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*** **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. Ca^{2+} bones!…but what else? p 190
   2. What do black widow spider venom, botulism, curare & nerve gas have in common? Botox pp 189-92

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

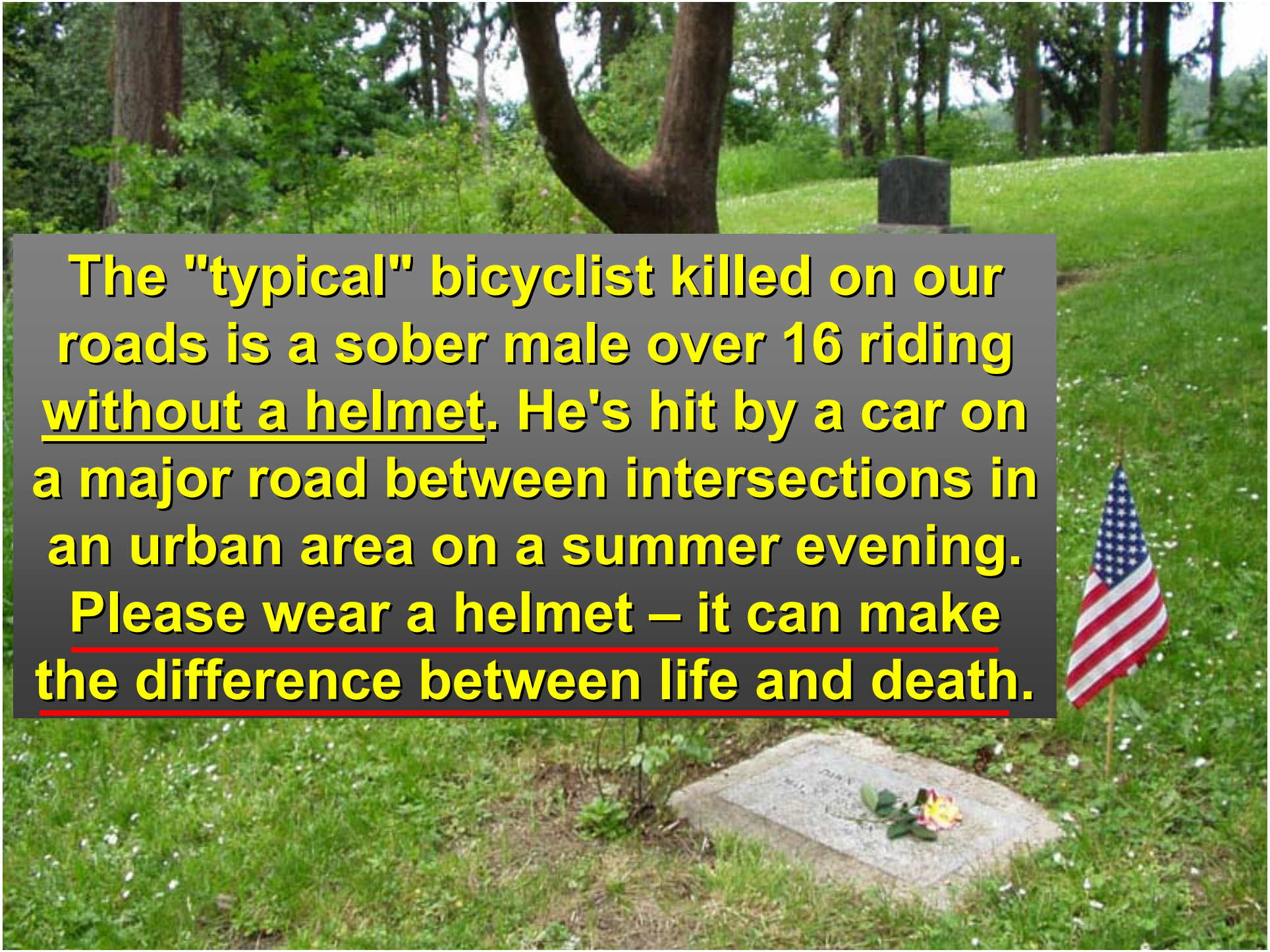
Springfield, OR 59,869

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.

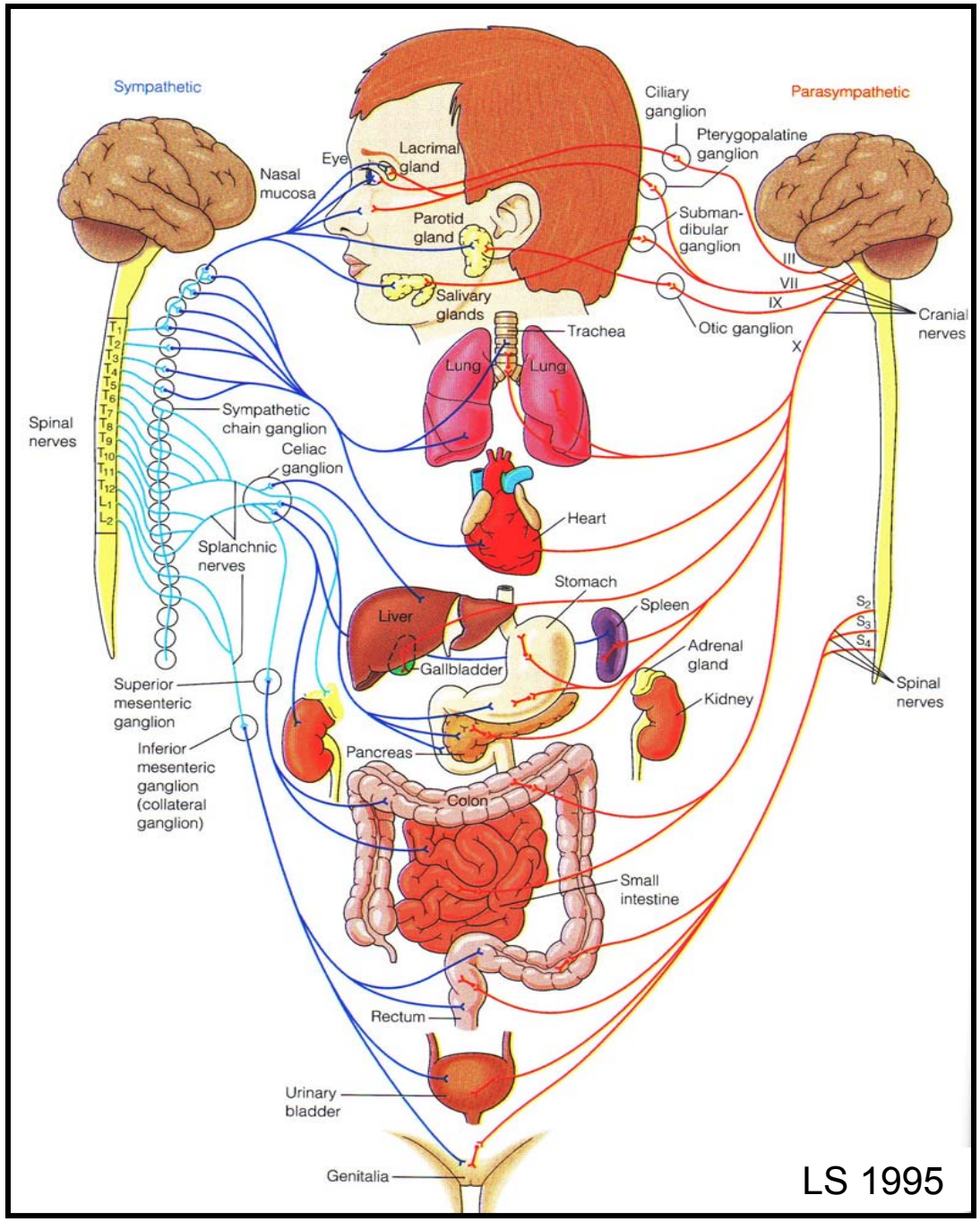
Stories, Discussion, Questions or Comments!

Autonomic Nervous System

Why overlap or dual innervation?

Fine-tune control & safety!

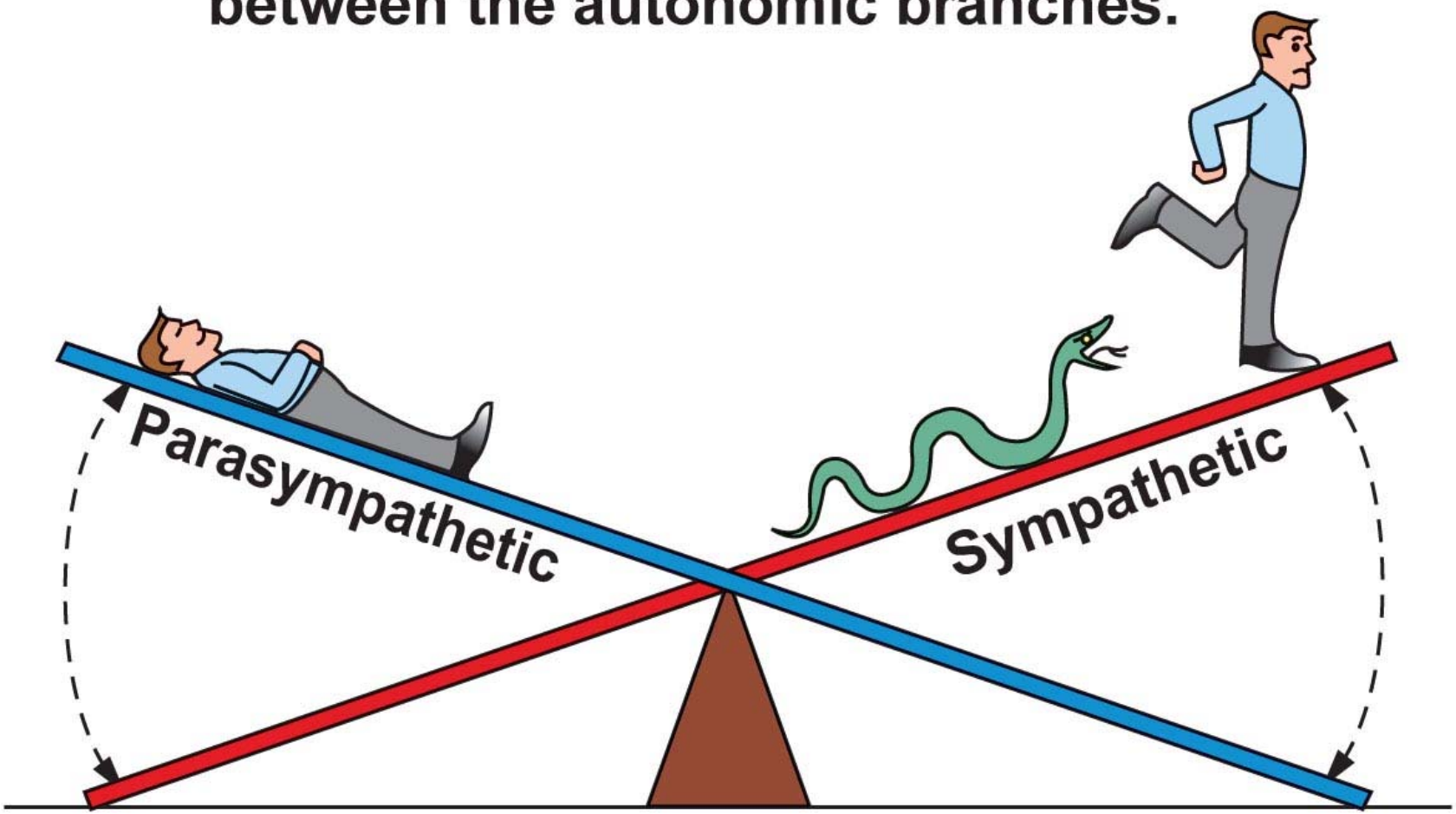
cf: LS 2012 fig 7-3




PARASYMPATHETIC = RESTING, DIGESTIVE, HOUSEKEEPING FUNCTIONS

FIGHT/FLIGHT/ALARM REACTION!!

Homeostasis is a dynamic balance between the autonomic branches.

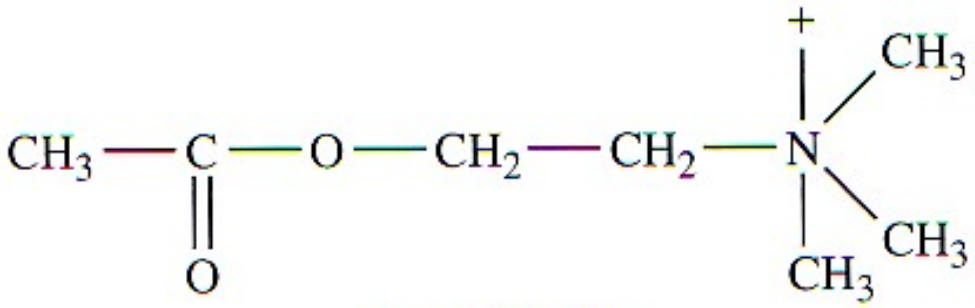


Rest-and-digest: Parasympathetic activity dominates.

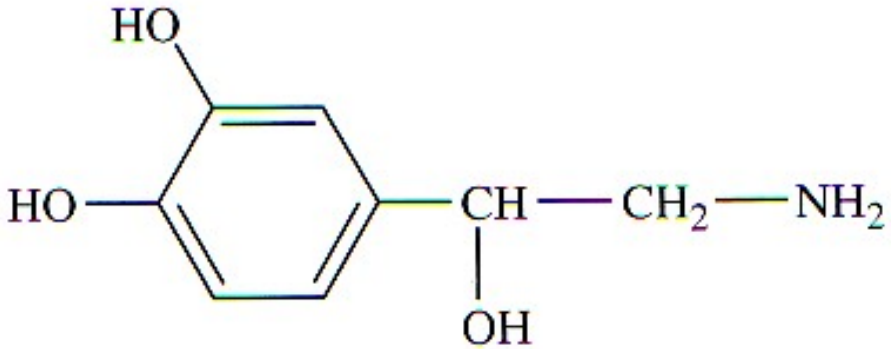
Fight-or-flight: Sympathetic activity dominates.

D Silverthorn 2010

Autonomic Neurotransmitters & Receptors



Acetylcholine



Norepinephrine

Cholinergic

Nicotinic

Muscarinic

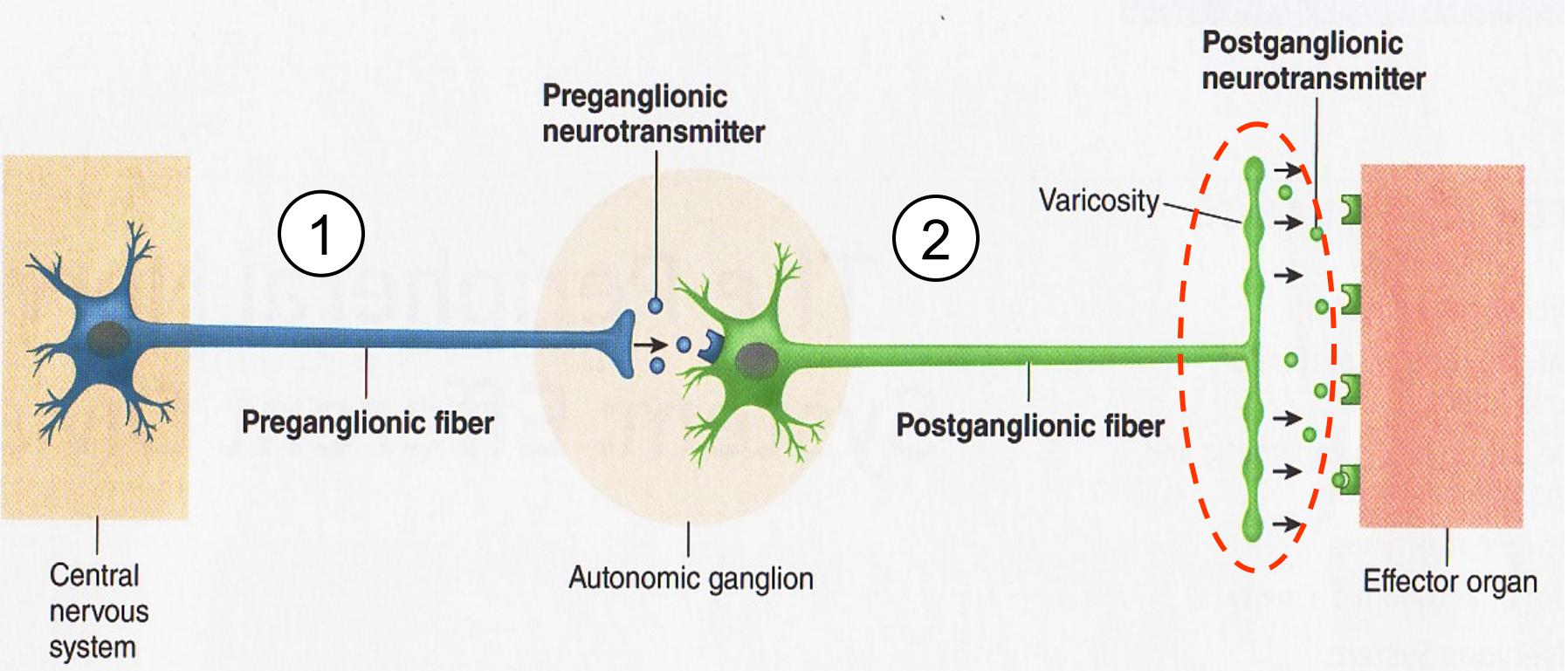
Adrenergic

α = Alpha

β = Beta

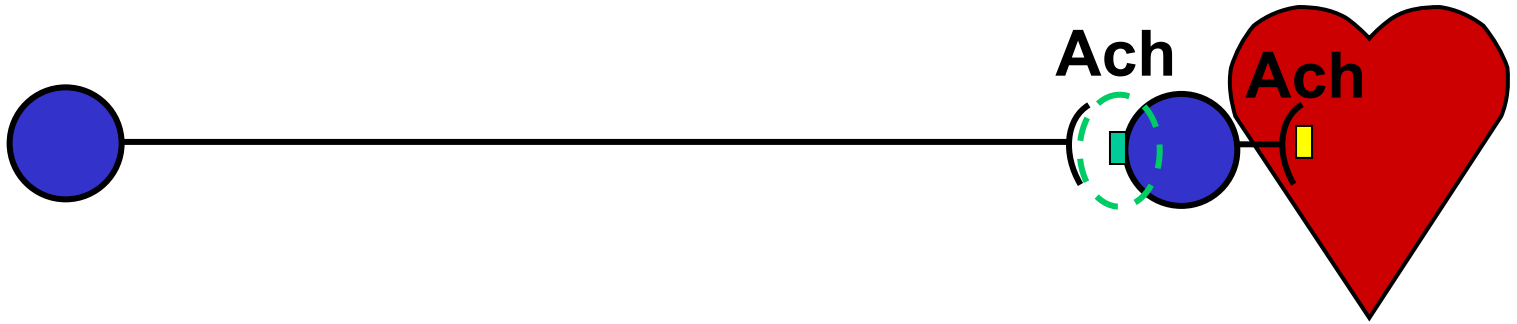
G&H 2011 p 731-3

Autonomic Nerves: Two Chain Pathway with Post-Ganglionic Varicosities



LS 2012 fig 7-1

Parasympathetic

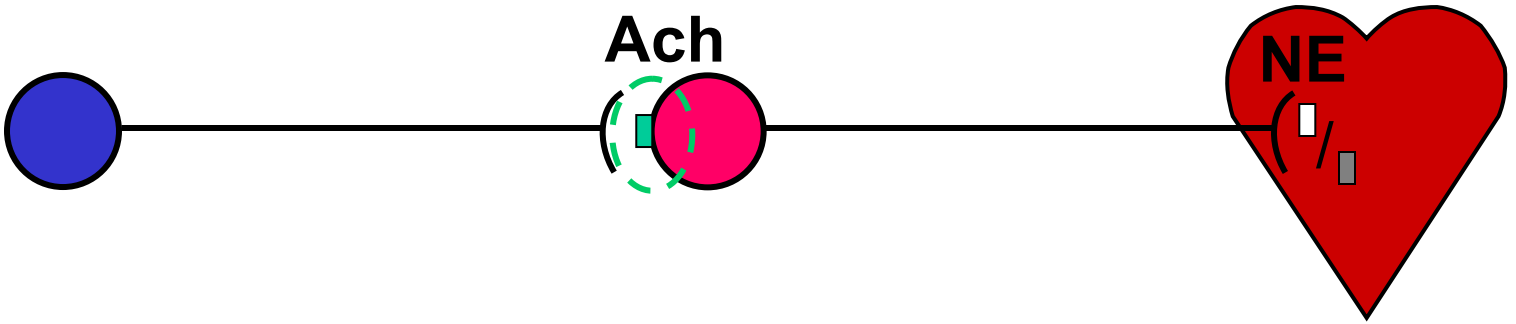


Ach = Acetylcholine

= Nicotinic Receptor

= Muscarinic Receptor

Sympathetic



NE = Norepinephrine

= α Receptor (α_1 , α_2)

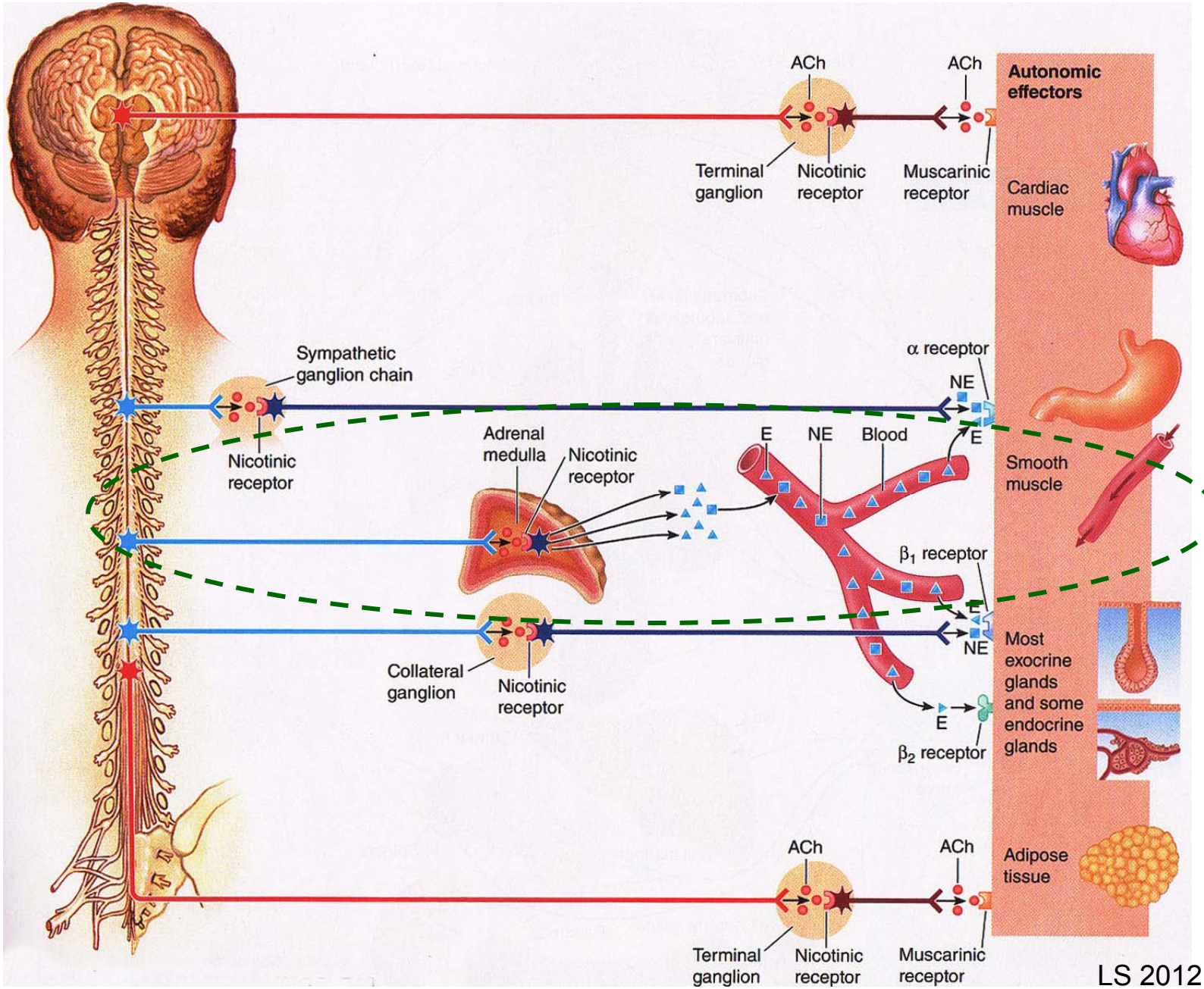
= β Receptor (β_1 , β_2)

Nicotine activates <u>both</u> 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 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

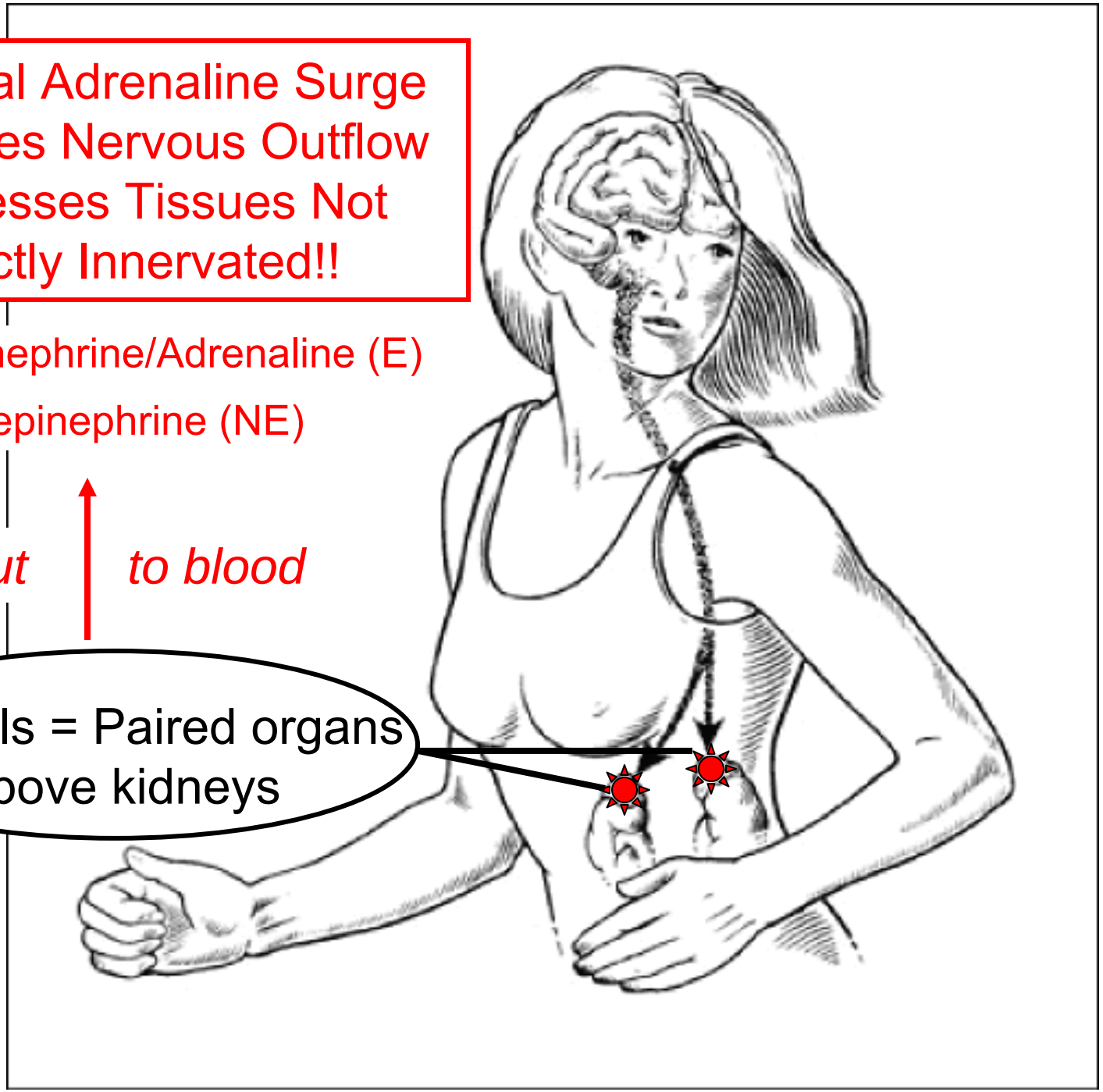
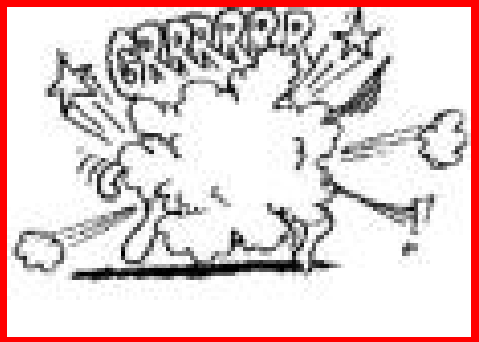


Table 7-1 Effects of Autonomic Nervous System on Various Organs

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)	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

LS 2012

Fight-or-Flight Stories!

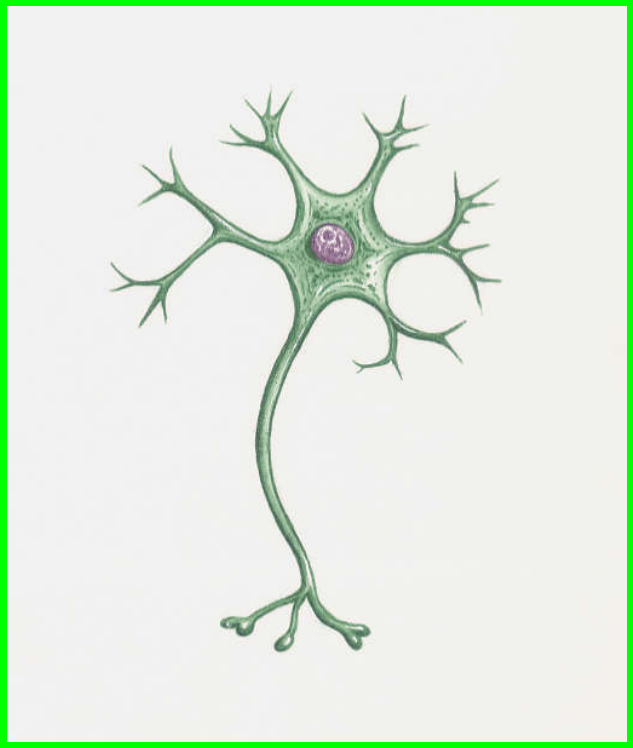


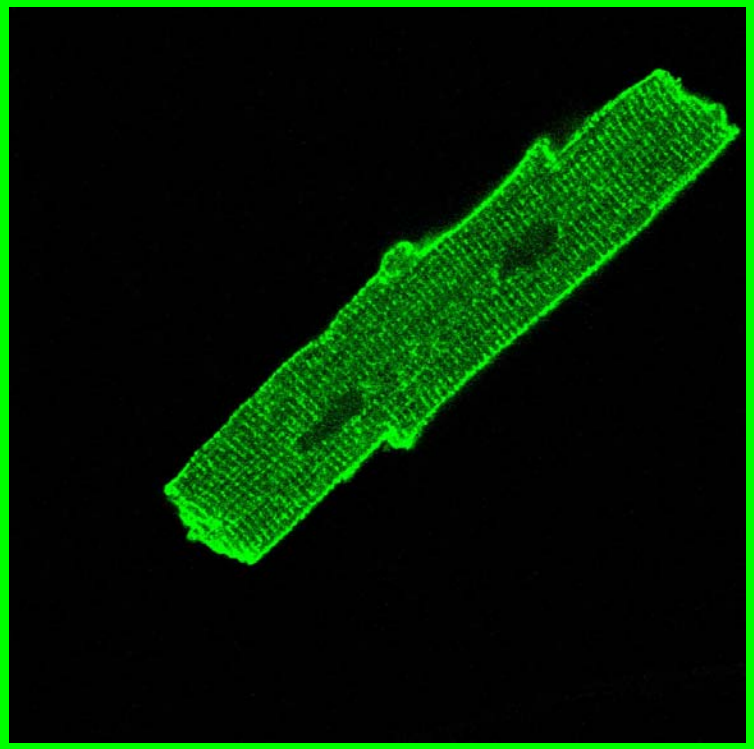
or

…choose this!!

Time for a break! ☺

Why are nerve & muscle unique?





They are excitable!!

Action Potentials ≡ Spikes ≡ Impulses

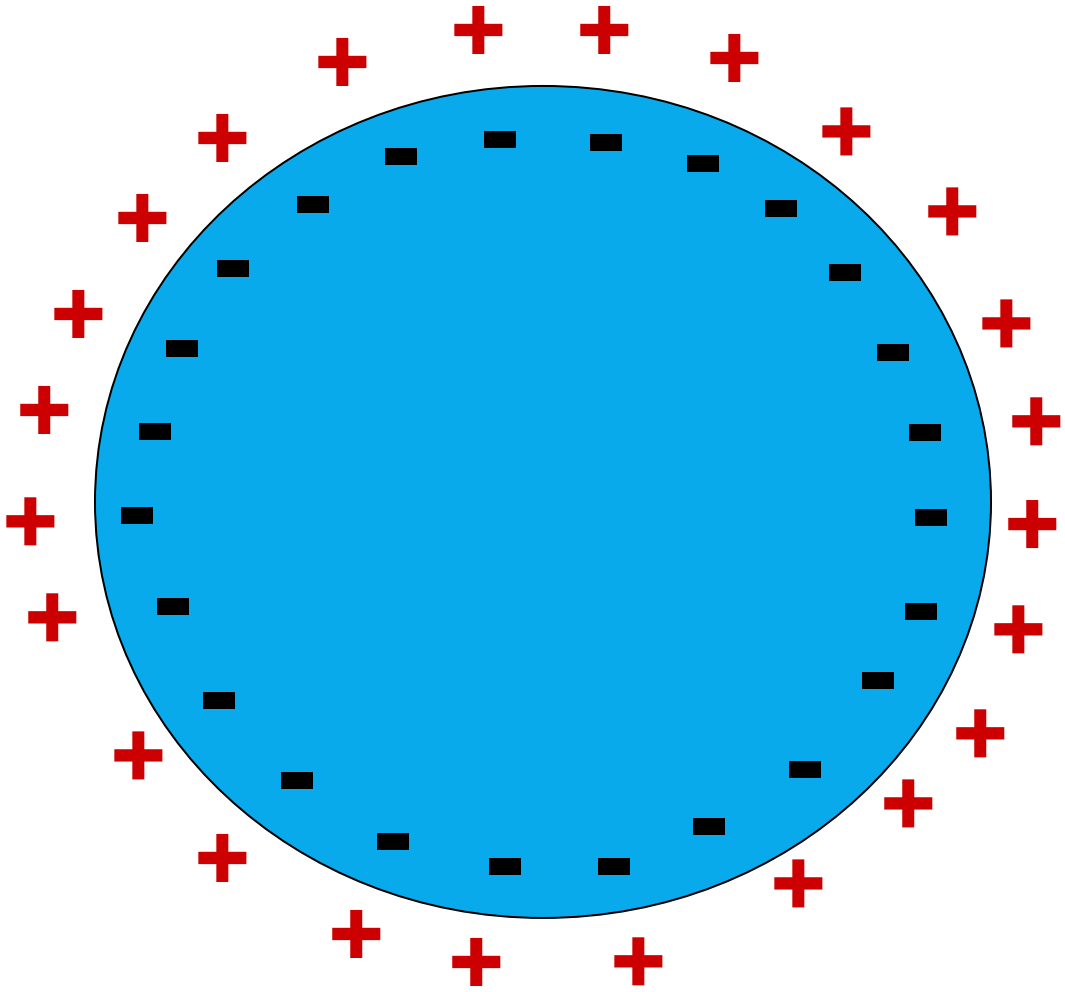
Ultra-short reversal of membrane potential

Only in nerve and muscle cells

Maintains strength over distance

Primary way nerves & muscles communicate!

"Resting"/Membrane Potential?

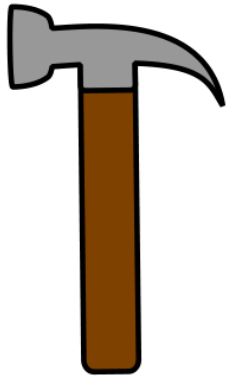


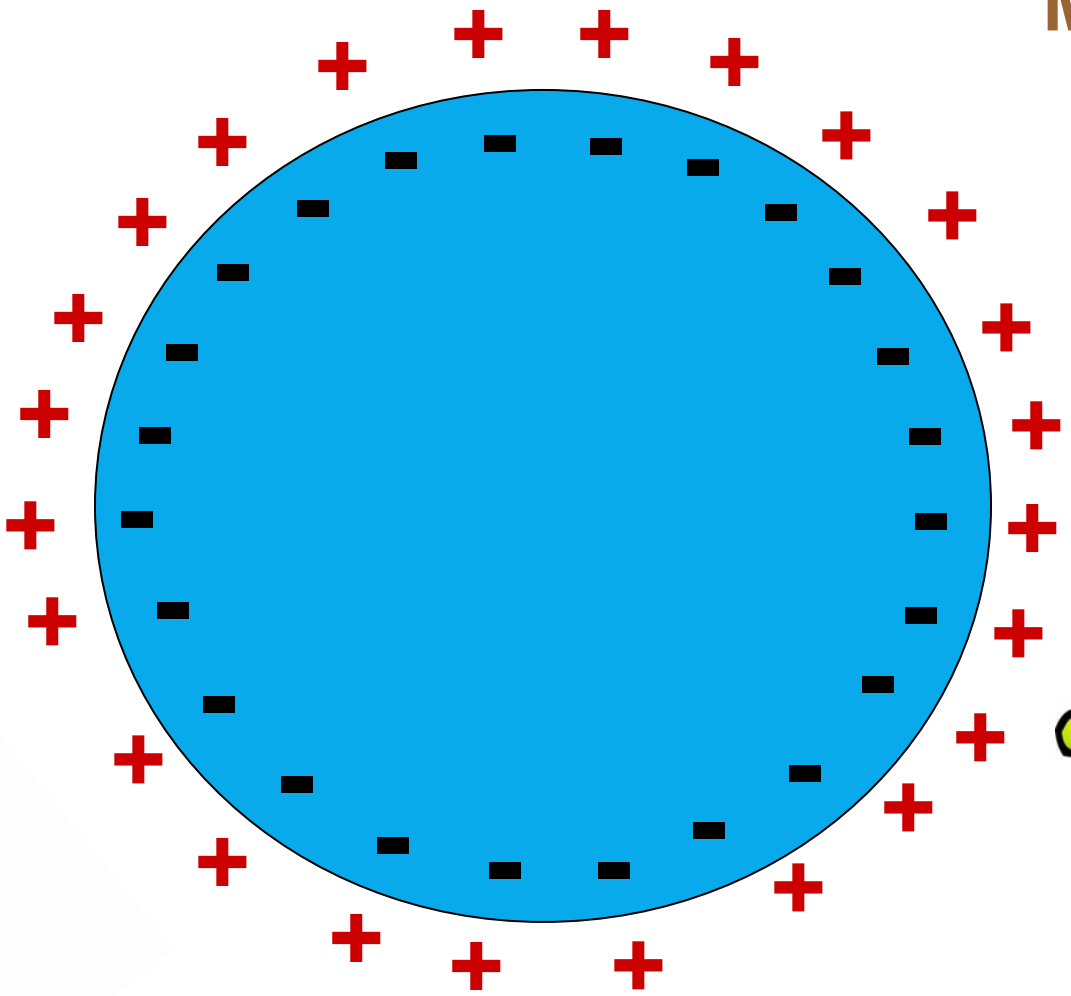
Cells are slightly negative inside!

Stimulate Cell @ Rest

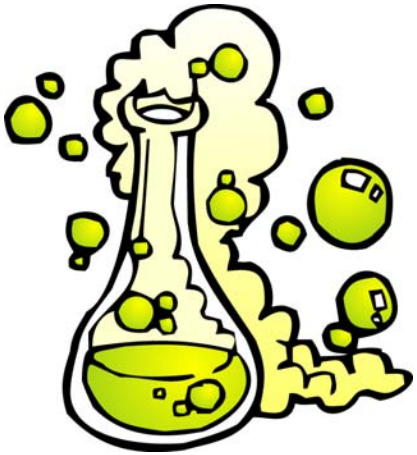
Thermal

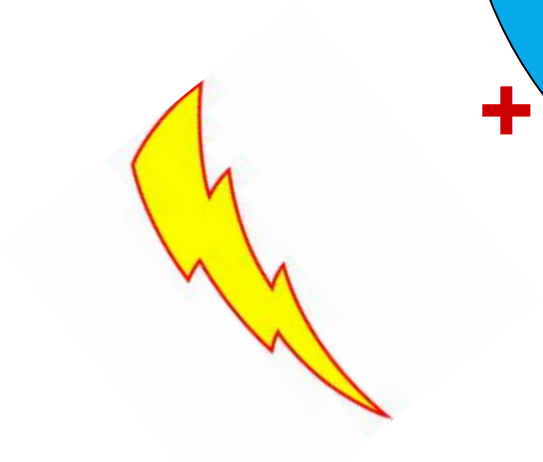
Mechanical





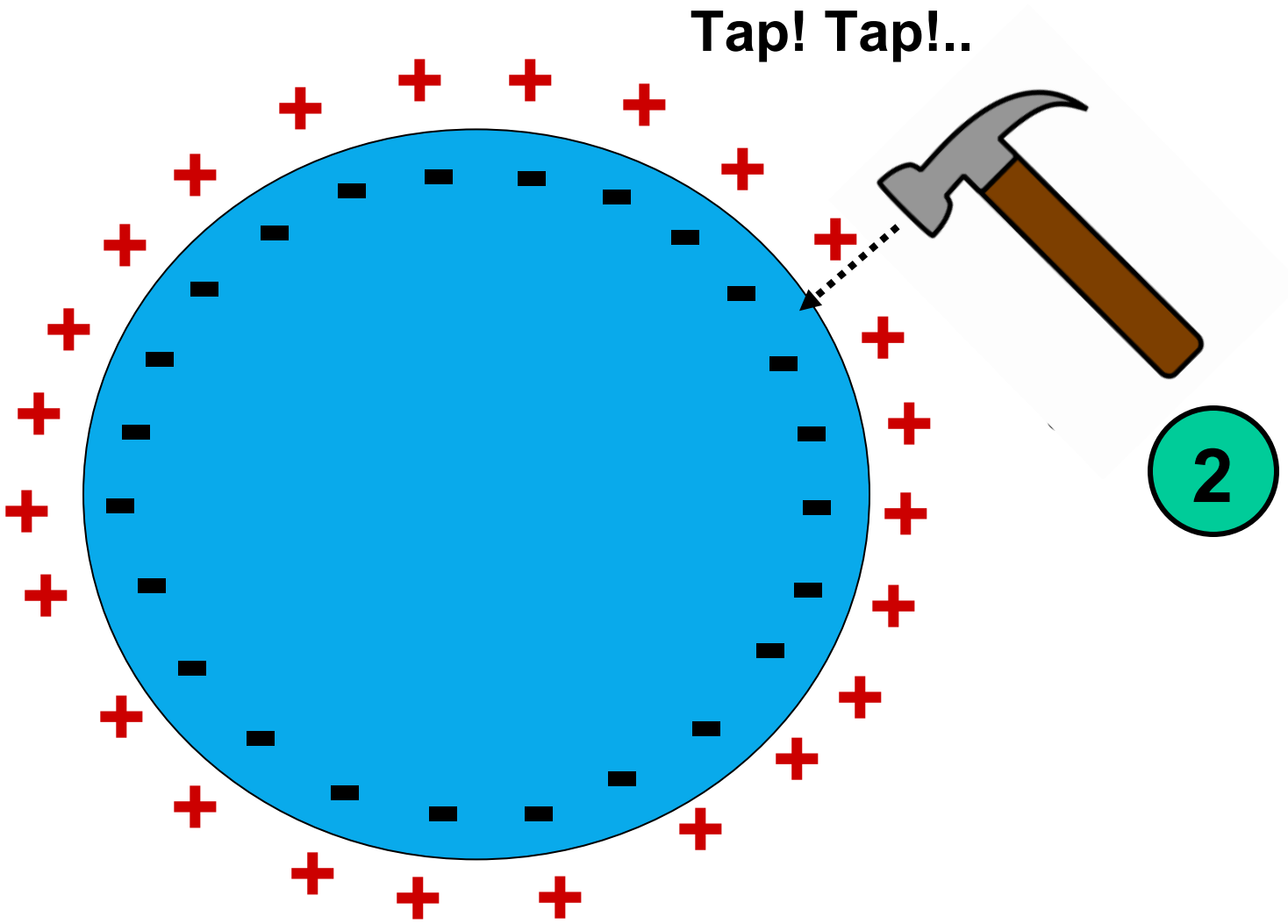
1



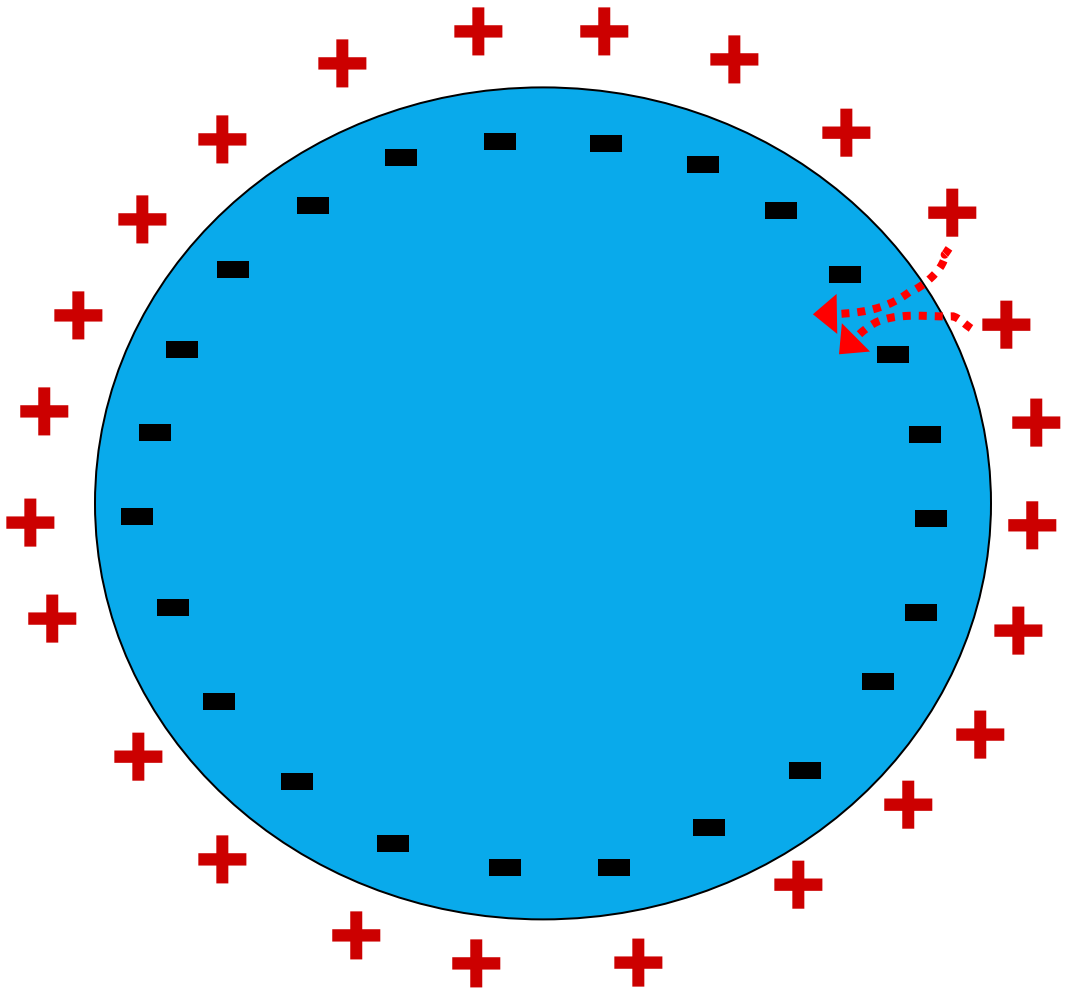


Electrical

Chemical

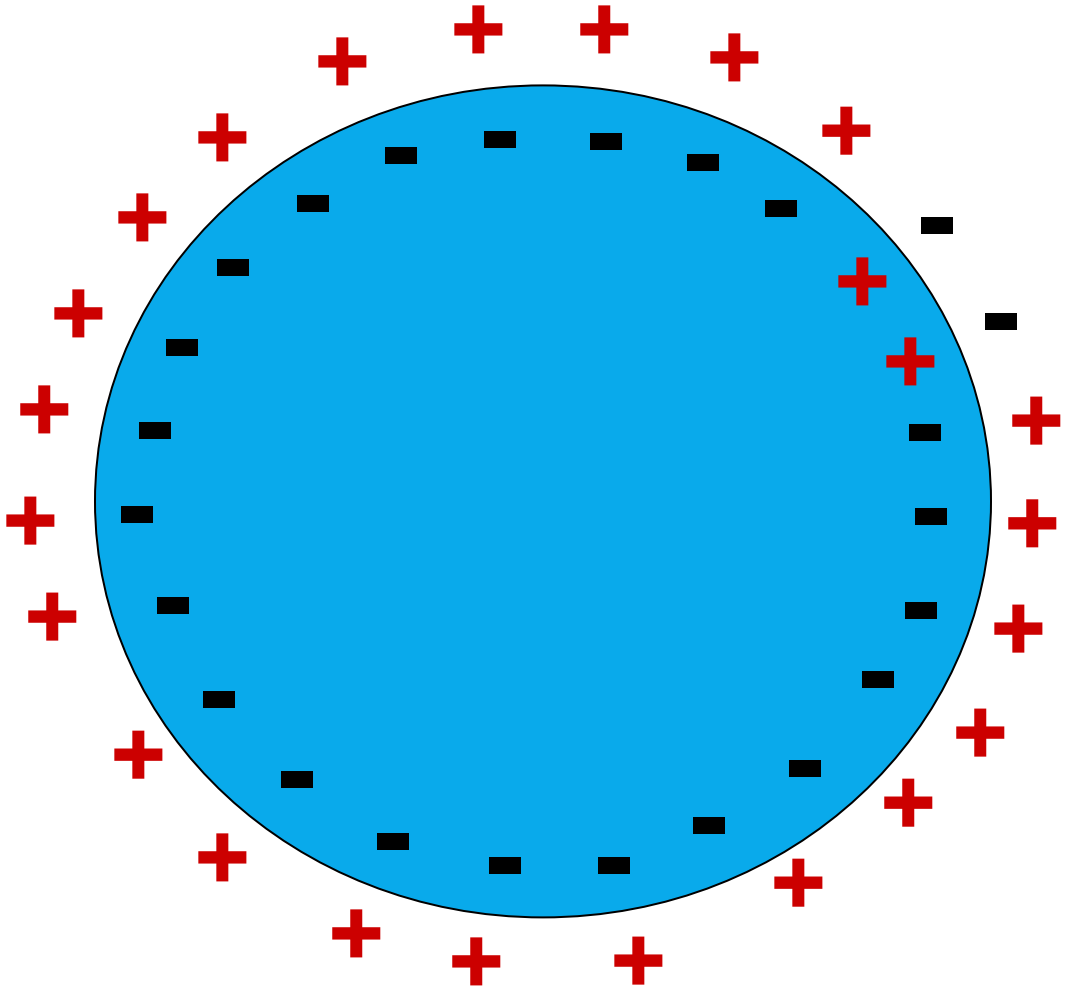

Tap! Tap!..
2

Changes Cell Membrane Permeability to Sodium/Na+!



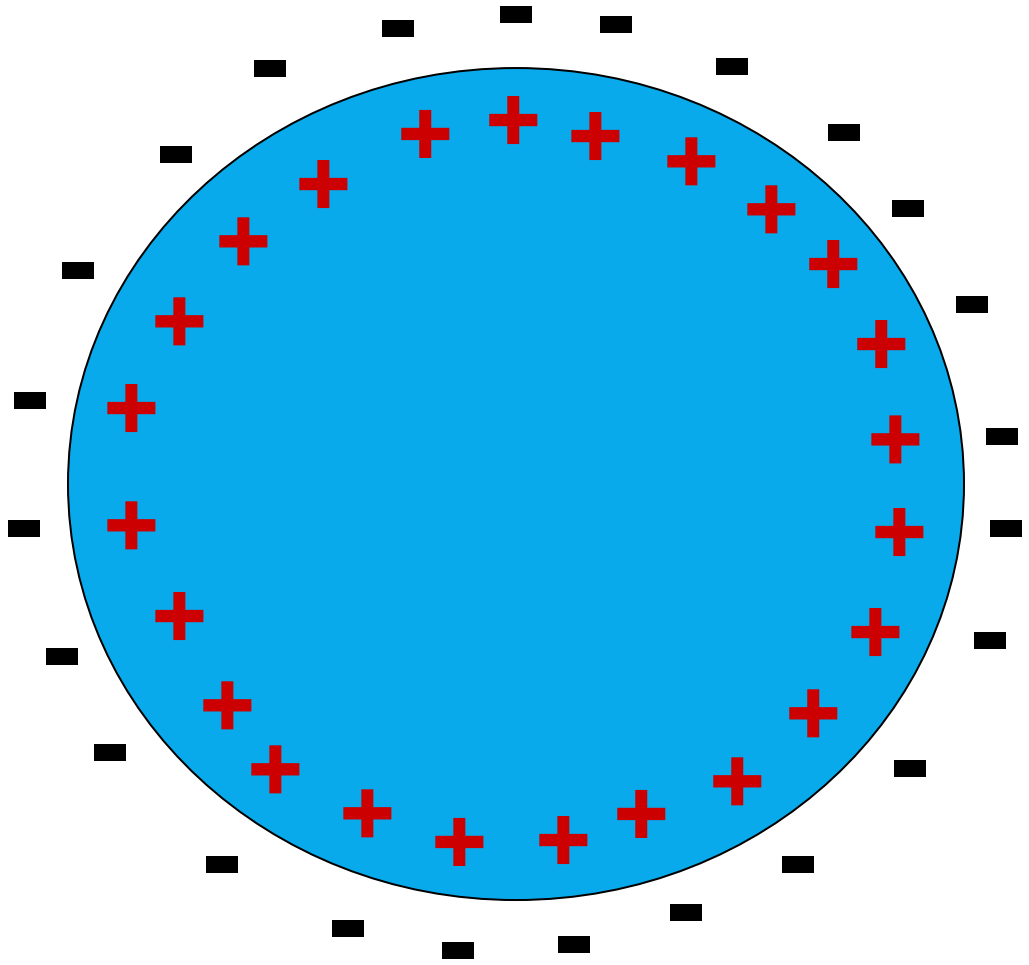
3

+ Charges/Na+ Rushes In!



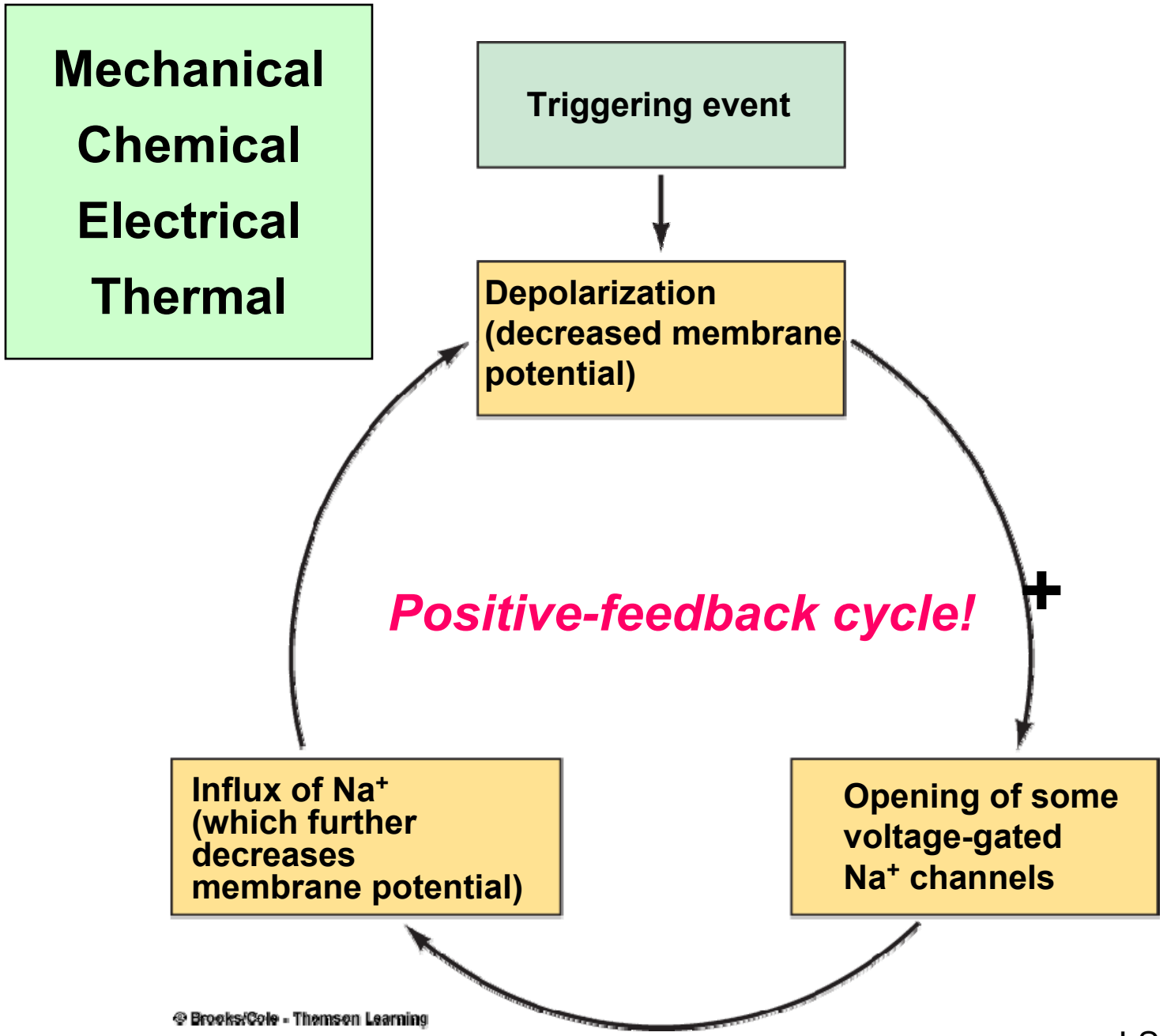
4

Action Potential has occurred!

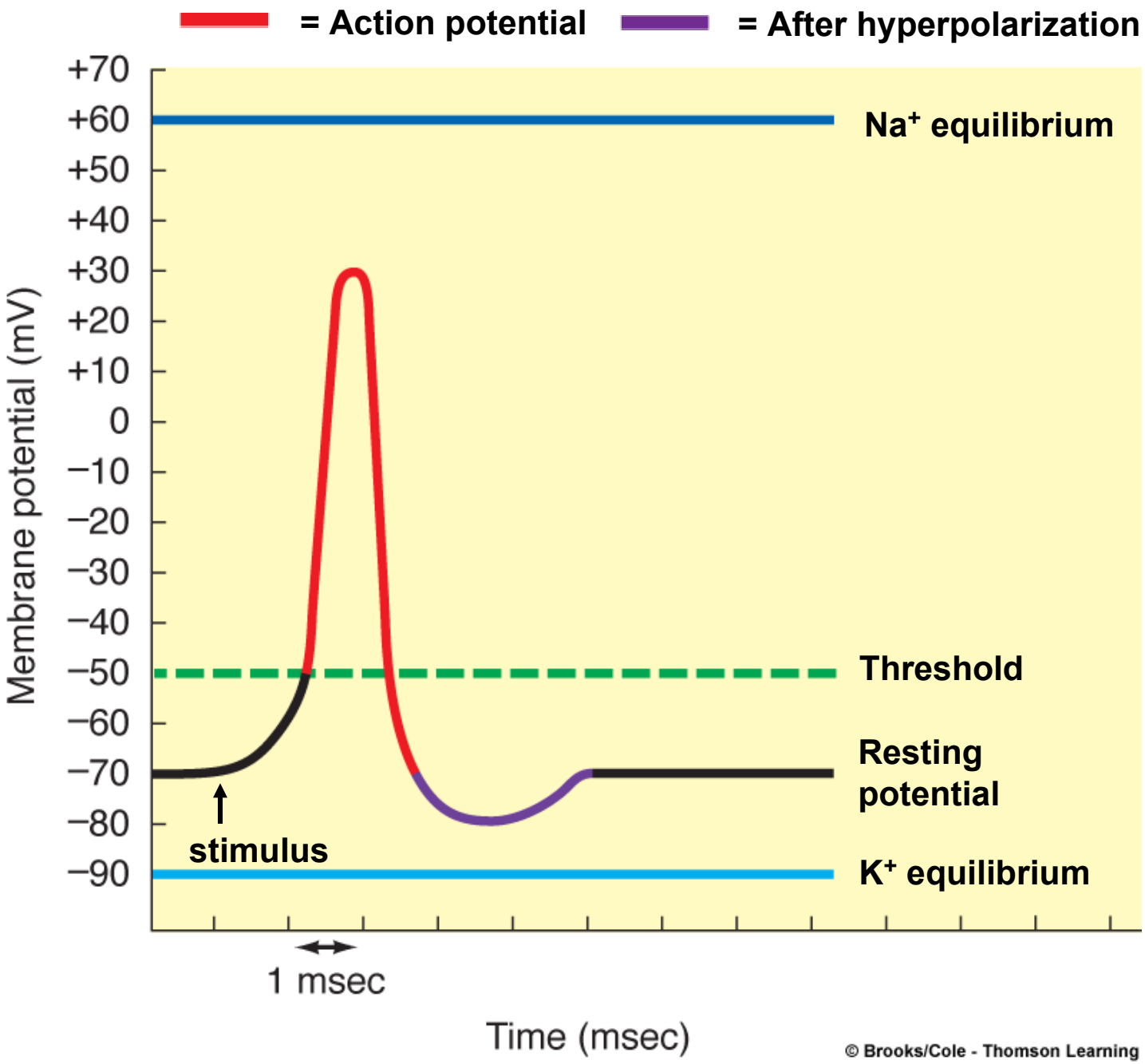


5

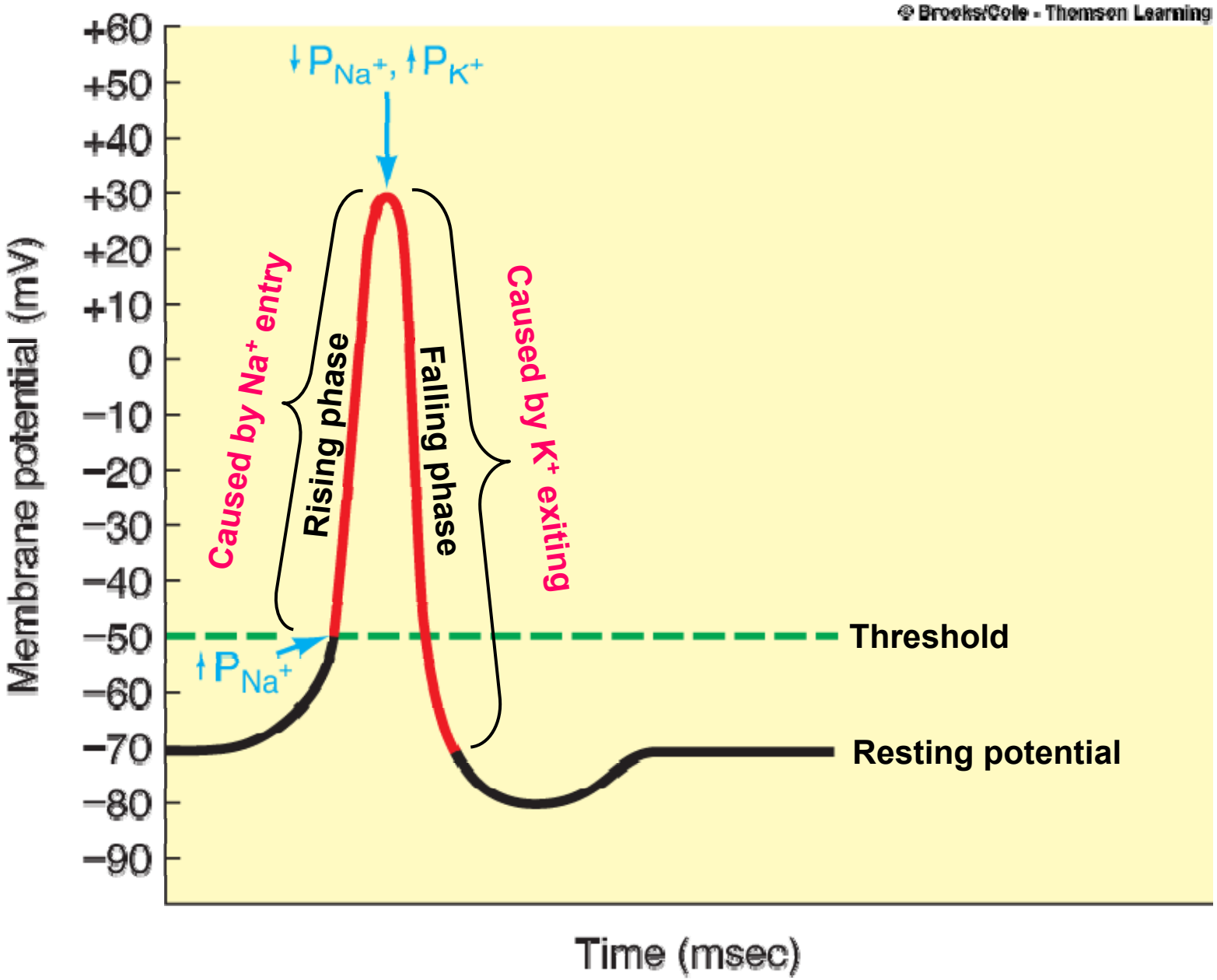
Brief (1-2 ms) reversal to + inside cell!



LS 2012 fig 4-7

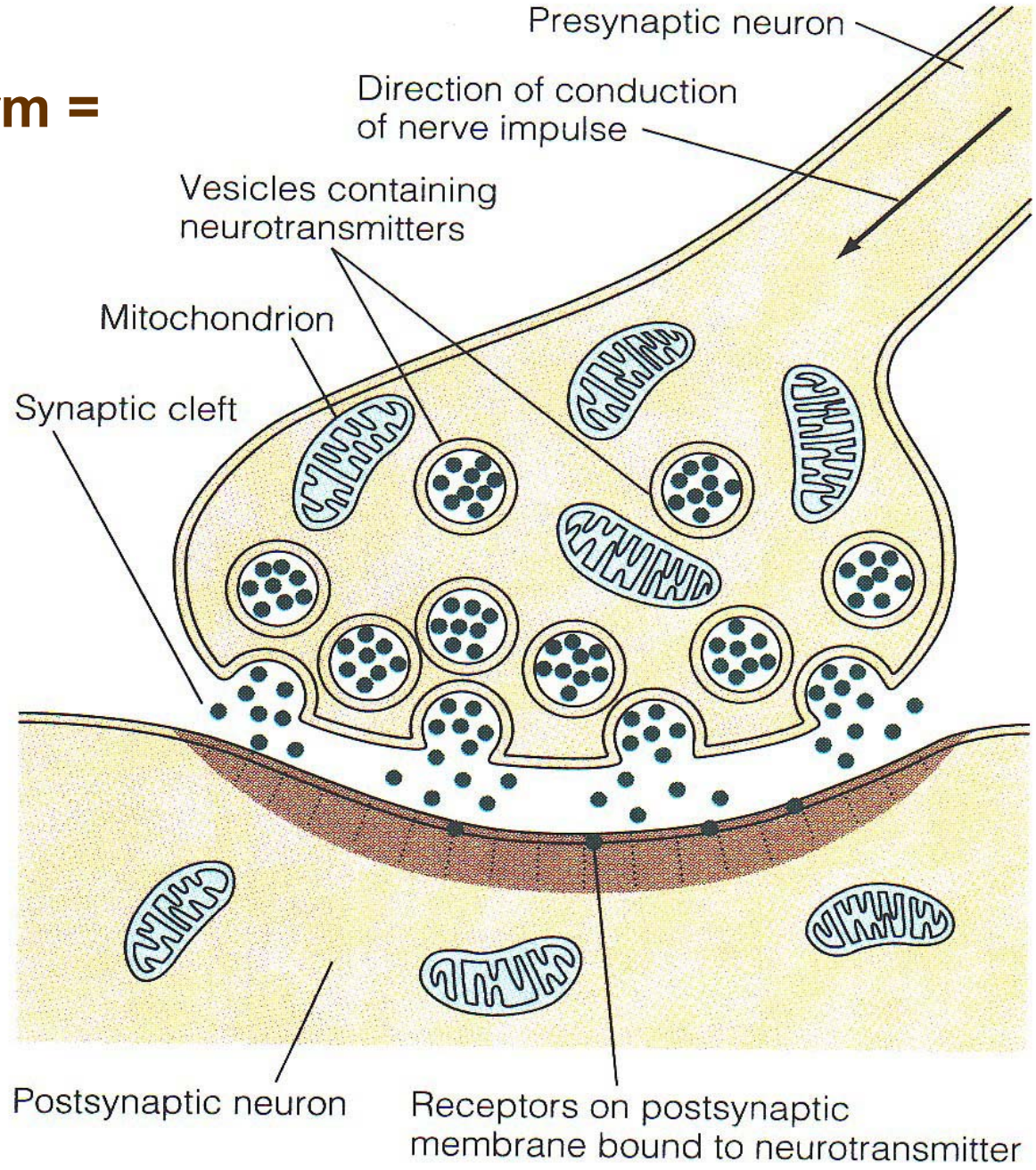


LS 2012 fig 4-5

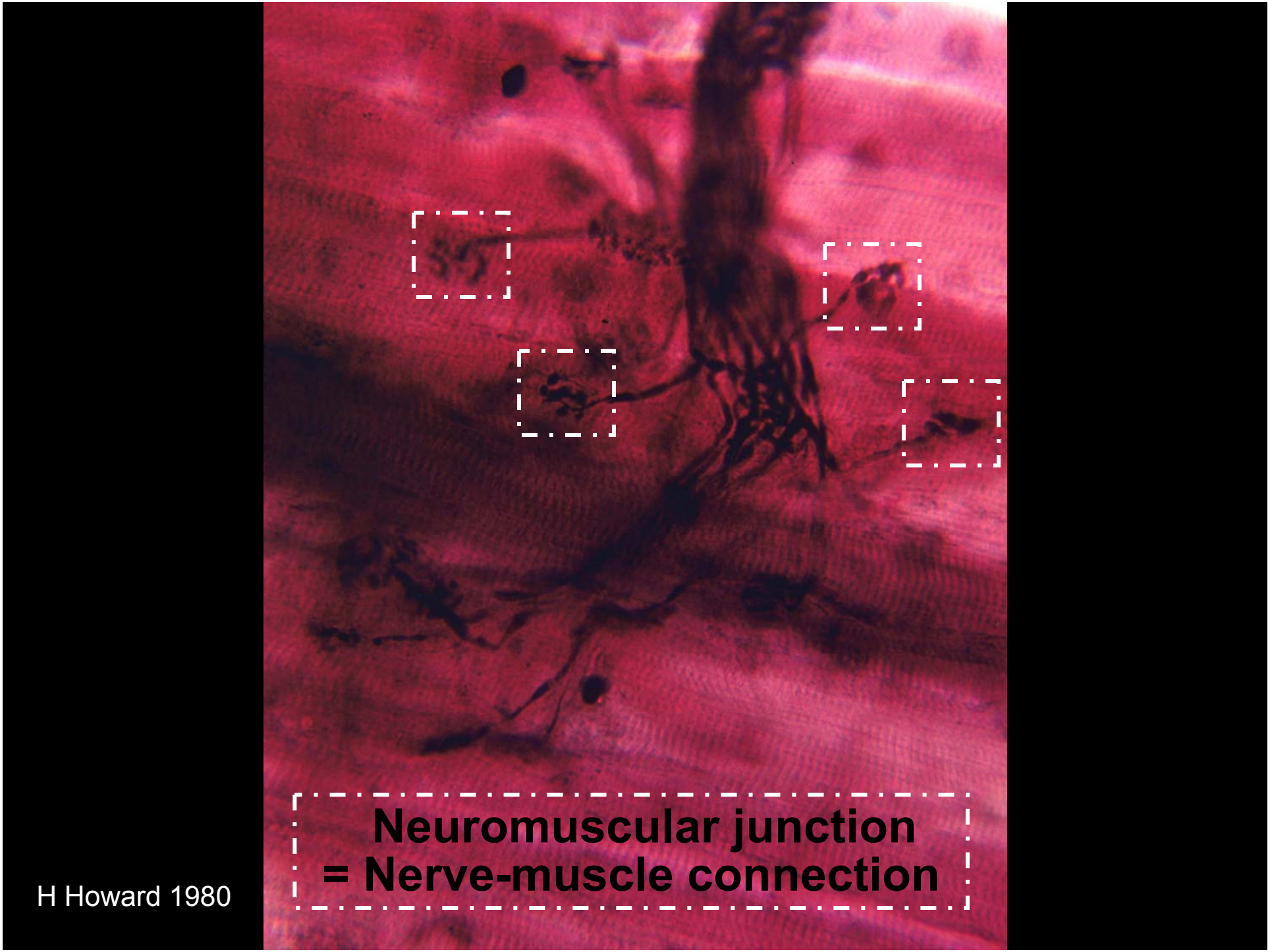


LS 2012 fig 4-8

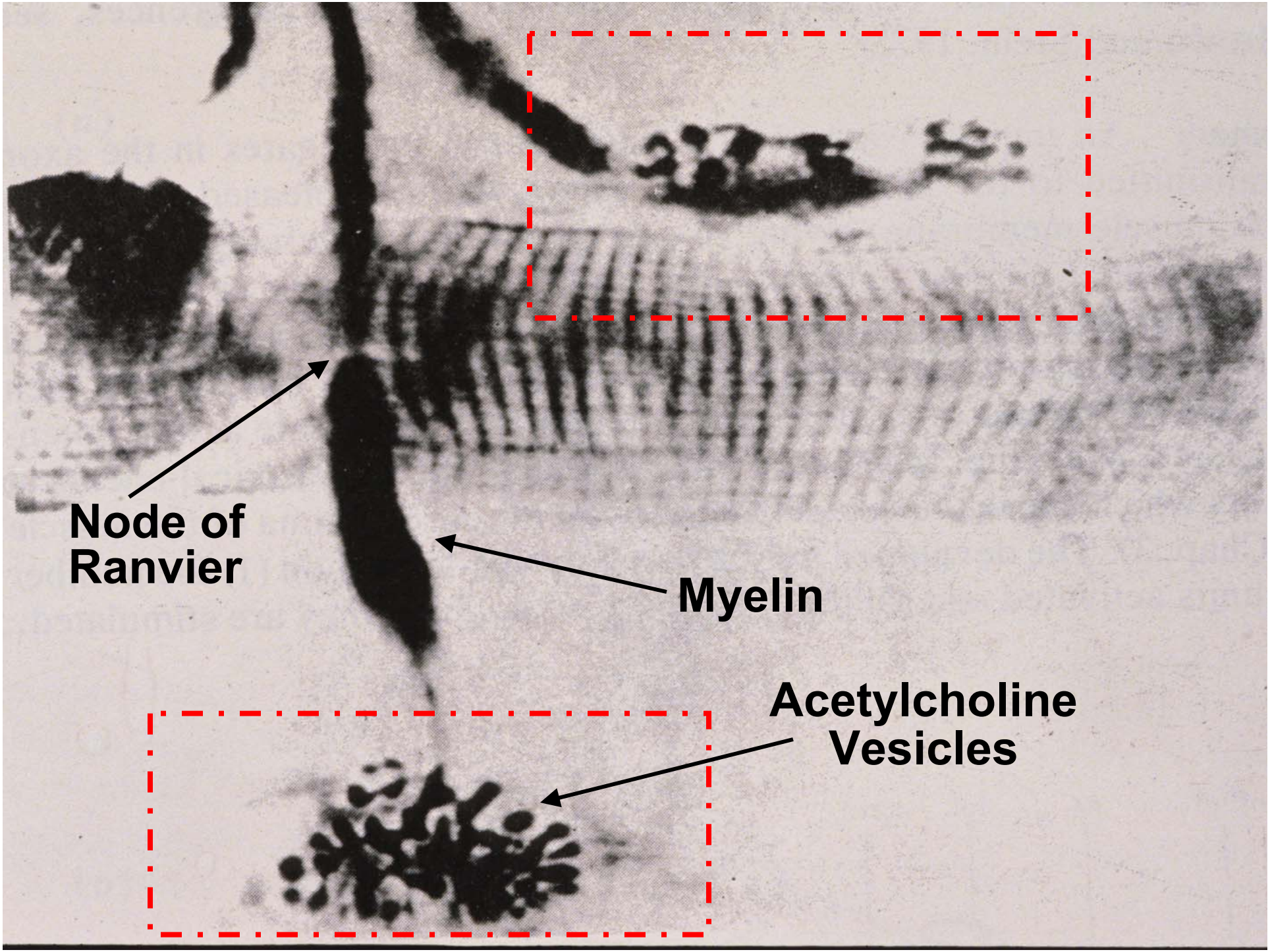
Synapse **=**
Generic term = connection between excitable cells!



DC 2003

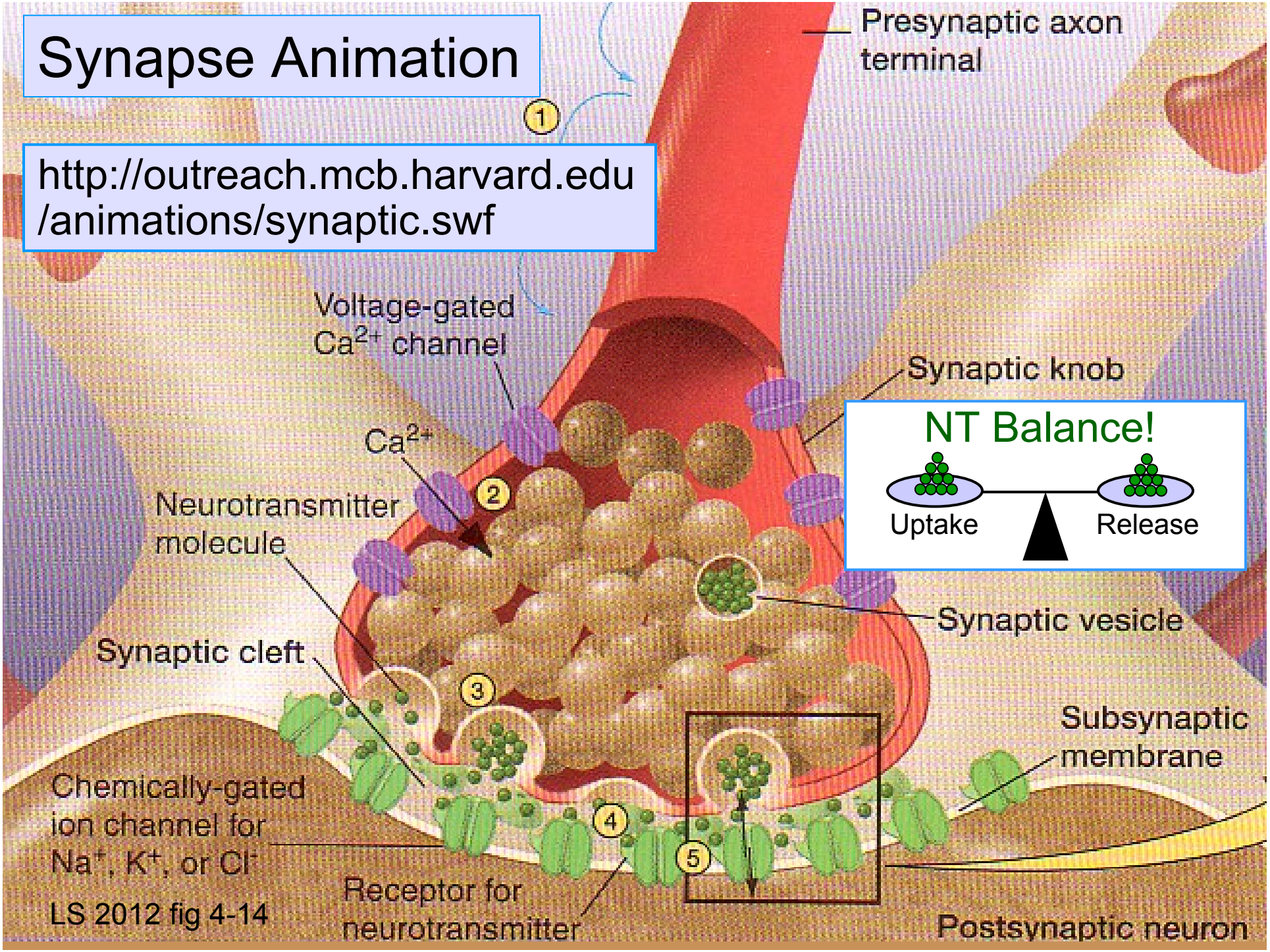


H Howard 1980

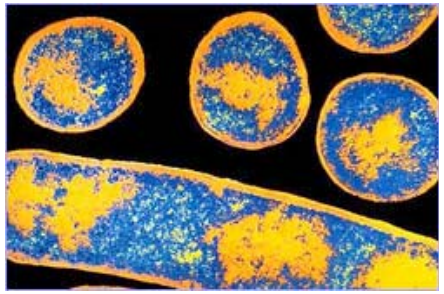

Node of
Ranvier
Myelin
Acetylcholine
Vesicles

Synapse Animation

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



LS 2012 fig 4-14



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