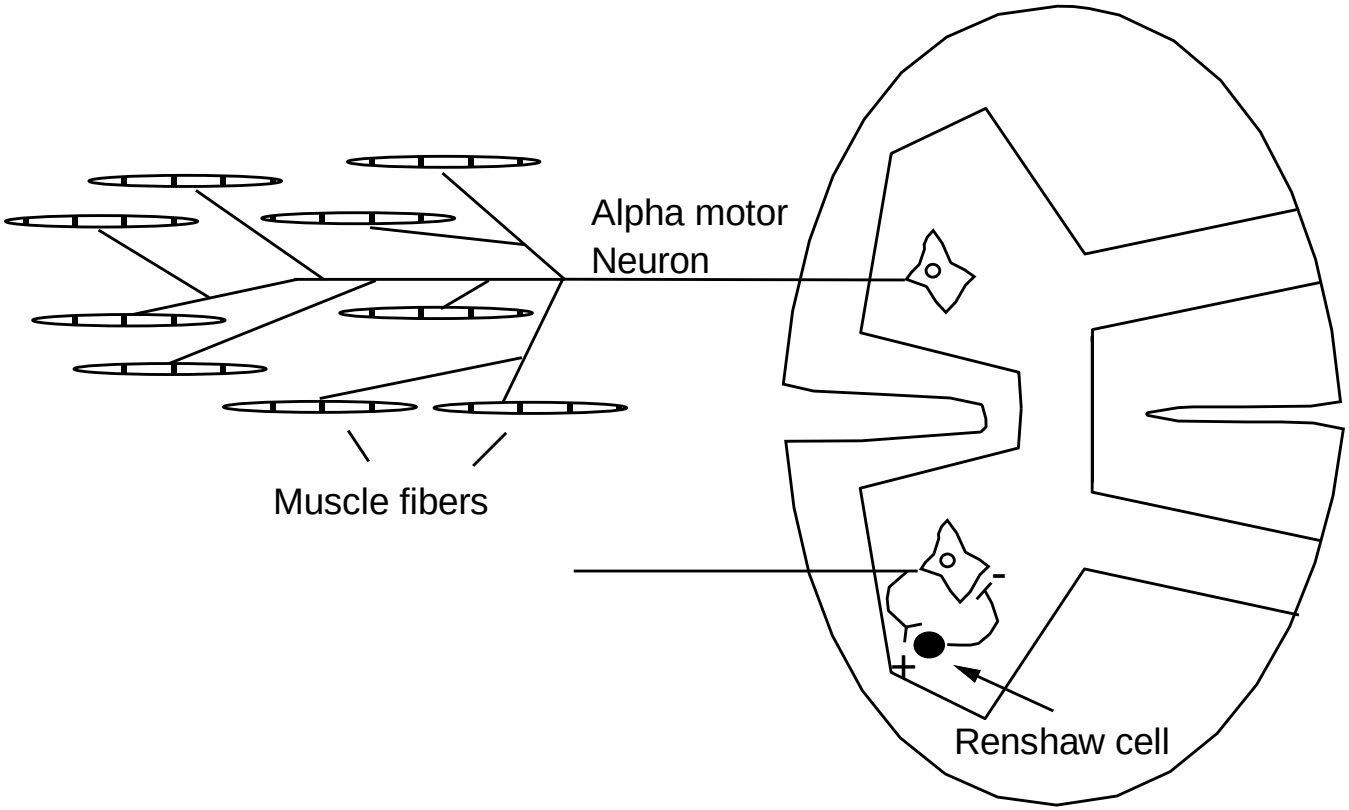
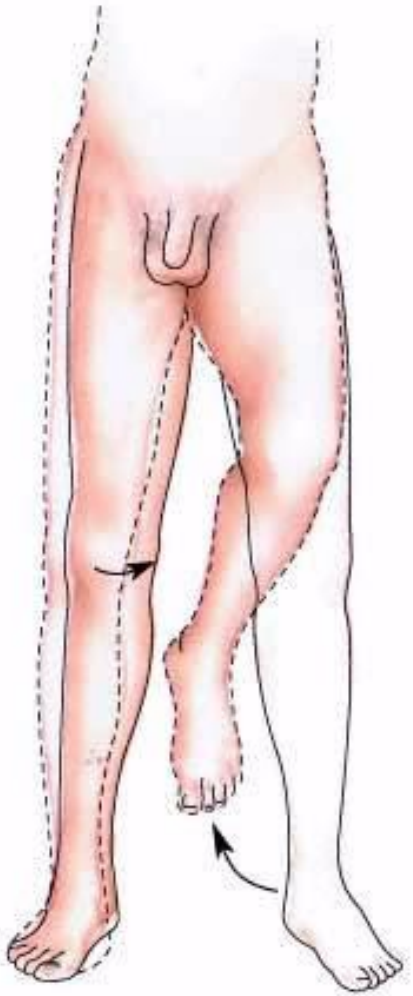
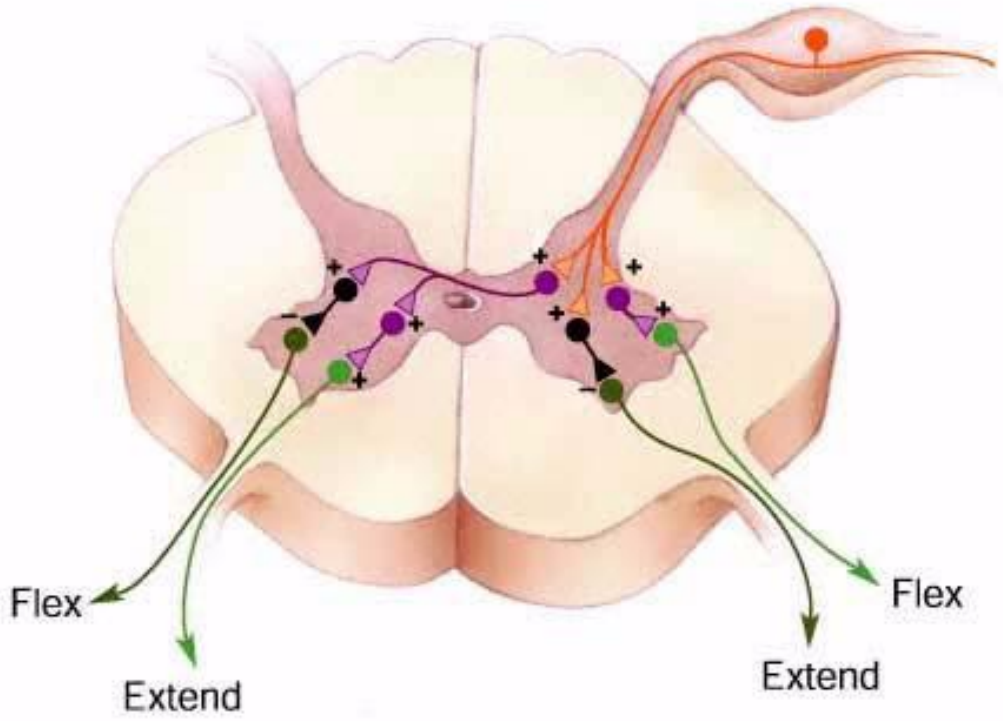
Supraspinal Motor Control

The Motor Unit

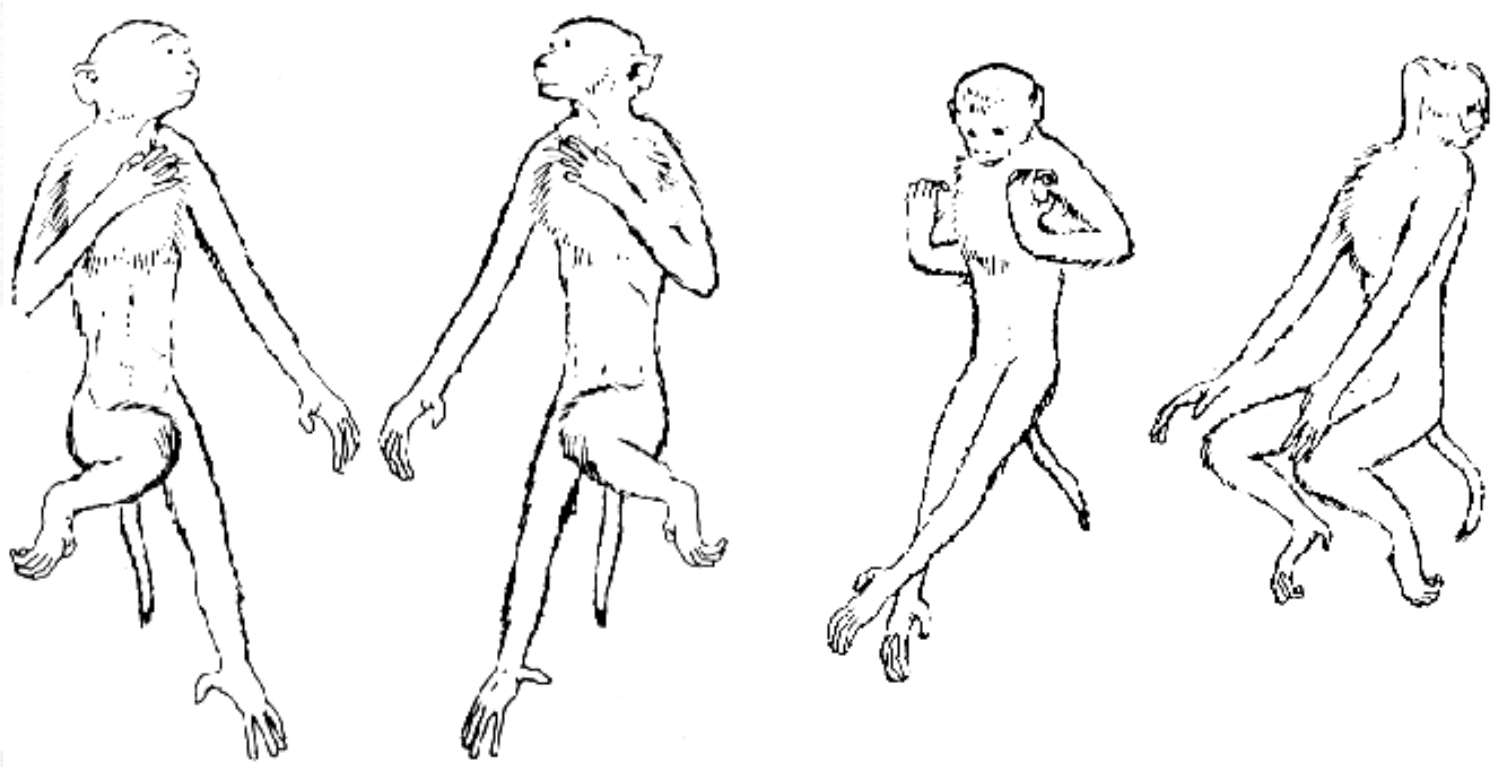


Flexor-Crossed Extensor Reflex



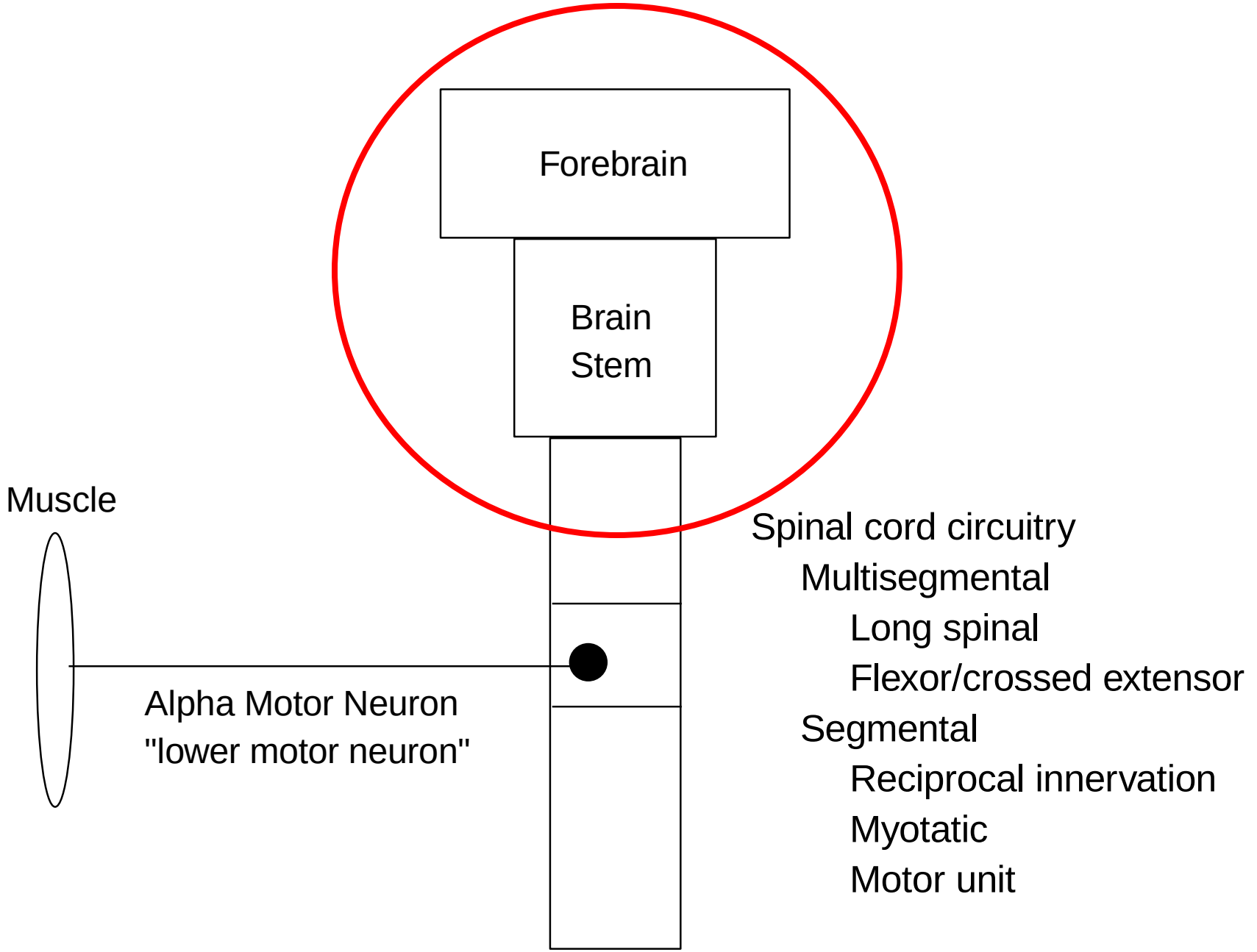


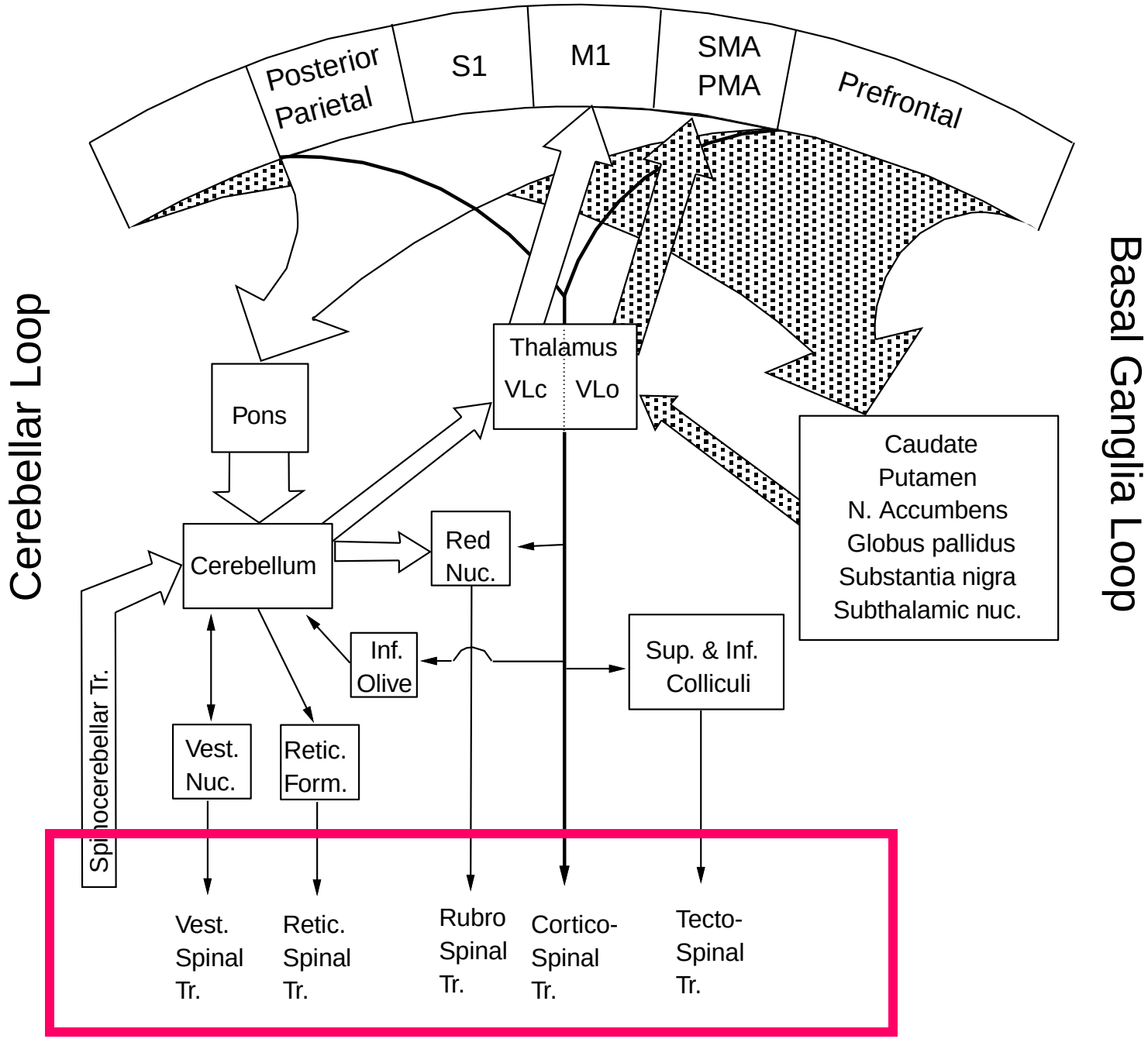
Long Spinal Reflexes

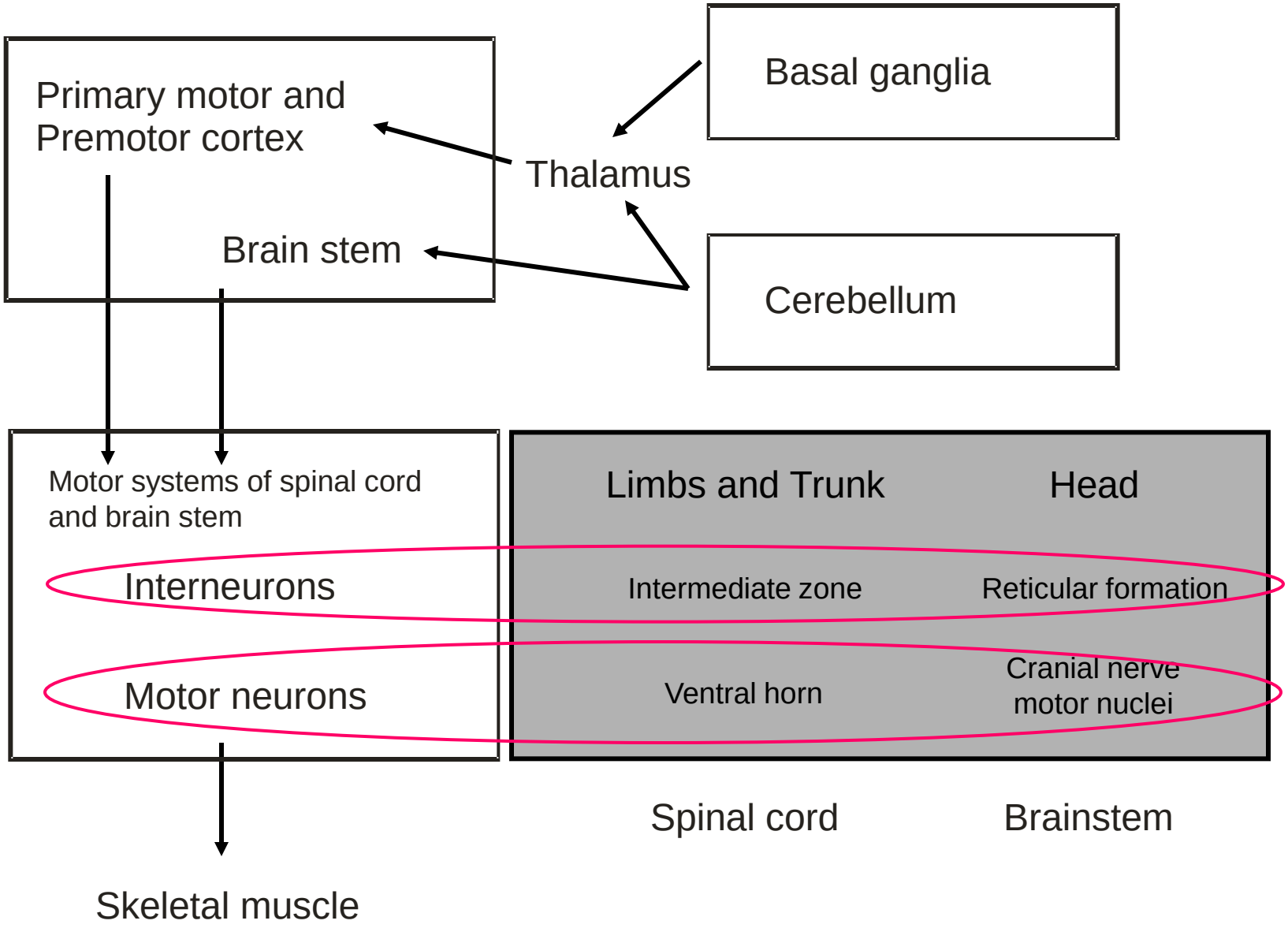


Inputs: vestibular, neck proprioceptors

Organized by circuits of propriospinal neurons

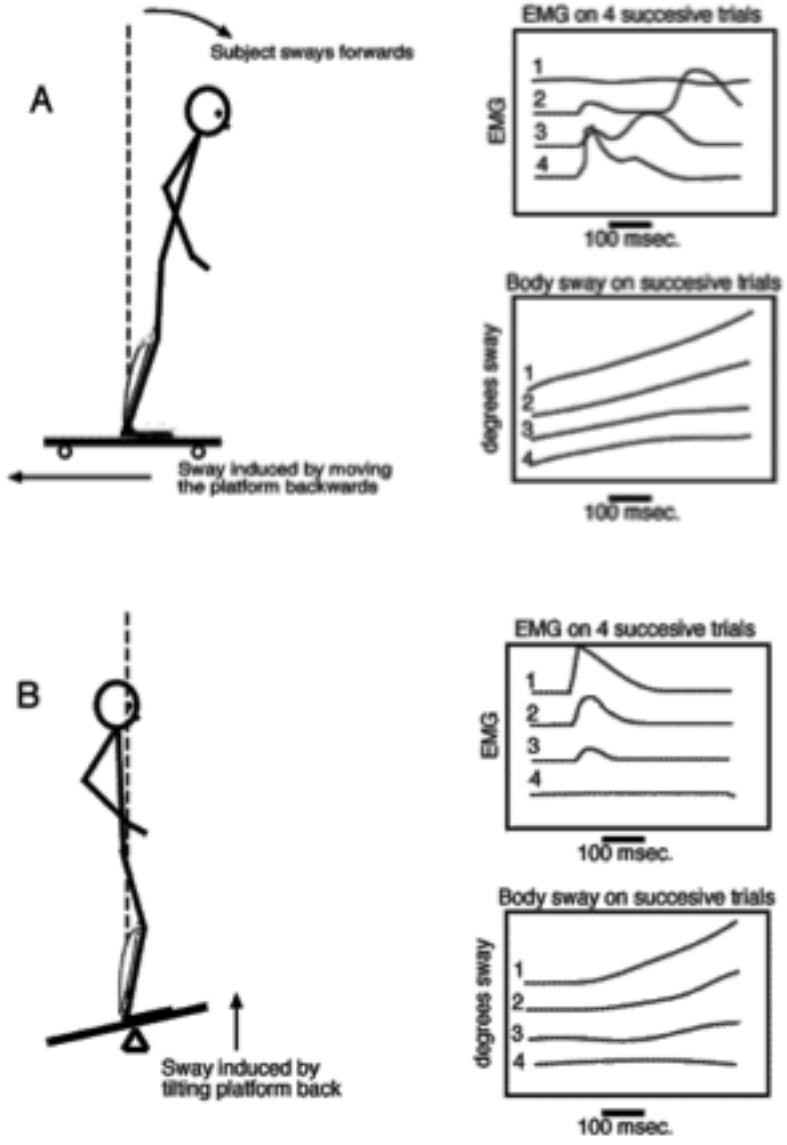

Forebrain
Brain
Stem
Muscle
Alpha Motor Neuron
"lower motor neuron"
Spinal cord circuitry
Multisegmental
Long spinal
Flexor/crossed extensor
Segmental
Reciprocal innervation
Myotatic
Motor unit


Posterior Parietal
S1
M1
SMA PMA
Prefrontal
Cerebellar Loop
Basal Ganglia Loop
Thalamus
VLc VLo
Pons
Cerebellum
Red Nuc.
Caudate
Putamen
N. Accumbens
Globus pallidus
Substantia nigra
Subthalamic nuc.
Inf. Olive
Sup. & Inf. Colliculi
Spinocerebellar Tr.
Vest. Nuc.
Retic. Form.
Vest. Spinal Tr.
Retic. Spinal Tr.
Rubro Spinal Tr.
Cortico-Spinal Tr.
Tecto-Spinal Tr.


Primary motor and
Premotor cortex
Basal ganglia
Thalamus
Brain stem
Cerebellum
Motor systems of spinal cord
and brain stem
Limbs and Trunk
Head
Interneurons
Intermediate zone
Reticular formation
Motor neurons
Ventral horn
Cranial nerve
motor nuclei
Spinal cord
Brainstem
Skeletal muscle

Experiments involving modulation of spinal reflexes during postural adjustment to induced body sway.

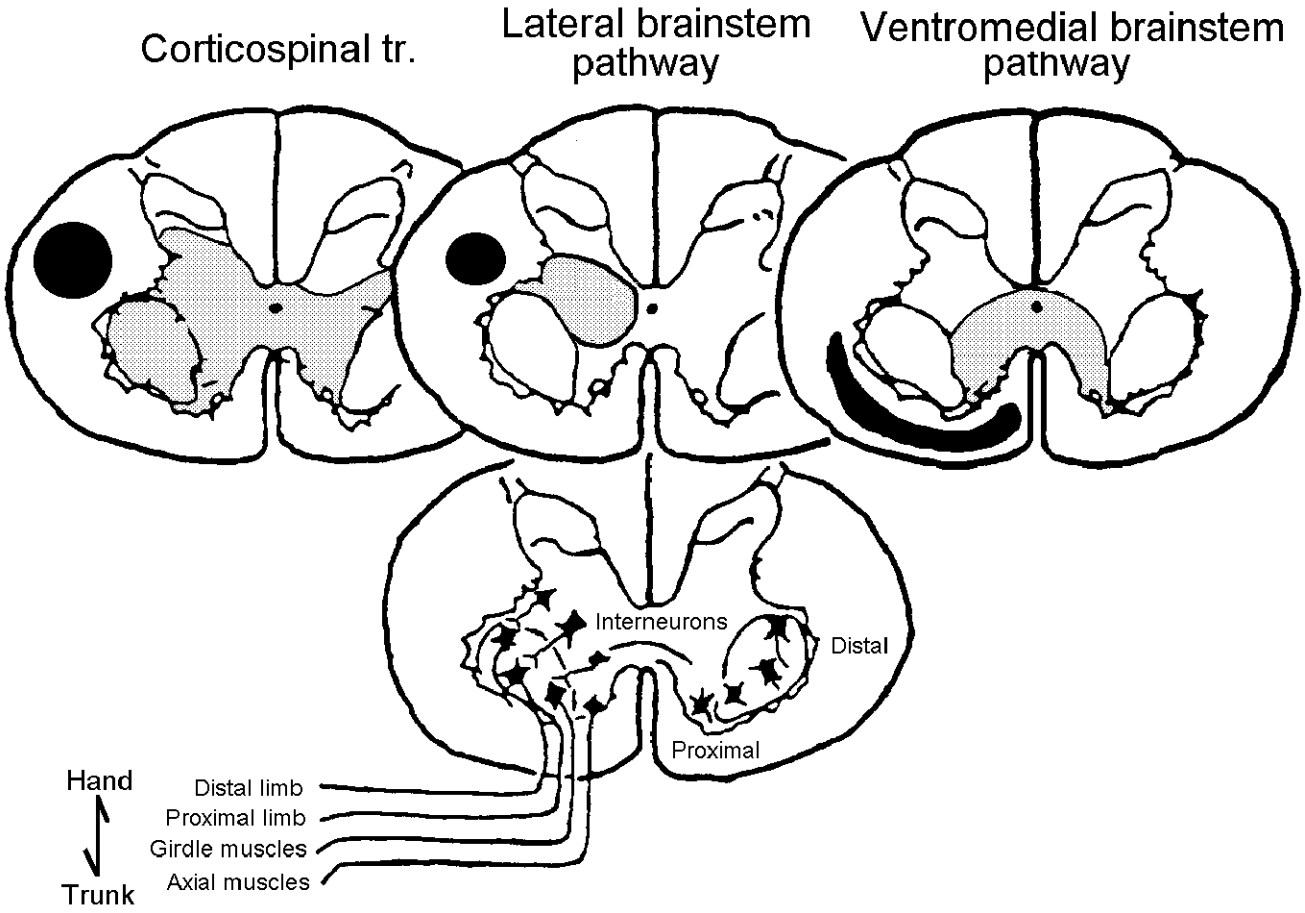
figure modified from Kandel et al. 1991, after Nashner 1976.



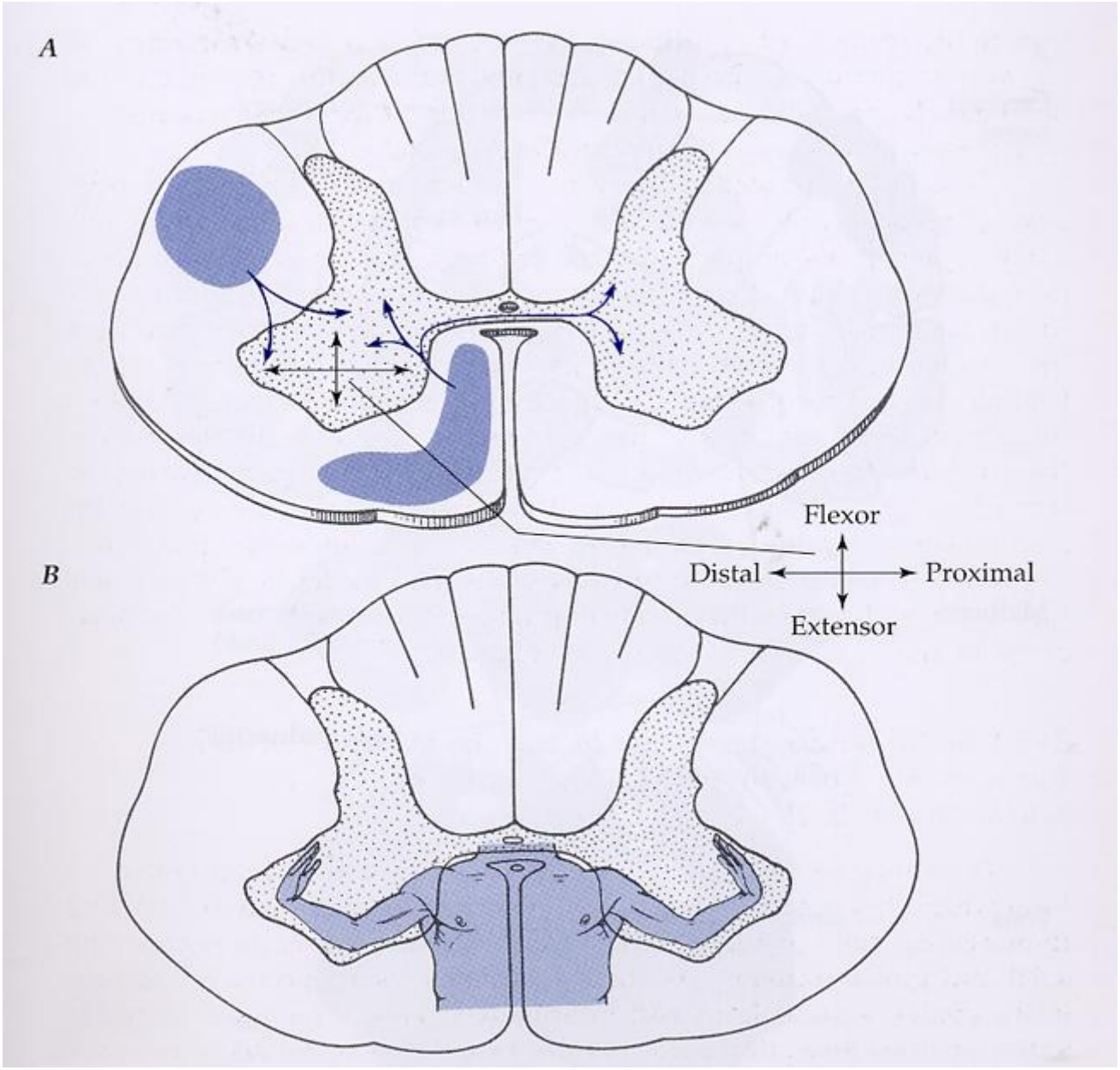

AZgallery.org

The Three Major Descending Pathways

"Upper motor neurons" "Long motor tracts"



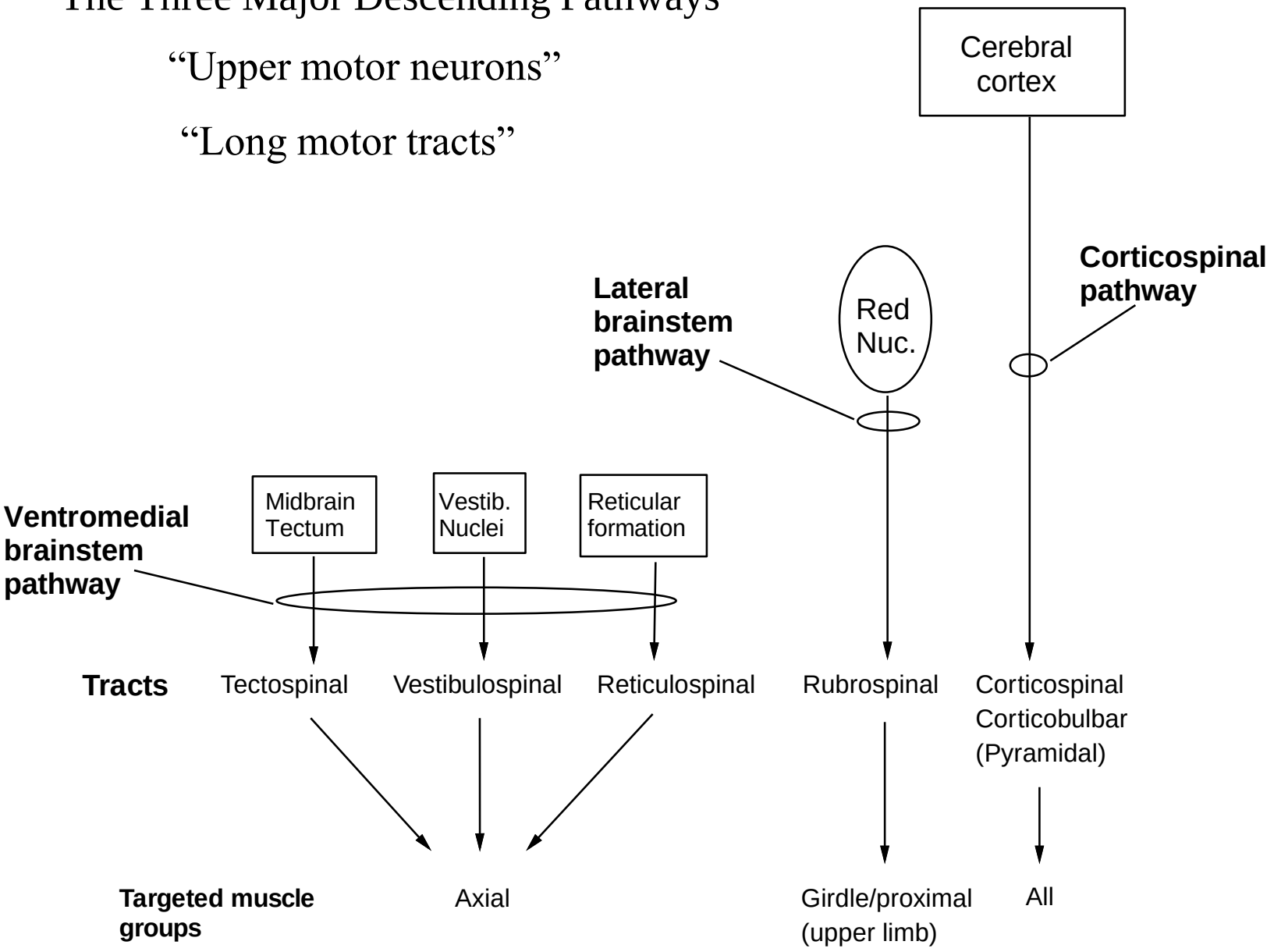
Lawrence and Kuypers


A
B
Flexor
Distal
Proximal
Extensor

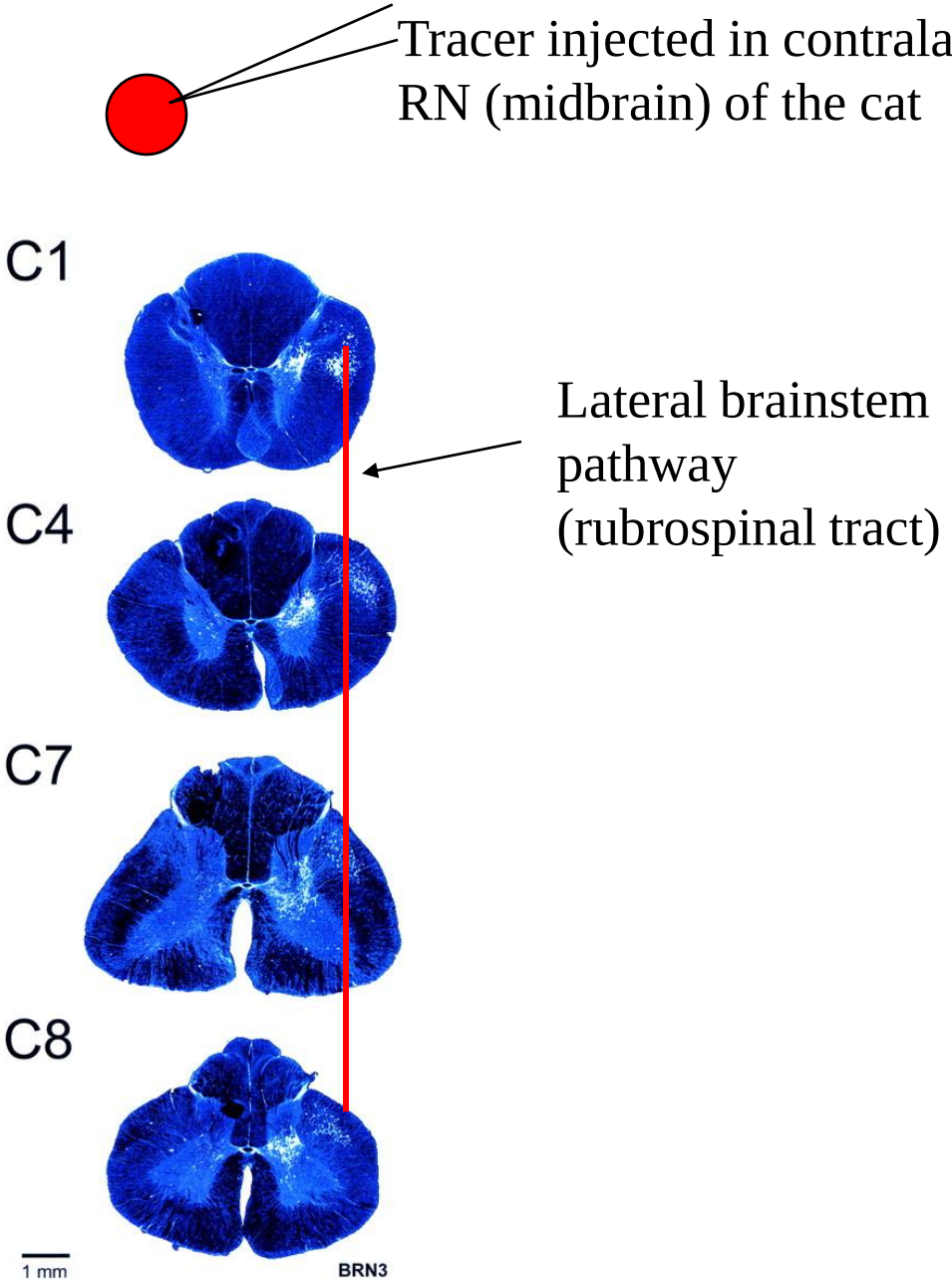
The Three Major Descending Pathways

"Upper motor neurons"

"Long motor tracts"



Spinal termination of the red nucleus



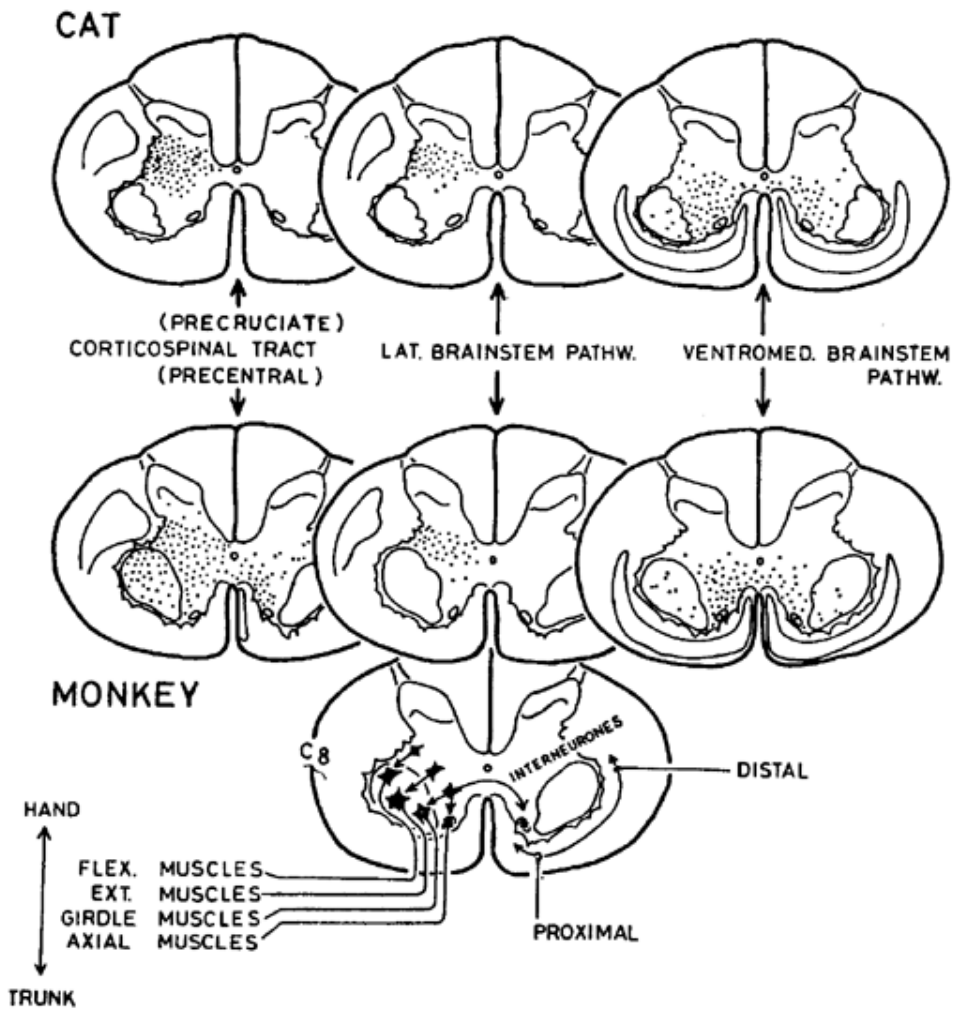


Fig. 7. Diagram of the distribution of cortical and brain-stem pathways in the spinal intermediate zone and motoneuronal cell groups in cat and rhesus monkey. Note the differences between the distributions of the cortical fibers in cat and monkey.

Ascending Descending

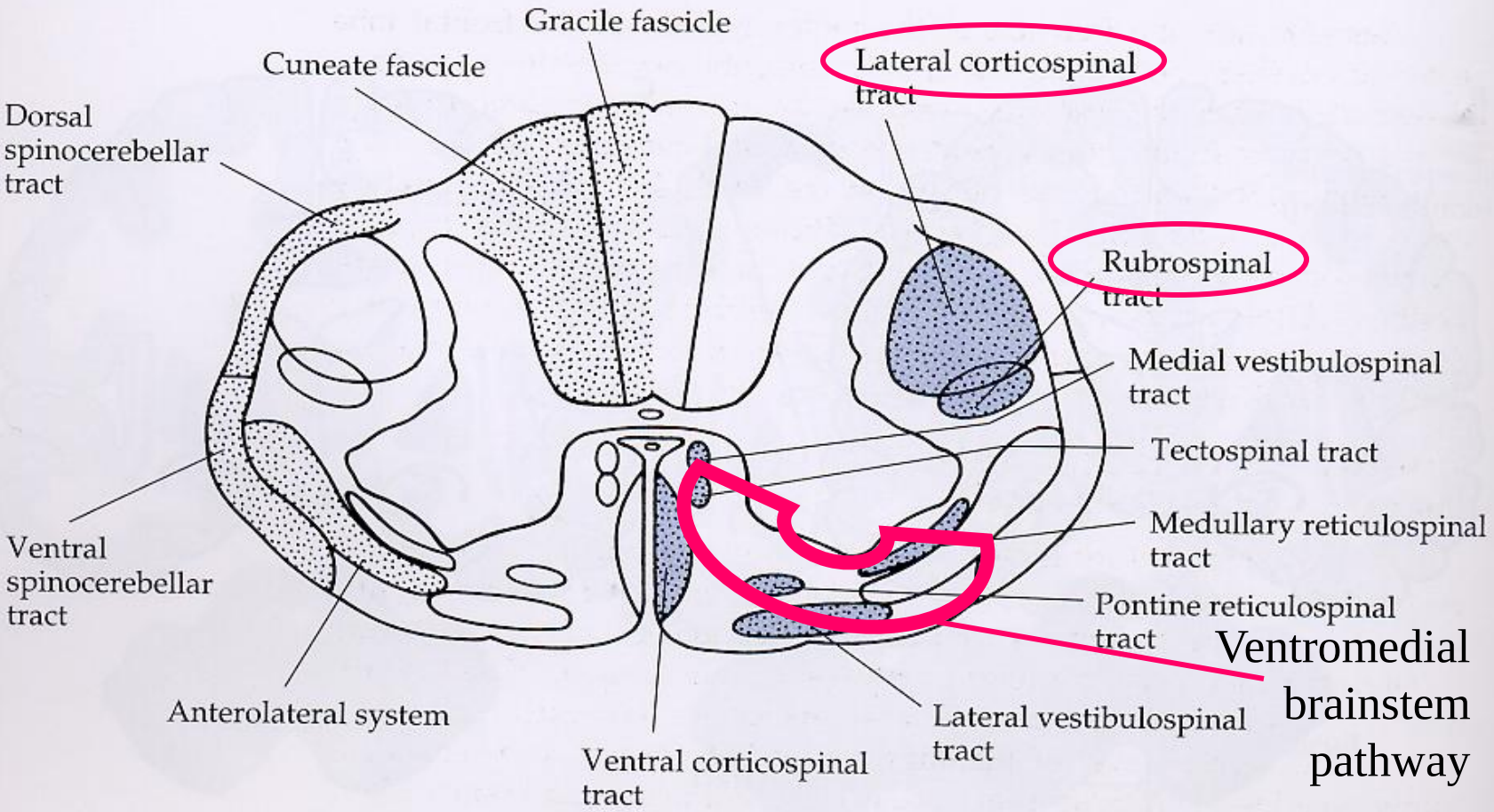
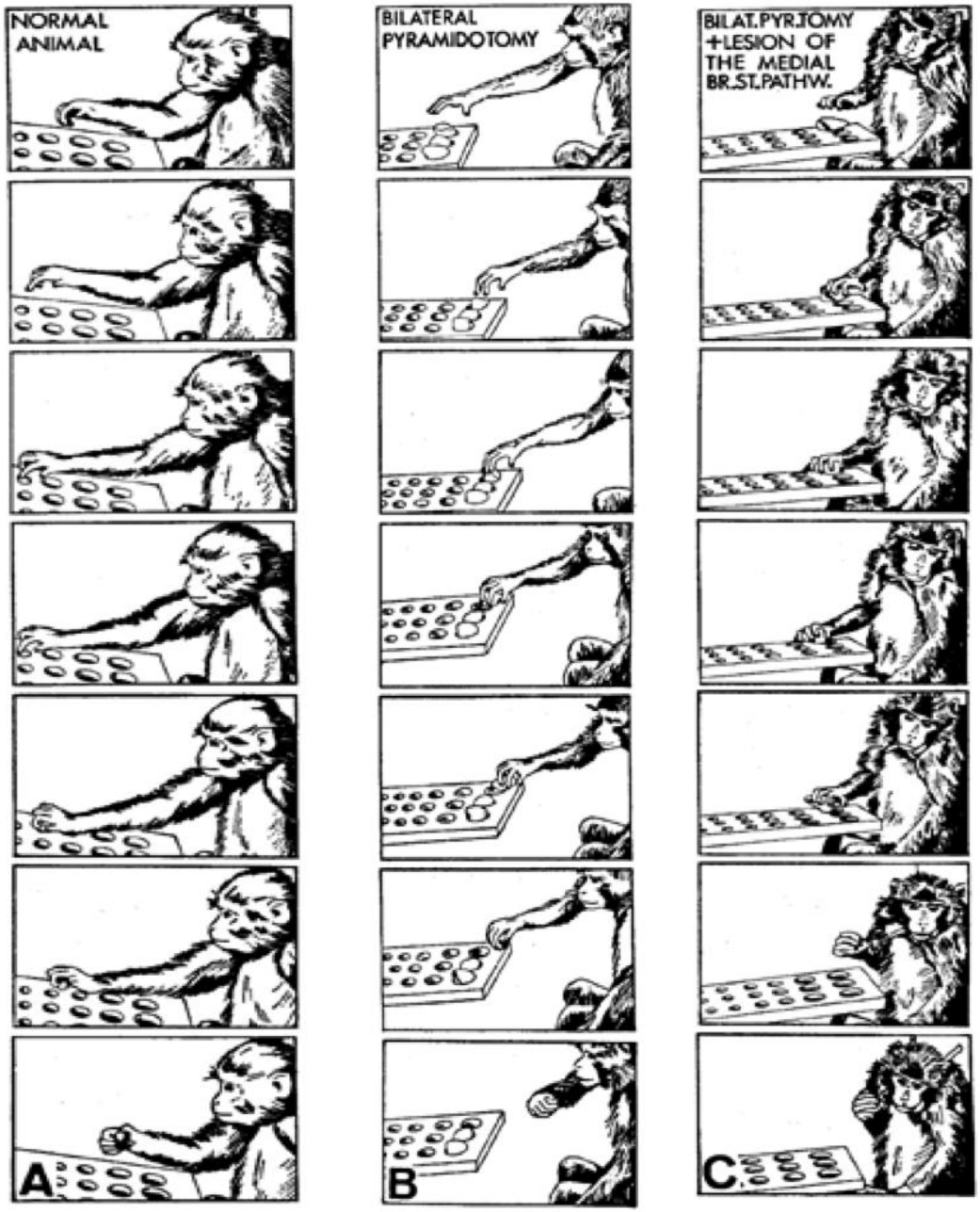


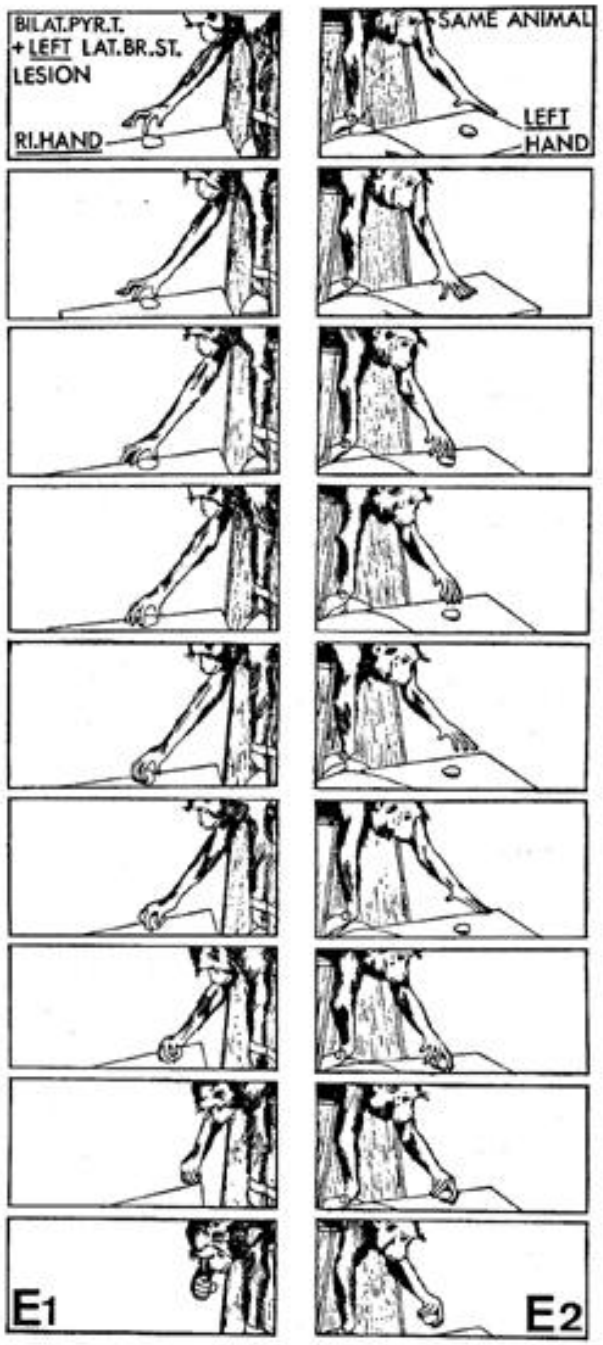
Figure 9–5. Schematic diagram of the spinal cord indicating the locations of the ascending *(left)* and descending *(right)* pathways.



Control of trunk,
axial muscles impaired
(↓ anti-gravity posture,
difficulty righting)

Bilateral pyramidotomy
(eliminate CST input)

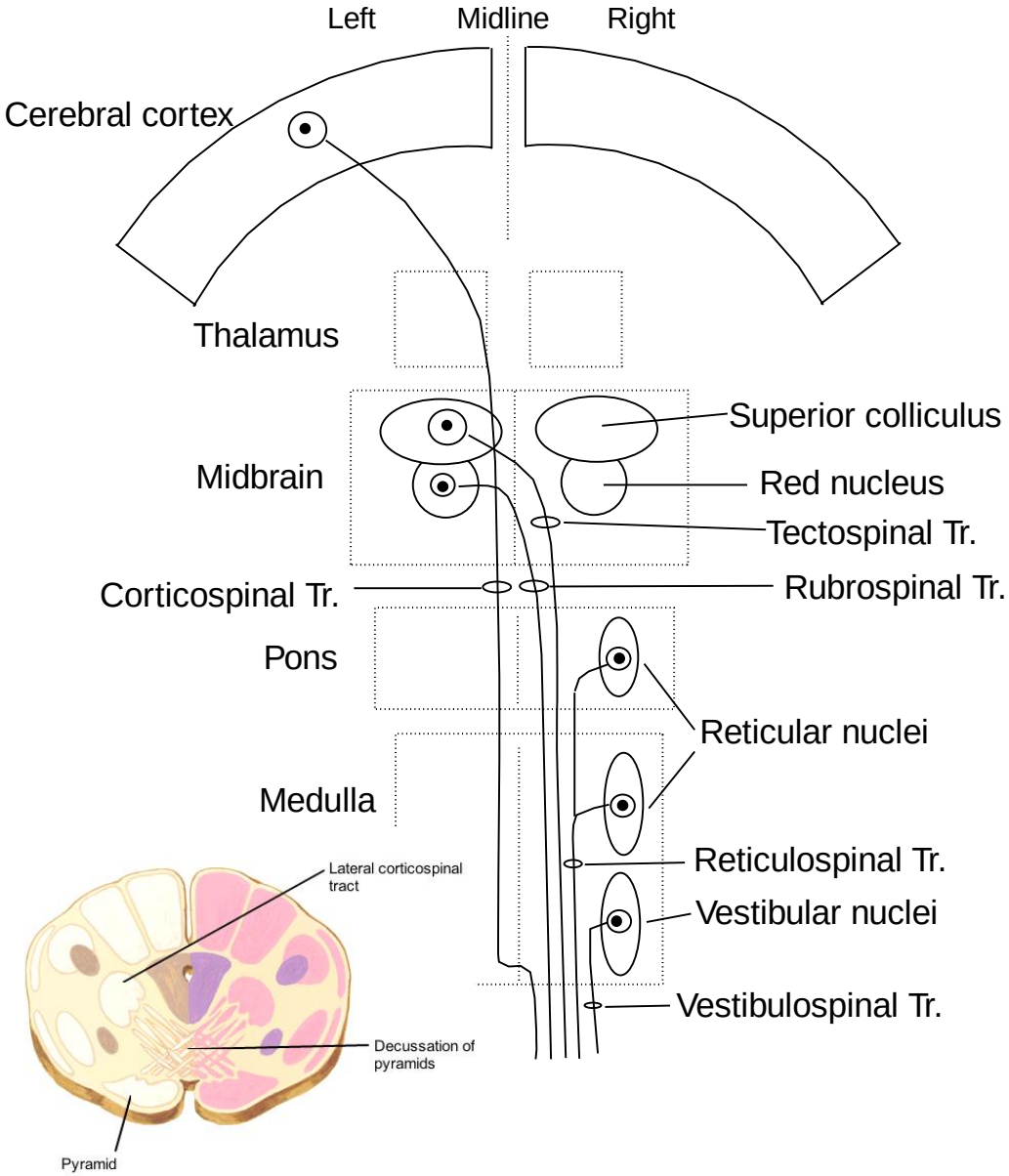
Left lateral brainstem lesion
(eliminate rubrospinal
influence on left)

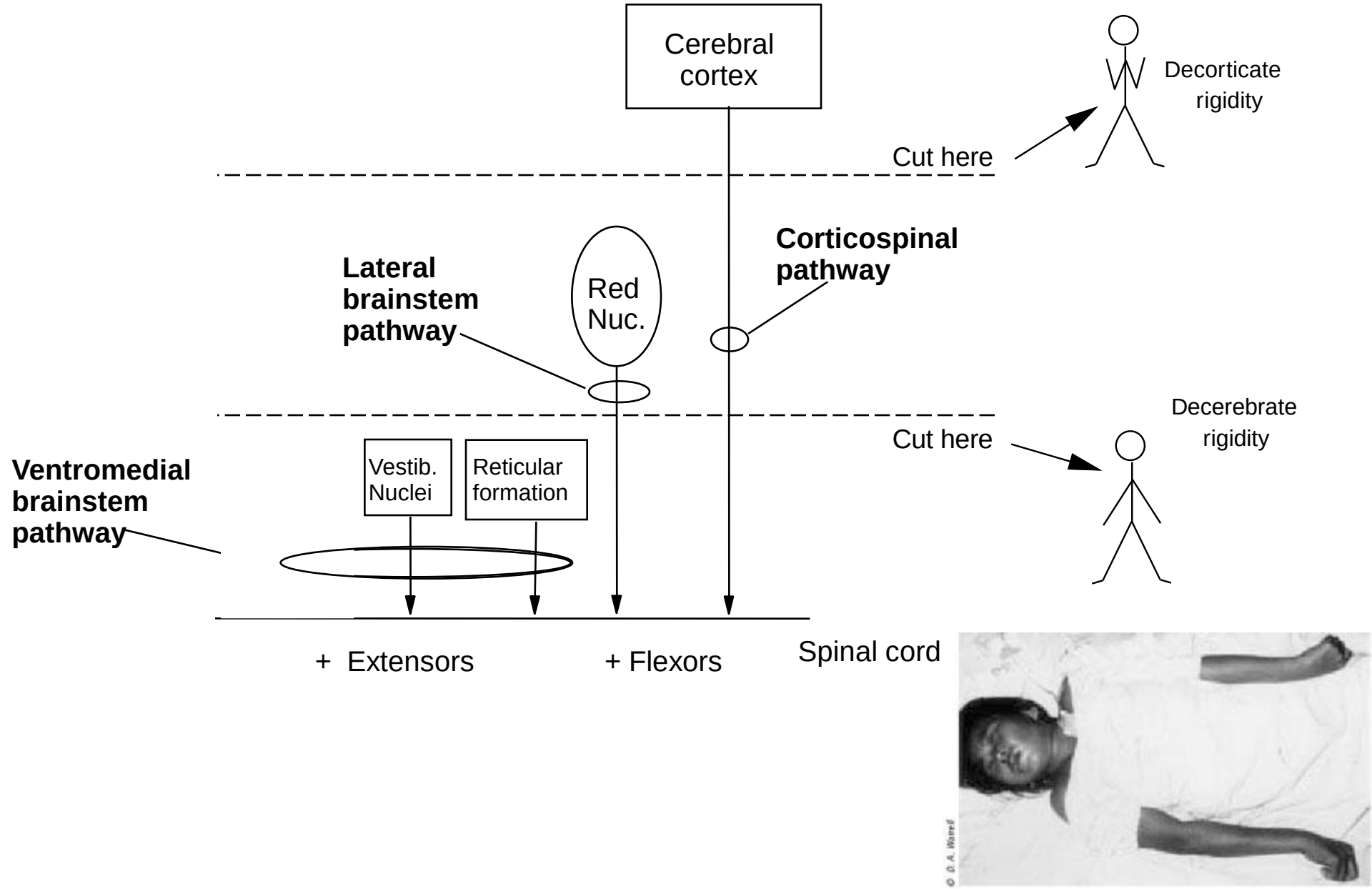


Lateral brainstem intact

Eliminate lateral brainstem

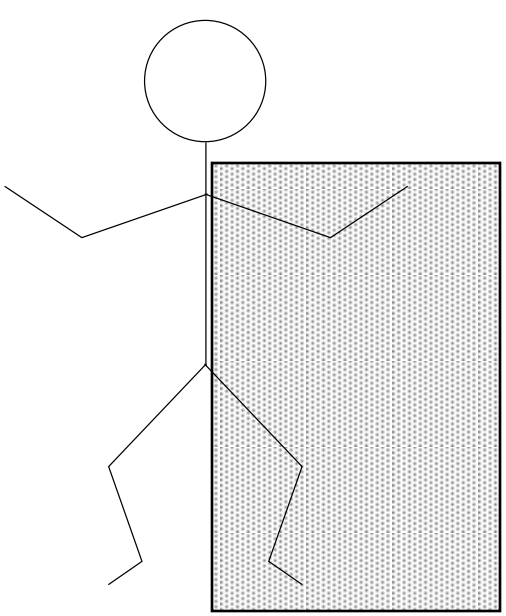
Descending Motor Pathways



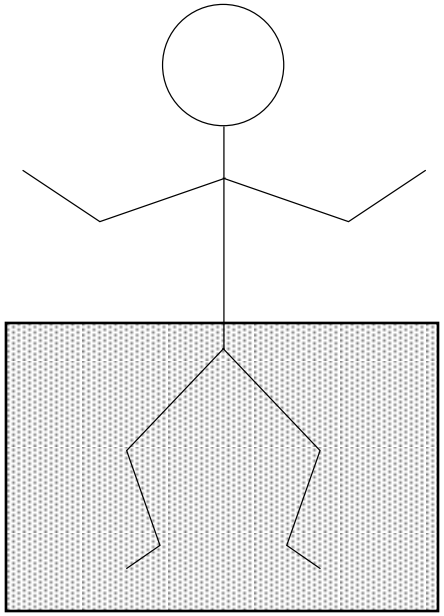

Cerebral cortex
Cut here
Decorticate rigidity
Corticospinal pathway
Lateral brainstem pathway
Red Nuc.
Cut here
Decerebrate rigidity
Ventromedial brainstem pathway
Vestib. Nuclei
Reticular formation
+ Extensors
+ Flexors
Spinal cord

Disease of muscle, lower motor neuron ⇒ Flaccid Paralysis

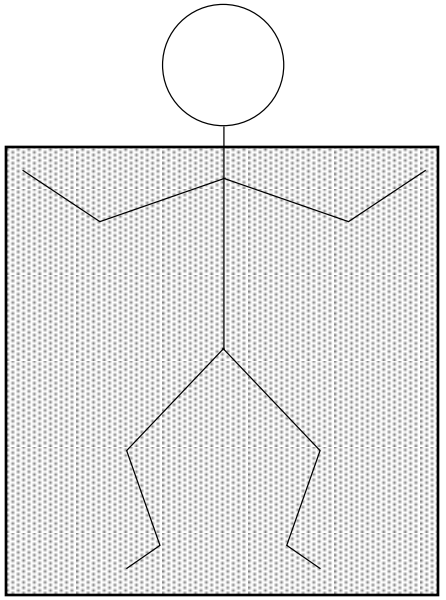
Damage to long motor tracts (UMN) ⇒ Spastic paralysis



Hemiplegia



Paraplegia

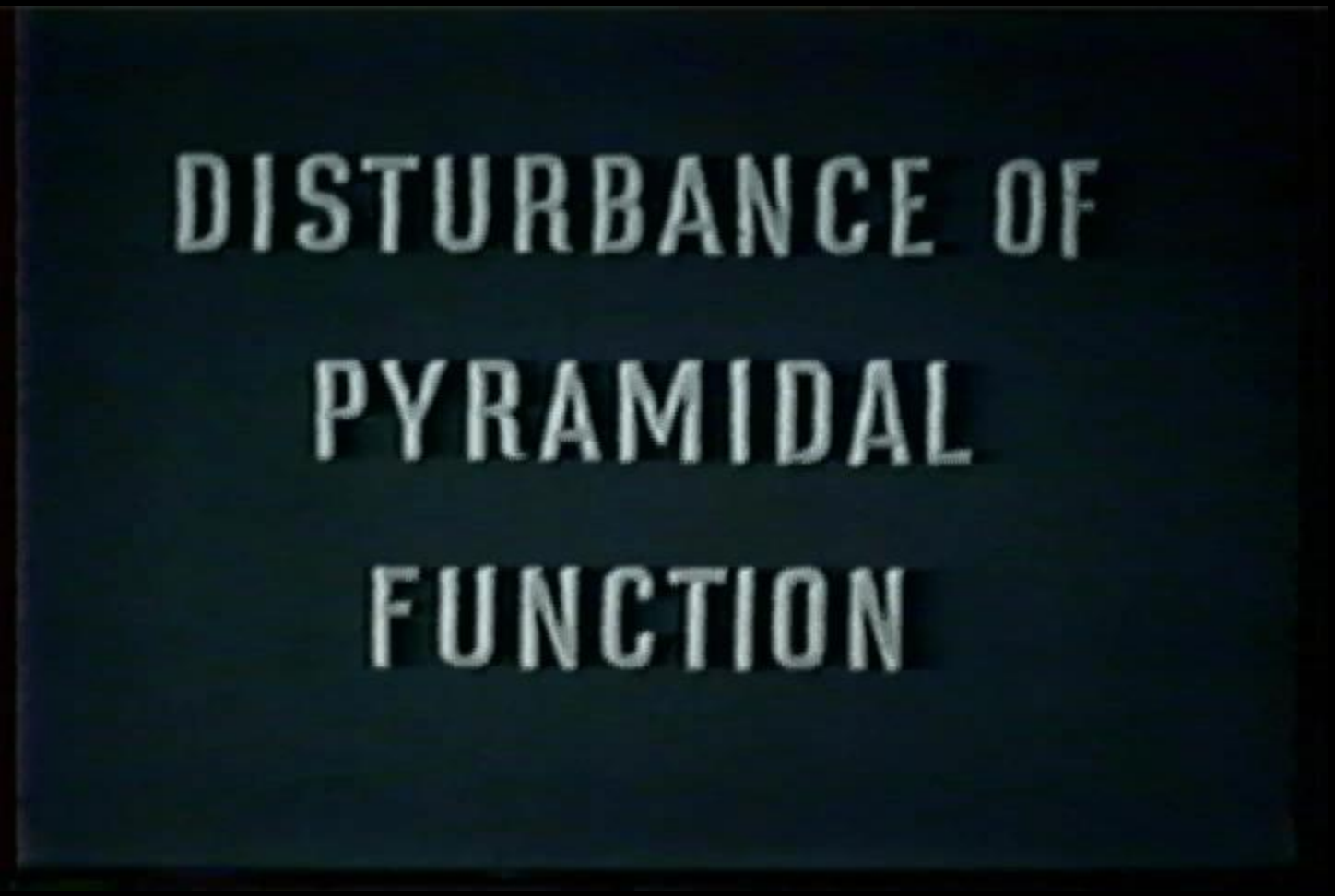


Quadriplegia

-plegia = paralysis

-paresis = weakness

Long Motor Tract Signs



- Weakness
- Spasticity
  - Hypertonia
  - Hyperreflexia
- Clonus
- Babinski sign

Positive Babinski sign
(following lesions to the pyramidal tract)

Thought to reflect a flexor withdrawal reflex that is normally suppressed by the corticospinal tract

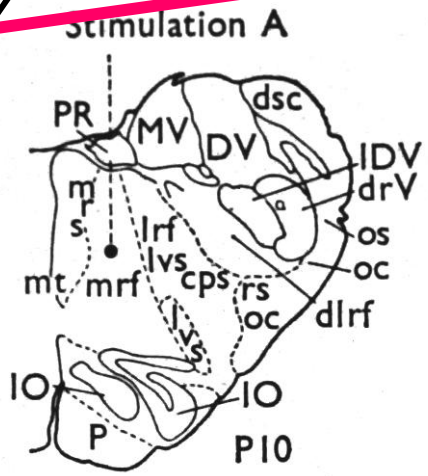
Normally under cortical inhibition

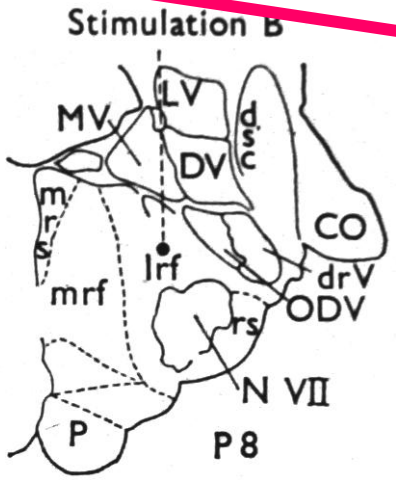
Medial reticular formation

Gamma motor neurons

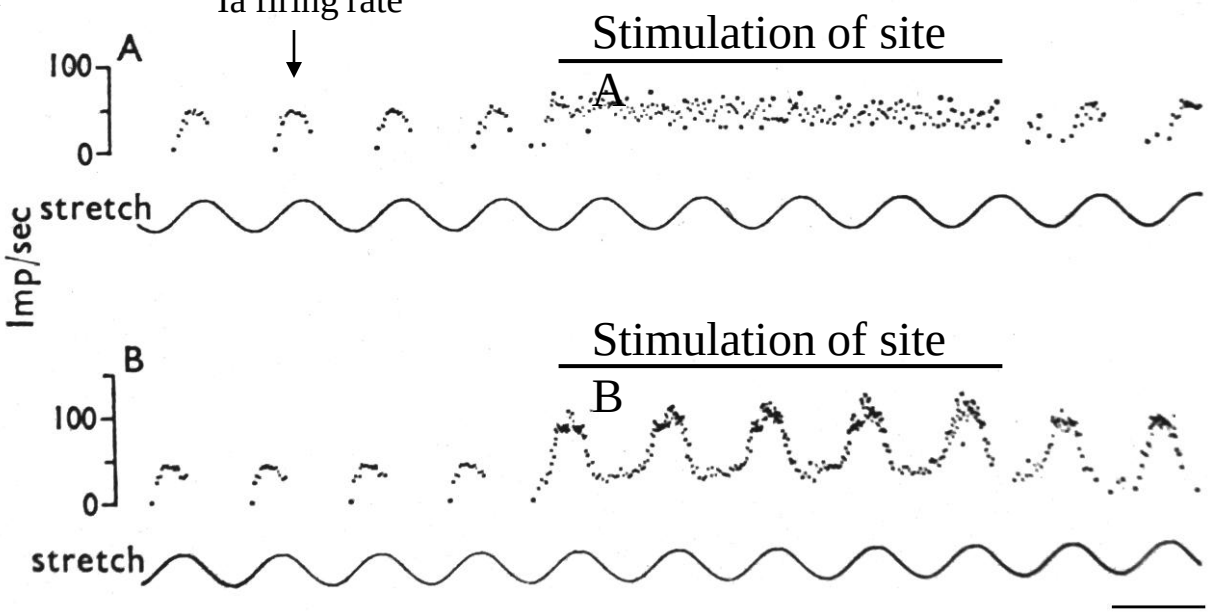
Lateral reticular formation

Gamma motor neurons





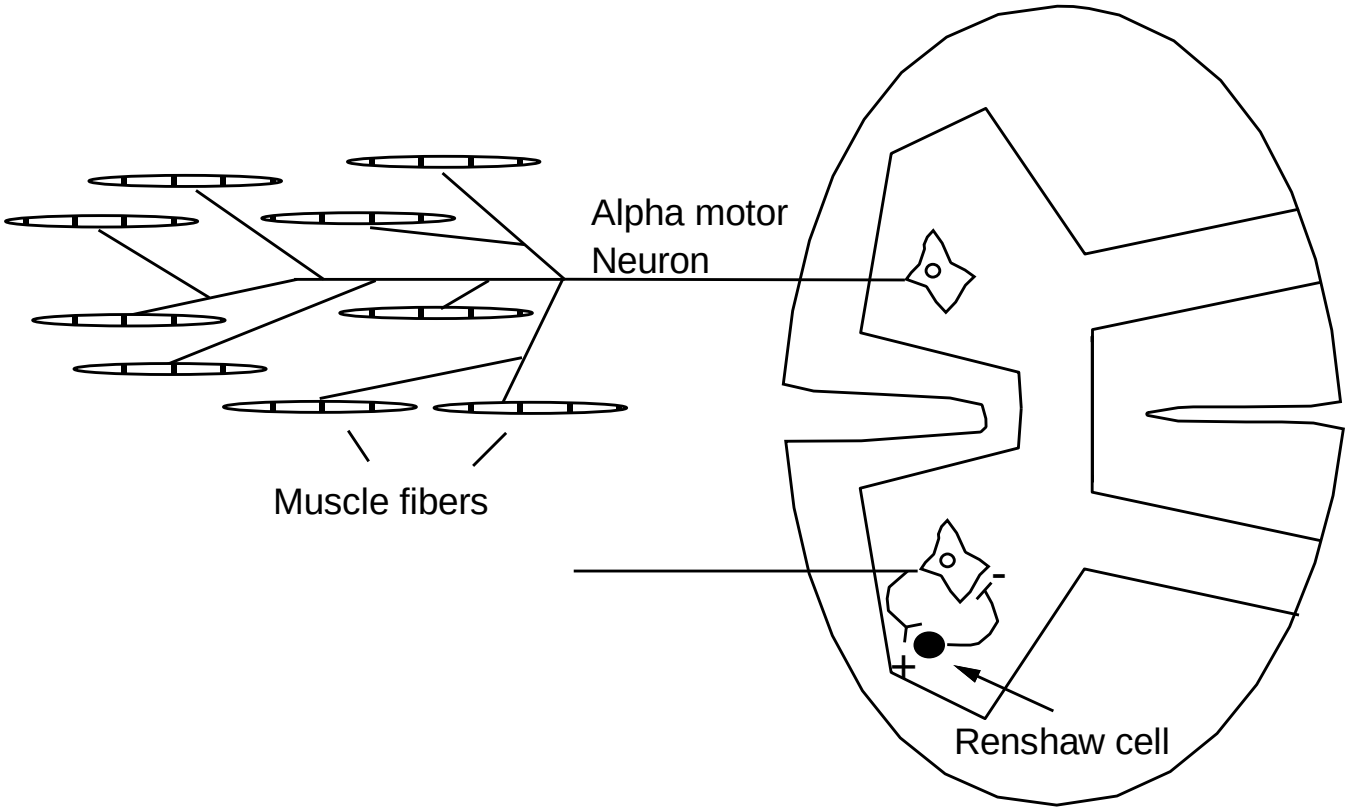
Ia firing rate



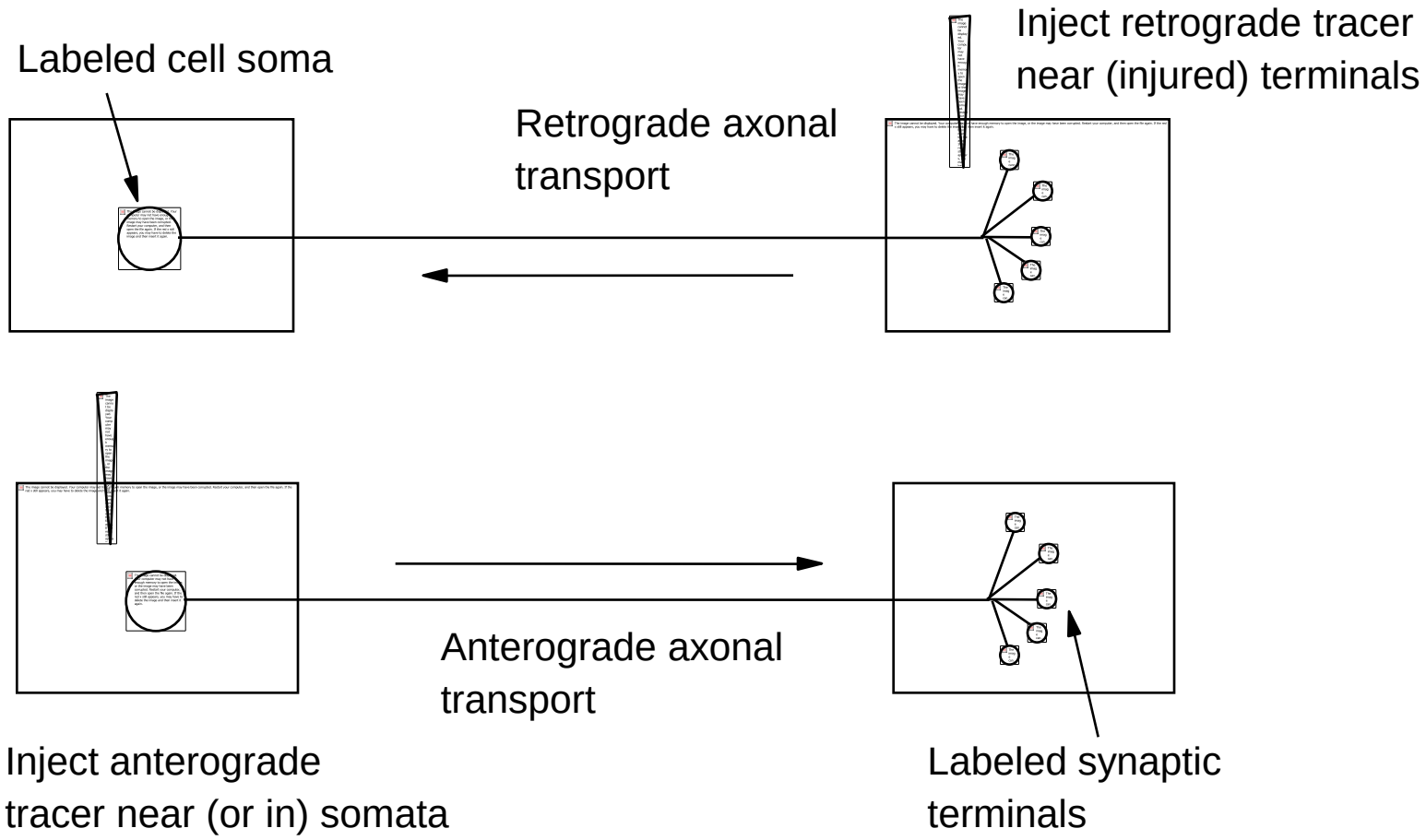
Clonus

Hyperreflexia due to increased excitability of α and/or γ MN

The Motor Unit

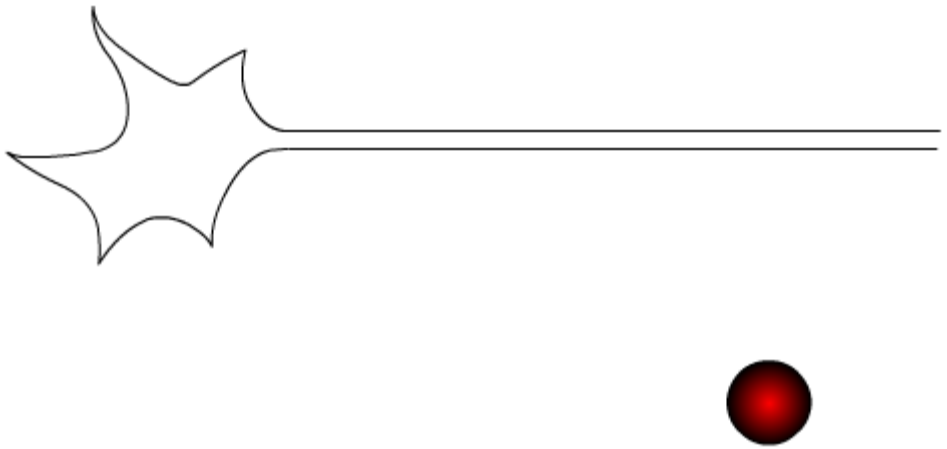


Tract Tracing With Chemical Tracers



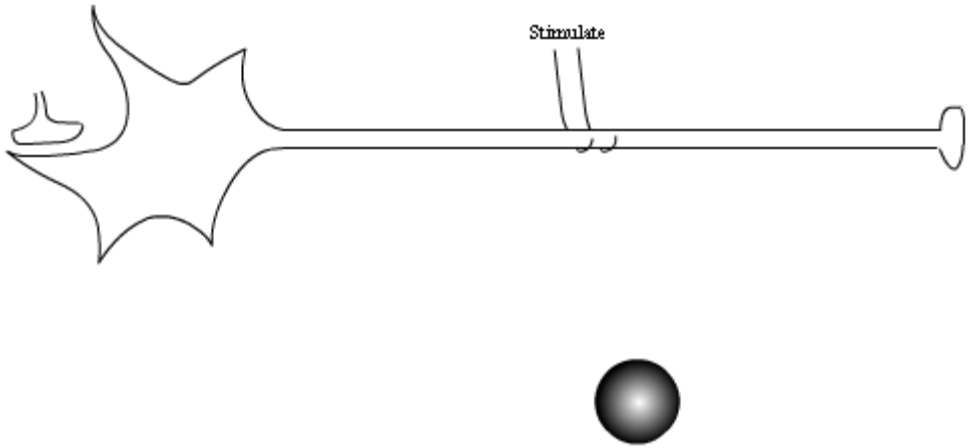
Horseradish peroxidase (and its enzymatic reaction products) travel in both the retrograde and anterograde directions

Electrophysiological Tract Tracing

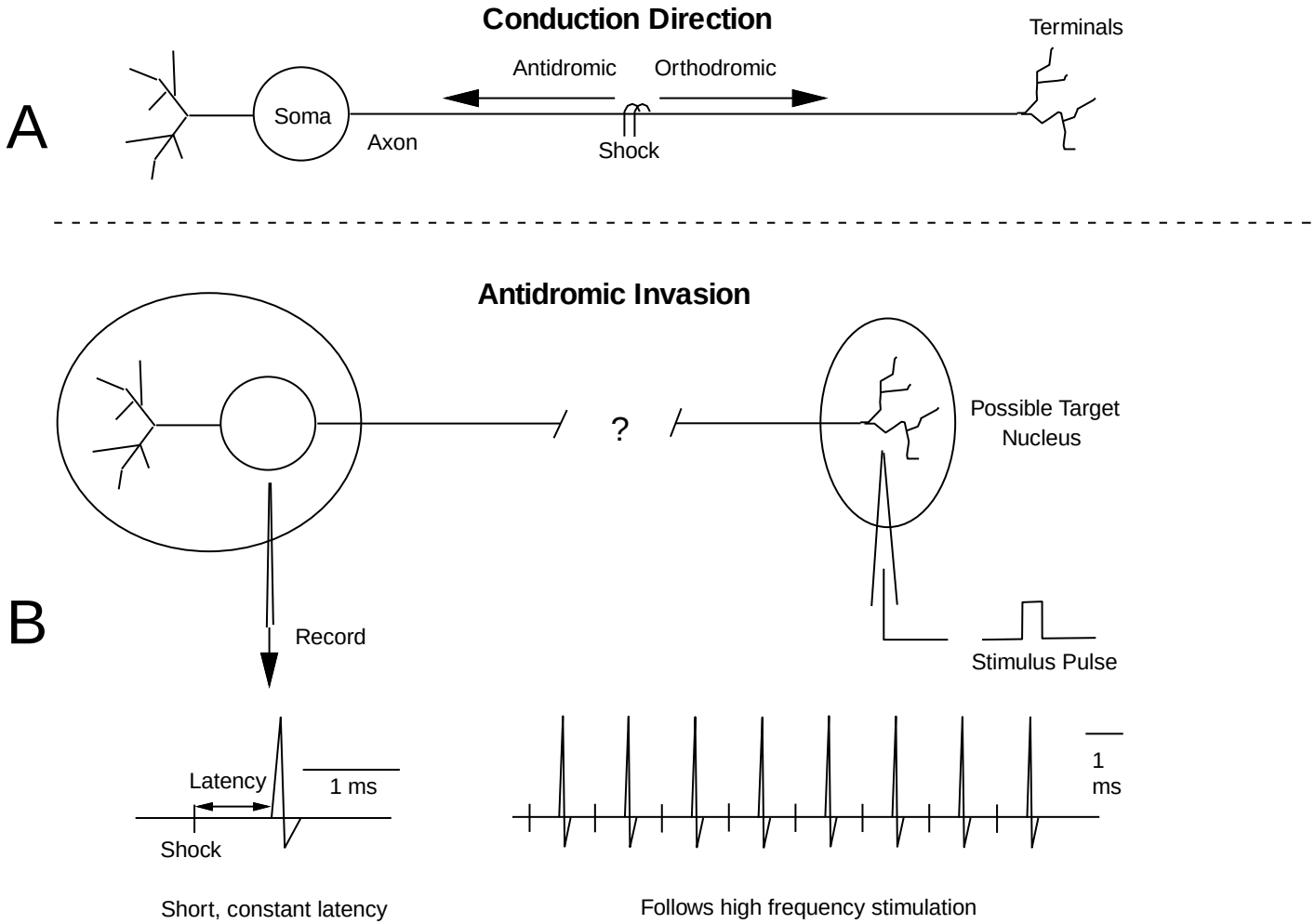


Orthodromic Conduction

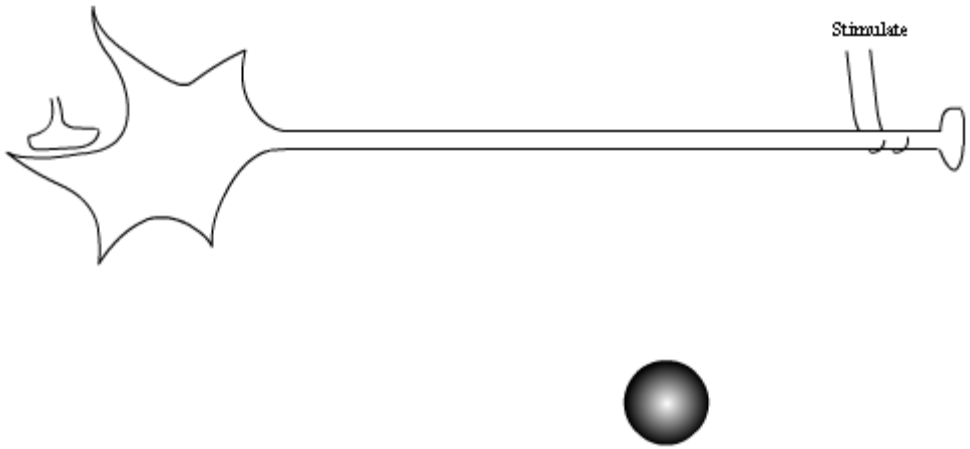
Antidromic and Orthodromic Spikes



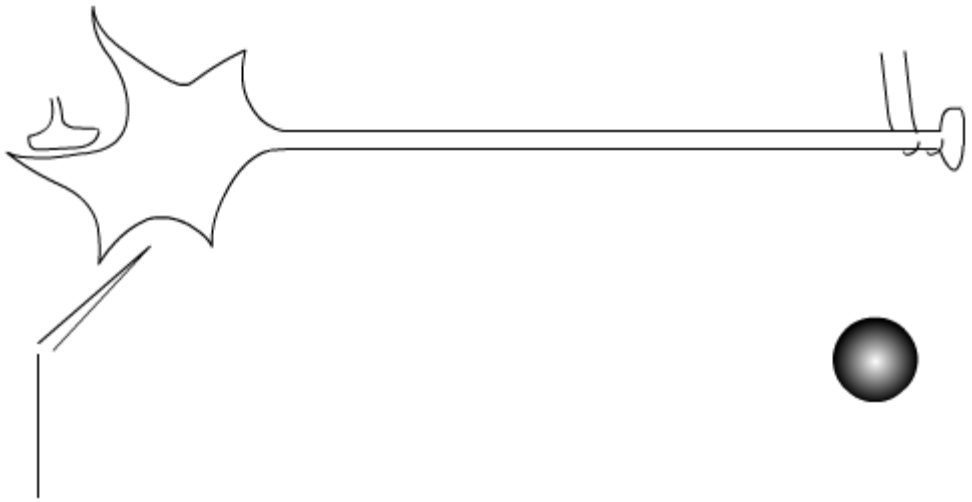
Tract Tracing by A/D Invasion



Collision

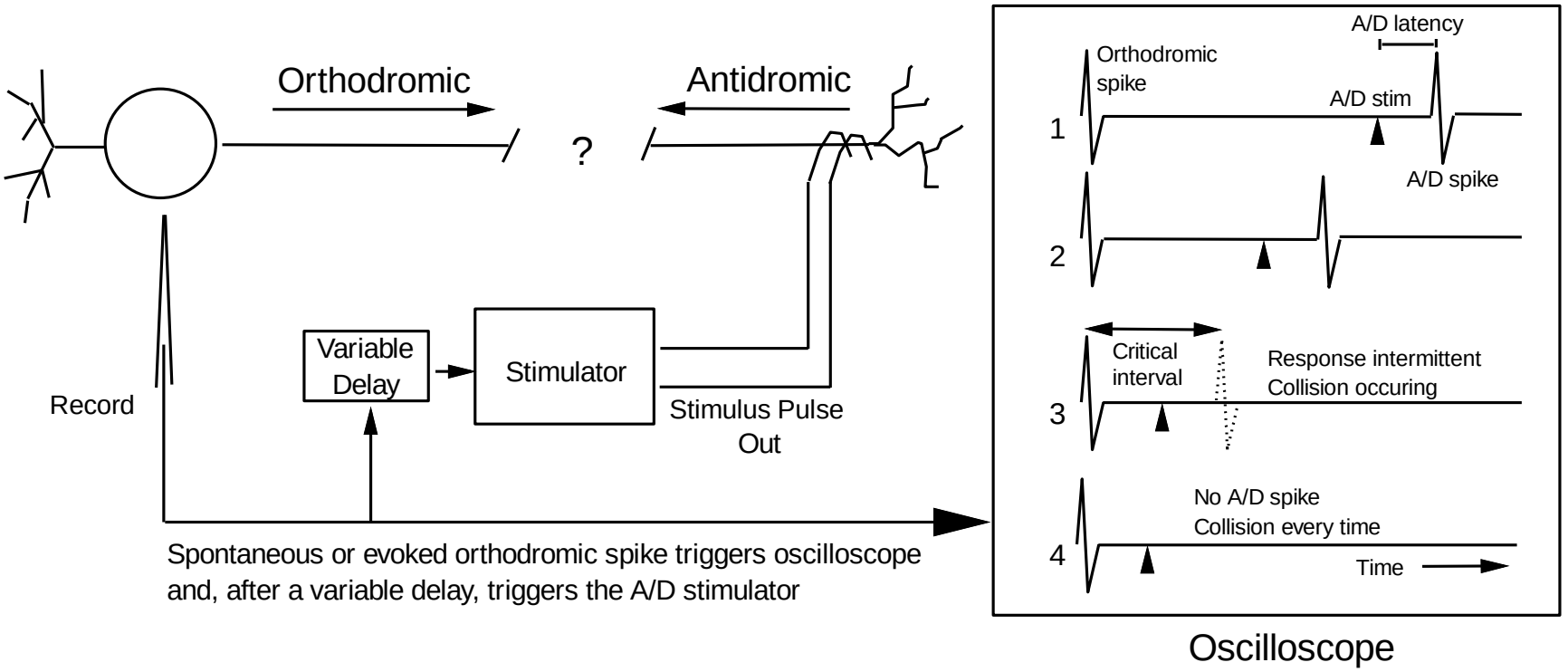


The Critical Interval Test

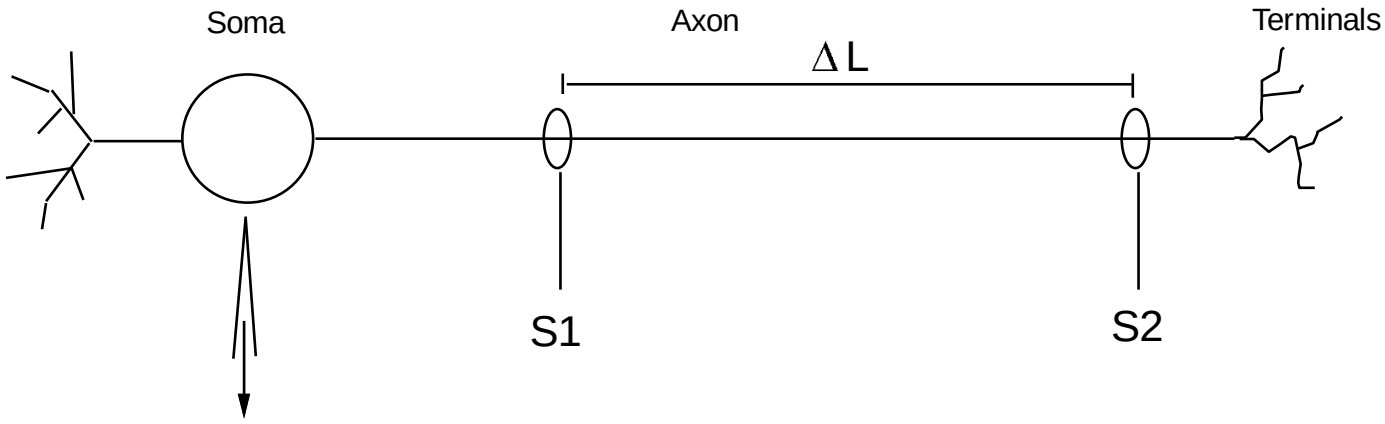


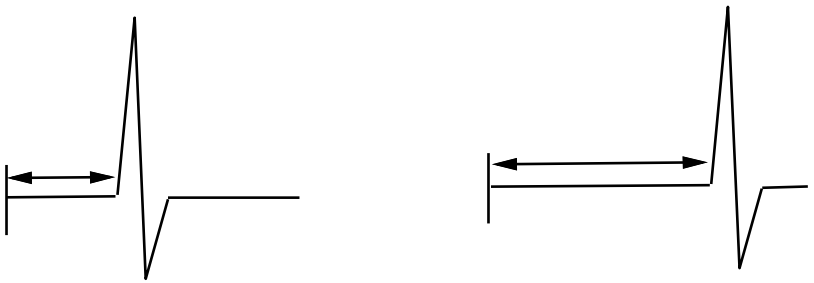
Oscilloscope Trace

Collision Test



Measurement of Conduction Velocity





A/D Latency 1

A/D Latency 2

ΔT = Lat. 2 - Lat. 1

Conduction Velocity = $\frac{\Delta L}{\Delta T}$