



I'm gonna smash Exam II because
— I'm dedicated & I ♥ physiology!



BI 121 Lecture 13

I. Announcements **No lab today – Study for Exam II!!**

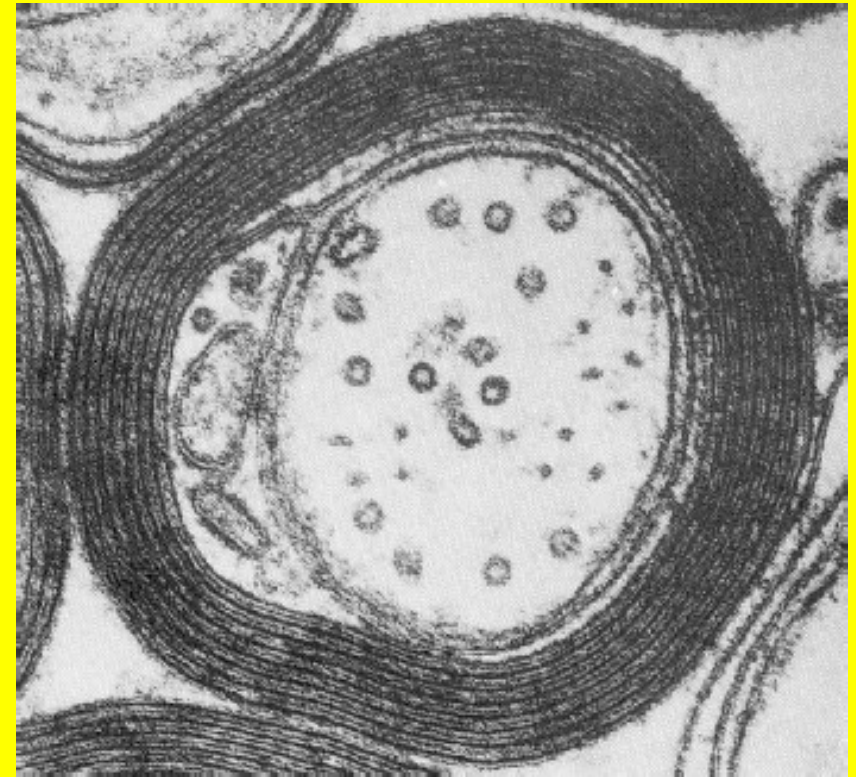
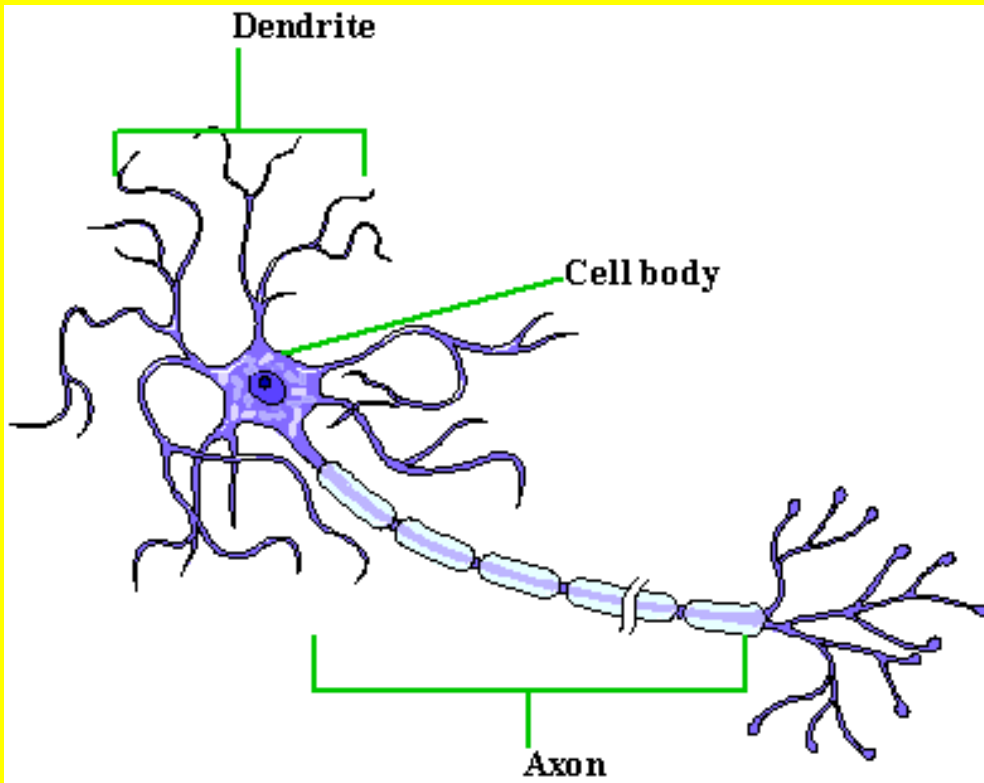
Optional Lab notebook check after last Lab 6, Mac pulmonary function testing (PFT) next Thursday. Q?

II. CNS Connections Myelin, brain + spinal cord (CNS) **Protect your head with a helmet!** Bicycle head injury statistics *NHTSA & BHSI, 2011 data*

III. Peripheral Nervous System LS sections of ch 3, 4, & 7

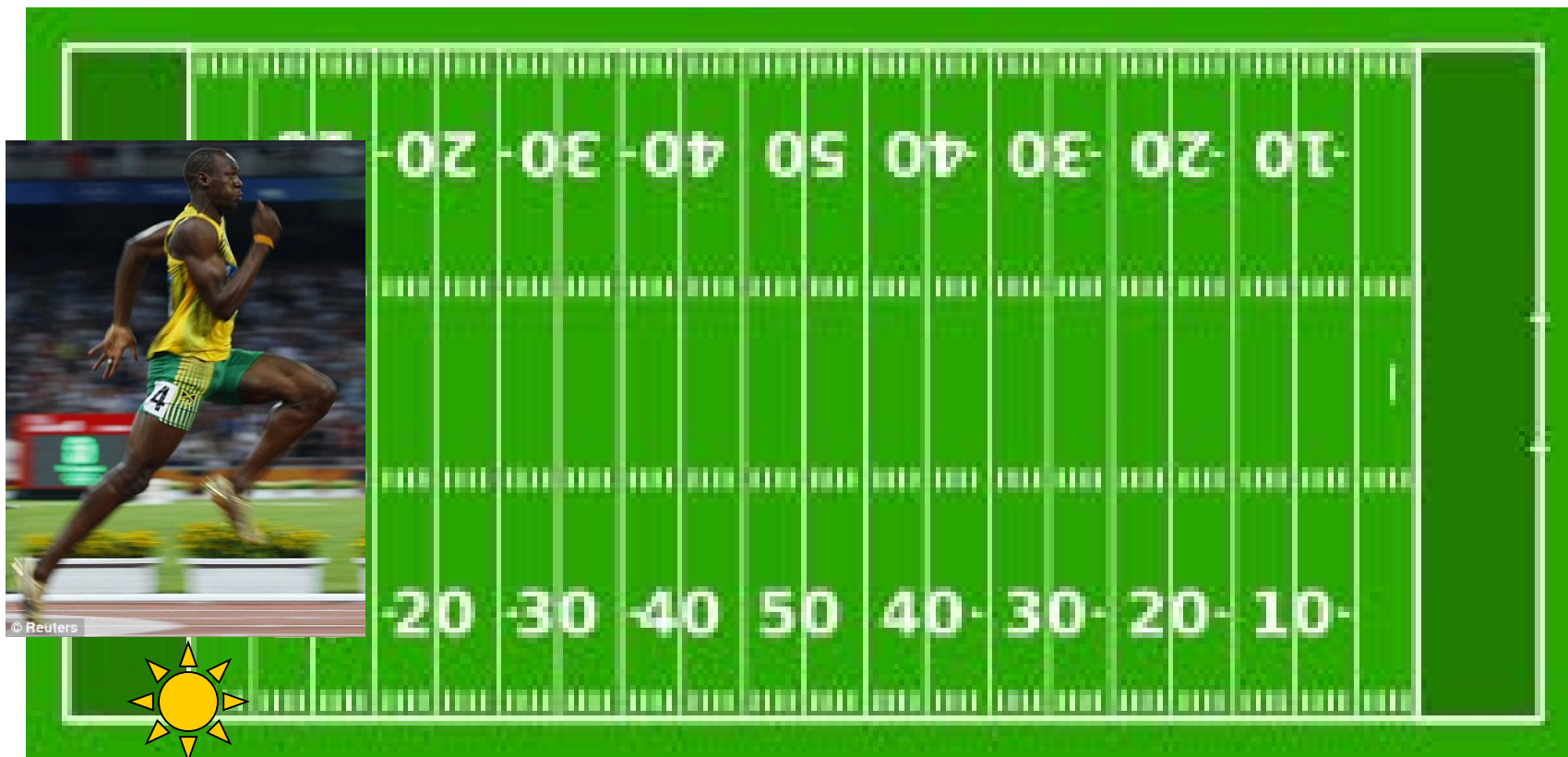
- A. Autonomic NS: Branches, neurotransmitters, receptors, actions, fight-or-flight stories ch 7 pp179-85
- B. Why are nerve & muscle unique? ch 4 p 71
- C. How do excitable cells signal? ch 3 pp62-7; ch 4 pp74-83
- D. How does the signal cross the nerve-muscle gap?
ch 7 p 185-92 fig 7-5 p 190
 1. Ca²⁺ bones!...but what else? p 190
 2. What do black widow spider venom, botulism, curare & nerve gas have in common? Botox pp 189-92

What is myelin? Why is it important?

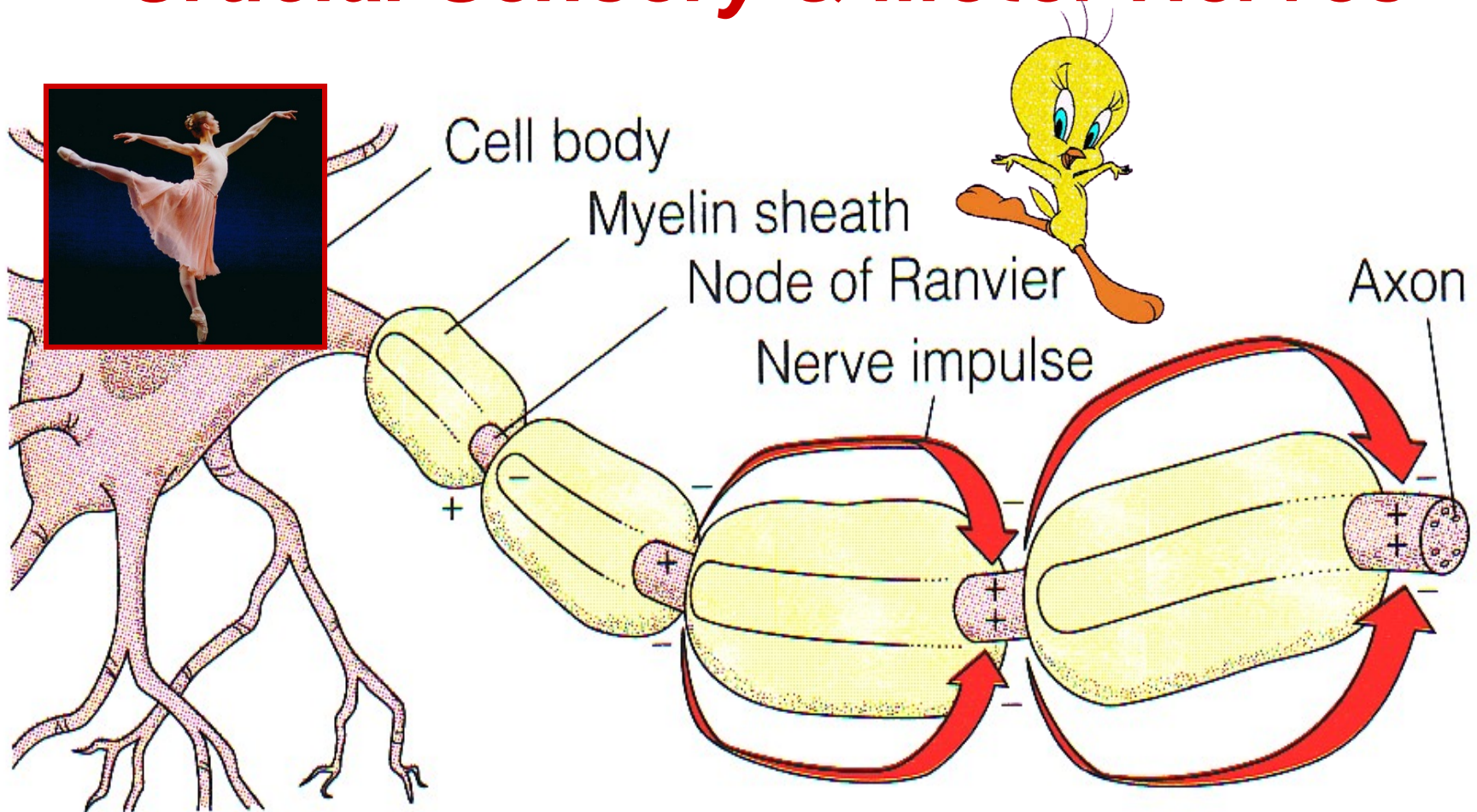


Lipid insulative coat
 $\uparrow \vec{v}$, *conserves ions & ATP*

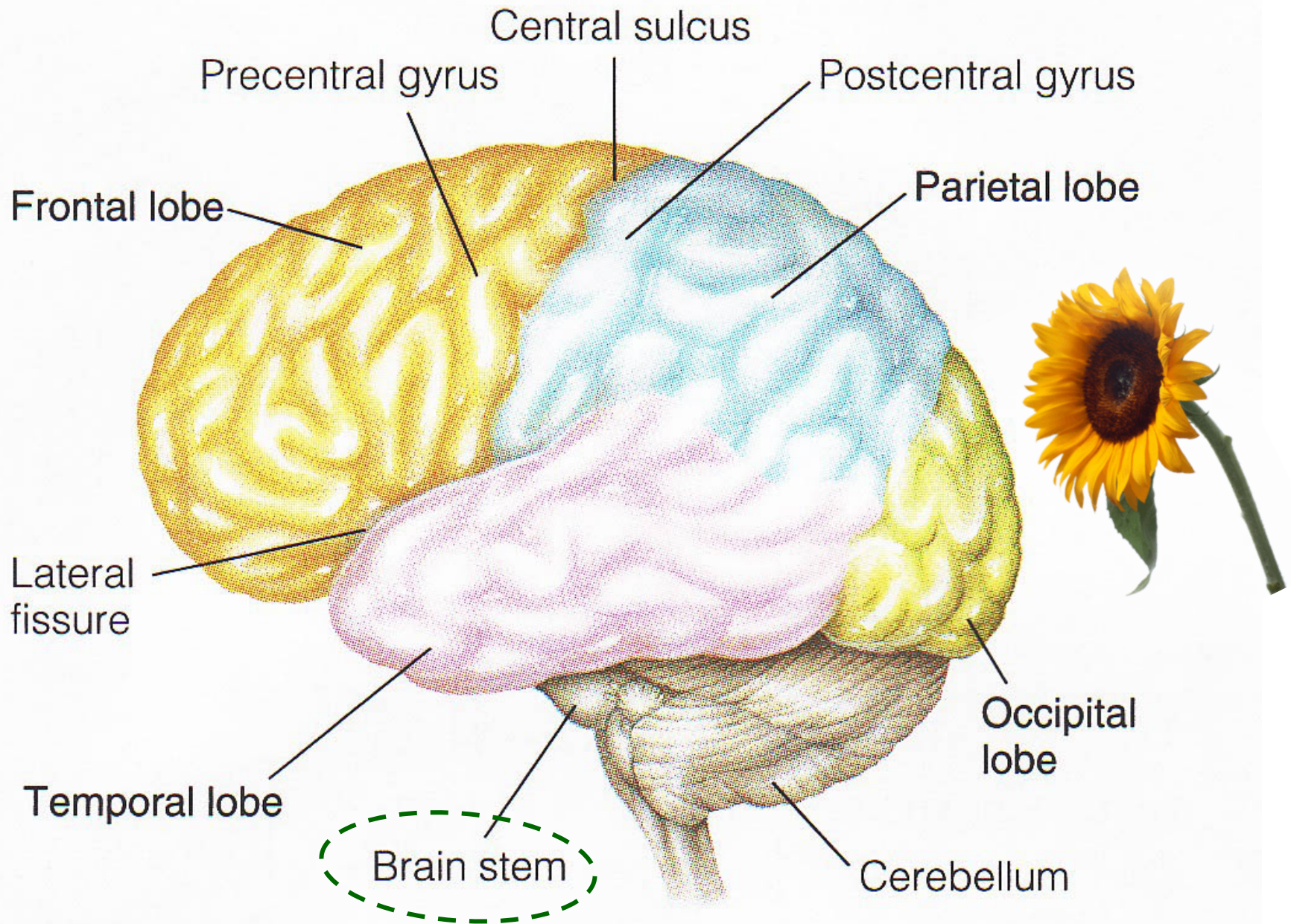
A large myelinated "survival" nerve can conduct impulses the length of football field in < 1 second!

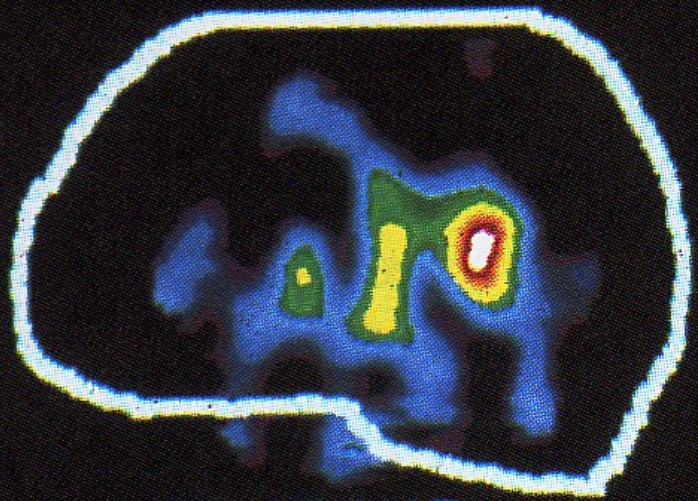


Saltatory/Leaping Conduction! *Crucial Sensory & Motor Nerves*

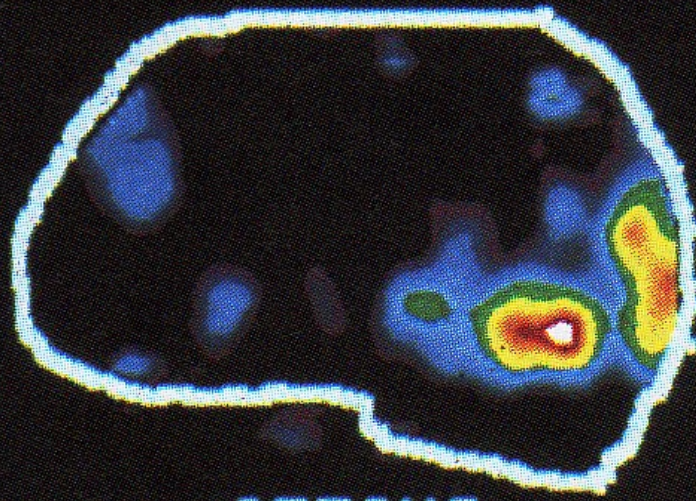


L. saltare to hop or leap! Fr. salt, sautier, sauté, leap, high air, vault

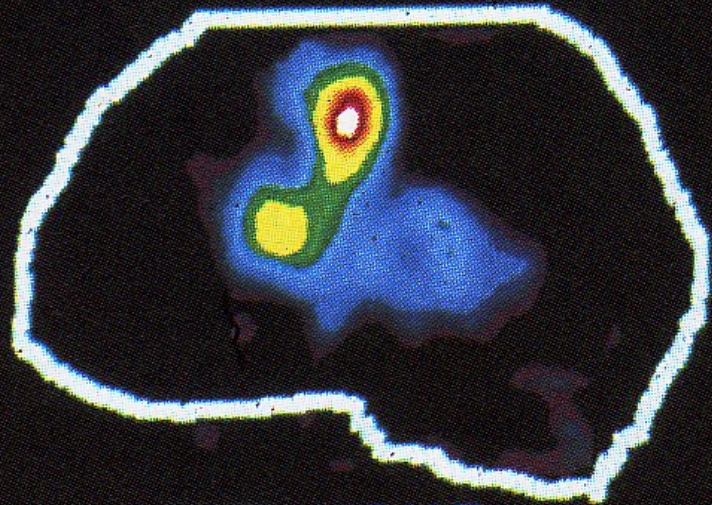




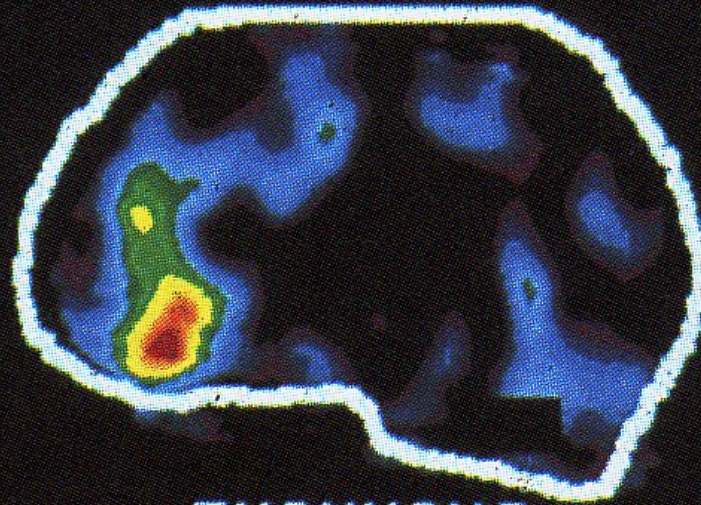
HEARING



SEEING

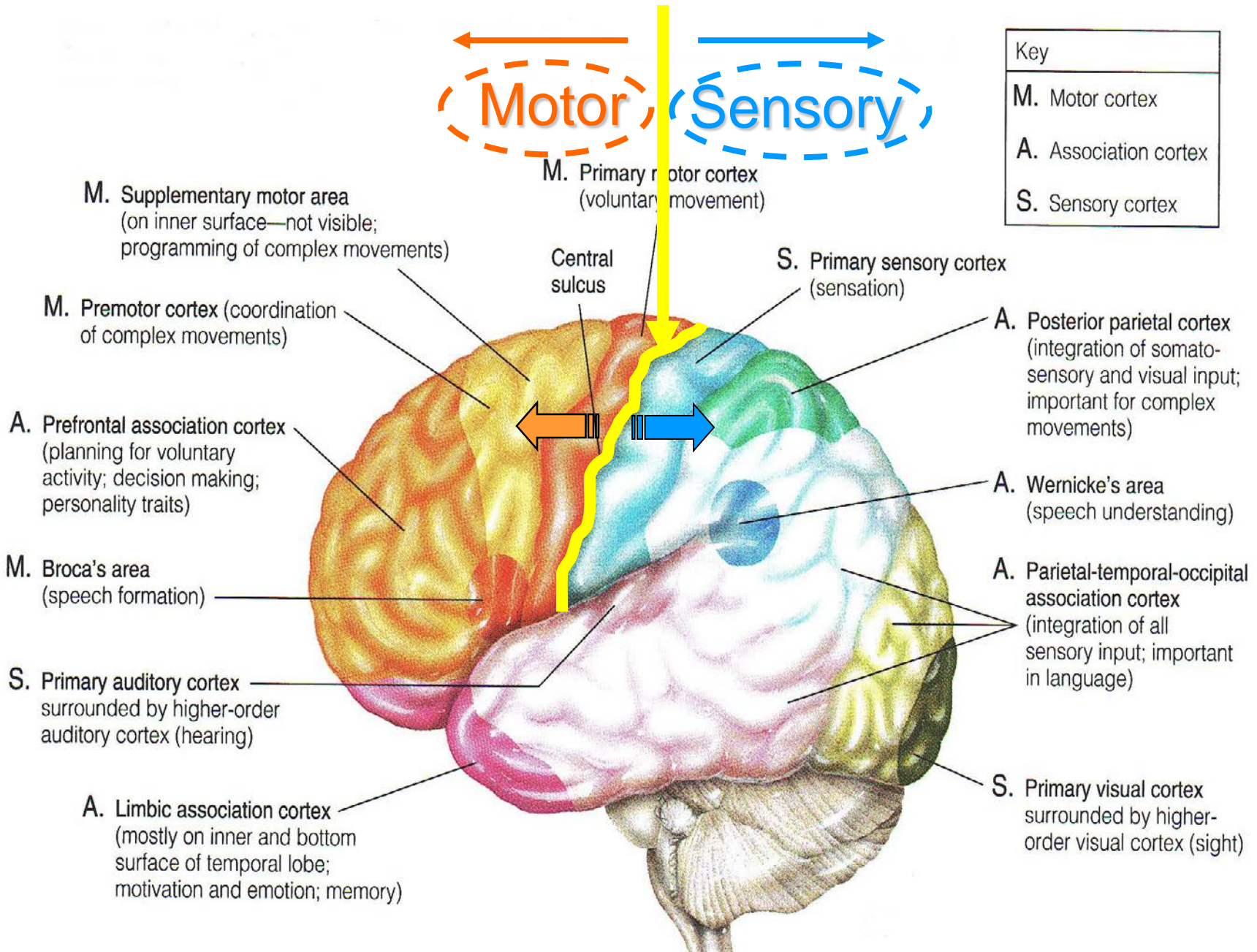


SPEAKING



THINKING





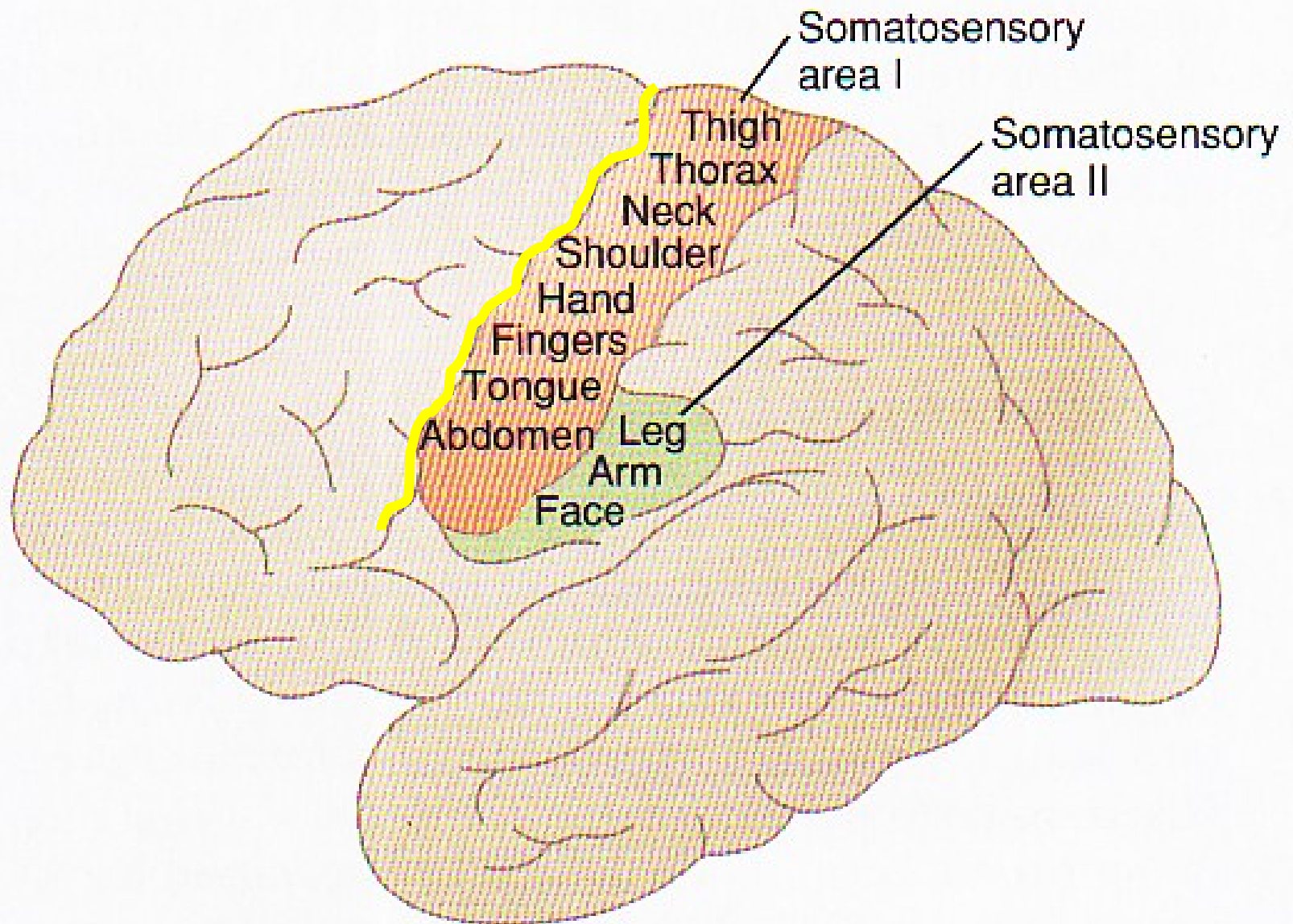
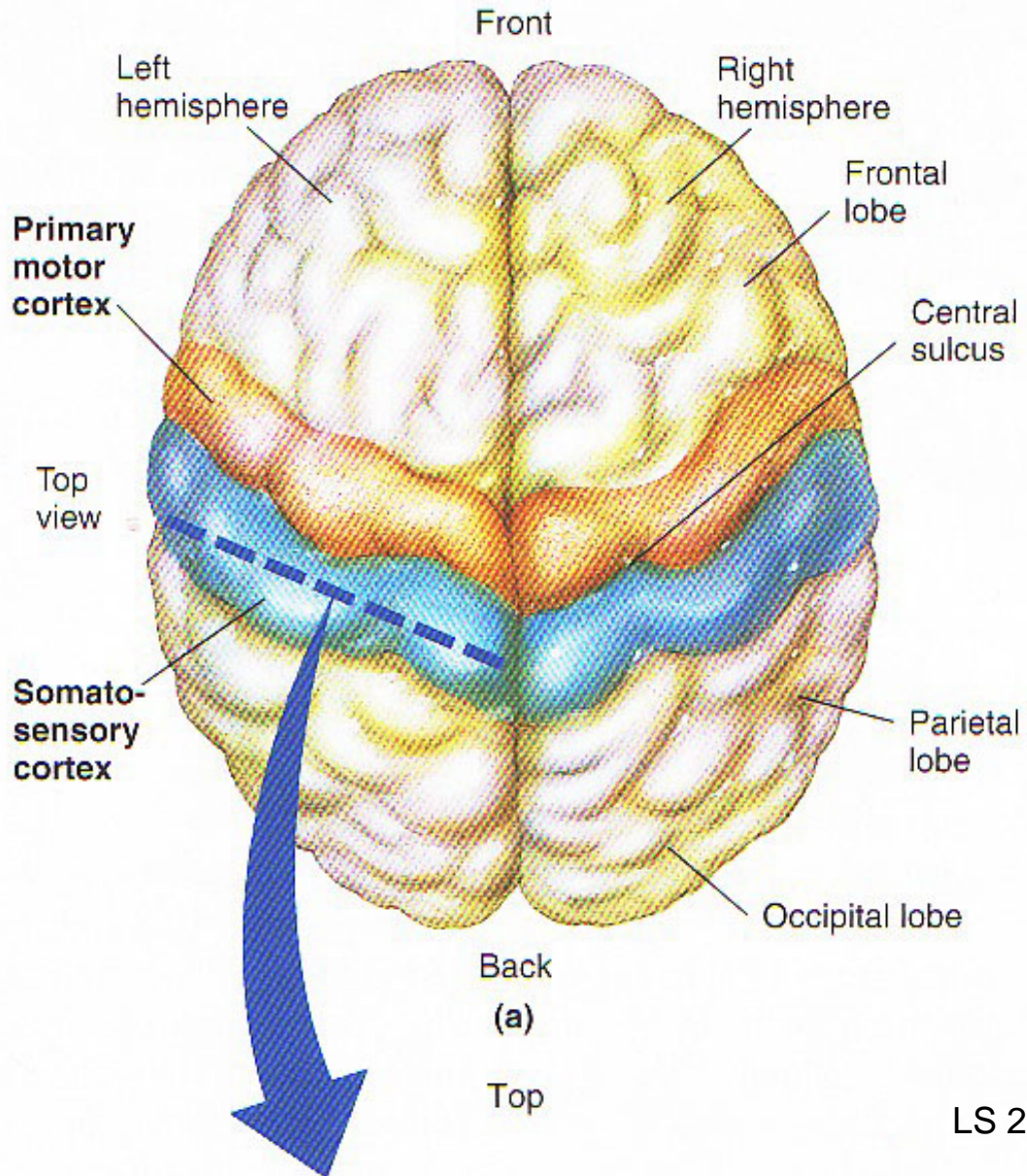


Figure 47-6

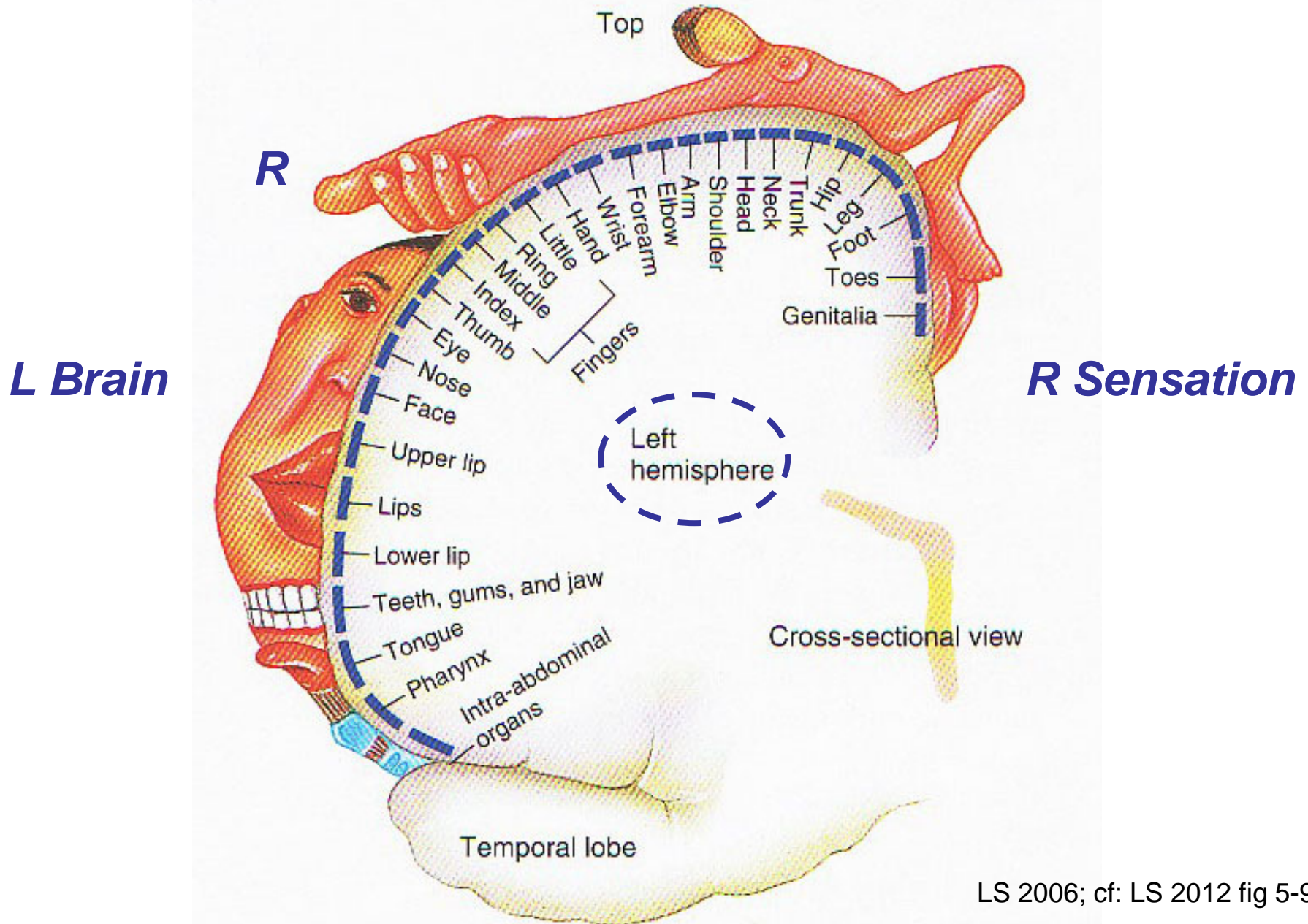
Guyton & Hall 2011

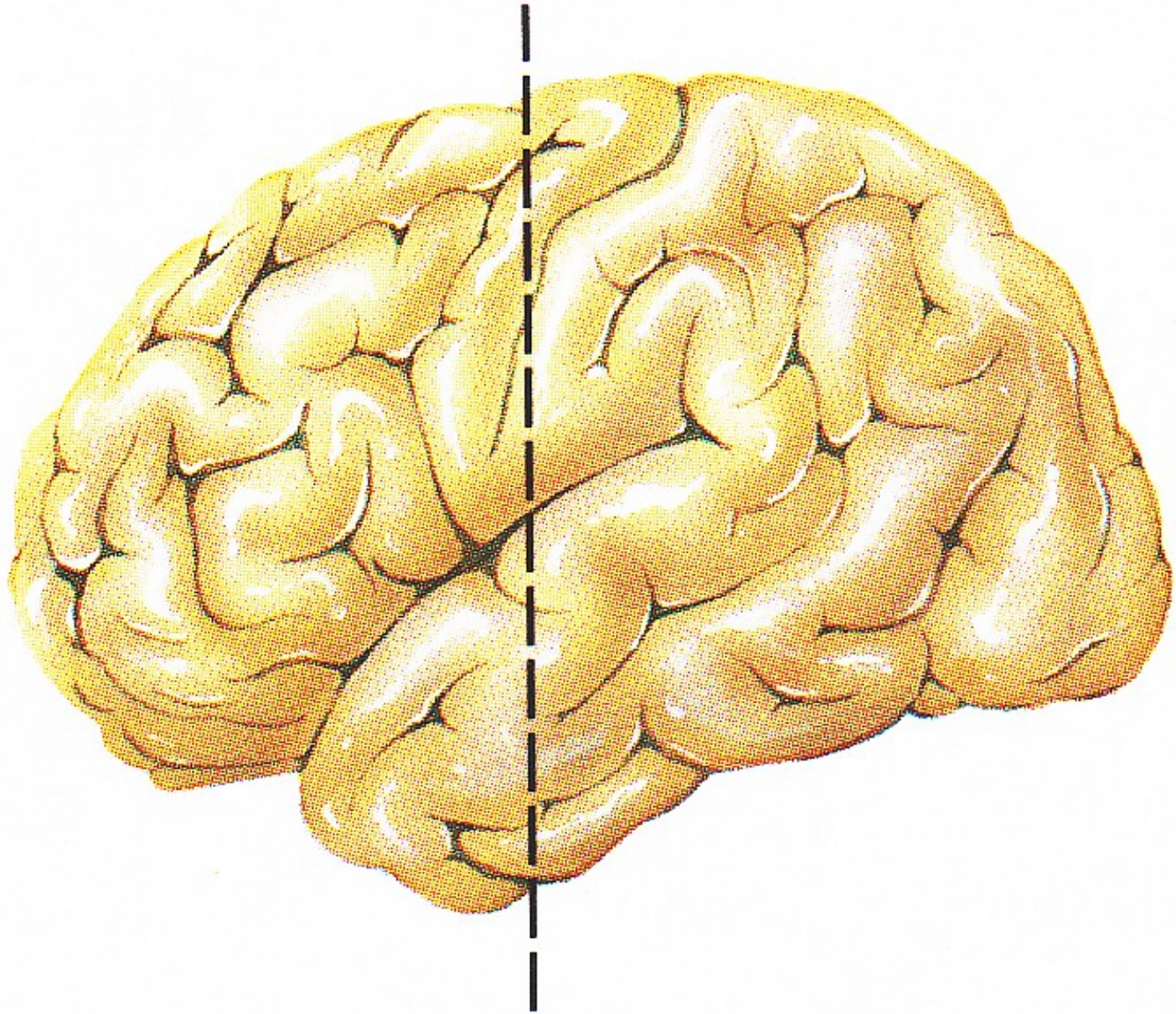
Two somatosensory cortical areas, somatosensory areas I and II.

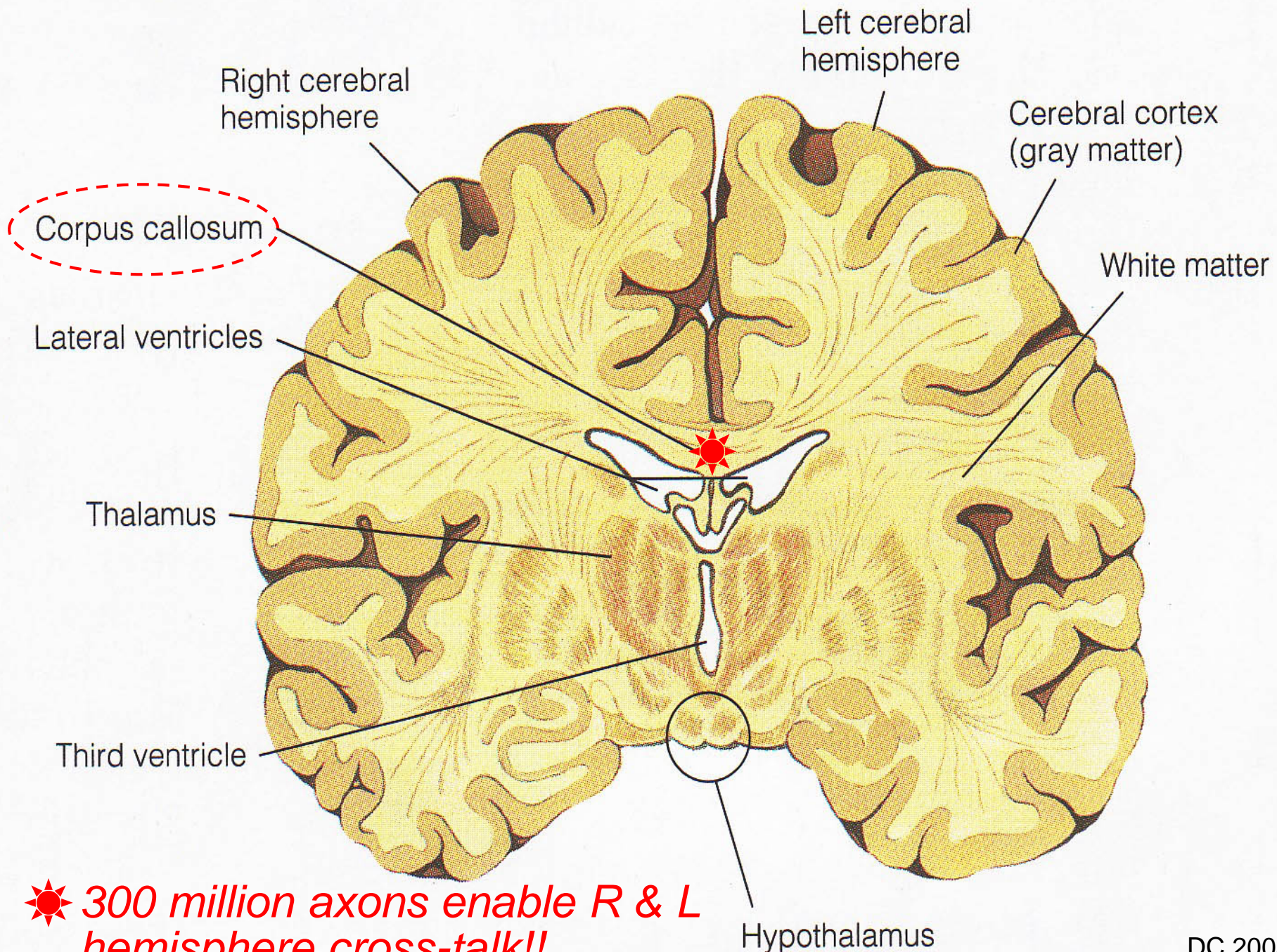
Section Human Brain (from above)



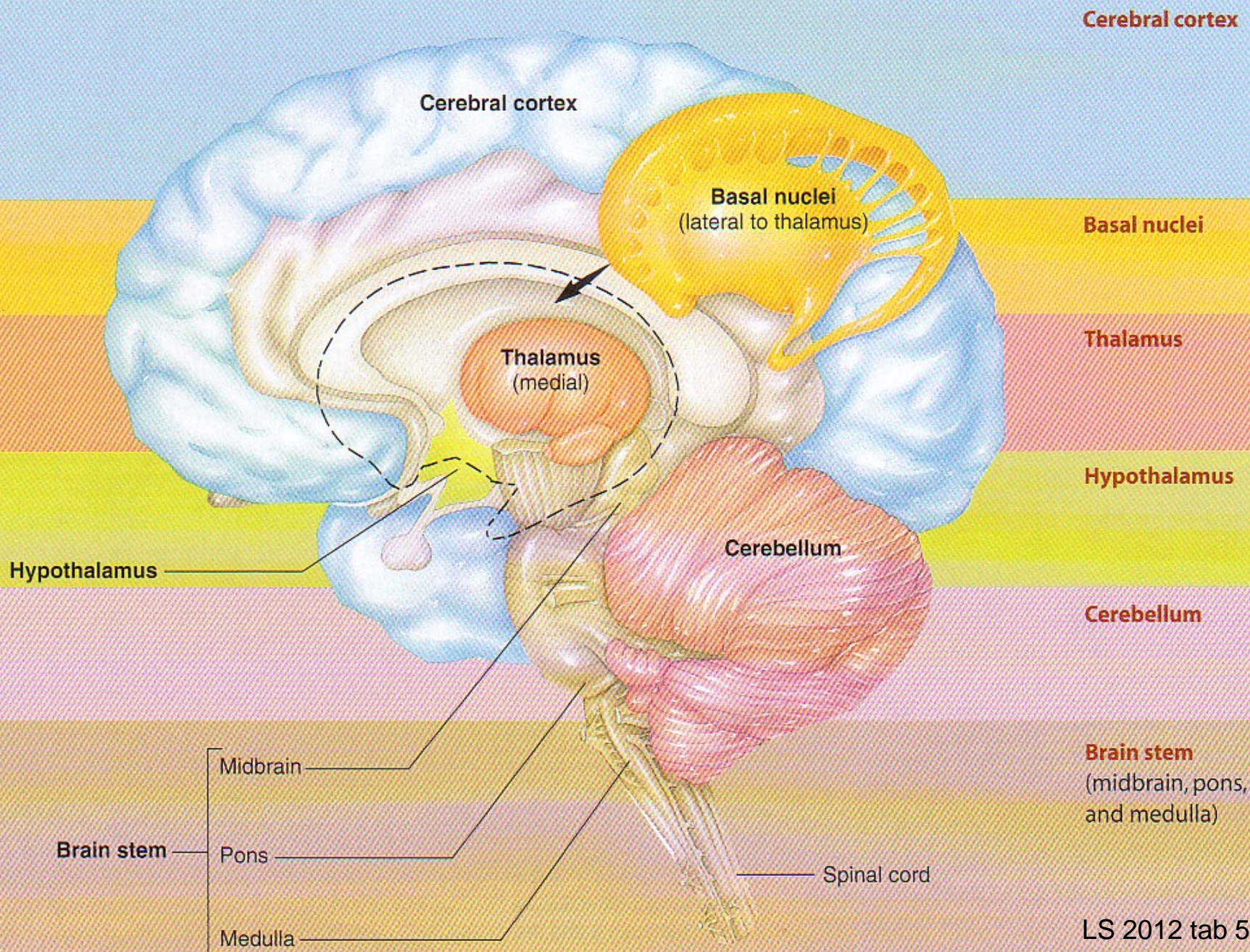
Sensory Homunculus







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



MRI 061307
Lumbar spine
Lateral view

L1

L2

L3

L4

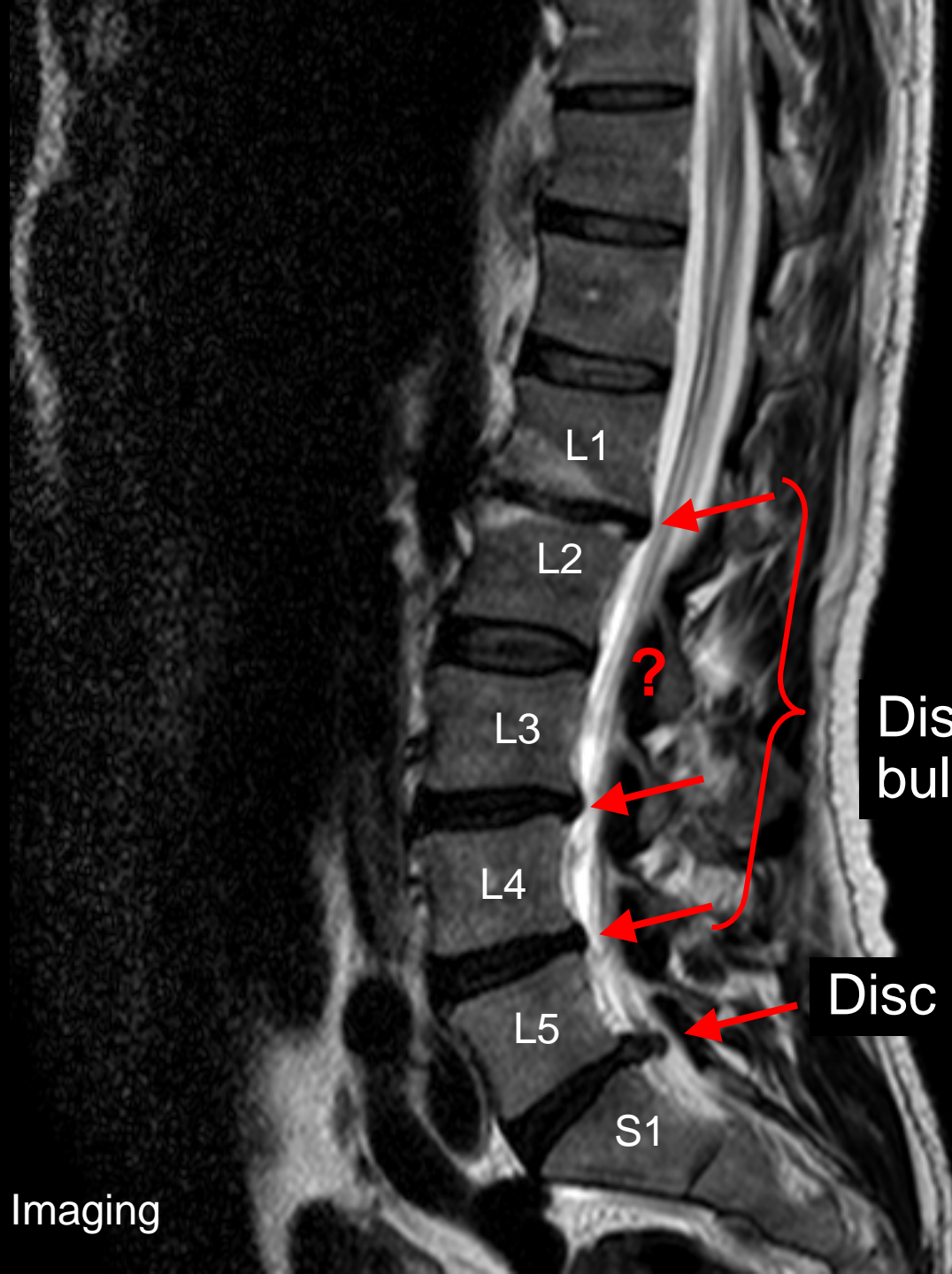
L5

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% σ

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!!



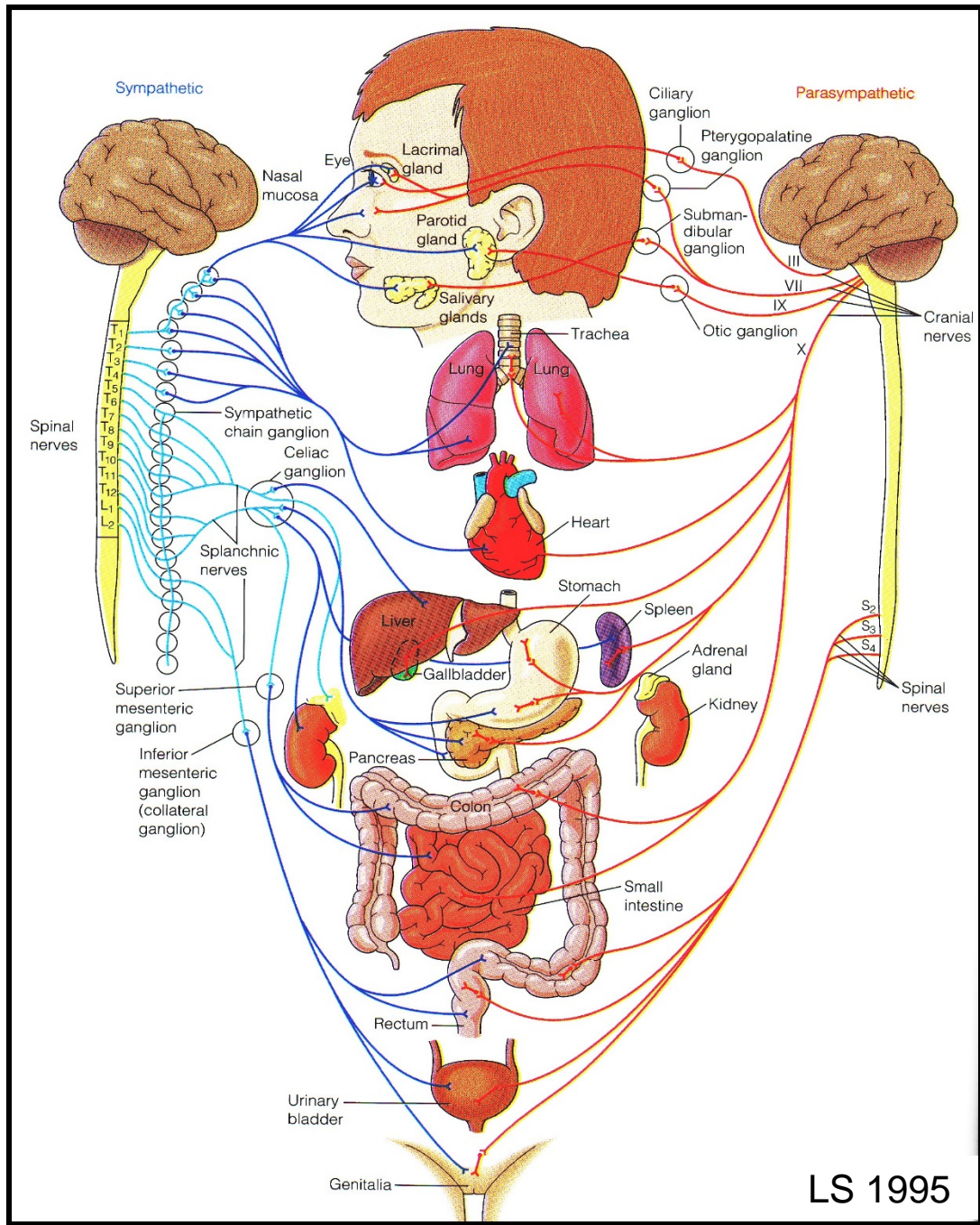
Stories, Discussion, Questions or Comments!



Autonomic Nervous System

Why overlap or dual innervation?

Fine-tune control & safety!



PARASYMPATHETIC = RESTING, DIGESTIVE,
HOUSEKEEPING FUNCTIONS

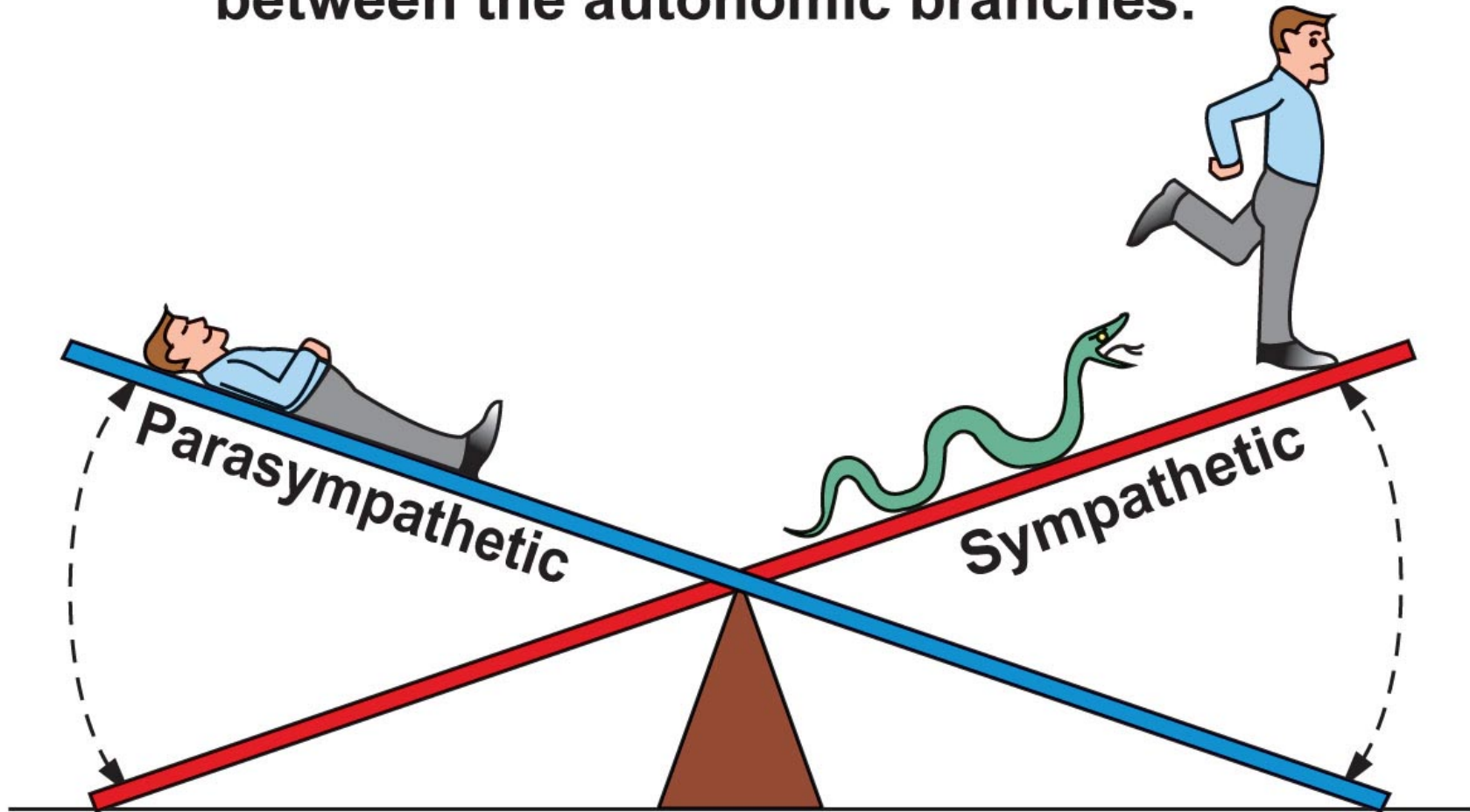


FIGHT/FLIGHT/ALARM REACTION!!

BI 121 +
other finals!



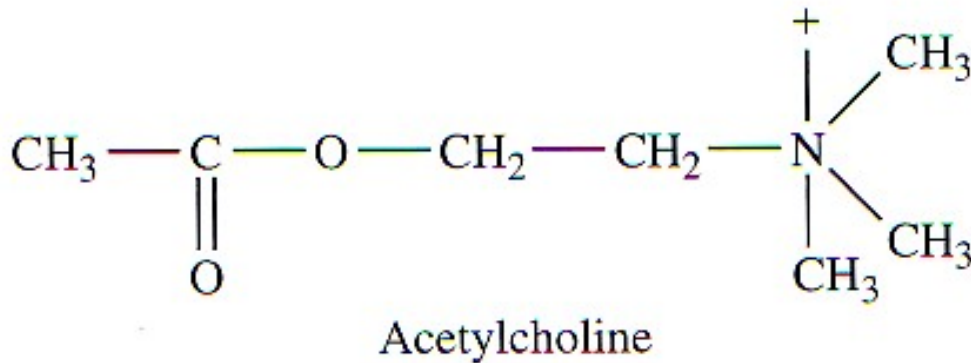
Homeostasis is a dynamic balance between the autonomic branches.



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

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

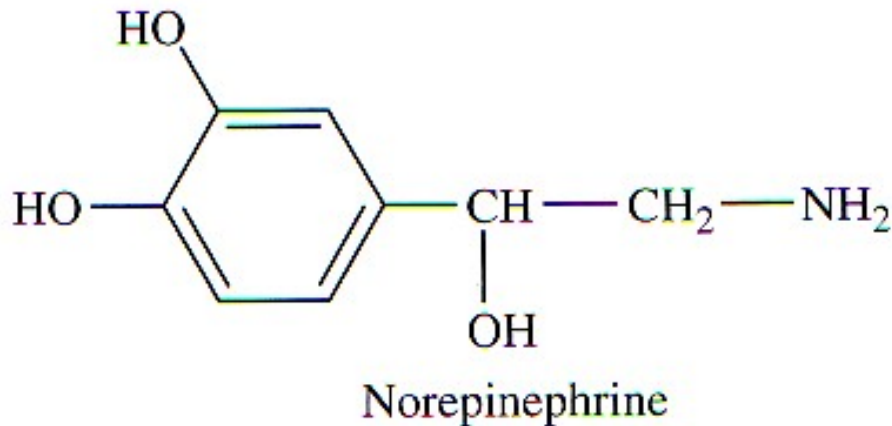
Autonomic Neurotransmitters & Receptors



Cholinergic

Nicotinic

Muscarinic

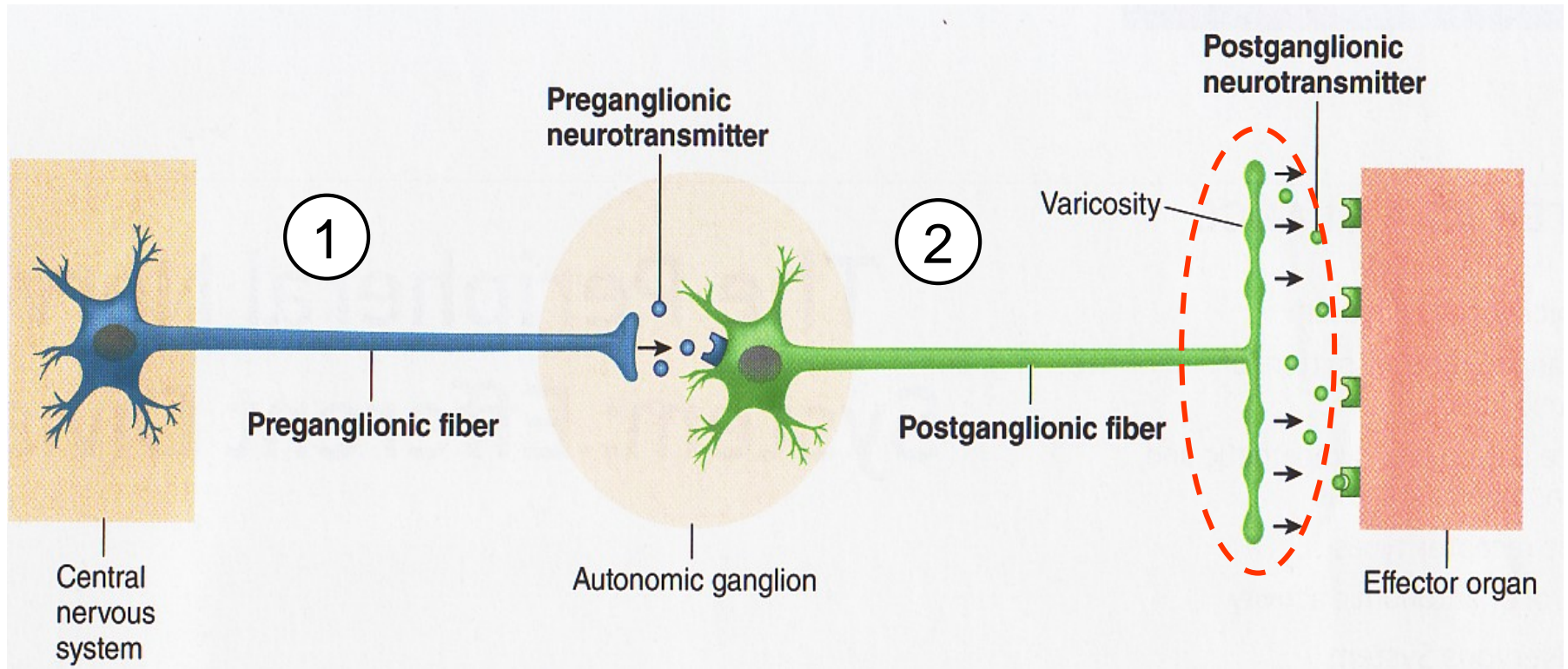


Adrenergic

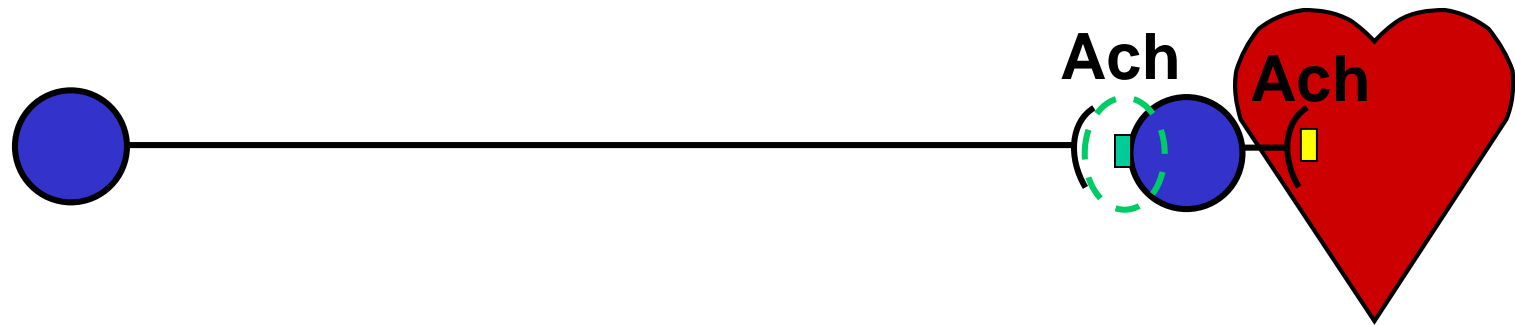
α = Alpha

β = Beta

Autonomic Nerves: *Two Chain Pathway* with *Post-Ganglionic Varicosities*

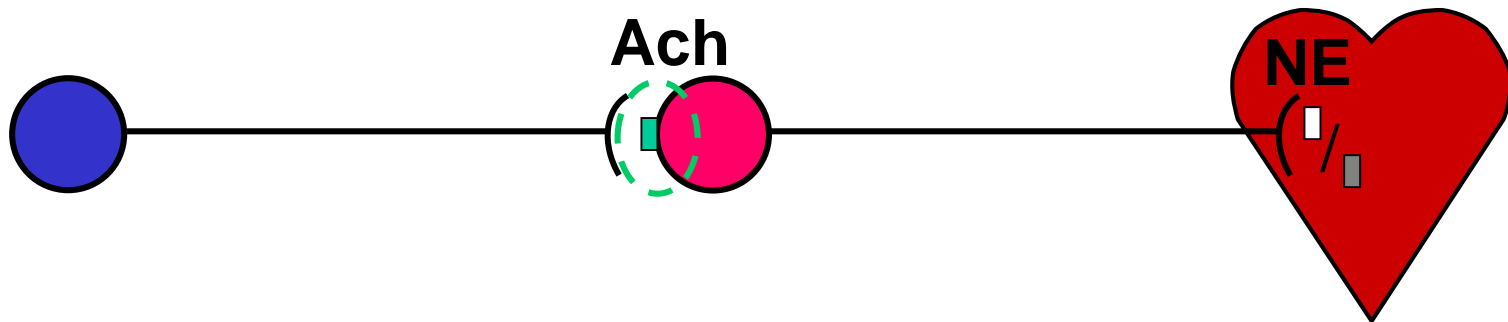


Parasympathetic



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!

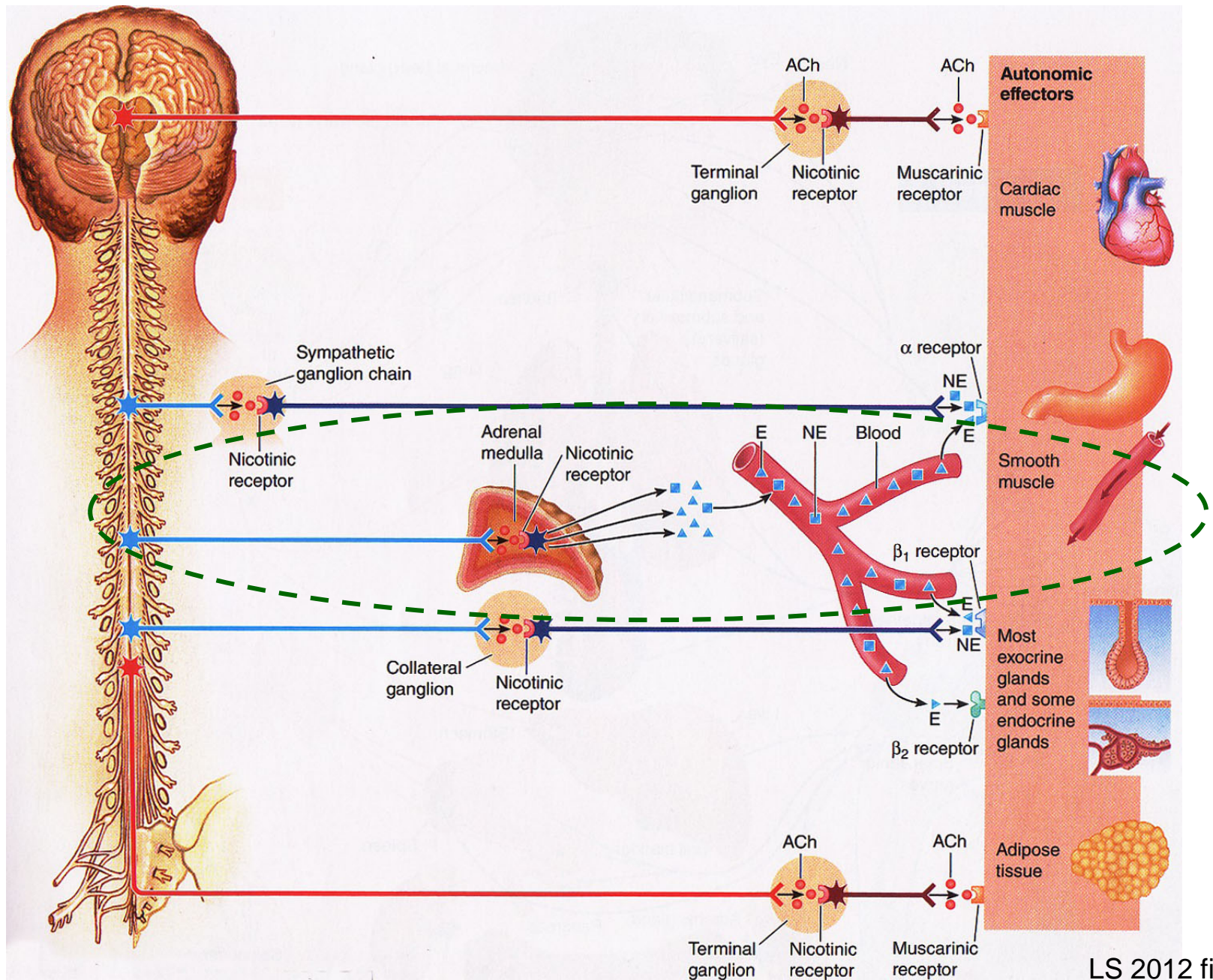
Problem?



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



Autonomic Nervous System Innervation



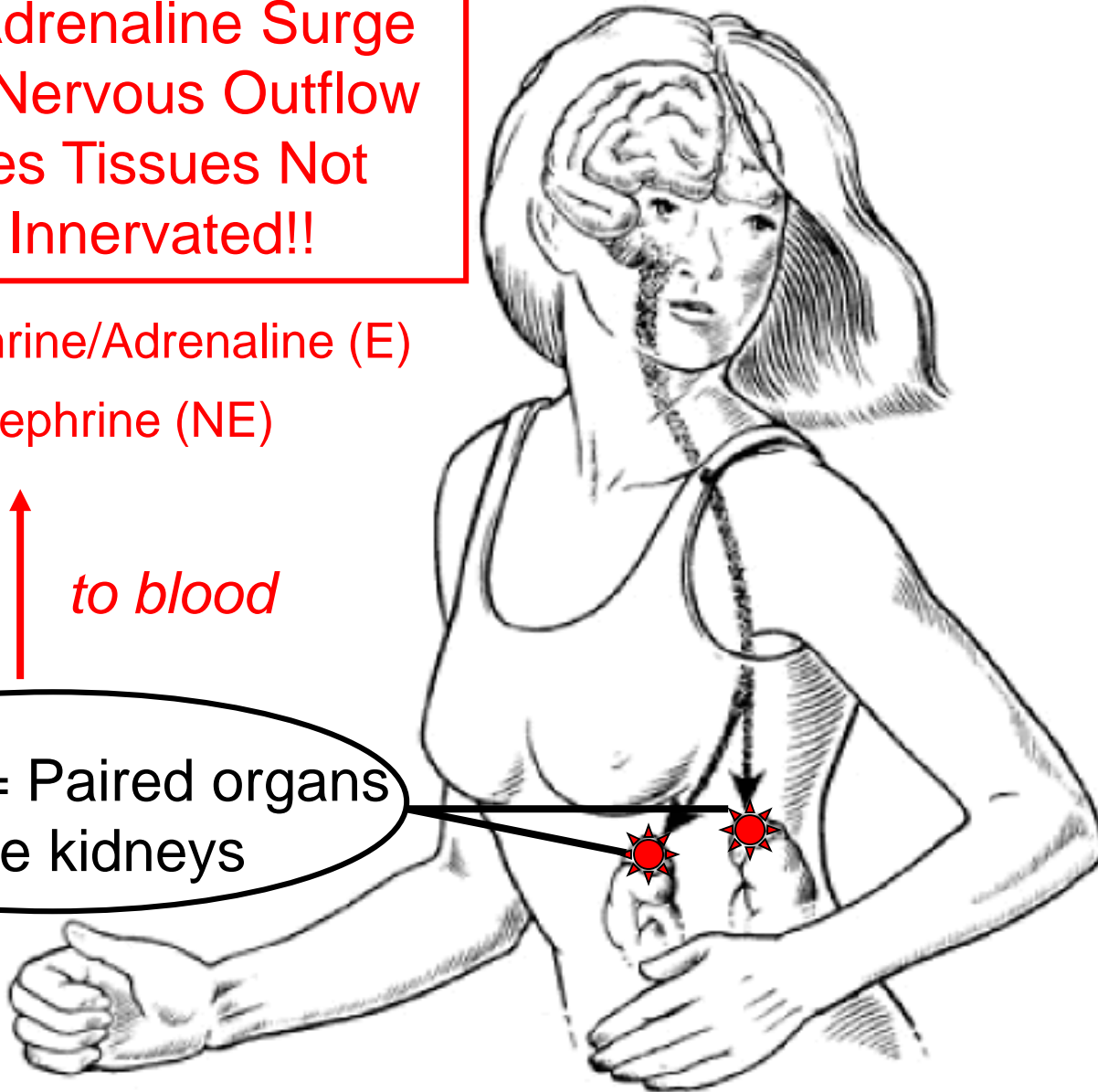
**In Sympathetic
Fight-or-Flight why
is it important to
activate the
adrenals?**

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

80% Epinephrine/Adrenaline (E)
20% Norepinephrine (NE)

Output ↑ *to blood*

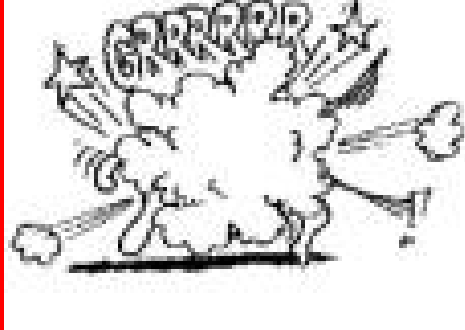
Adrenals = Paired organs
above kidneys



▲ 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) 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
Urinary Bladder	Relaxes	Contracts (emptying)
Eye	Dilates the pupil Adjusts the eye for far vision	Constricts the pupil 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		
<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
Endocrine Glands		
<i>Adrenal medulla</i>	Stimulates epinephrine and norepinephrine secretion	None
<i>Endocrine pancreas</i>	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

Fight-or-Flight Stories!



or



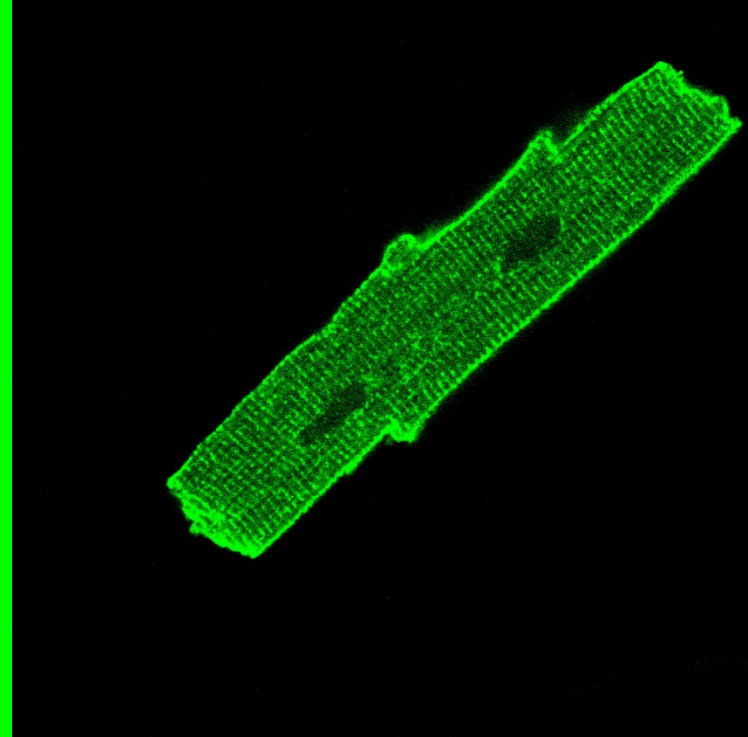
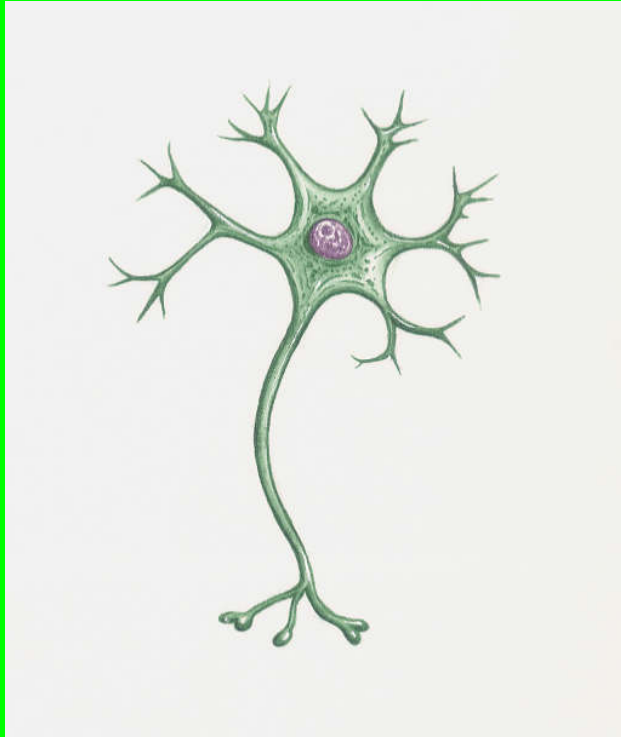
...choose this!!



Time for a break! 😊



Why are nerve & muscle unique?



They are excitable!!

Action Potentials \equiv Spikes \equiv Impulses

Ultra-short reversal of membrane potential

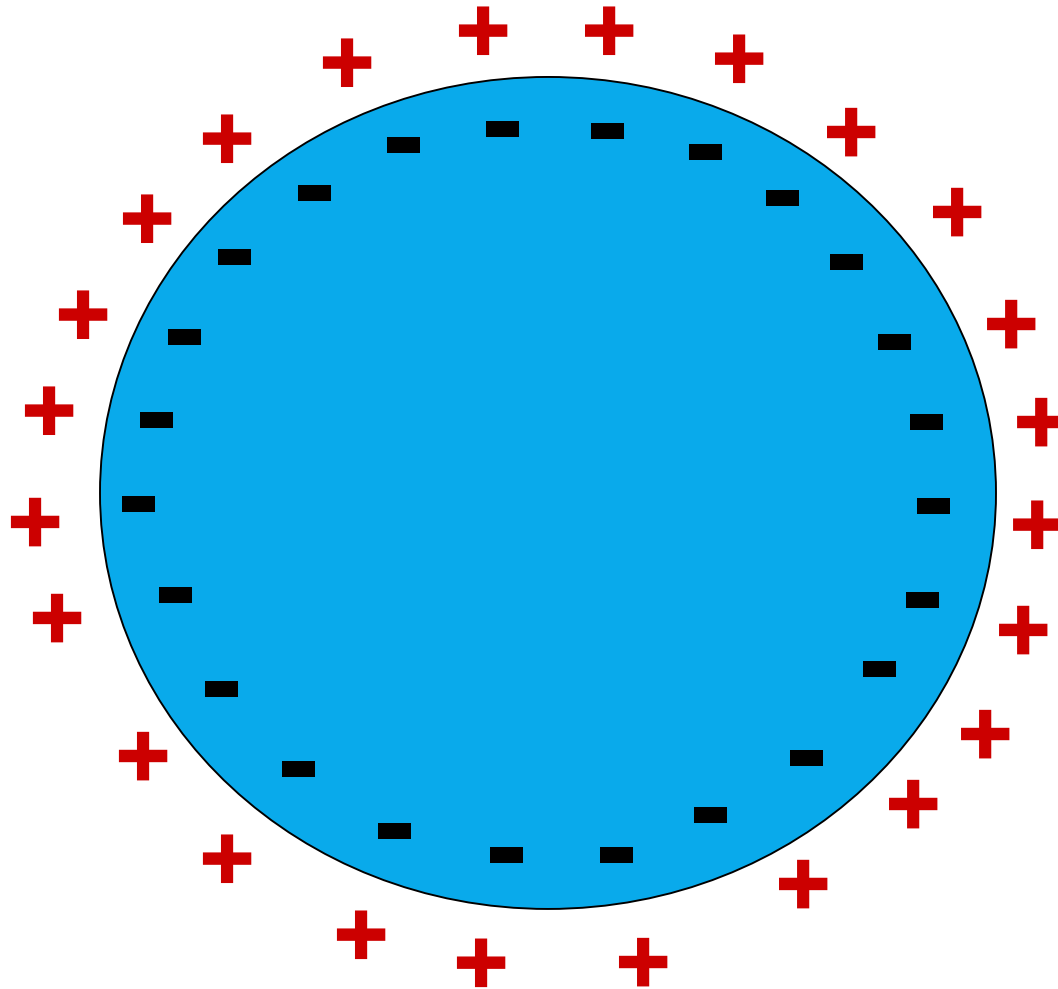
Only in nerve and muscle cells

Maintains strength over distance

Primary way nerves & muscles communicate!



"Resting"/Membrane Potential?



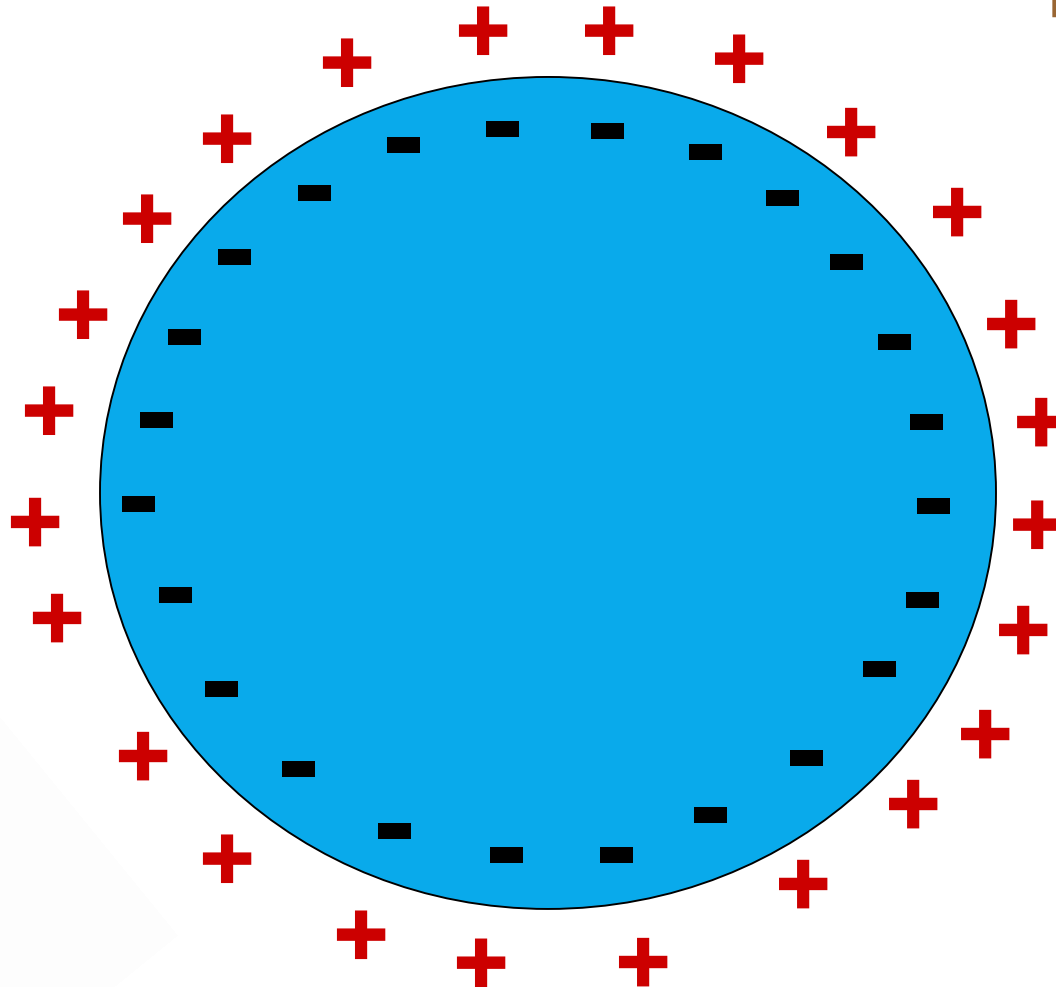
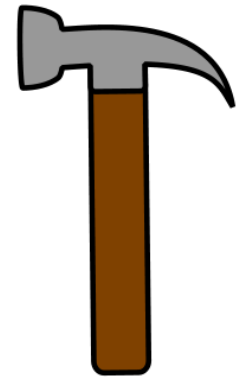
Cells are slightly negative inside!

Stimulate Cell @ Rest

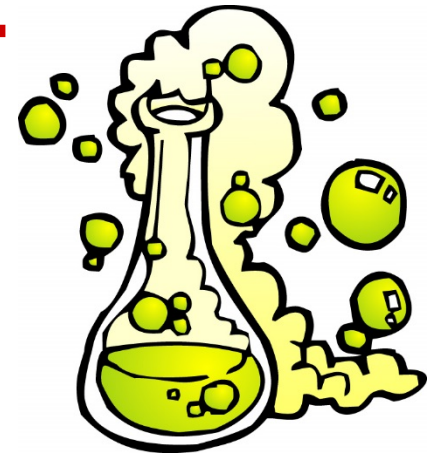
Thermal



Mechanical



1

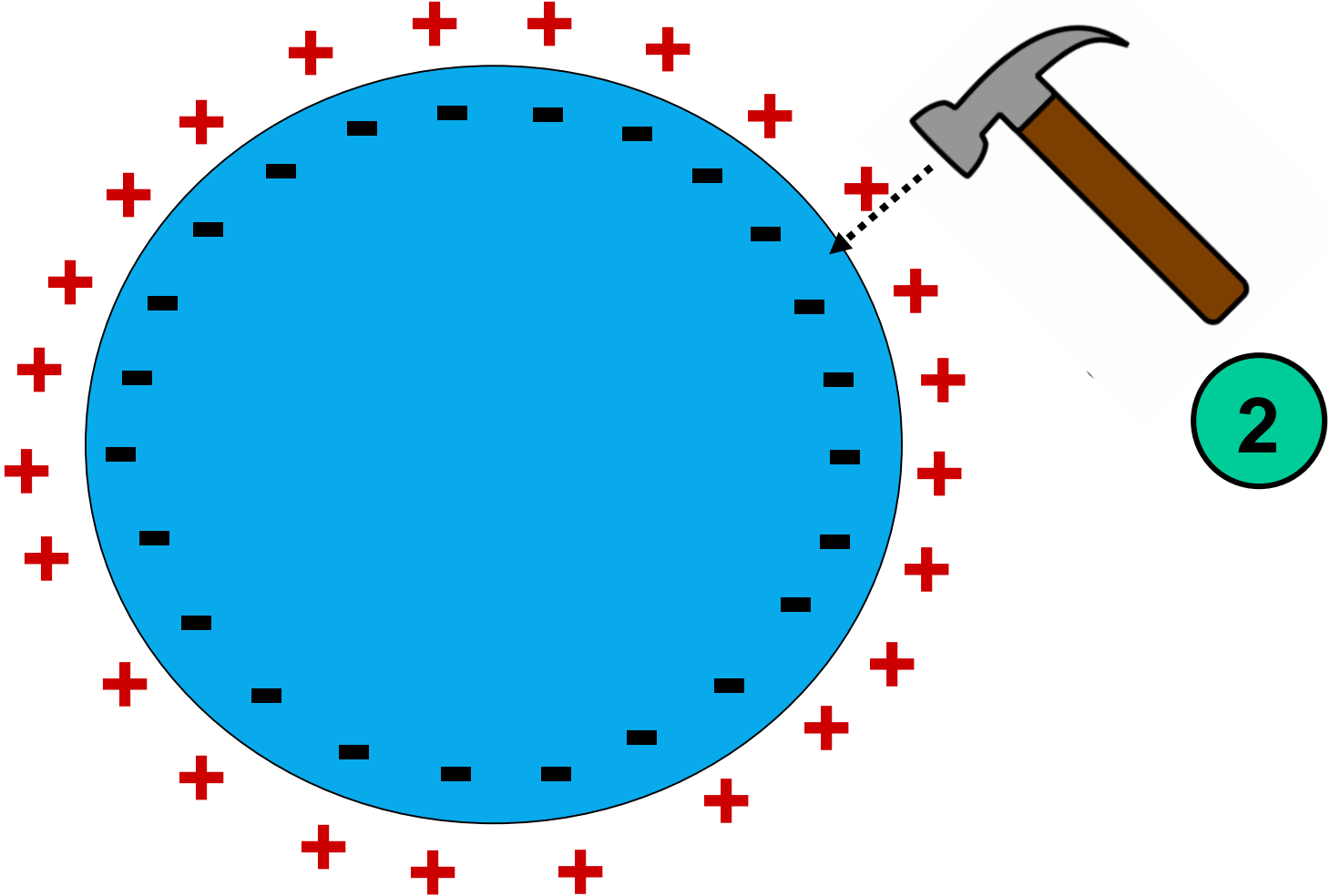


Electrical

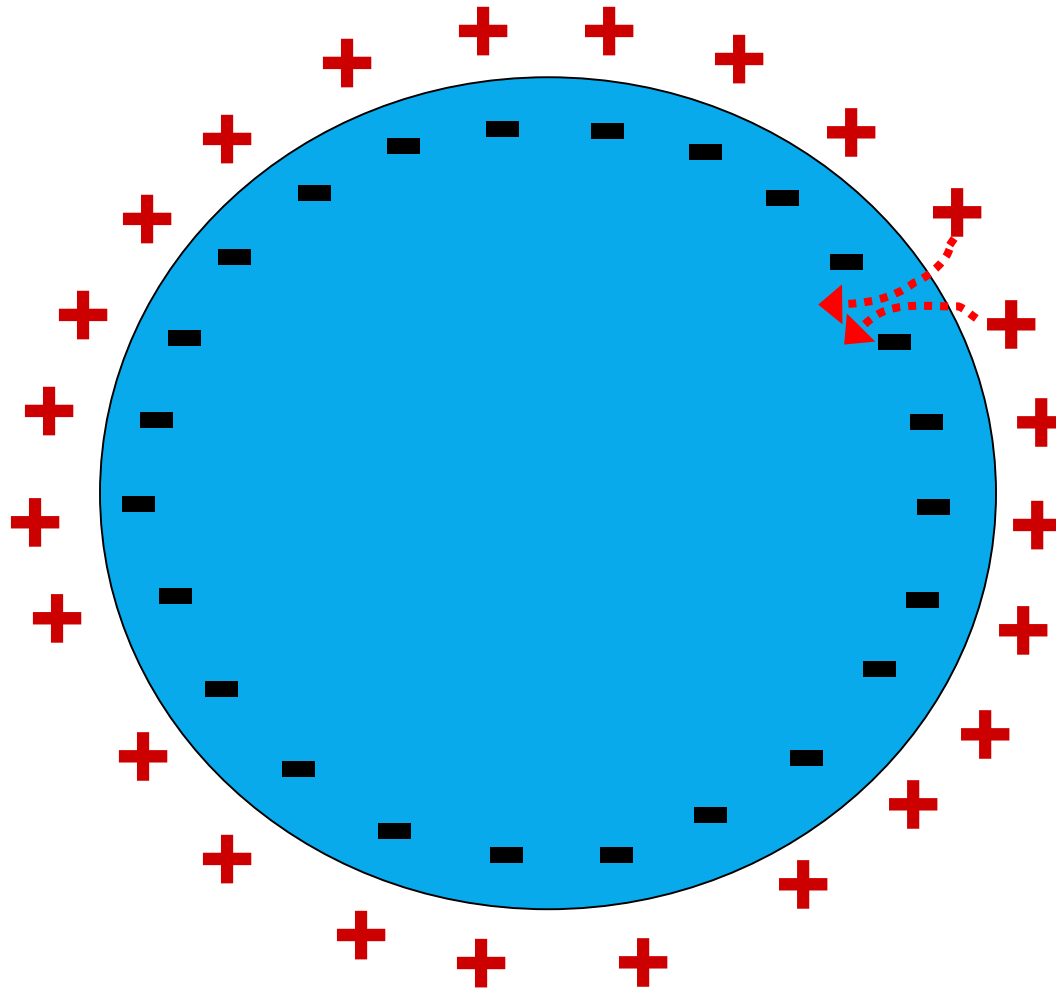


Chemical

Tap! Tap!..

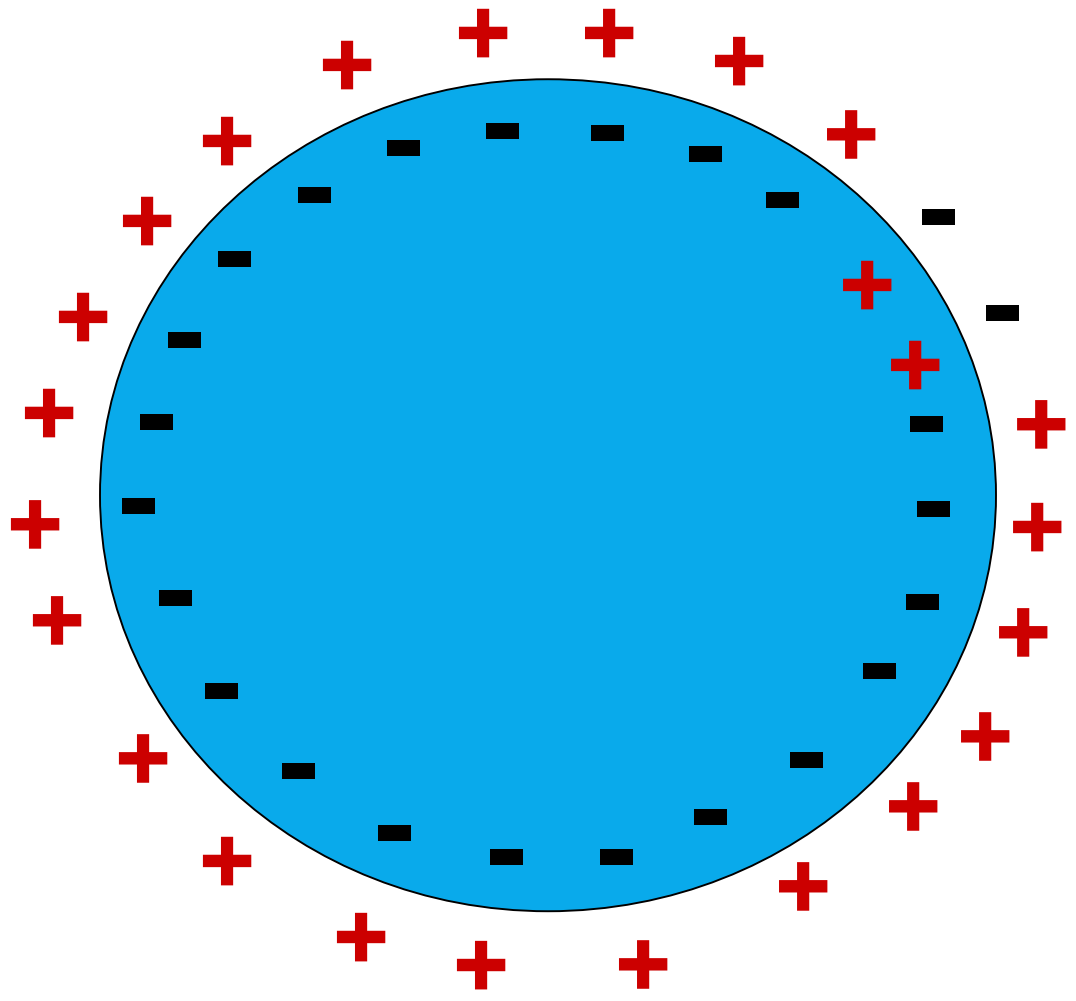


Changes Cell Membrane Permeability to Sodium/Na+!



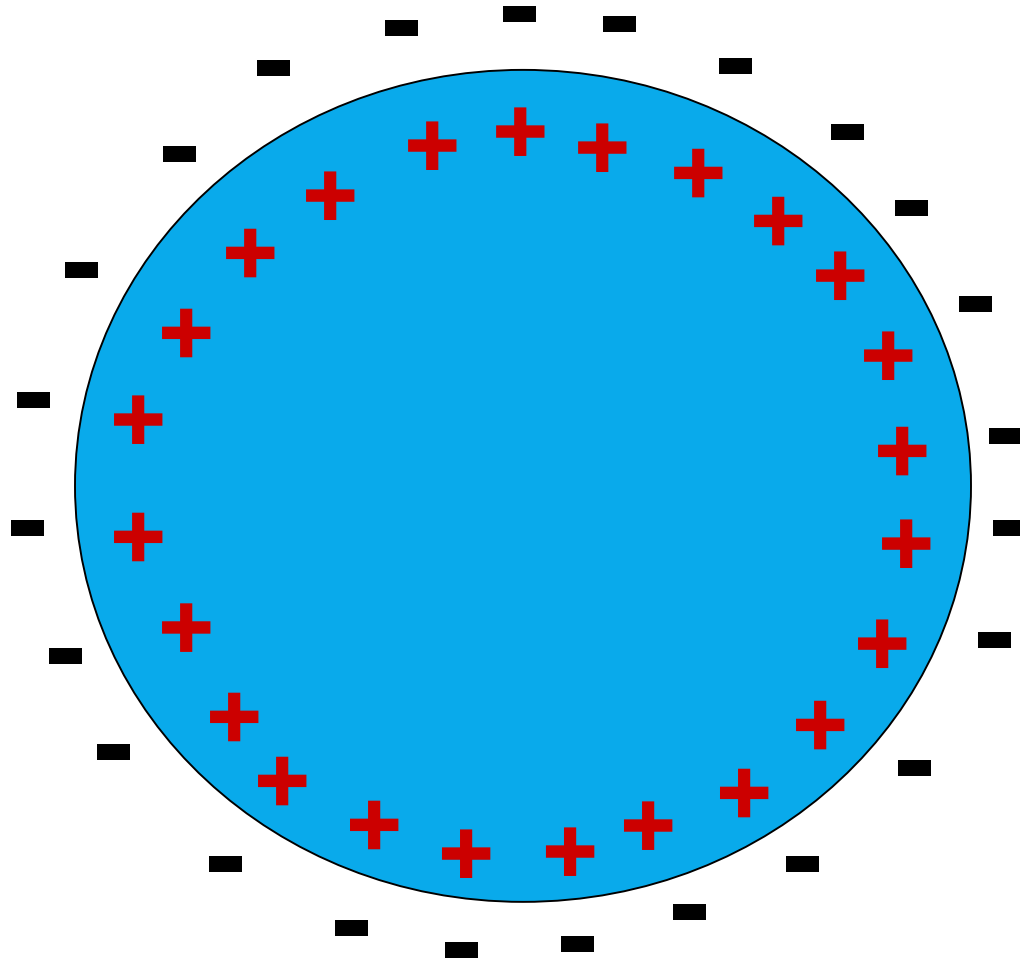
3

+ Charges/Na+ Rushes In!



4

Action Potential has occurred!



5

Brief (1-2 ms) reversal to + inside cell!

Mechanical
Chemical
Electrical
Thermal

Triggering event



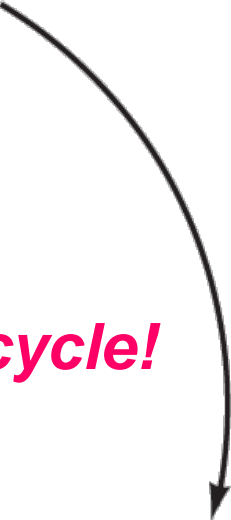
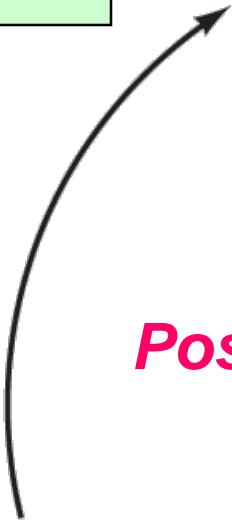
Depolarization
(decreased membrane potential)

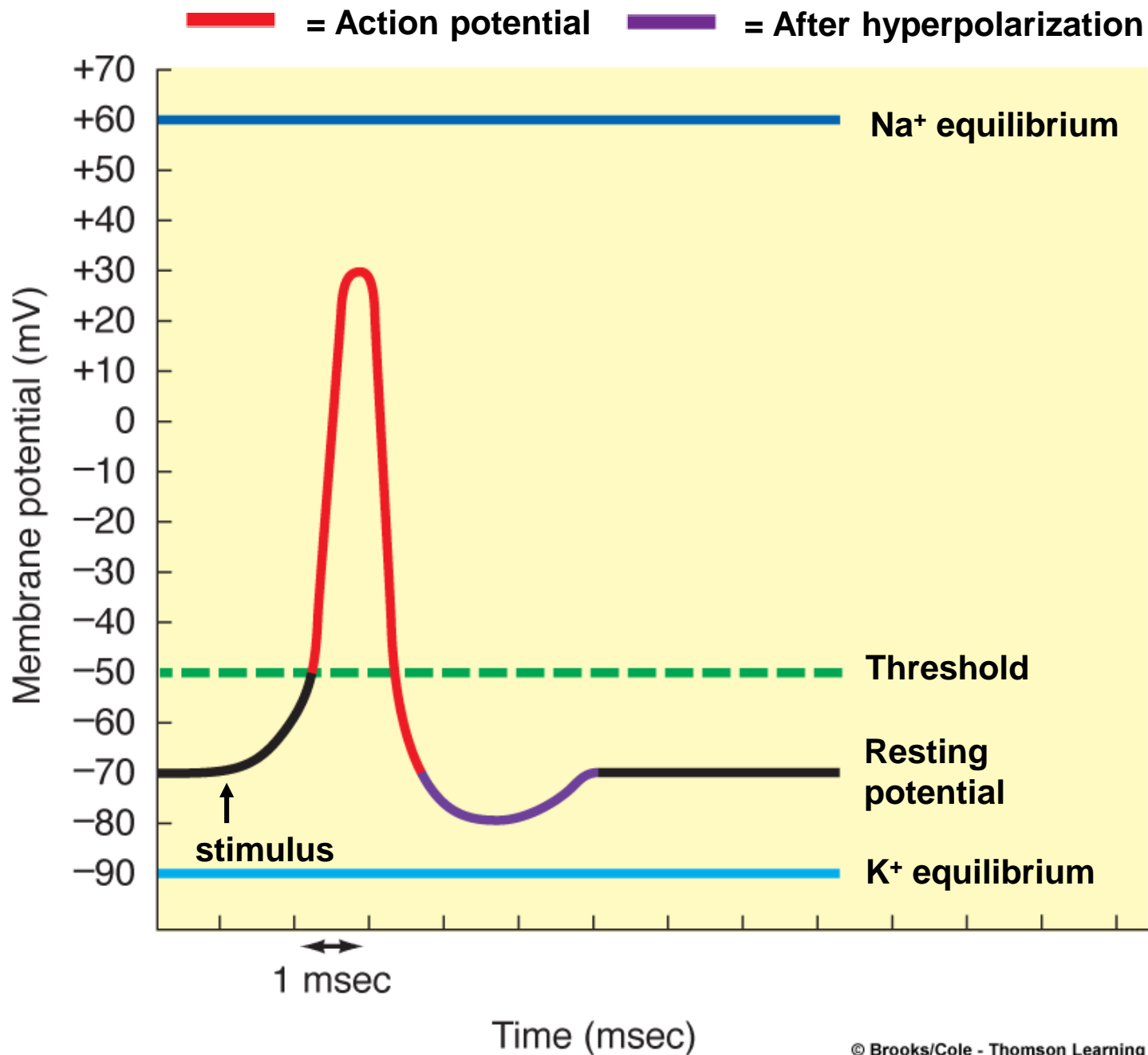
Positive-feedback cycle!

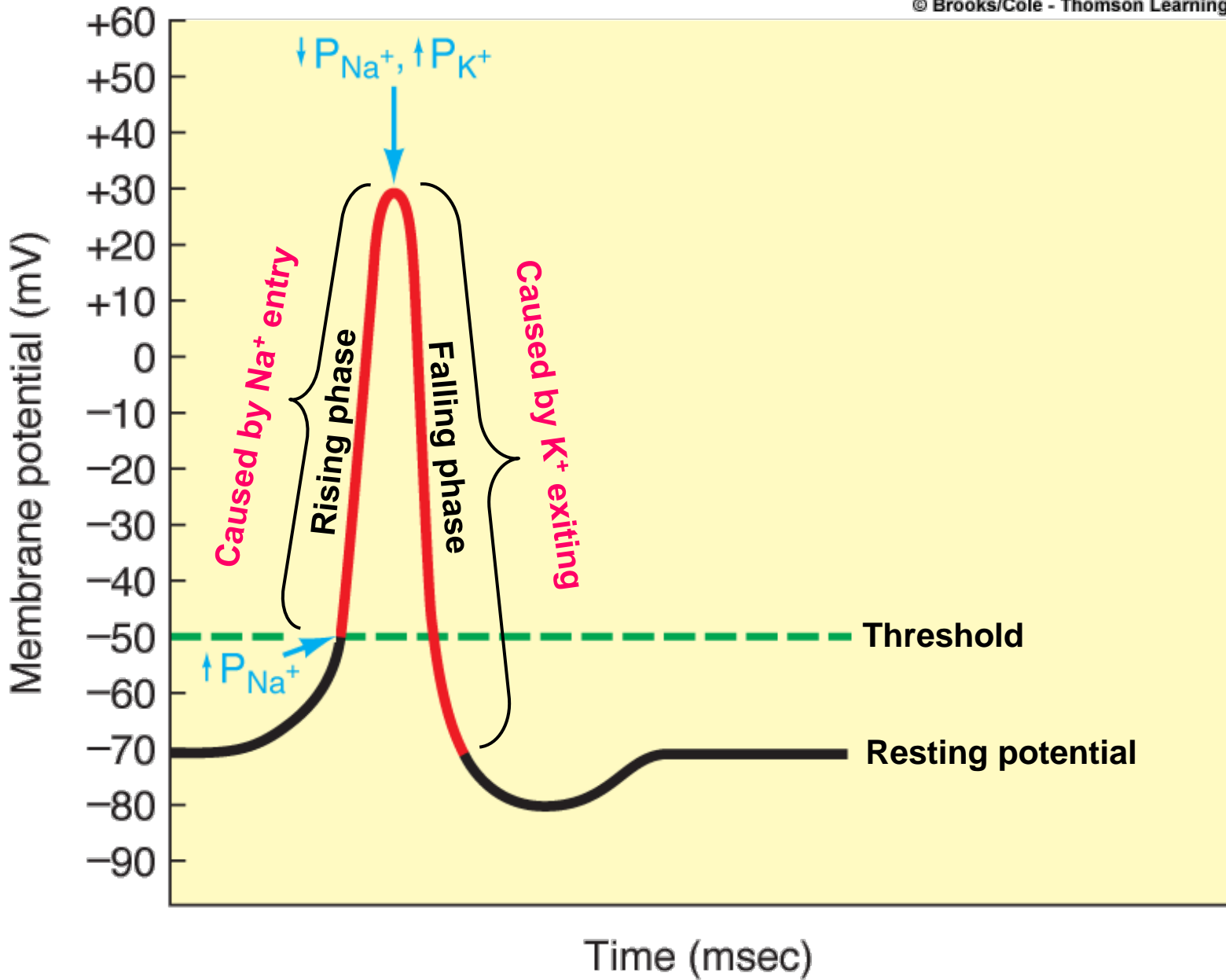
+

Influx of Na⁺
(which further
decreases
membrane potential)

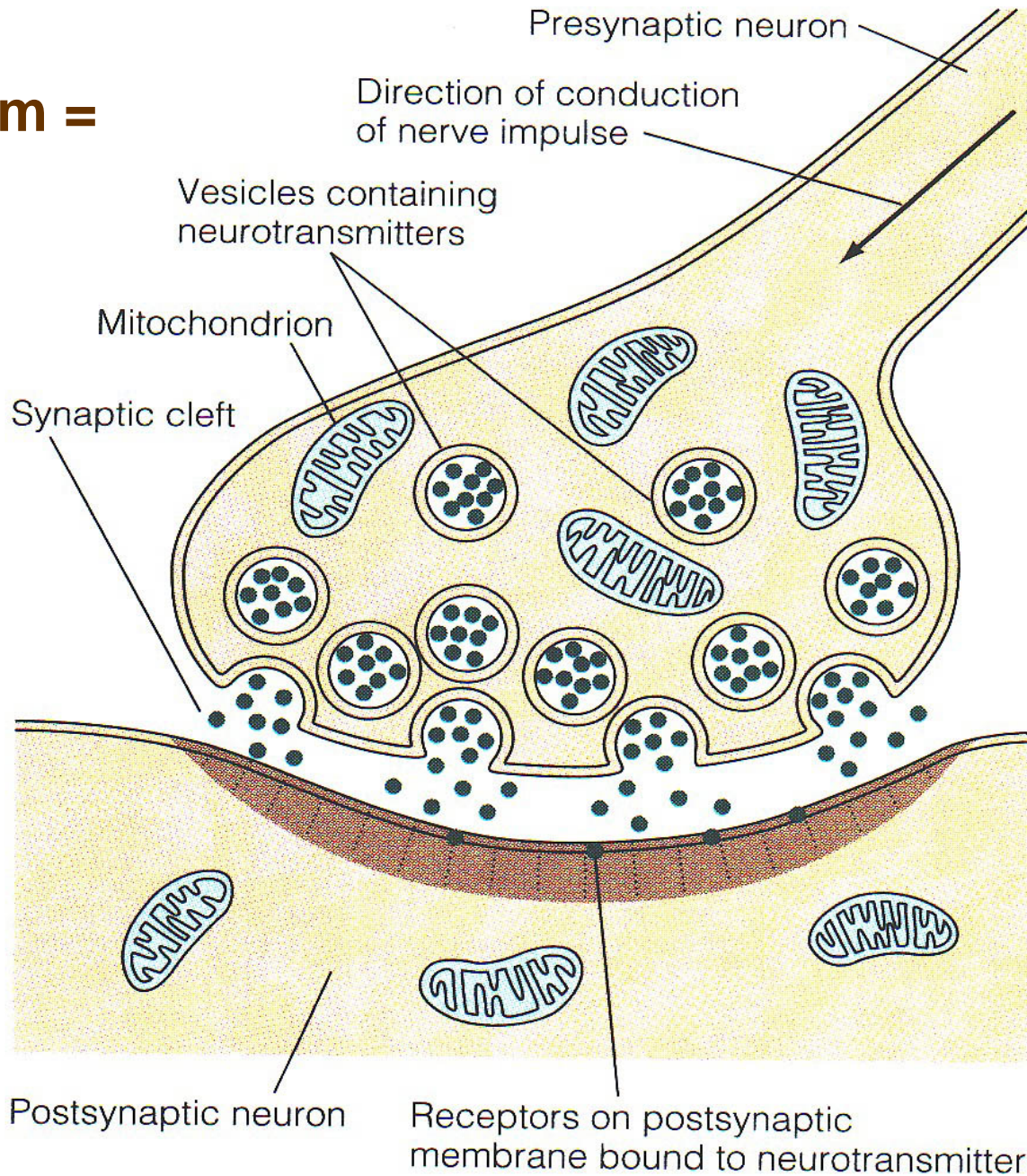
Opening of some
voltage-gated
Na⁺ channels

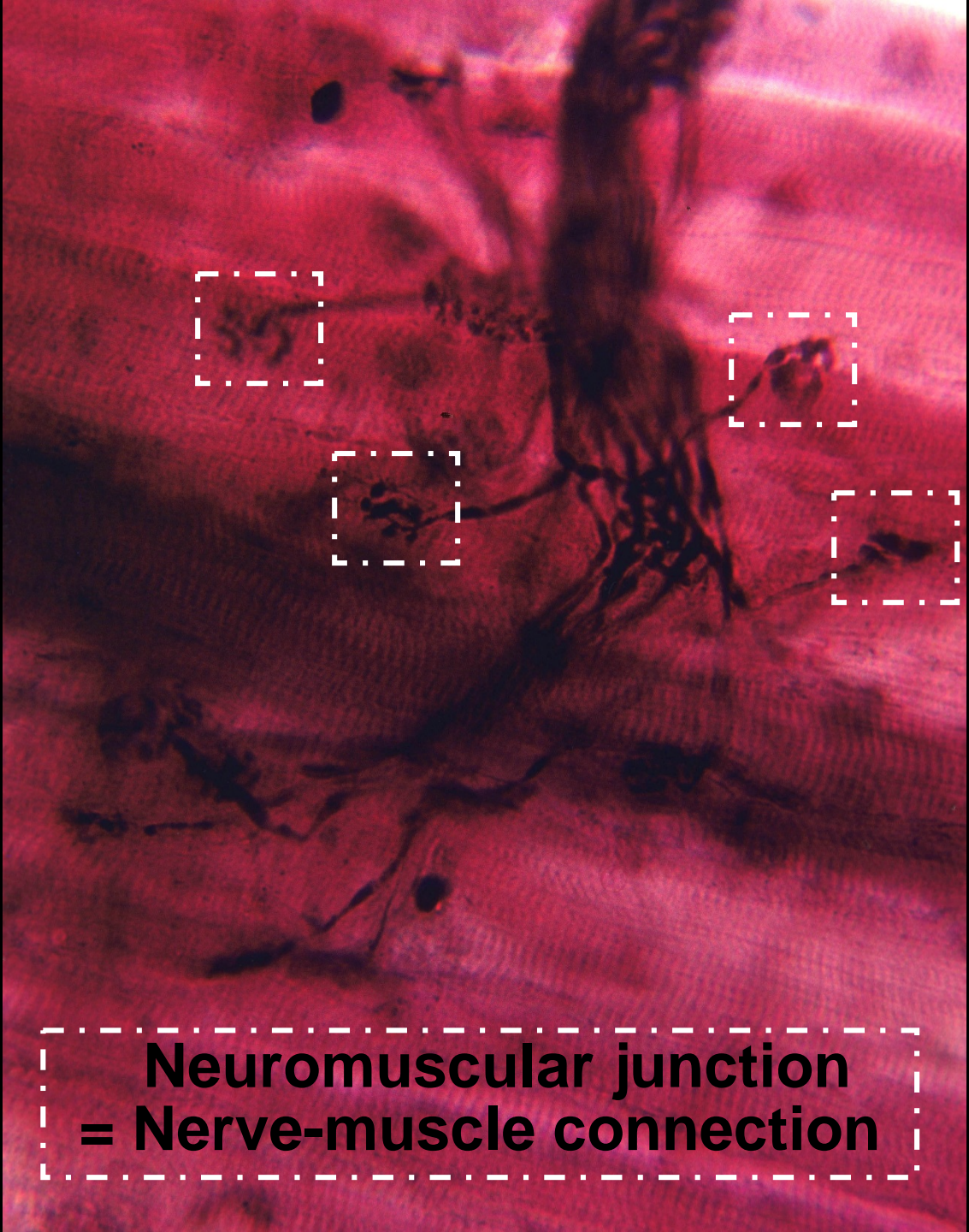




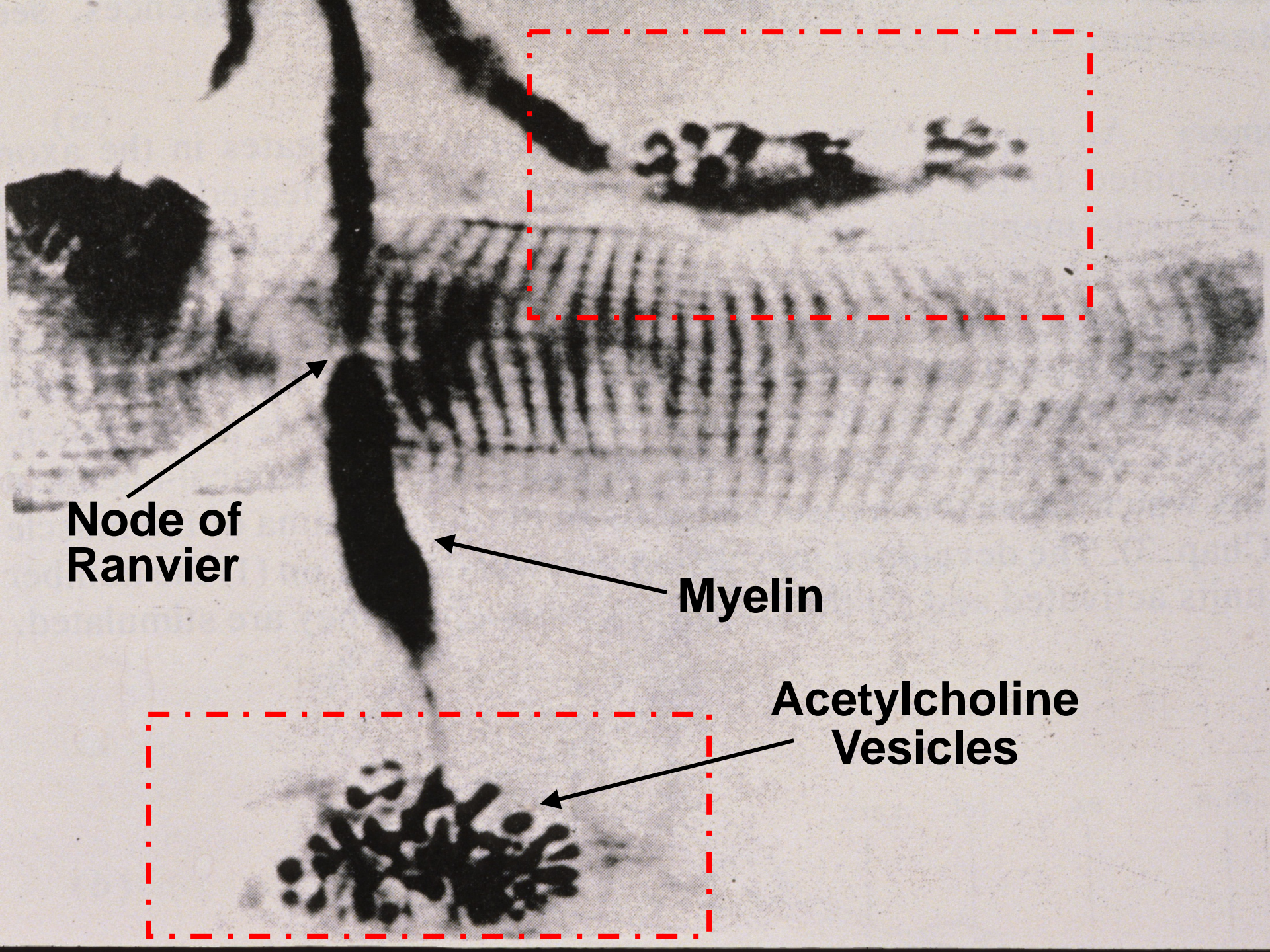


**Synapse =
Generic term =
connection
between
excitable
cells!**





**Neuromuscular junction
= Nerve-muscle connection**



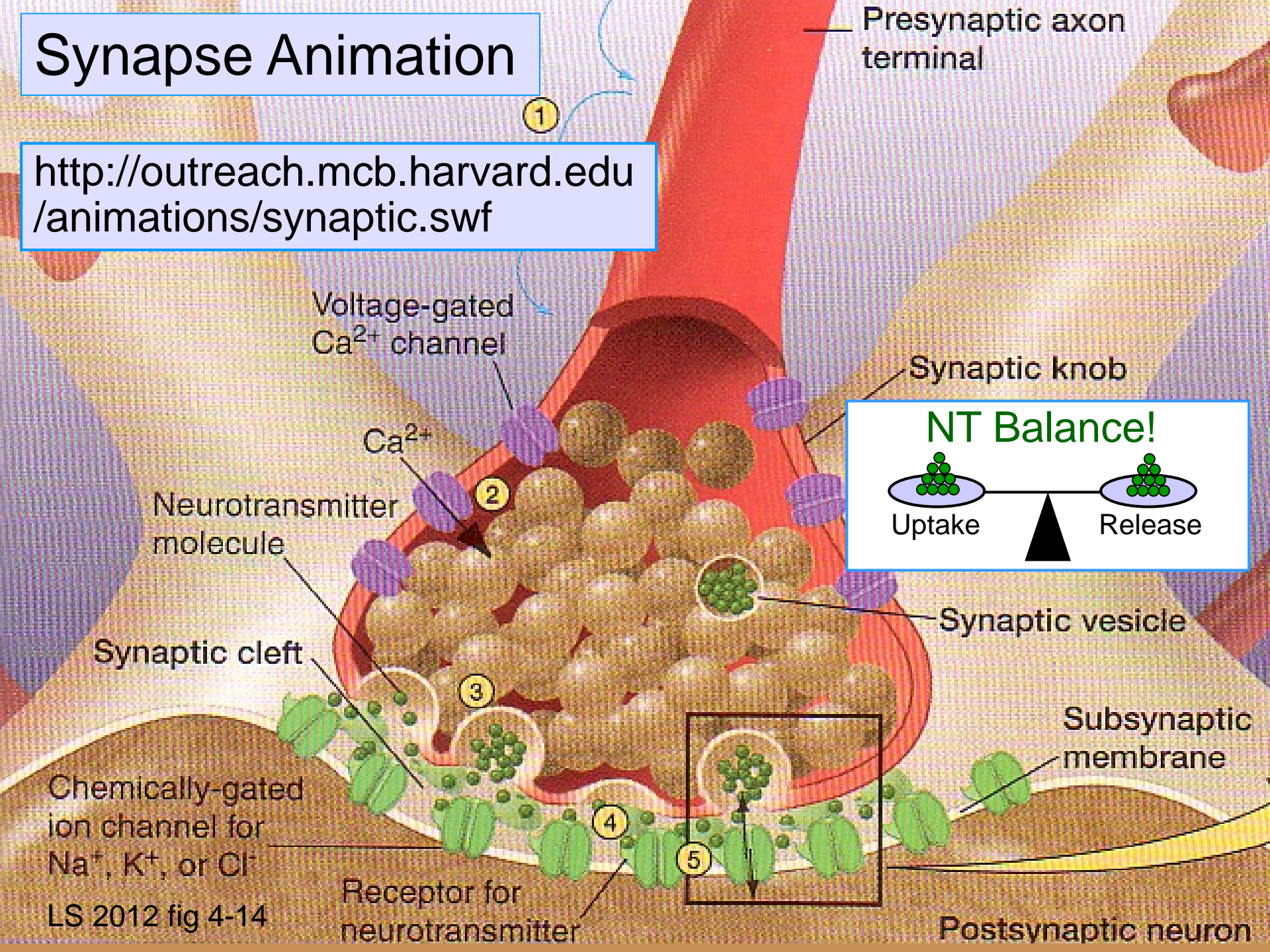
**Node of
Ranvier**

Myelin

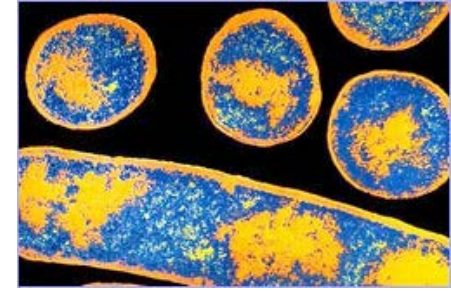
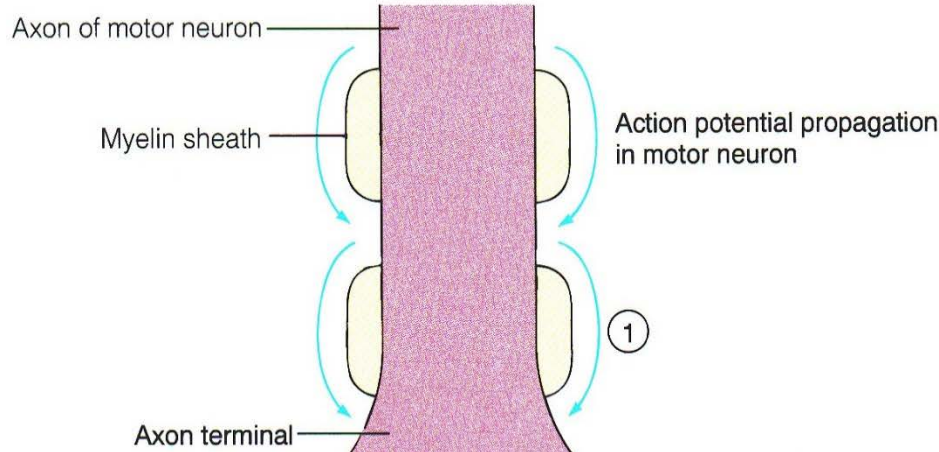
**Acetylcholine
Vesicles**

Synapse Animation

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



↑ 3



~~3~~



Terminal button

Vesicle of acetylcholine

Ca²⁺

Calcium channel

Action potential propagation in muscle fiber

Plasma membrane of muscle fiber

Acetylcholine receptor site

Cation channel

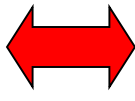
Acetylcholinesterase

Muscle fiber

Local current flow between depolarized end plate and adjacent membrane

Motor end plate

~~7~~



4

