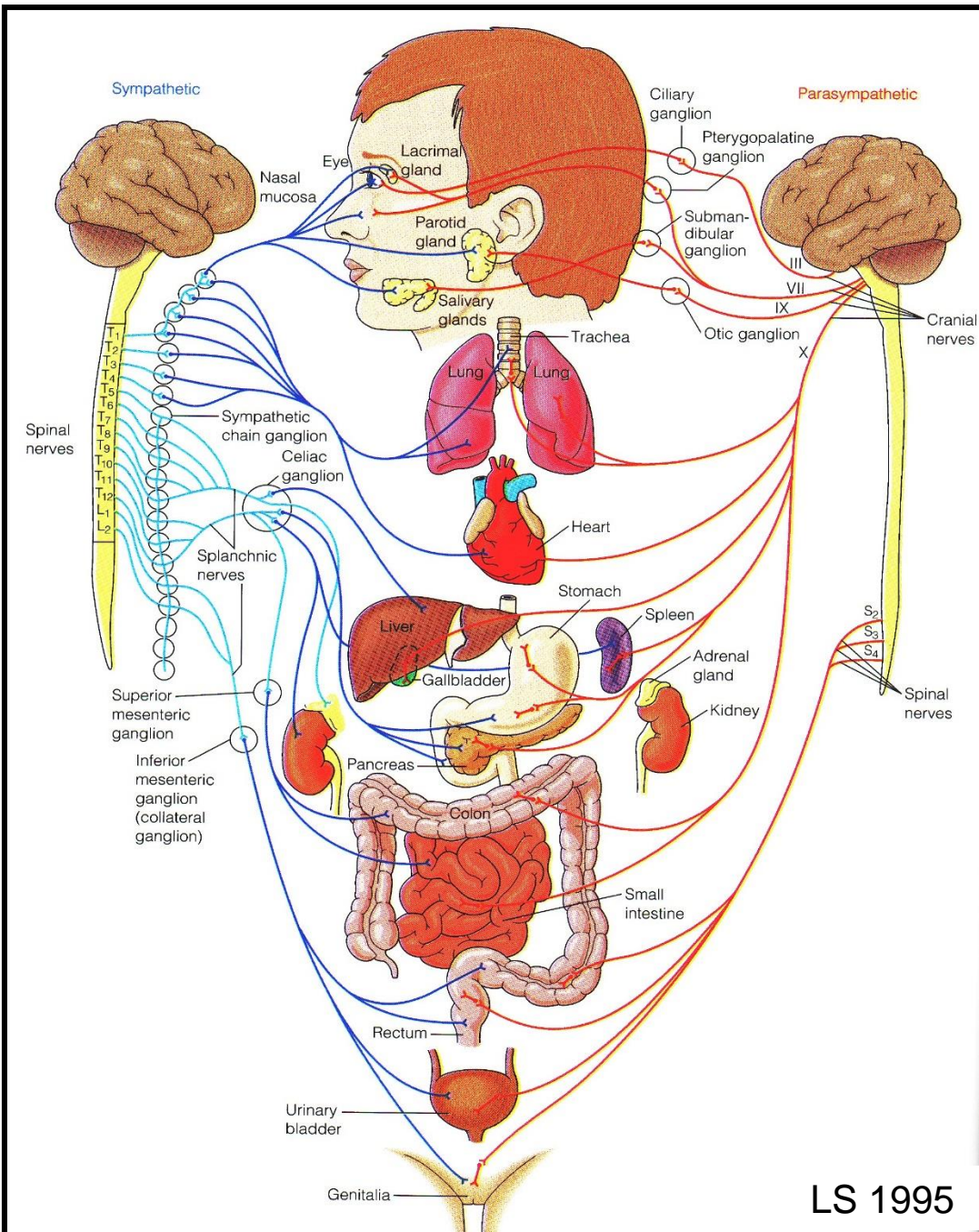
BI 121 +  
other exams!



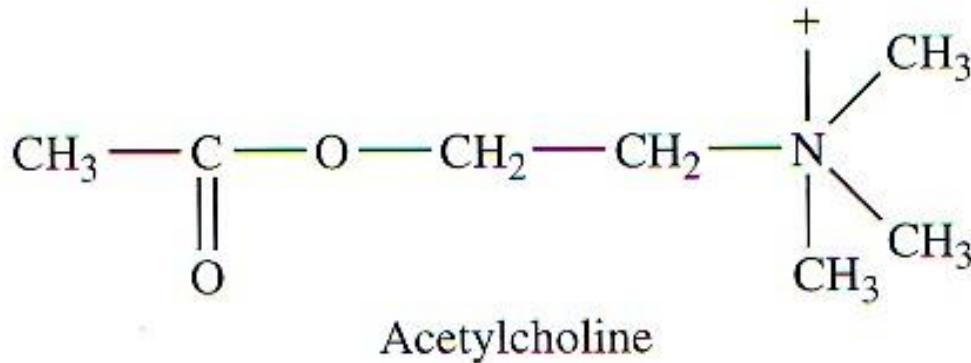
# Autonomic Nervous System

Why overlap or dual innervation?

*Fine-tune control & safety!*



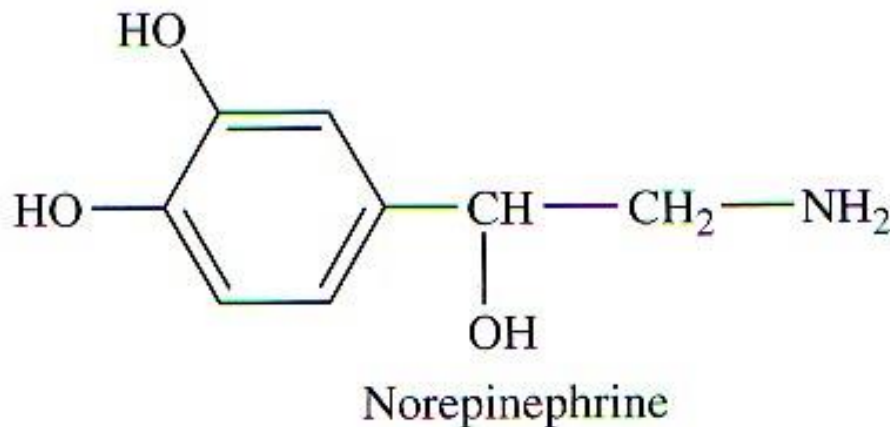
# Autonomic Neurotransmitters & Receptors



## Cholinergic

Nicotinic

Muscarinic

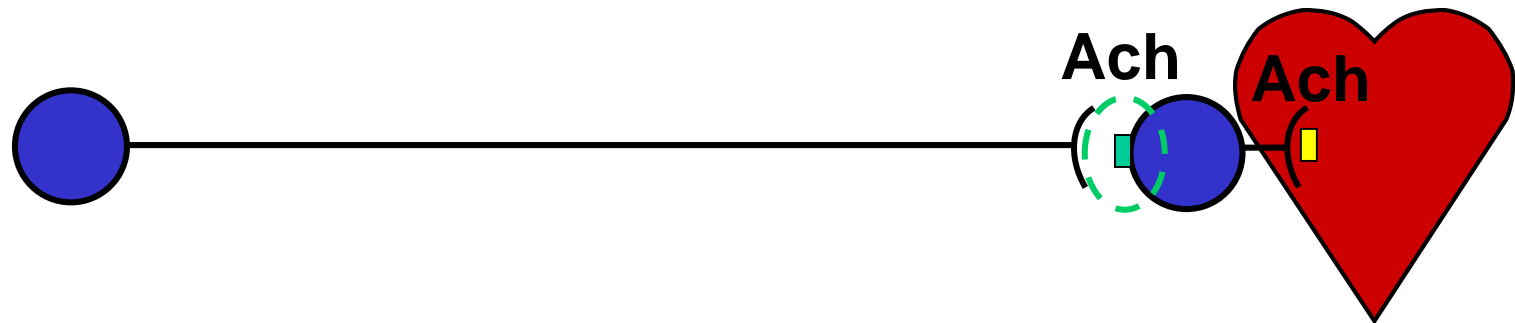


## Adrenergic

α = Alpha

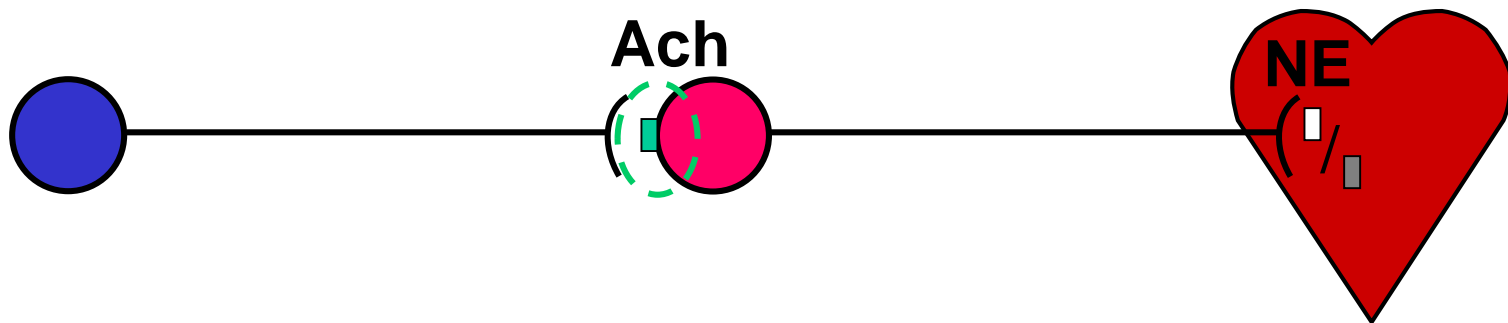
β = Beta

## *Parasympathetic*



Ach = Acetylcholine  
■ = Nicotinic Receptor  
■ = Muscarinic Receptor

## *Sympathetic*



NE = Norepinephrine  
□ = α Receptor ( $\alpha_1$ ,  $\alpha_2$ )  
■ = β Receptor ( $\beta_1$ ,  $\beta_2$ )



**Nicotine activates both Sympathetic & Parasympathetic post-ganglionic neurons!**

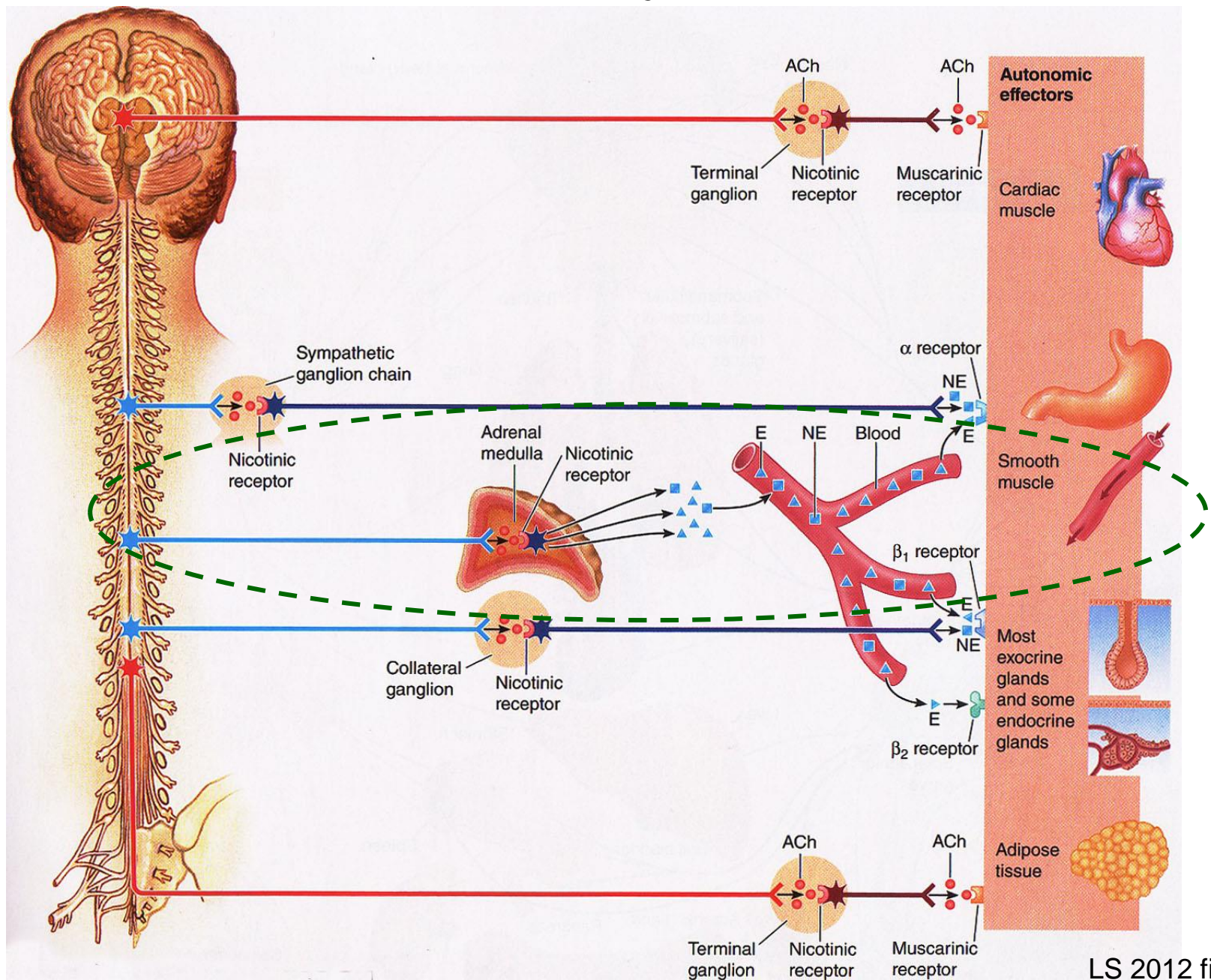
**Problem?**



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



# Autonomic Nervous System Innervation



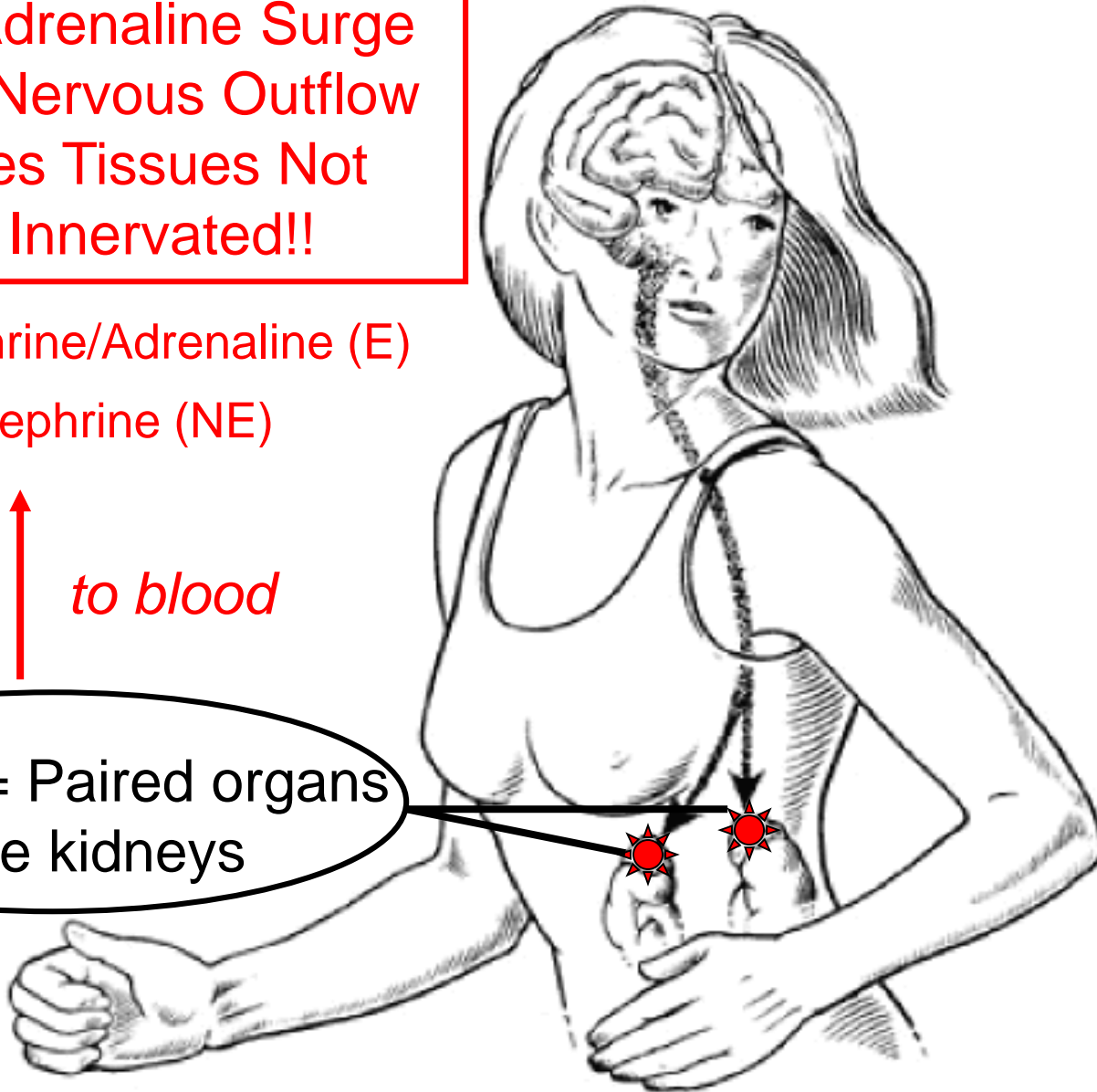
***In Sympathetic***  
***Fight-or-Flight*** why  
***is it important to***  
***activate the***  
***adrenals?***

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
<b>Heart</b>	Increases heart rate and increases force of contraction of the whole heart	Decreases heart rate and decreases force of contraction of the atria only
<b>Blood Vessels</b>	Constricts	Dilates vessels supplying the penis and the clitoris only
<b>Lungs</b>	Dilates the bronchioles (airways)	Constricts the bronchioles
<b>Digestive Tract</b>	Decreases motility (movement) Contracts sphincters (to prevent forward movement of tract contents) Inhibits digestive secretions	Increases motility Relaxes sphincters (to permit forward movement of tract contents) Stimulates digestive secretions
<b>Urinary Bladder</b>	Relaxes	Contracts (emptying)
<b>Eye</b>	Dilates the pupil Adjusts the eye for far vision	Constricts the pupil Adjusts the eye for near vision
<b>Liver (glycogen stores)</b>	Glycogenolysis (glucose is released)	None
<b>Adipose Cells (fat stores)</b>	Lipolysis (fatty acids are released)	None
<b>Exocrine Glands</b>		
<i>Exocrine pancreas</i>	Inhibits pancreatic exocrine secretion	Stimulates pancreatic exocrine secretion (important for digestion)
<i>Sweat glands</i>	Stimulates secretion by sweat glands important in cooling the body	Stimulates secretion by specialized sweat glands in the armpits and genital area
<i>Salivary glands</i>	Stimulates a small volume of thick saliva rich in mucus	Stimulates a large volume of watery saliva rich in enzymes
<b>Endocrine Glands</b>		
<i>Adrenal medulla</i>	Stimulates epinephrine and norepinephrine secretion	None
<i>Endocrine pancreas</i>	Inhibits insulin secretion	Stimulates insulin secretion
<b>Genitals</b>	Controls ejaculation (males) and orgasm contractions (both sexes)	Controls erection (penis in males and clitoris in females)
<b>Brain Activity</b>	Increases alertness	None