



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!!**

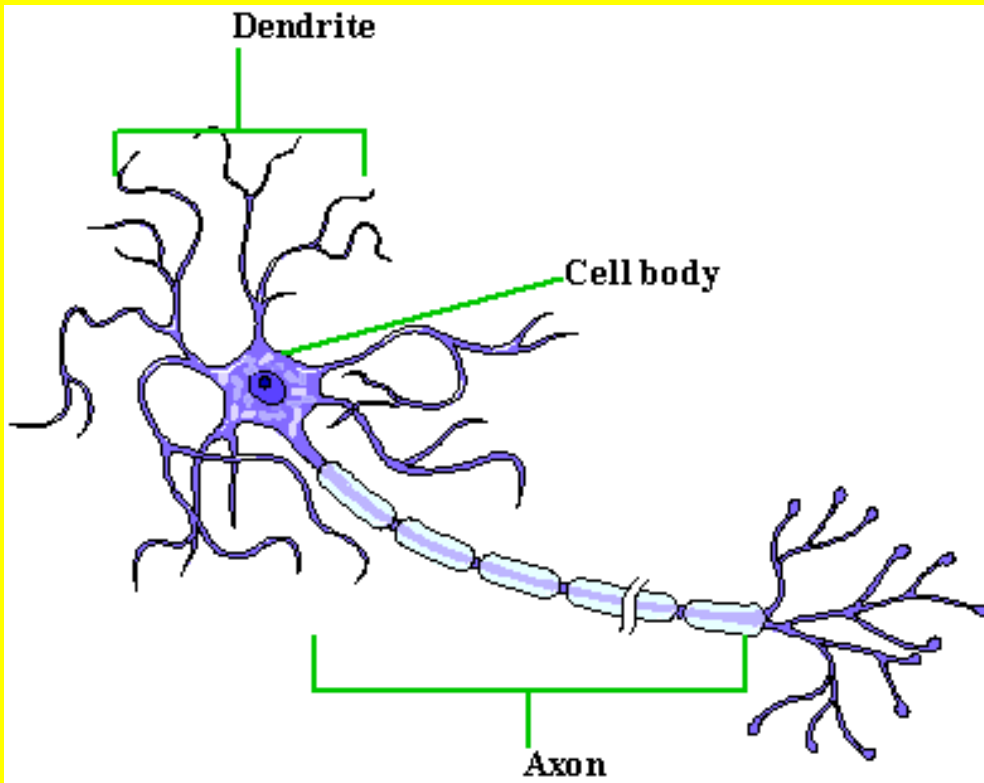
Optional Lab notebook check after last Lab 6, Mac pulmonary function testing (PFT) next Thursday. Q?

II. CNS Connections Myelin, brain + spinal cord (CNS) **Protect your head with a helmet!** Bicycle head injury statistics *NHTSA & BHSI, 2014 data*

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

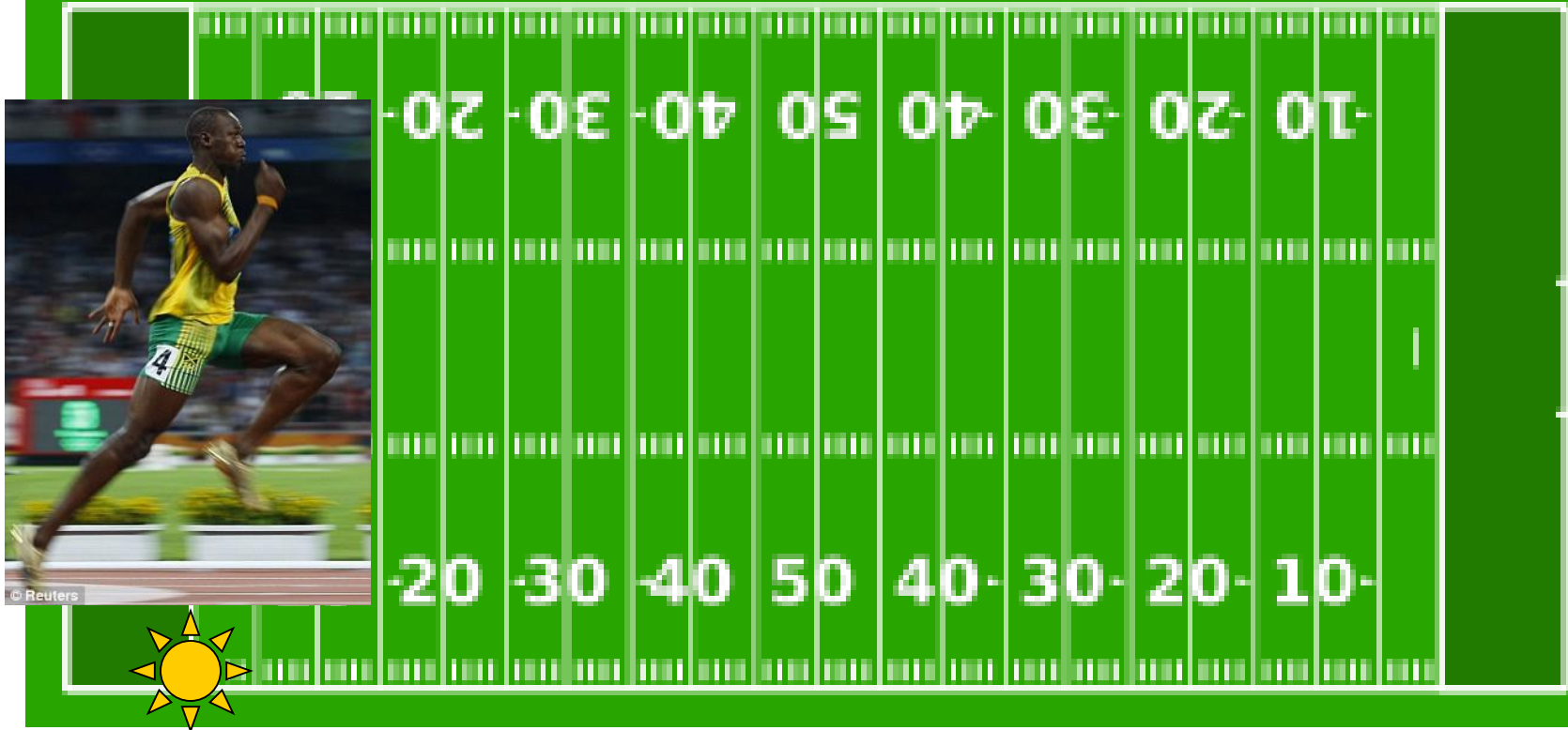
- A. Autonomic NS: Branches, neurotransmitters, receptors, actions, fight-or-flight stories ch 7 pp179-85
- B. Why are nerve & muscle unique? ch 4 p 71
- C. How do excitable cells signal? ch 3 pp62-7; ch 4 pp74-83
- D. How does the signal cross the nerve-muscle gap?
ch 7 p 185-92 fig 7-5 p 190
 1. Ca²⁺ 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?

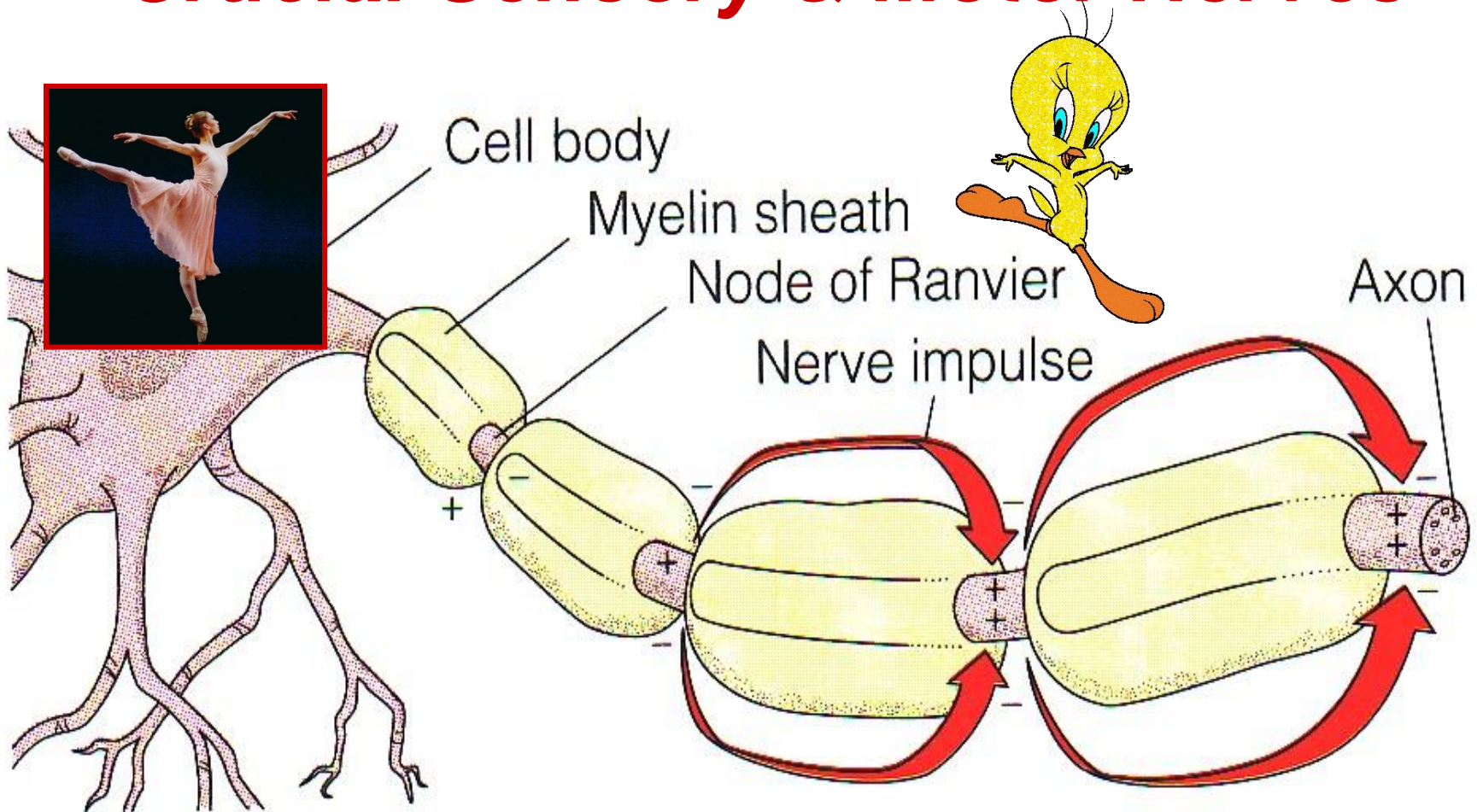


Lipid insulative coat
 $\uparrow \vec{v}$, *conserves ions & ATP*

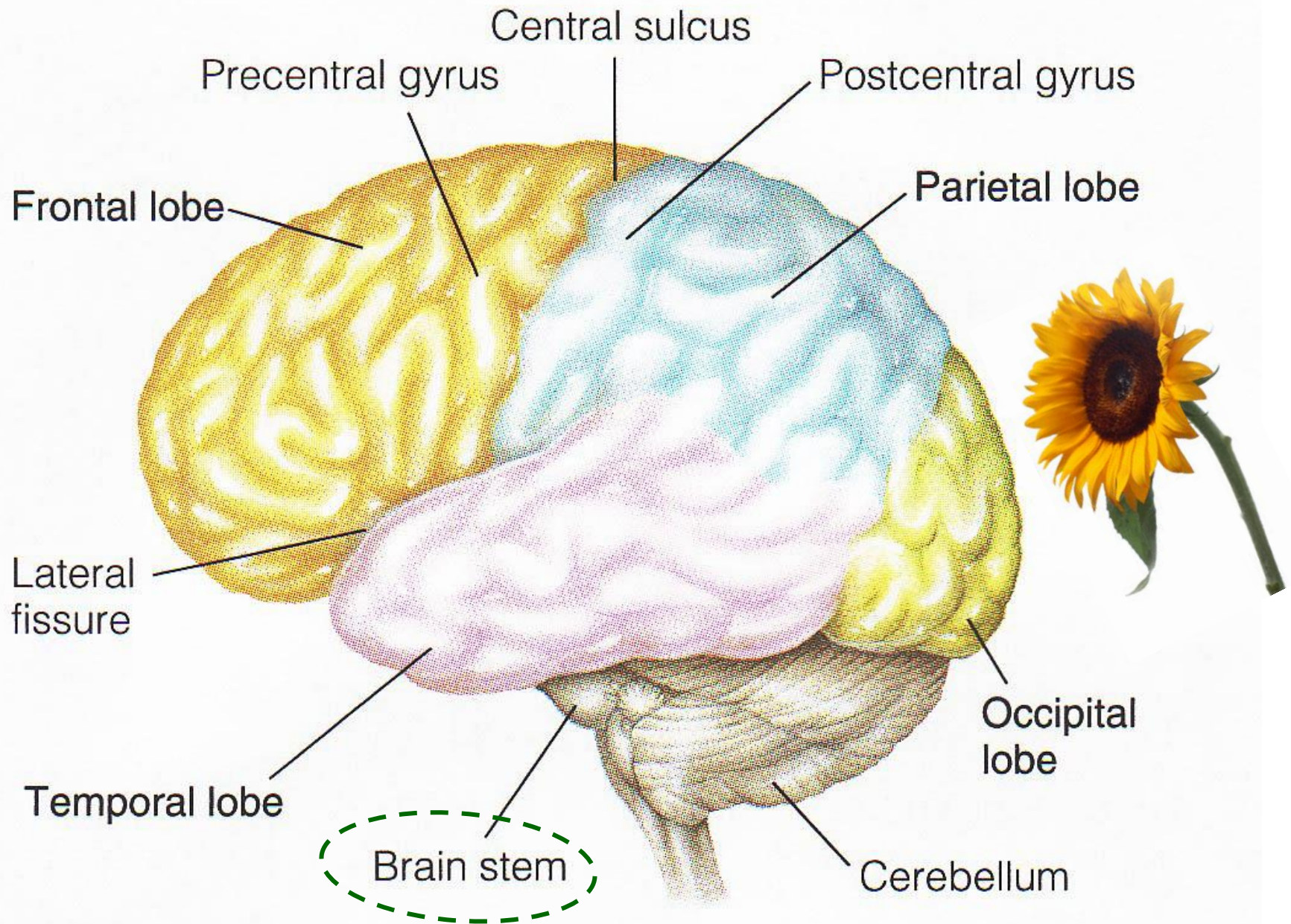
A large myelinated "survival" nerve can conduct impulses the length of football field in < 1 second!

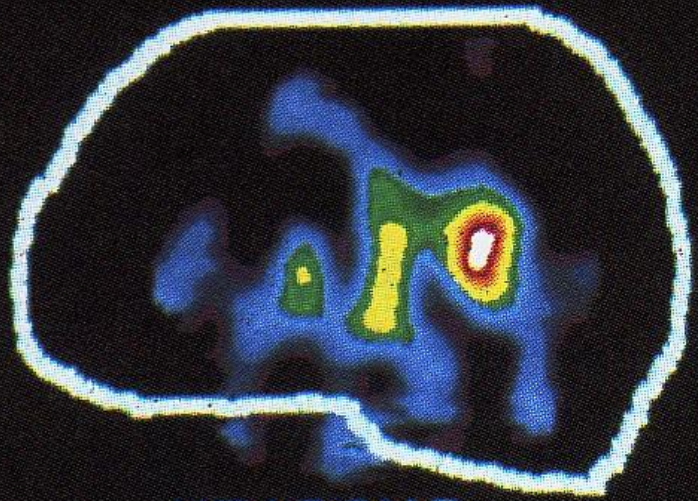


Saltatory/Leaping Conduction! *Crucial Sensory & Motor Nerves*

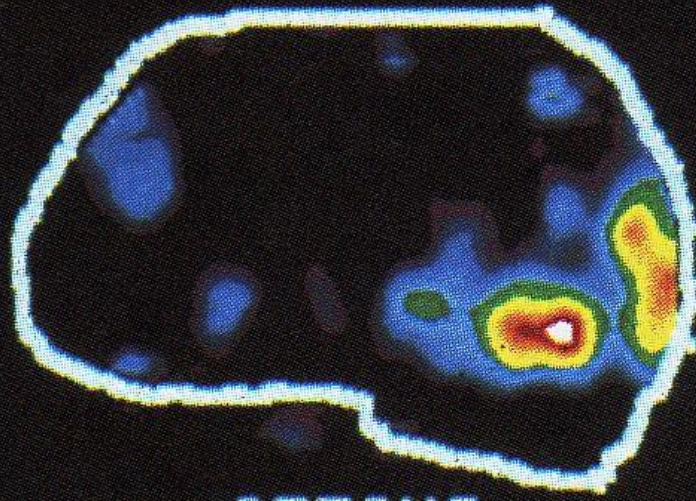


L. saltare to hop or leap! Fr. salt, sautier, sauté, leap, high air, vault

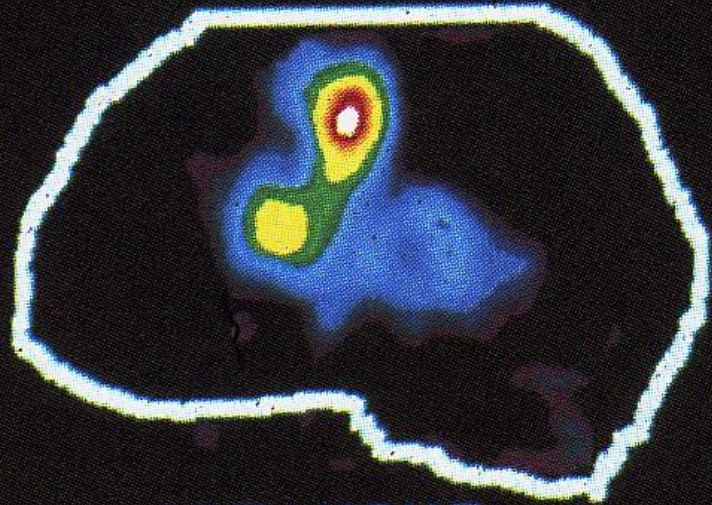




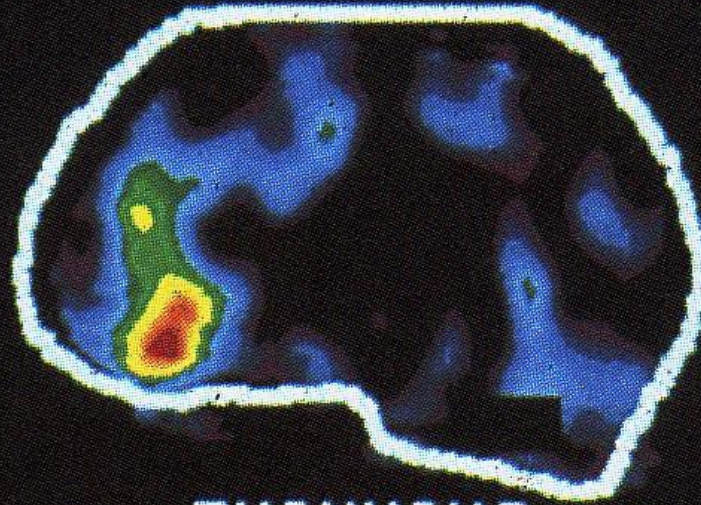
HEARING



SEEING



SPEAKING

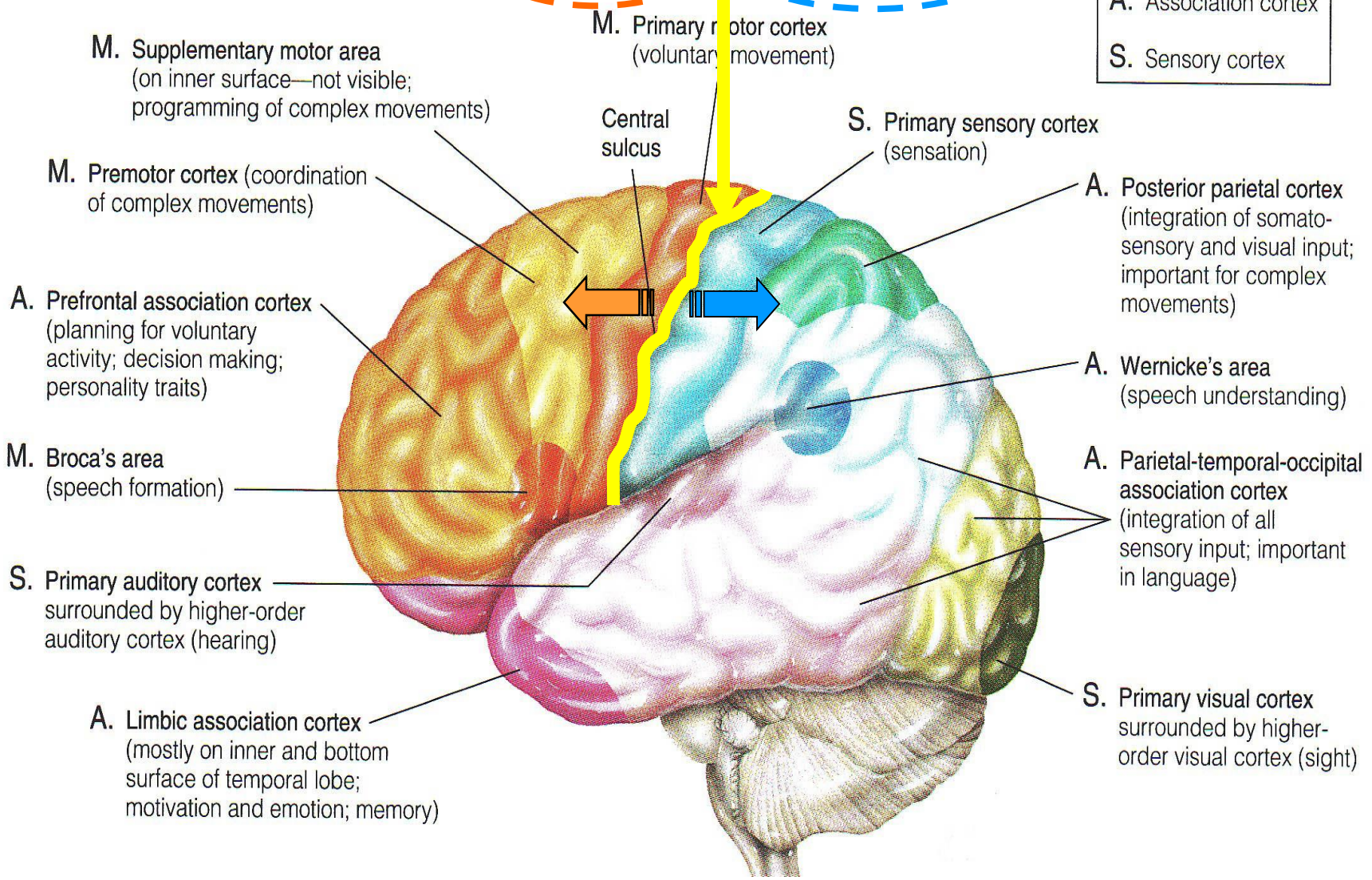


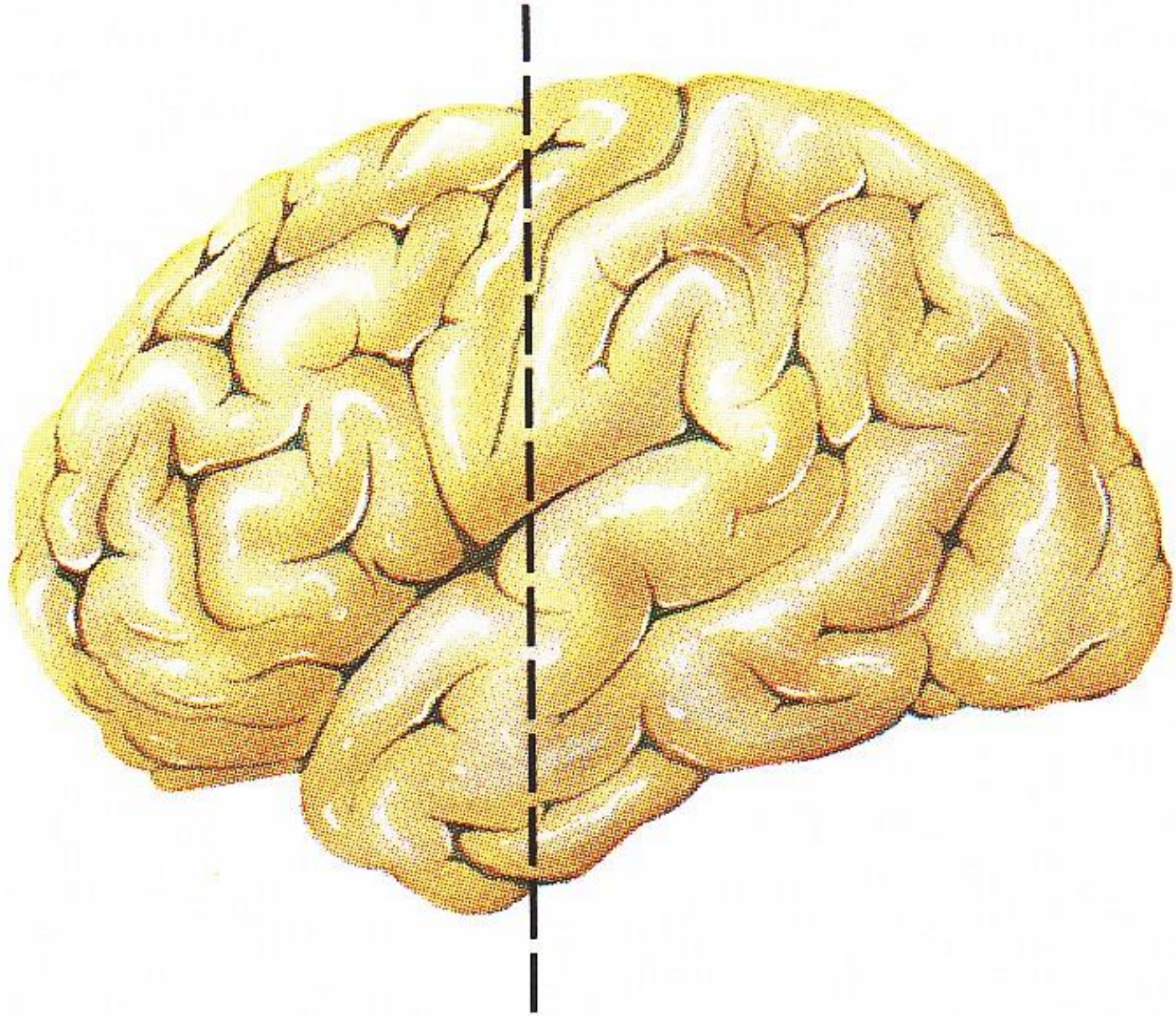
THINKING

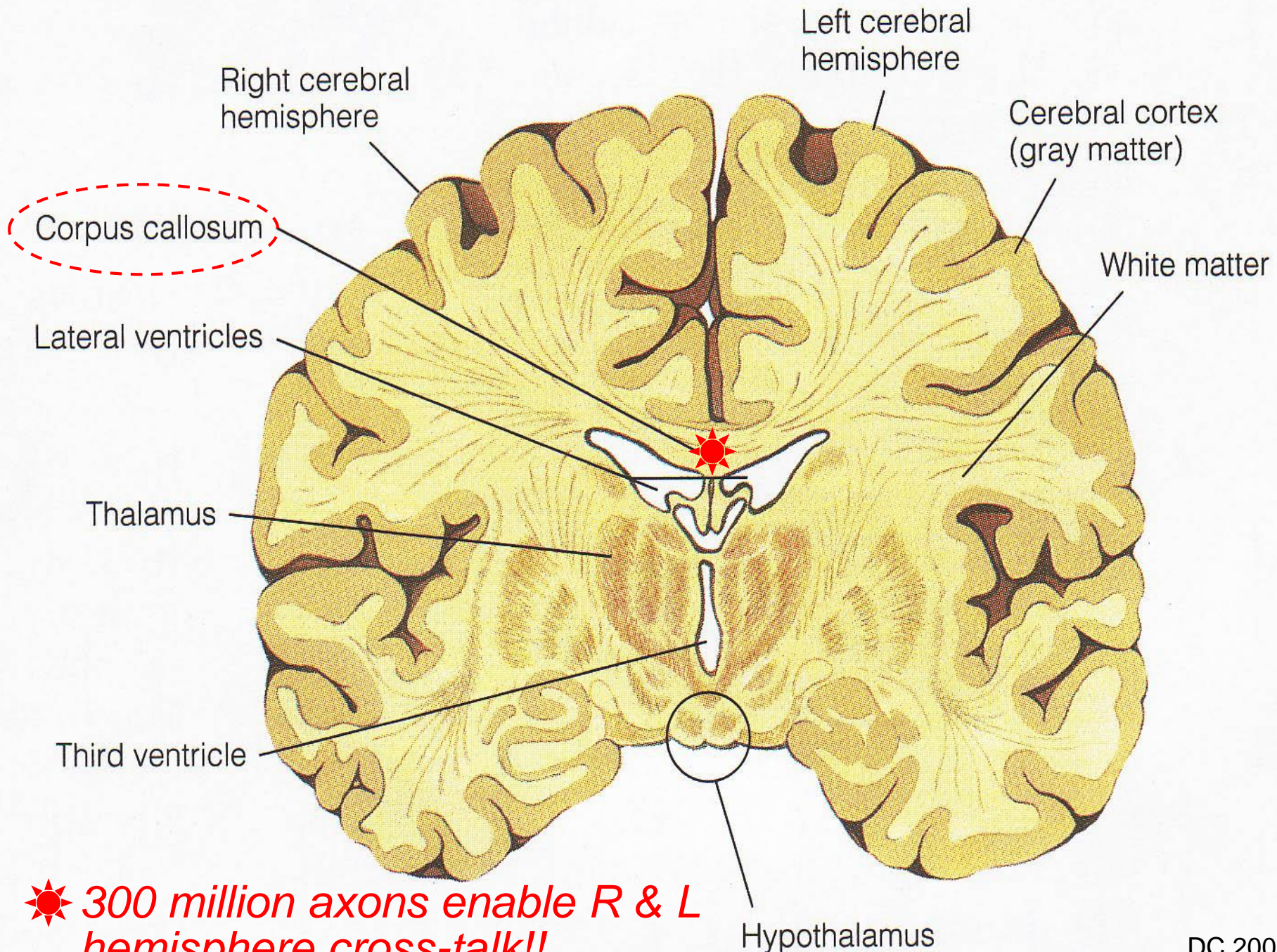




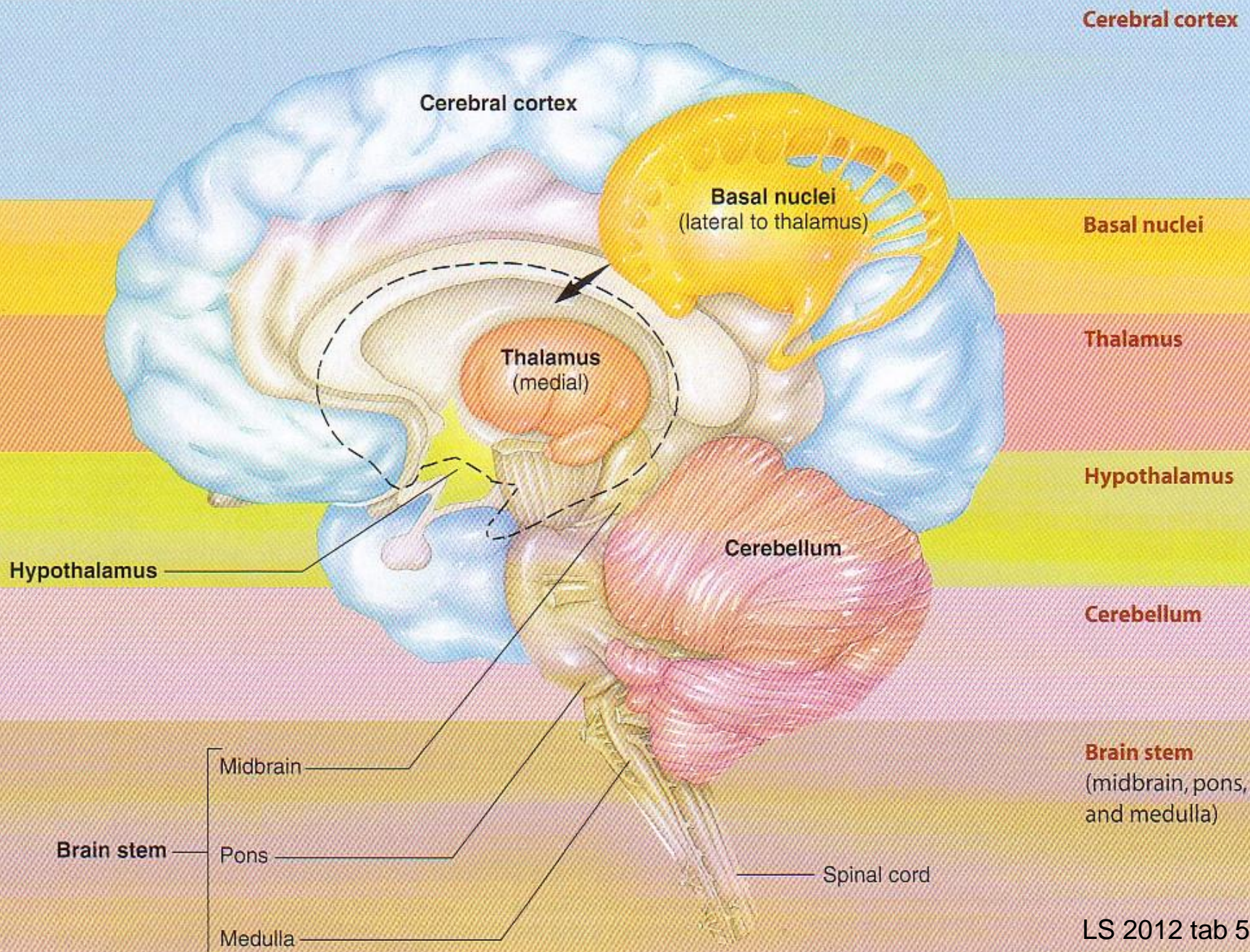
| Key | |
|-----|--------------------|
| M. | Motor cortex |
| A. | Association cortex |
| S. | Sensory cortex |







★ 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

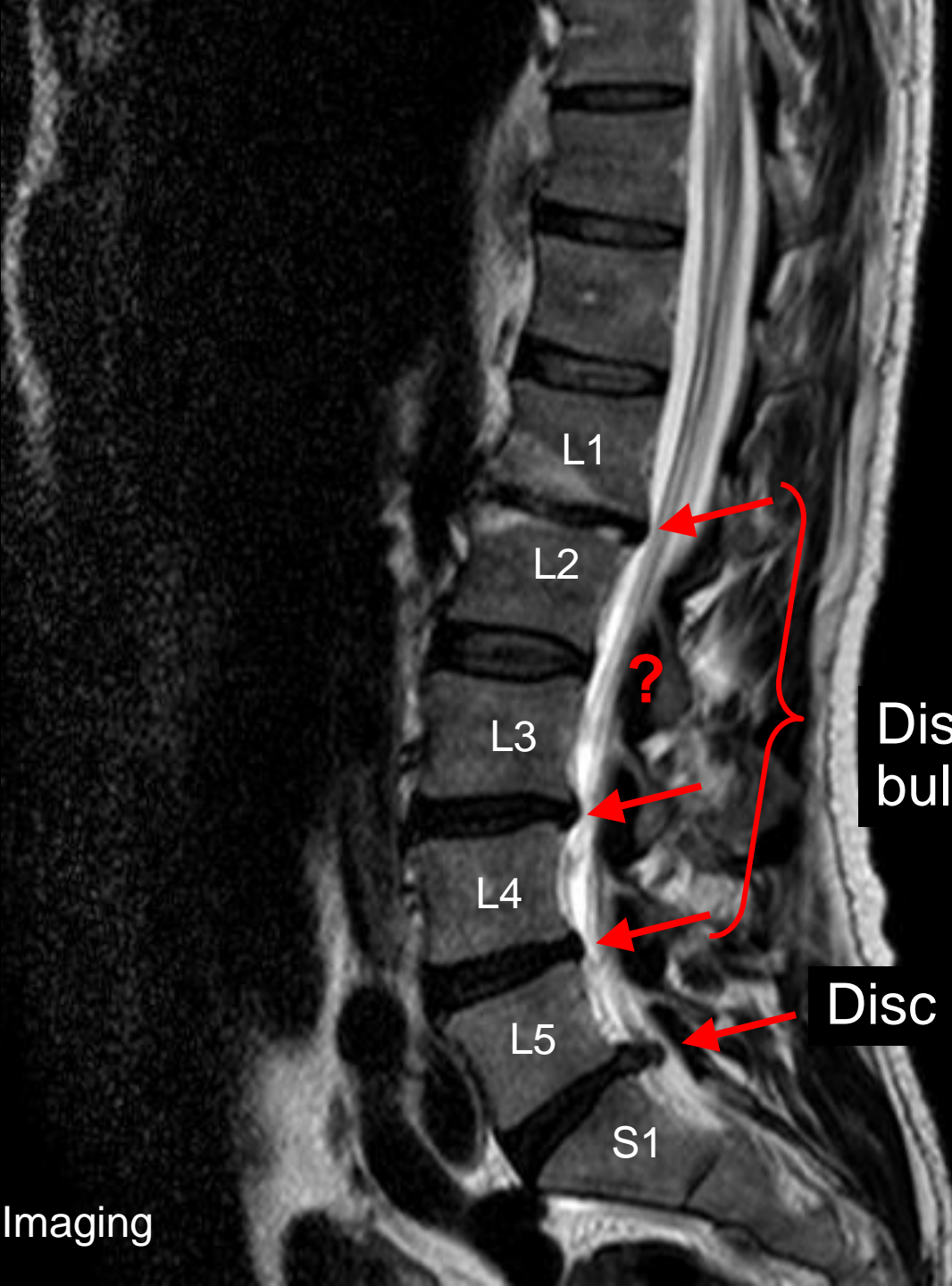
L5

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

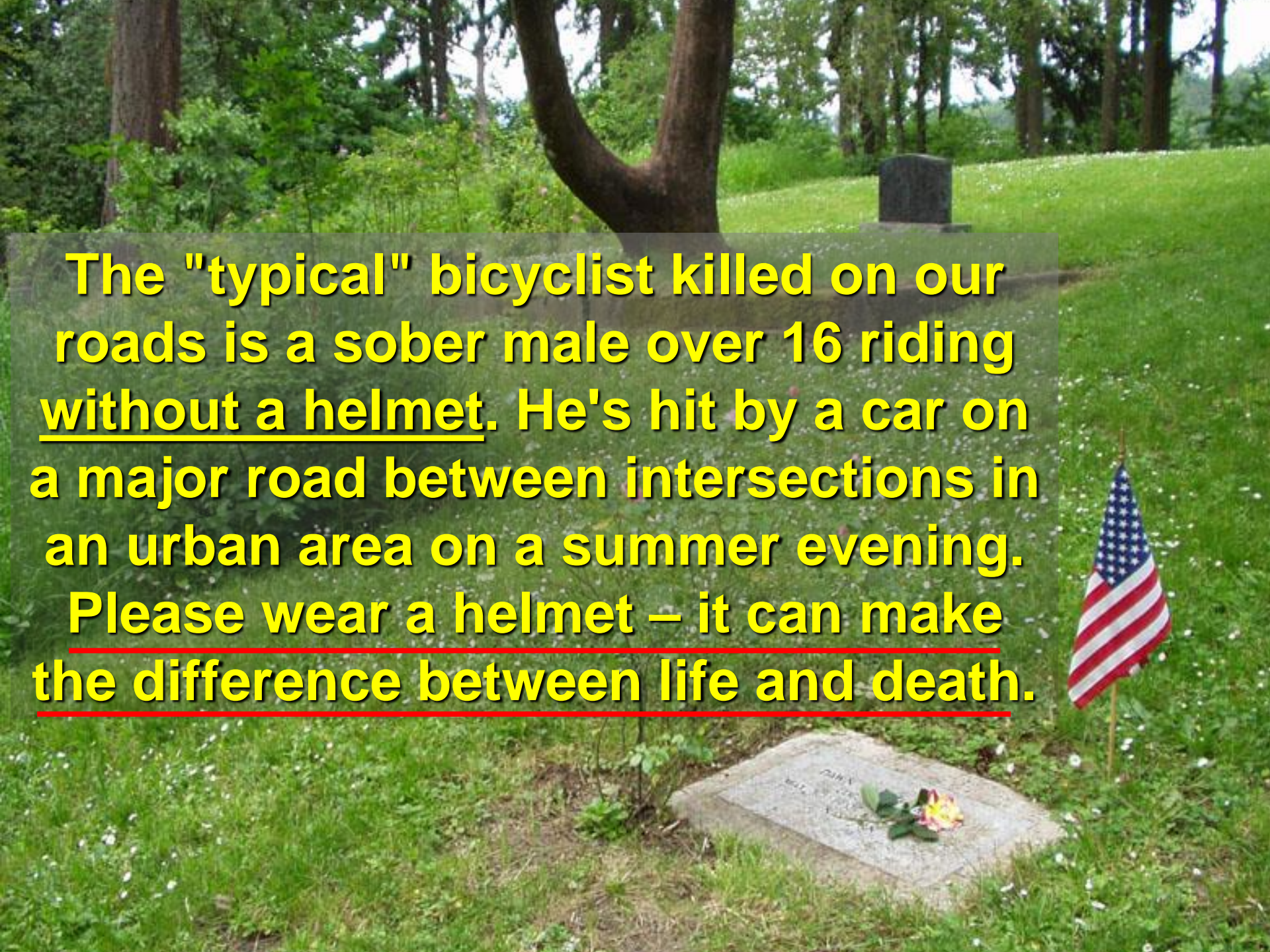
13% of deaths children \leq 14 yr, 87% σ

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!

A photograph of a cemetery. In the foreground, there is a low, rectangular gravestone with a single rose placed on it. To the right of the gravestone, a small American flag is planted in the grass. In the background, a large, dark tree trunk is visible, and further back, another gravestone stands on a grassy slope. The scene is set in a lush, green environment with many trees.

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!!



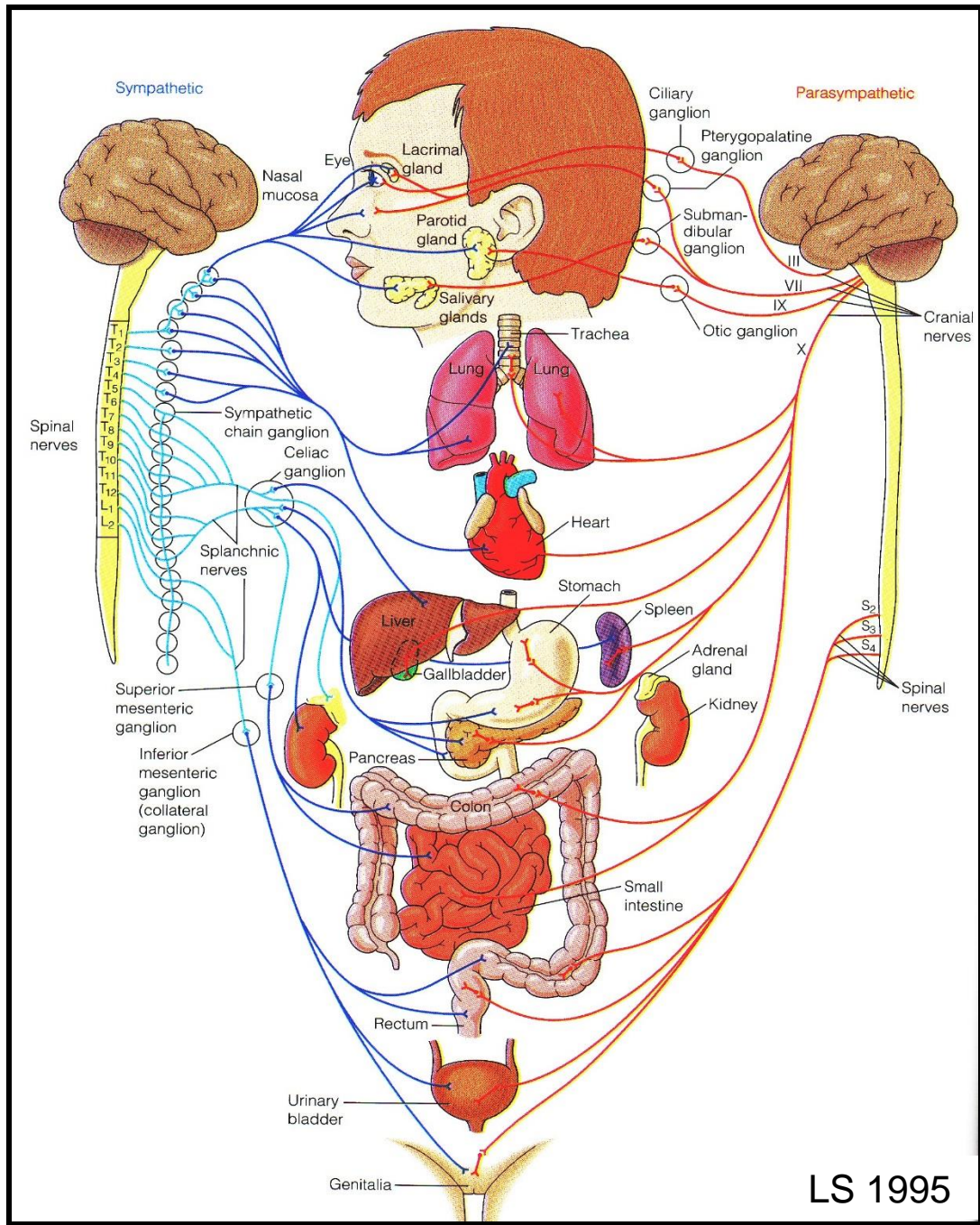
Stories, Discussion, Questions or Comments!



Autonomic Nervous System

Why overlap or dual innervation?

Fine-tune control & safety!



PARASYMPATHETIC = RESTING, DIGESTIVE,
HOUSEKEEPING FUNCTIONS

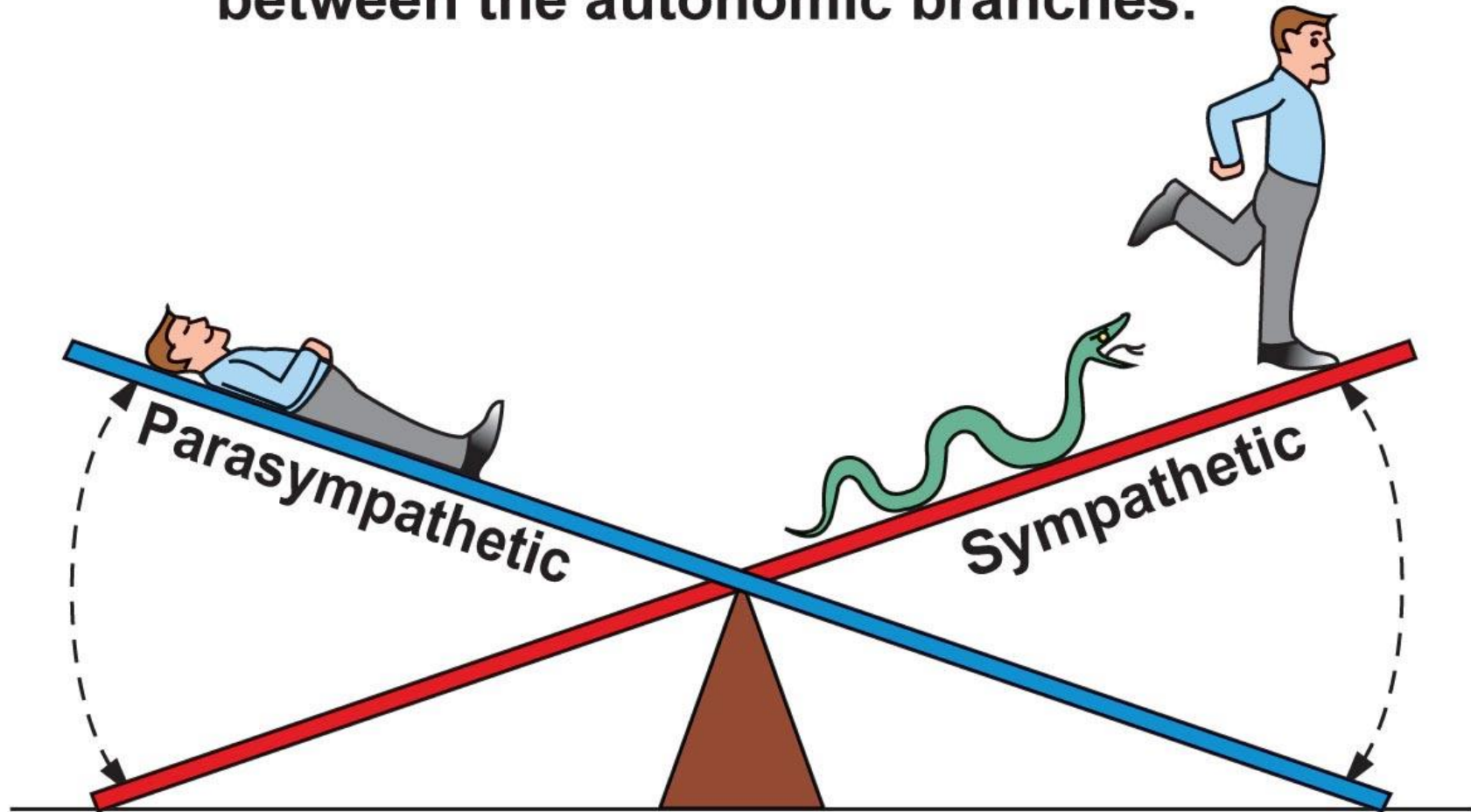


FIGHT/FLIGHT/ALARM REACTION!!

BI 121 +
other finals!



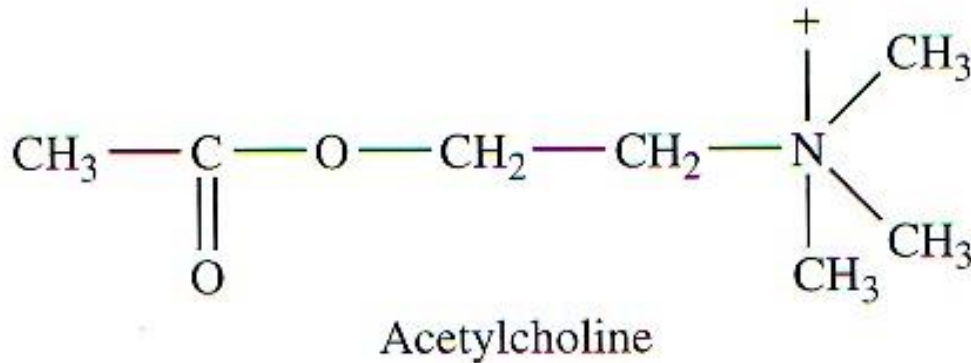
Homeostasis is a dynamic balance between the autonomic branches.



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

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

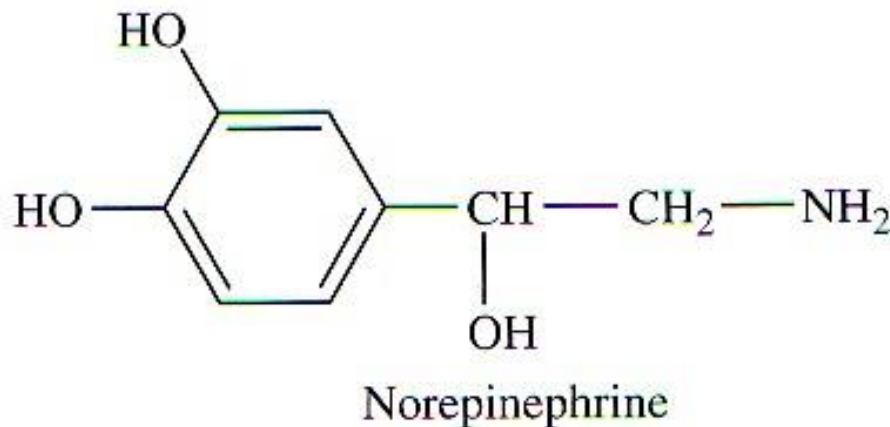
Autonomic Neurotransmitters & Receptors



Cholinergic

Nicotinic

Muscarinic

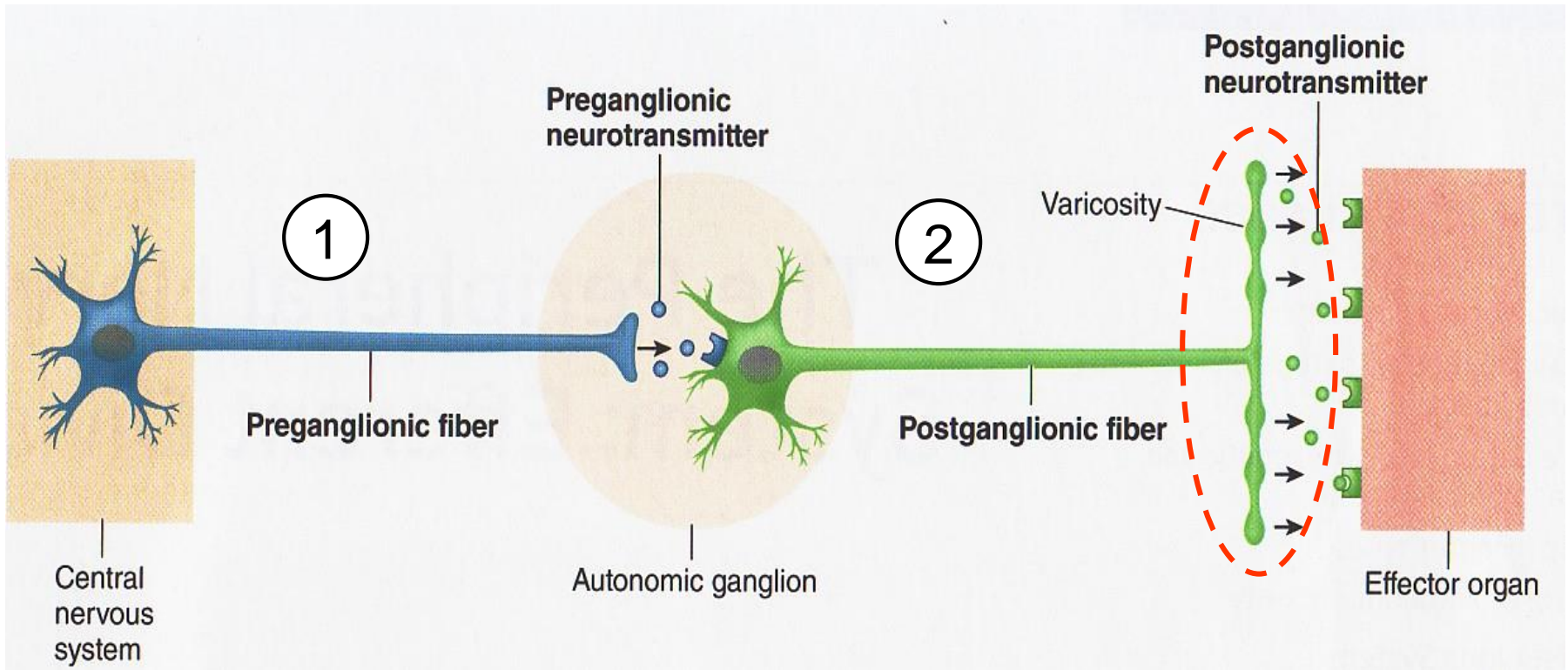


Adrenergic

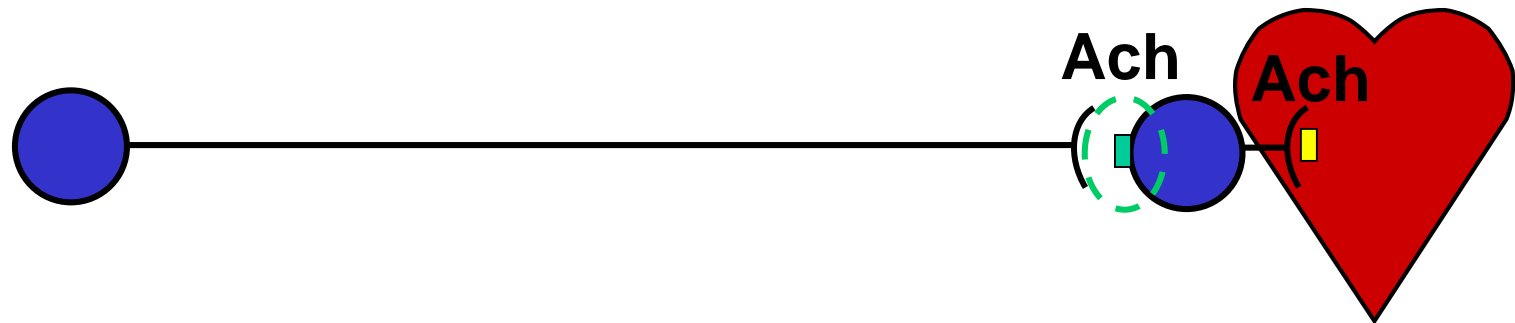
α = Alpha

β = Beta

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

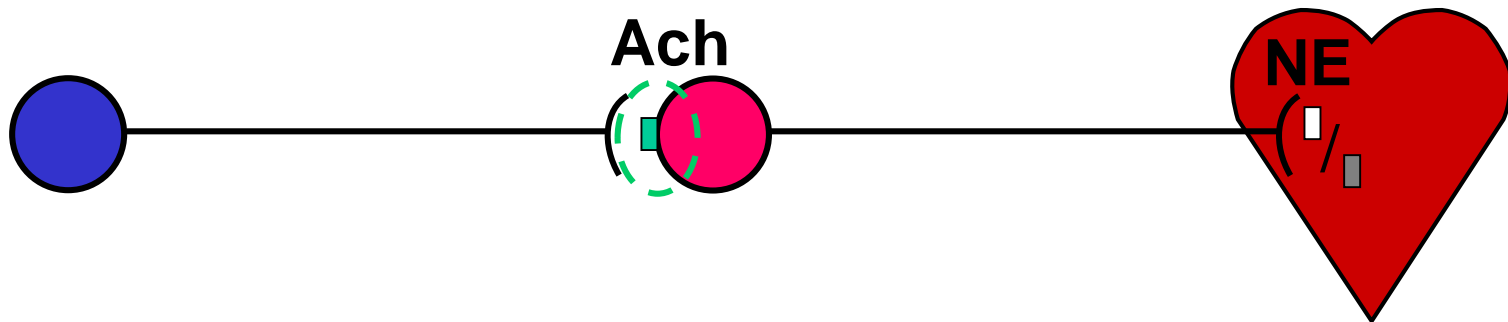


Parasympathetic



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!

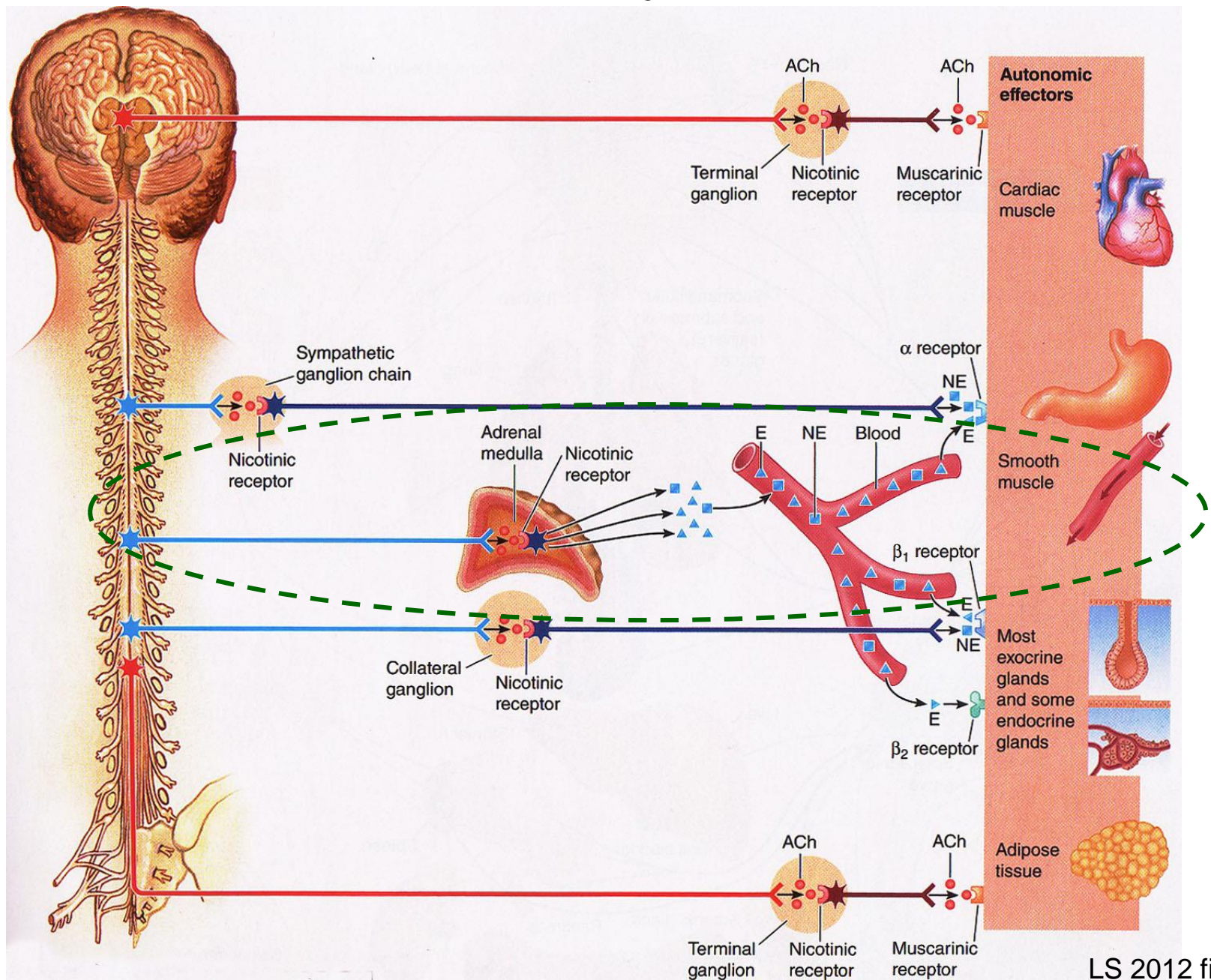
Problem?



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



Autonomic Nervous System Innervation



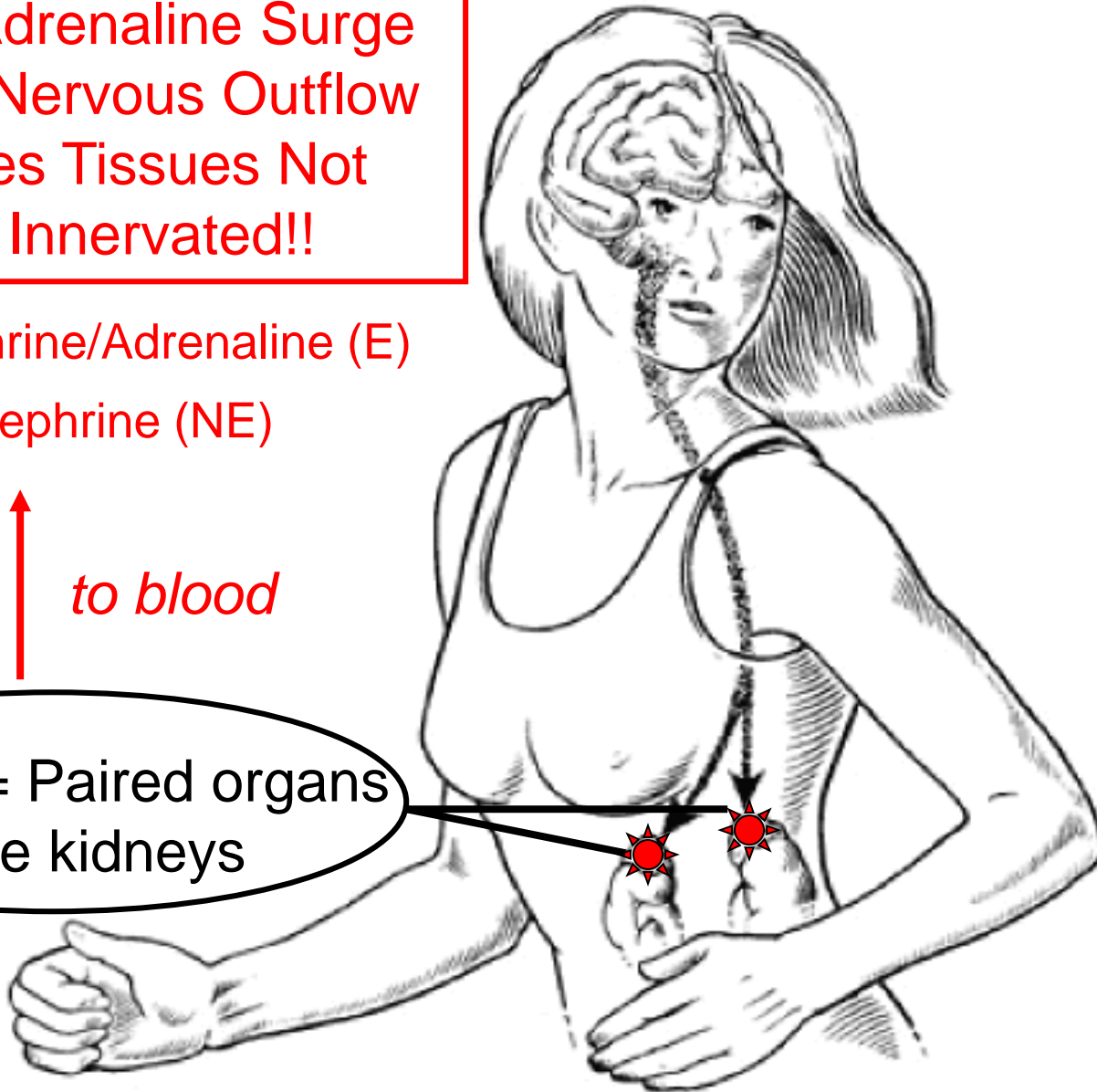
**In Sympathetic
Fight-or-Flight why
is it important to
activate the
adrenals?**

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



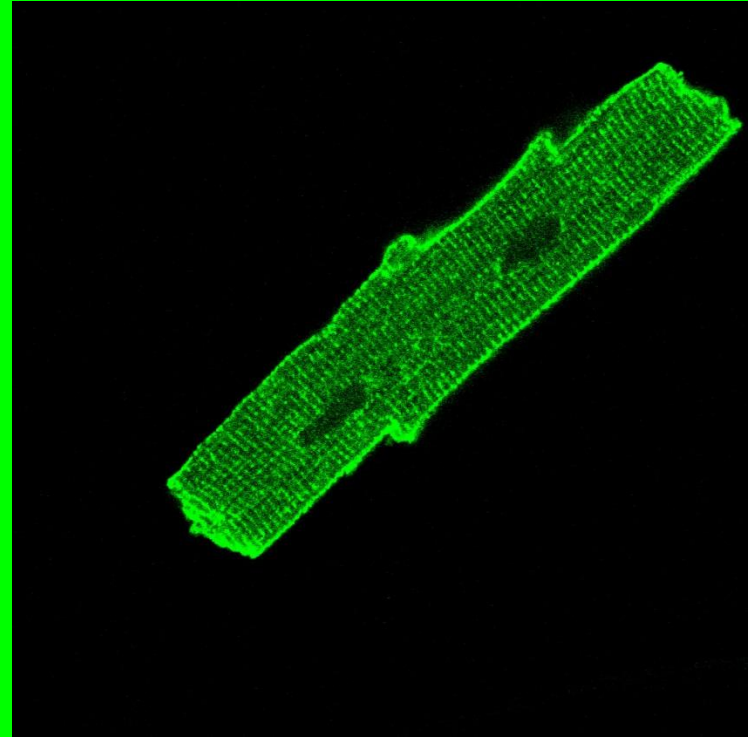
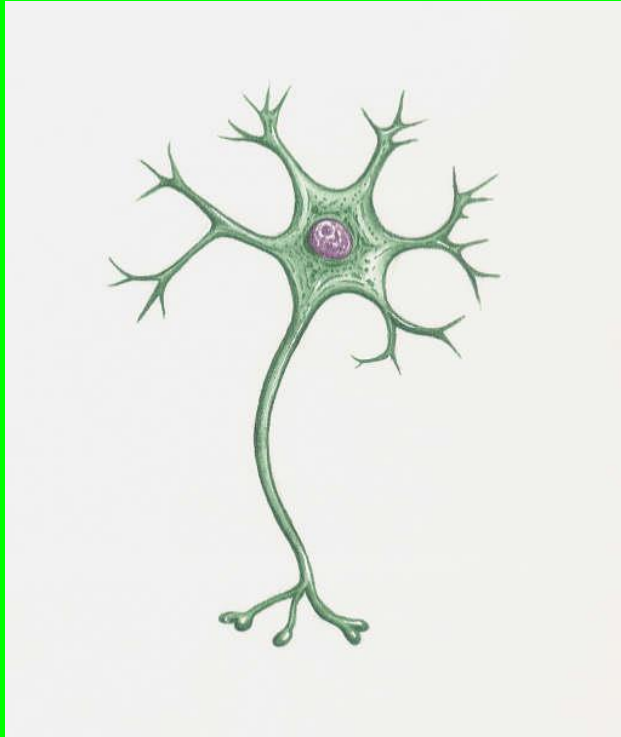
...choose this!!



Time for a break! 😊



Why are nerve & muscle unique?



They are excitable!!

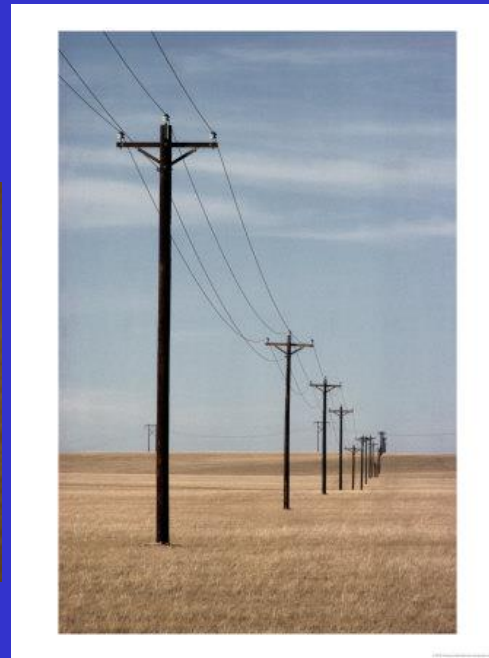
Action Potentials \equiv Spikes \equiv Impulses

Ultra-short reversal of membrane potential

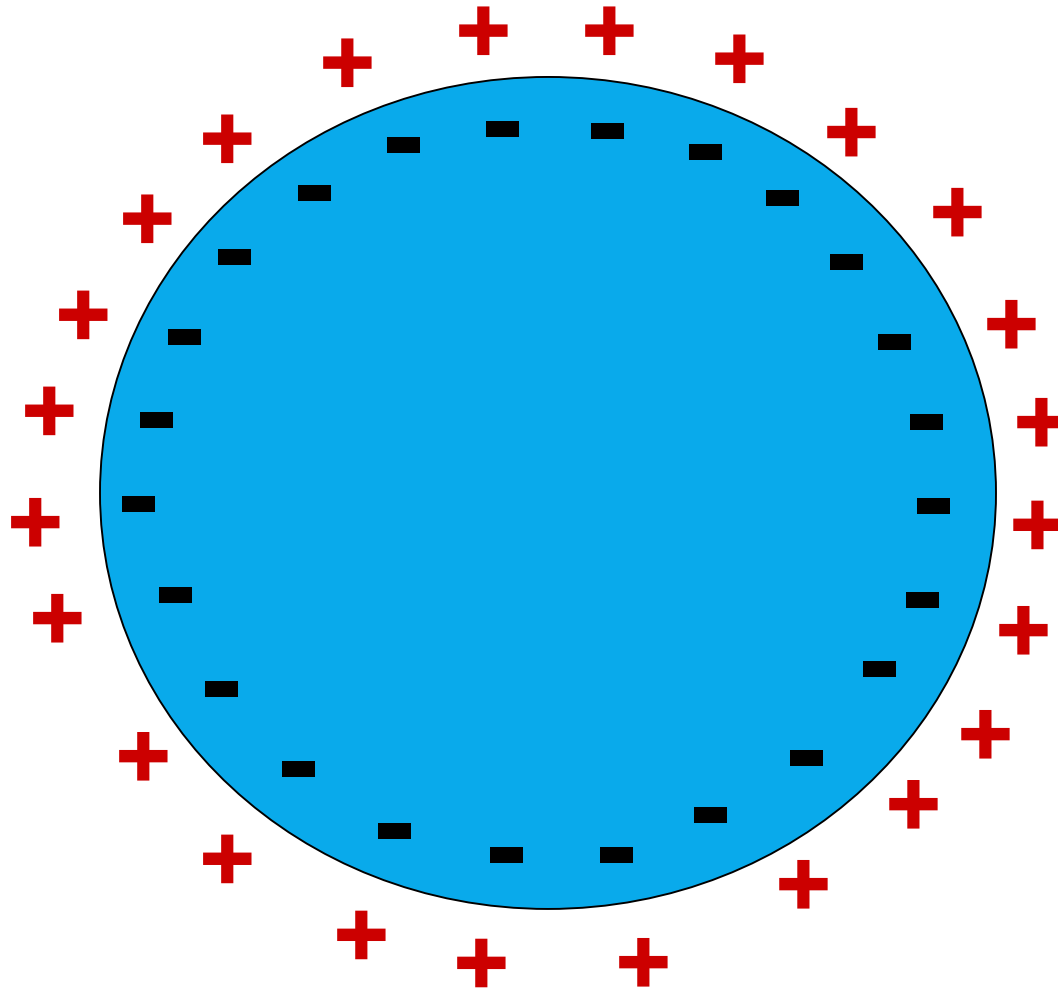
Only in nerve and muscle cells

Maintains strength over distance

Primary way nerves & muscles communicate!



"Resting"/Membrane Potential?



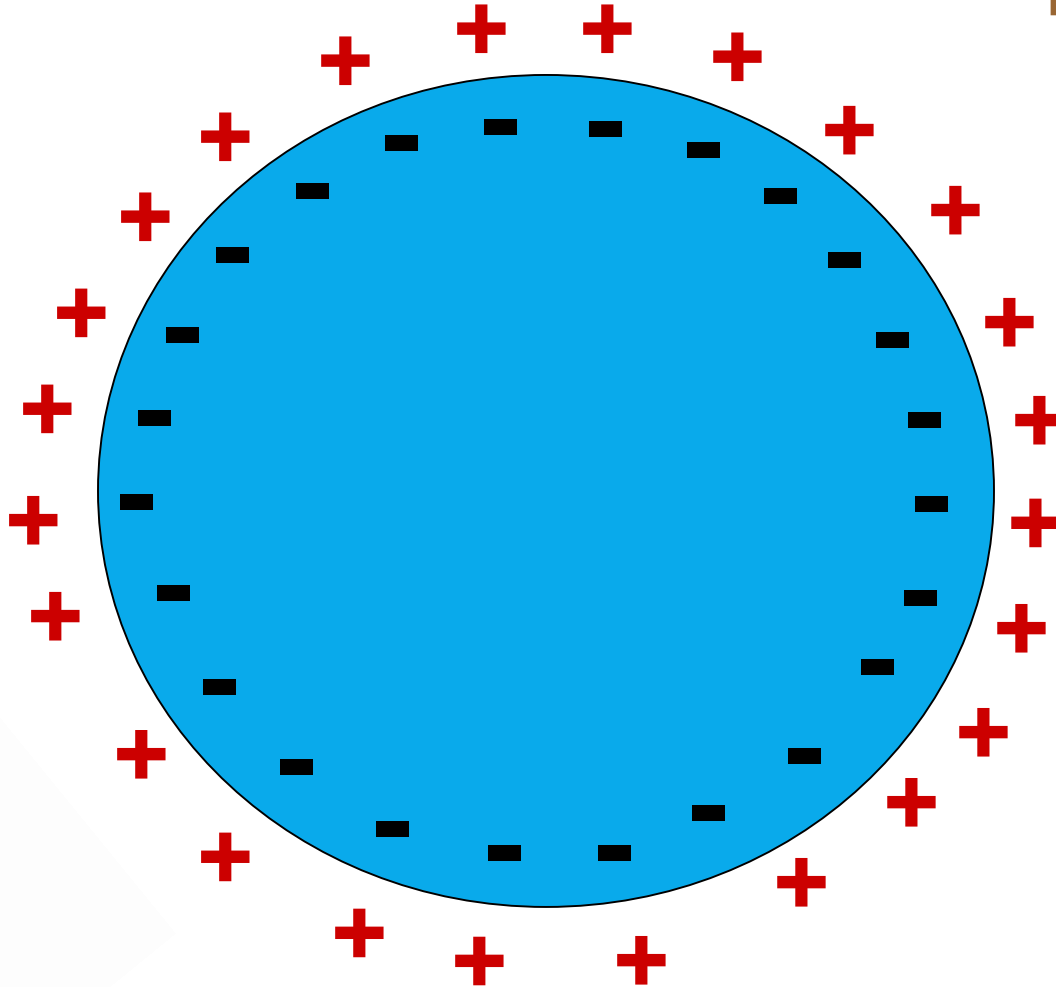
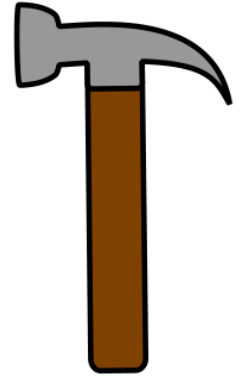
Cells are slightly negative inside!

Stimulate Cell @ Rest

Thermal



Mechanical



1

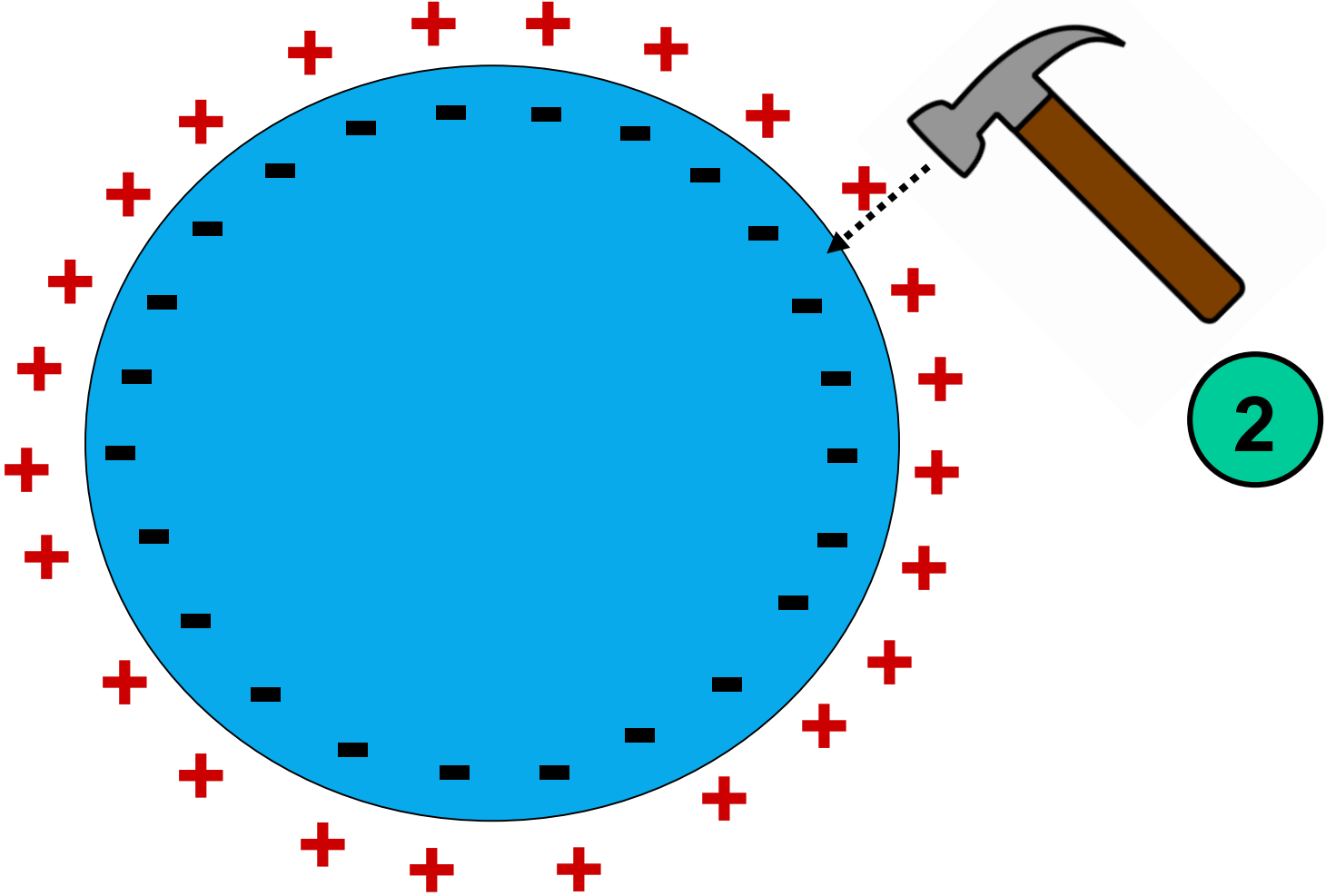


Electrical

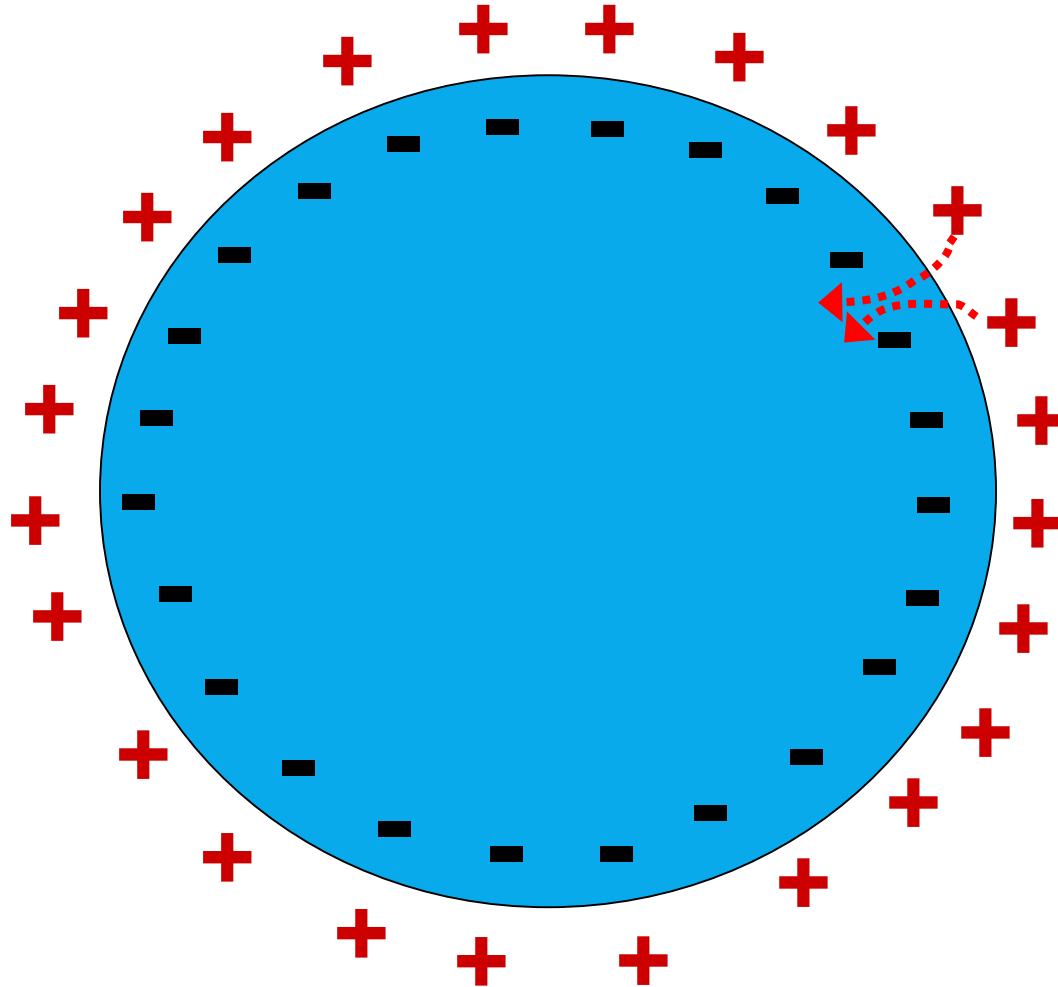
Chemical



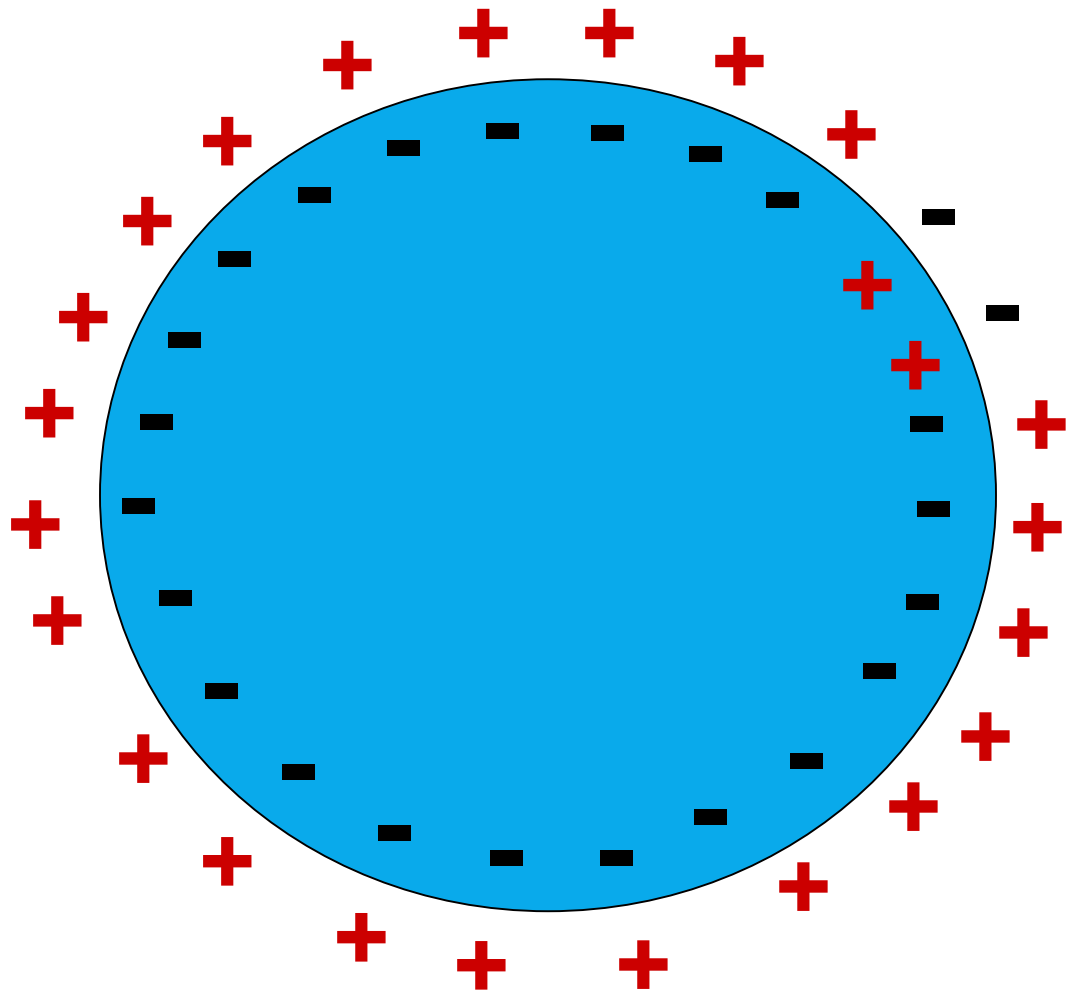
Tap! Tap!..



Changes Cell Membrane Permeability to Sodium/Na+!

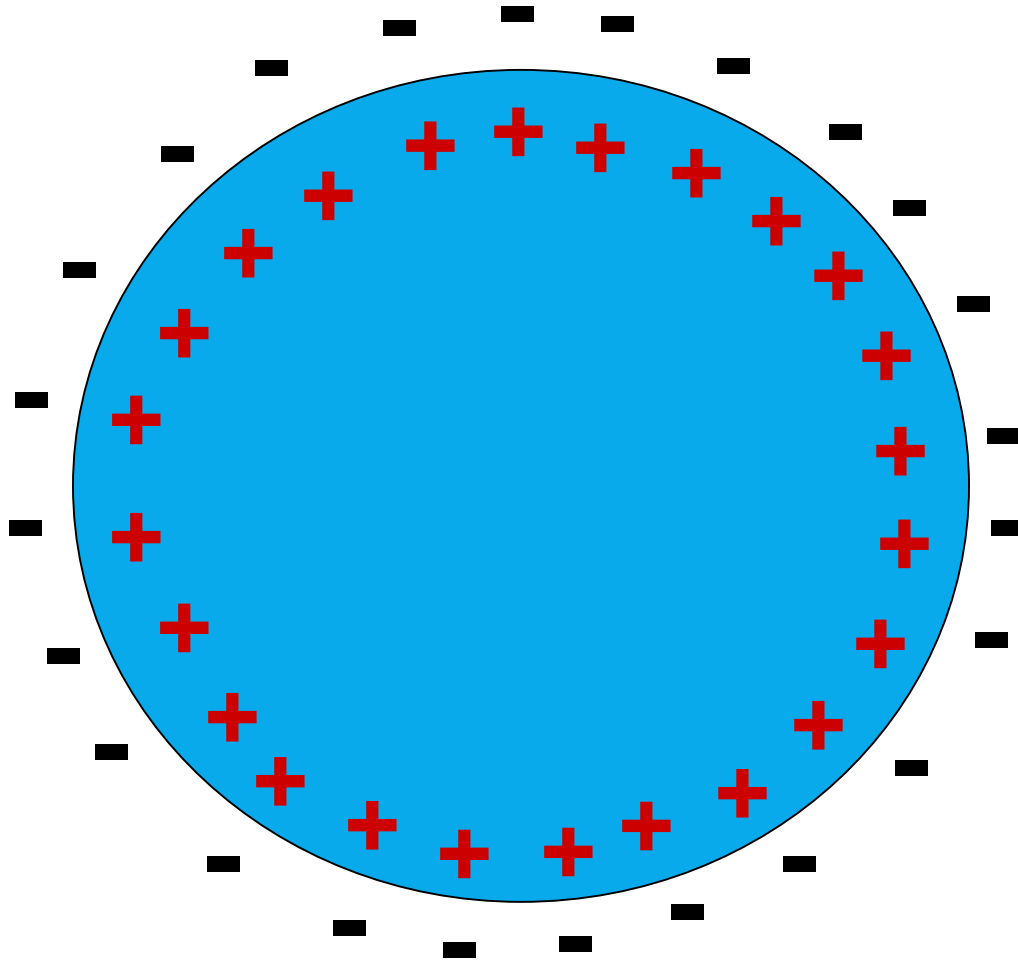


+ Charges/Na+ Rushes In!



4

Action Potential has occurred!



5

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

Mechanical
Chemical
Electrical
Thermal

Triggering event



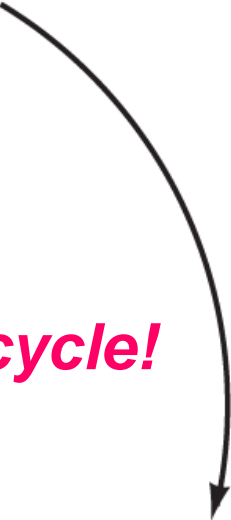
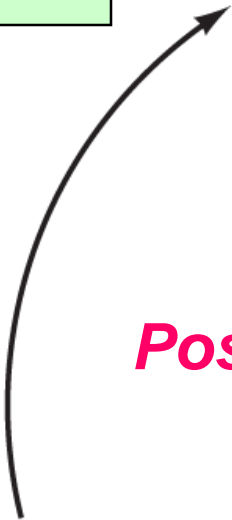
Depolarization
(decreased membrane potential)

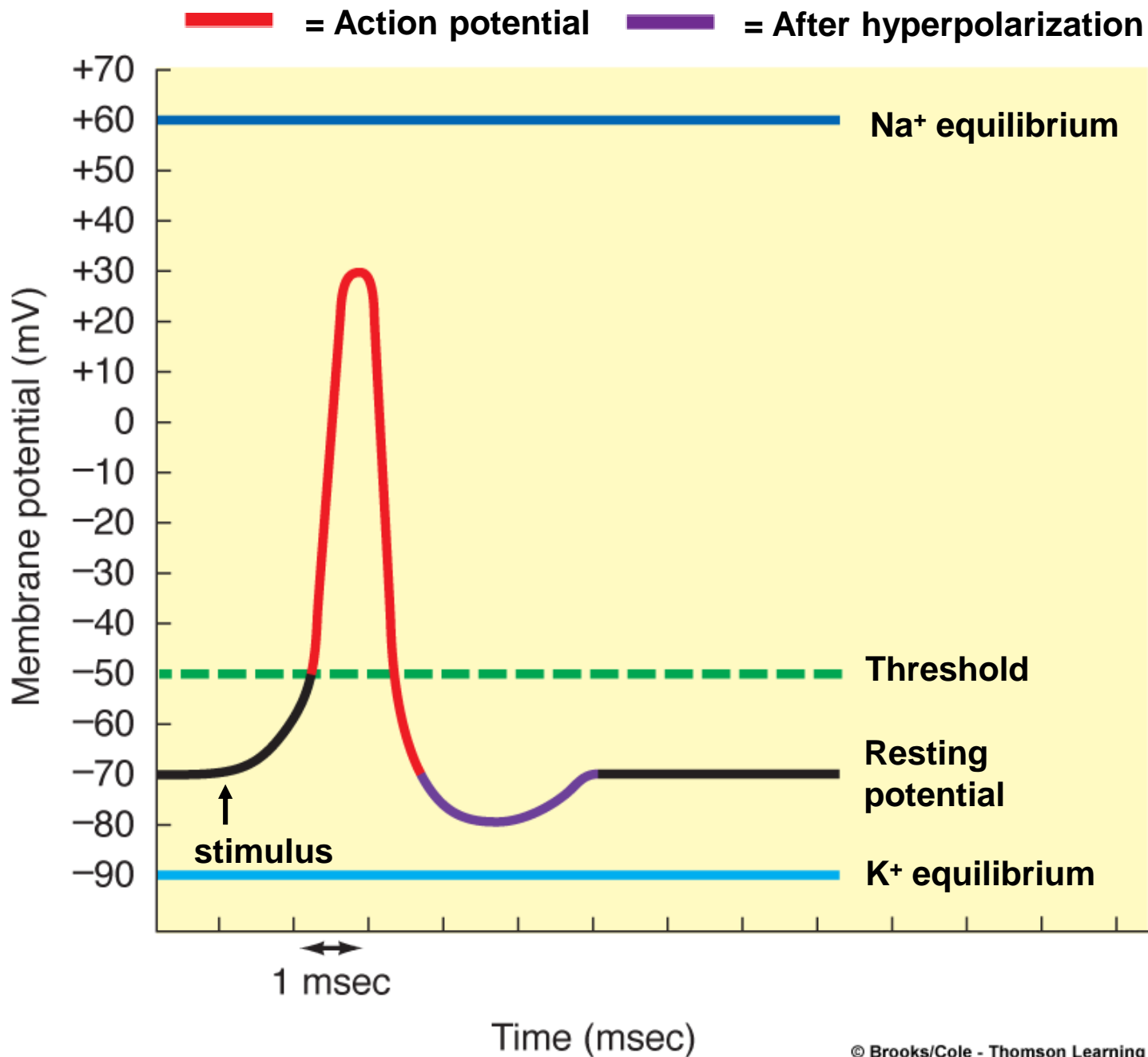
Positive-feedback cycle!

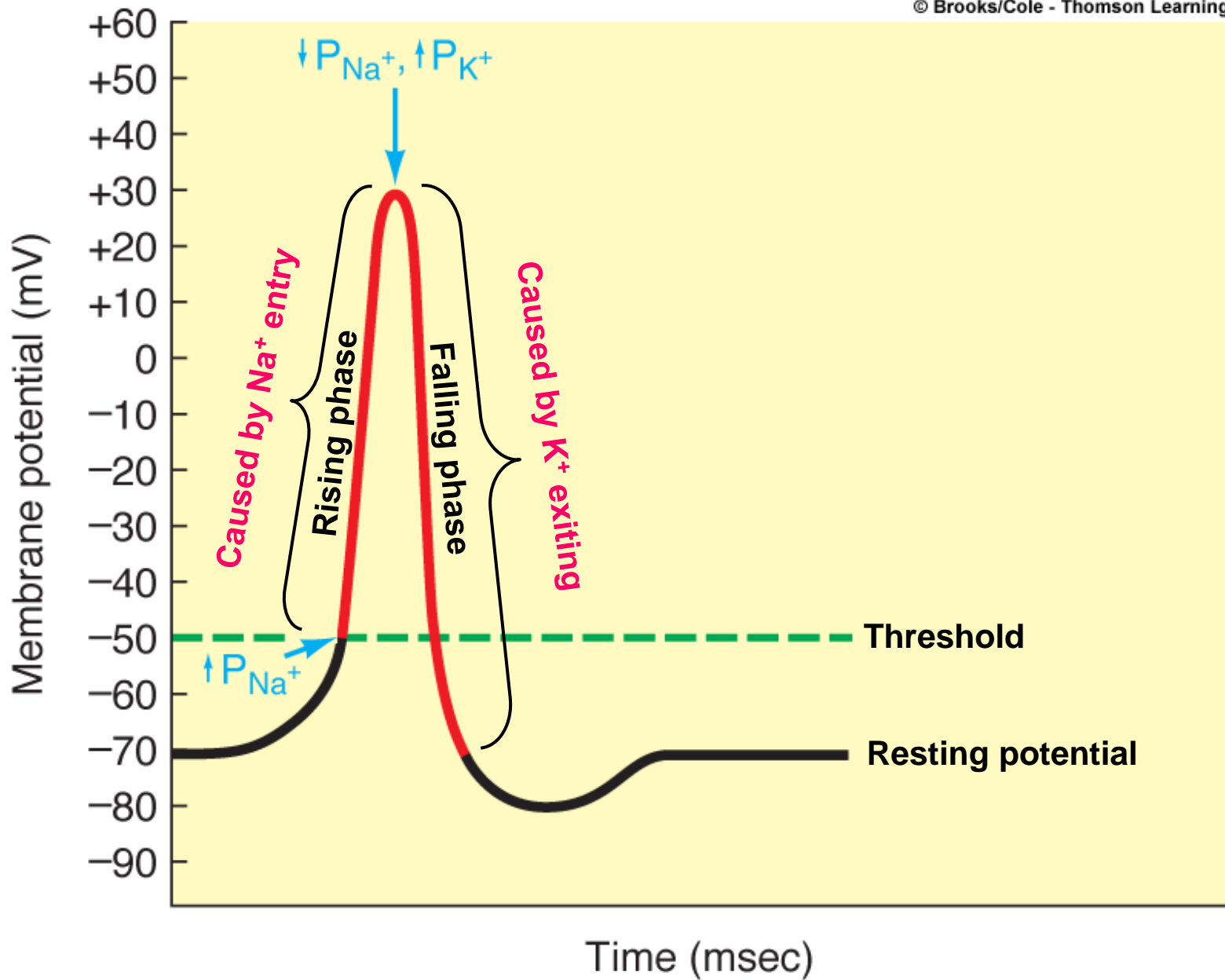
+

Influx of Na⁺
(which further
decreases
membrane potential)

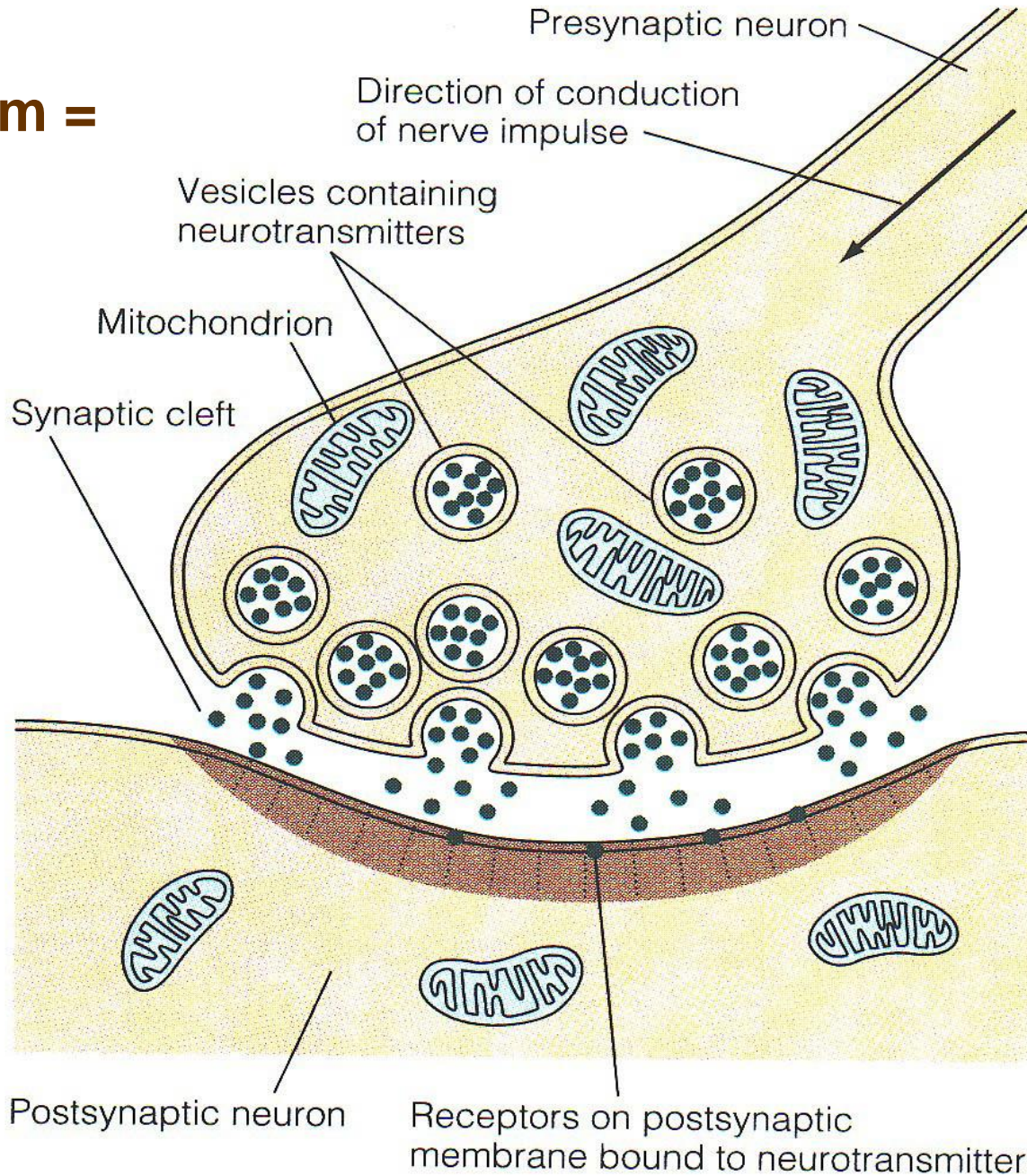
Opening of some
voltage-gated
Na⁺ channels



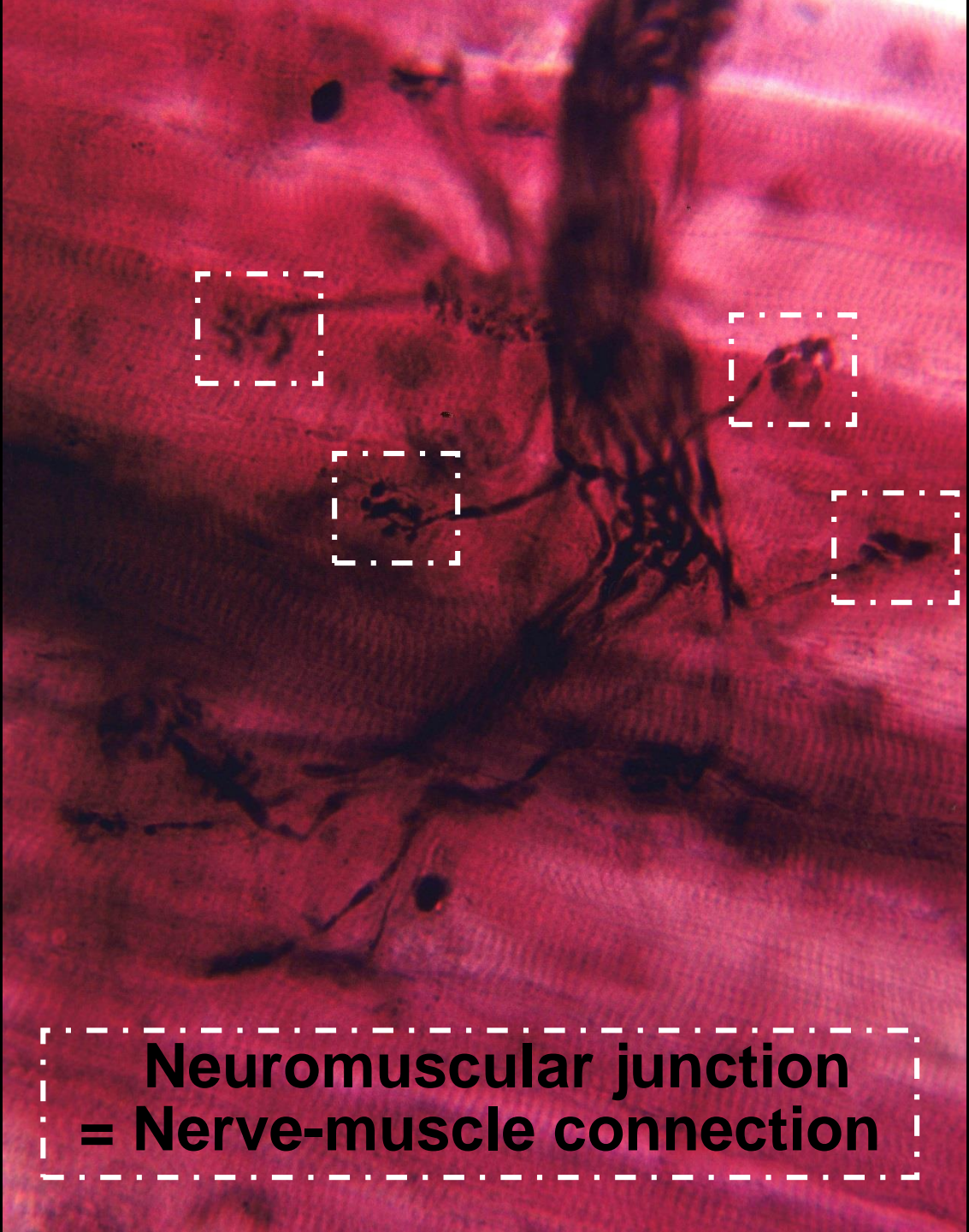




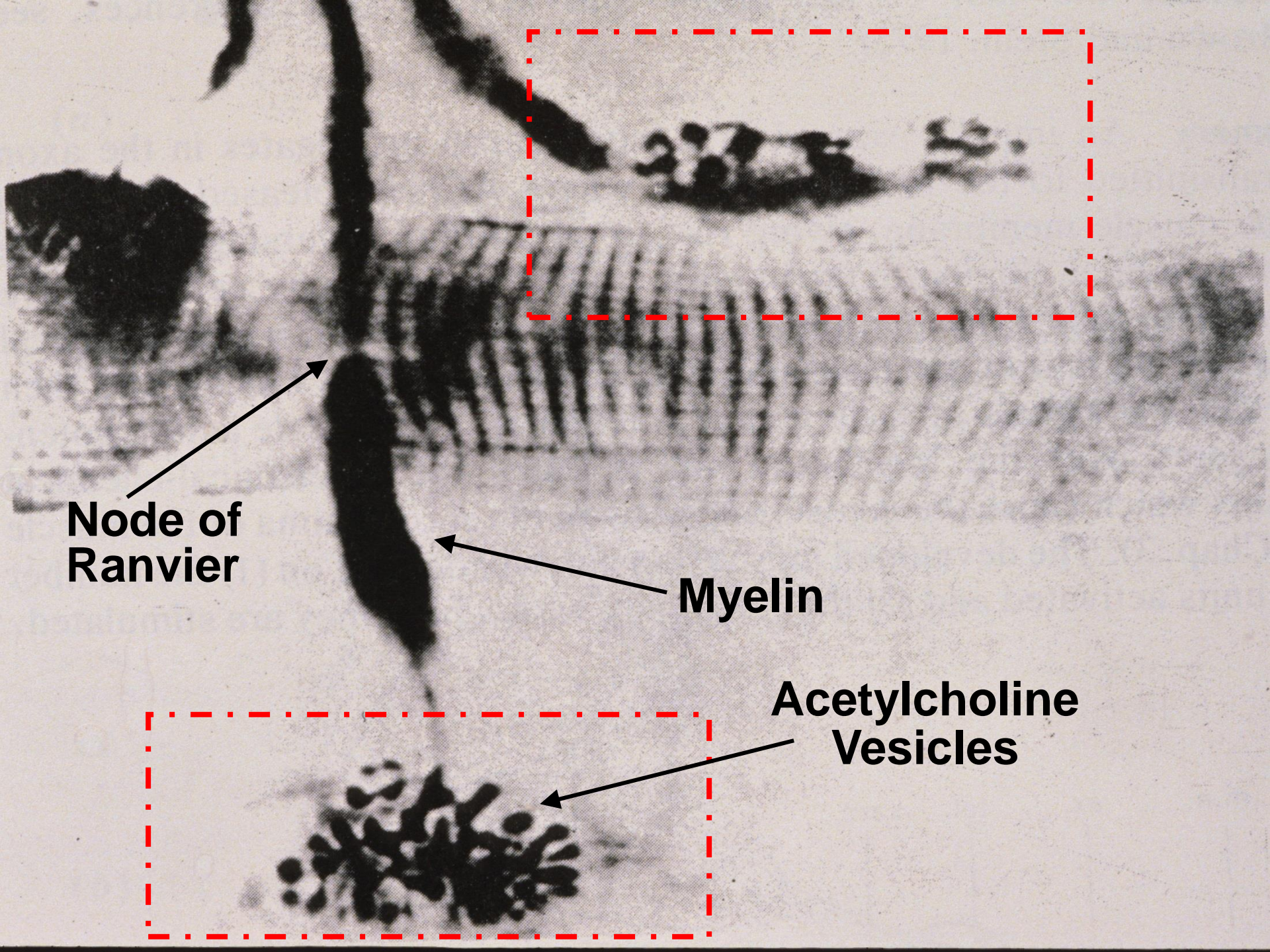
**Synapse =
Generic term =
connection
between
excitable
cells!**



H Howard 1980



**Neuromuscular junction
= Nerve-muscle connection**



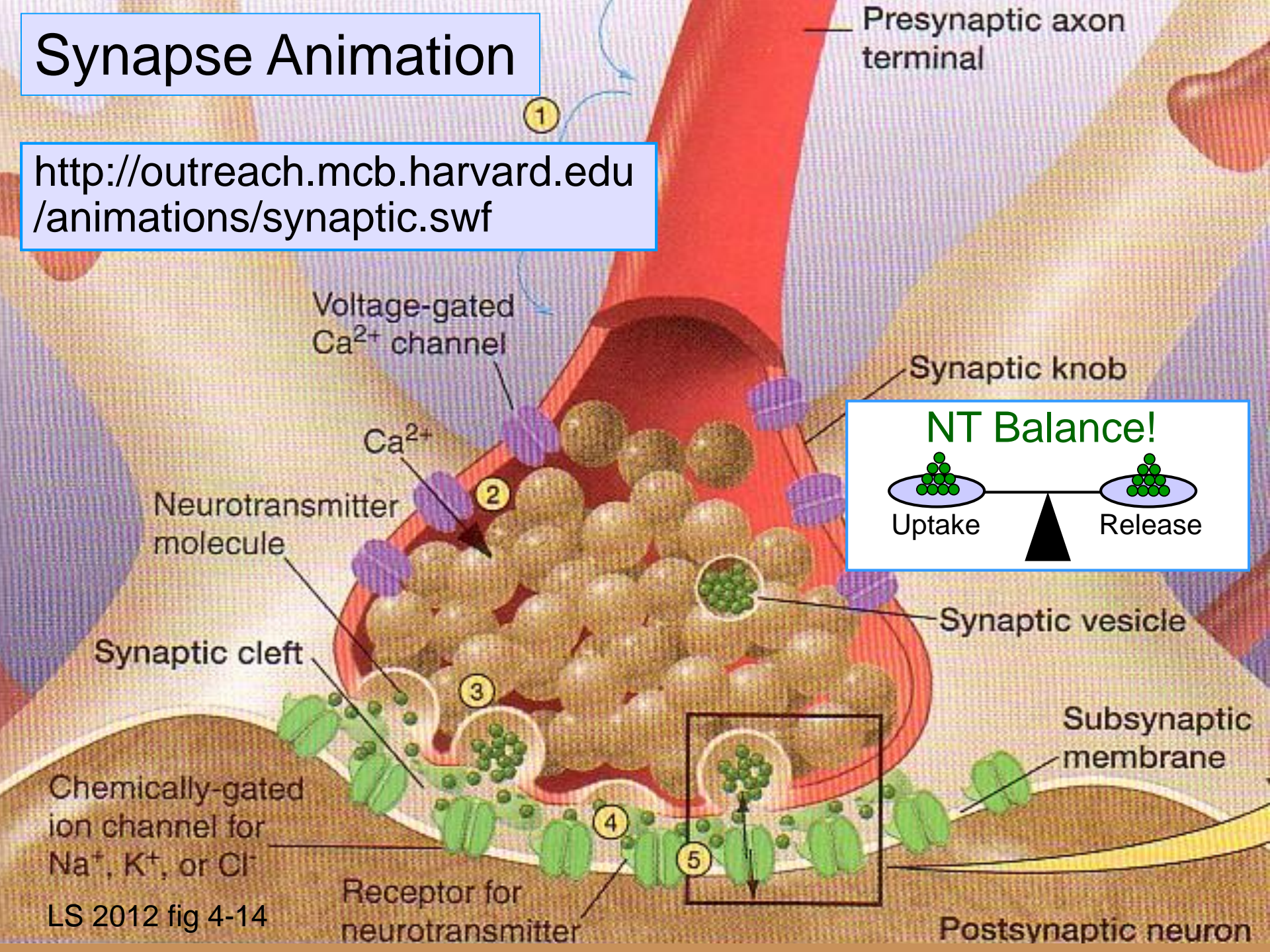
**Node of
Ranvier**

Myelin

**Acetylcholine
Vesicles**

Synapse Animation

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



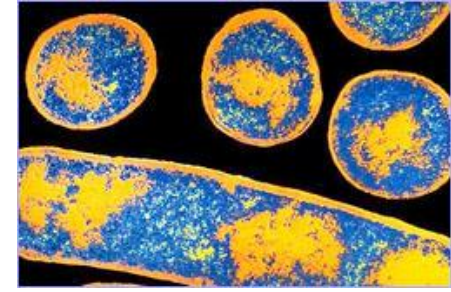
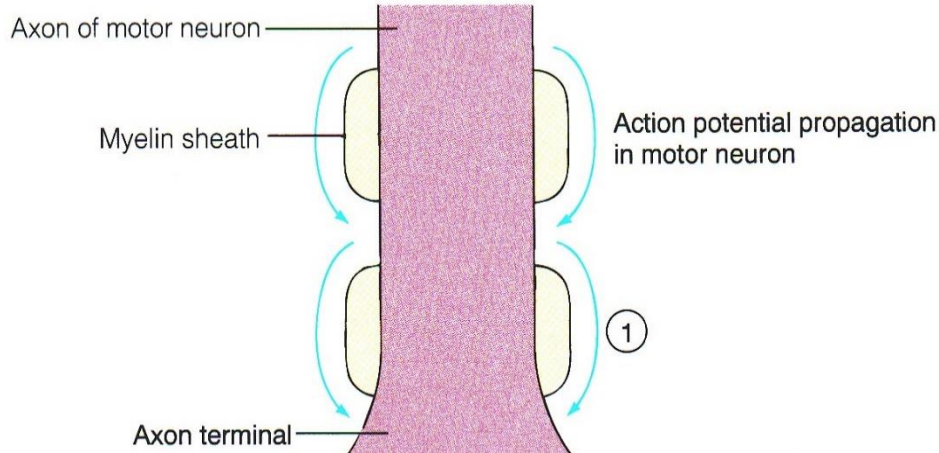
Chemically-gated ion channel for Na^+ , K^+ , or Cl^-

LS 2012 fig 4-14

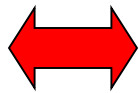
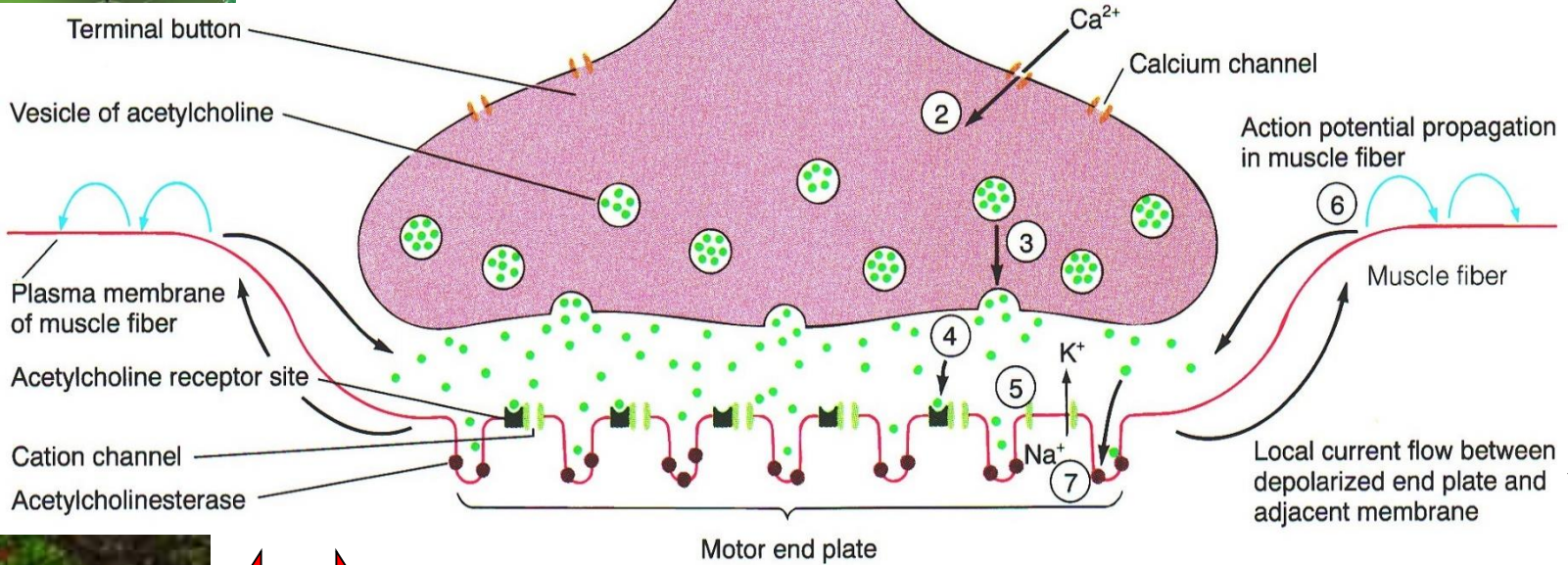
Receptor for neurotransmitter

Postsynaptic neuron

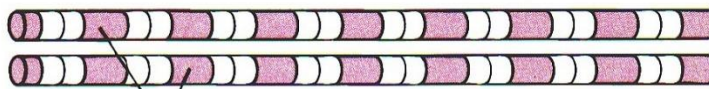
↑ 3



~~3~~



4



~~7~~