

# Motor System lectures!

## Part 1: Upper Motor Neurons

"All about me (UMN)"



Nickname: "The Conductor"



Address: Cortex and Brainstem

\*Confined to CNS\*

Professional Responsibilities



- Maintenance of muscle tone
- regulation of posture against gravity

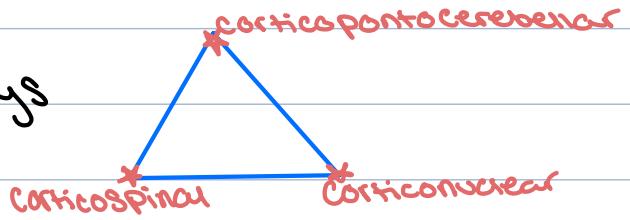


INITIATION  
of voluntary movement

2 Systems: Pyramidal vs Extrapyramidal

Pyramidal System

- 3 main pathways



Corticospinal tract

Efferent info to LMN innervating skel. musc

- Trunk, limbs, tail

Facilitates LMN contralateral flexors

Inhibits LMN contralateral extensors

\*Decussates in the pyramids

↳ dog/cat

"Thomas"

Lesions: Normal gait, contralat. post. rxn deficit

Corticuclear tract

Efferent info to CN LMN

CN III, IV, VI eye movement

CN V mastication

CN VII facial expression

CN XI neck movement

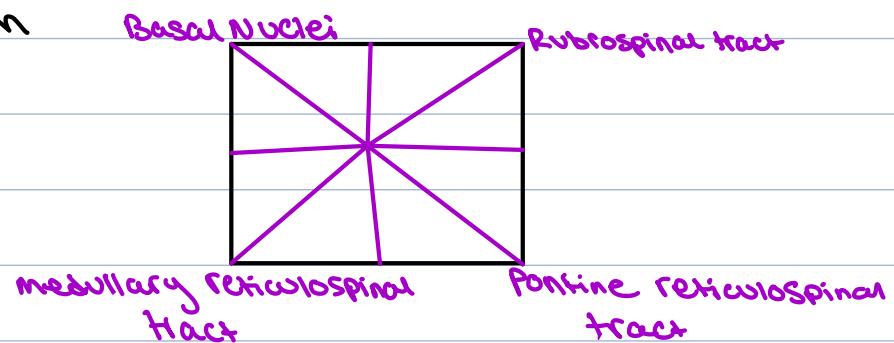
CN XII tongue movement

## Corticoponto~~cerebellar~~ tract

Feedback pathway: Info to cerebellum regarding planned movement  
\* cerebellum is always monitoring

## Extrapyramidal System

$$\text{Pyramid (3)} + \text{(1) extra} = \square$$



## Basal Nuclei

↳ Modulates motor activity through thalamus

3 main nuclei



## Direct pathway

↳ Allows execution of motor command

## Indirect pathway

↳ Prevents execution of motor command

Dysfunction → festination



## Substantia Nigra

Neurons release dopamine

activate D1 Dopamine receptors

NO thalamic inhibition

Enhanced thalamic excitation of cerebral motor cortex

## RubroSpinal Tract

↳ Input to **RED** nucleus from Cerebral cortex, basal nuclei, cerebellum

Facilitates LMN for limb flexor muscles (functionally similar to)  
Inhibits LMN for limb extensor muscles (Corticospinal tract)



bTO = Oliver Twist



Olivary Nucleus  
Olivocerebellar tract: To contralateral cerebellum

↓ "twist"

Lesions: Severe loss of coordination

## Reticulospinal Tracts (Yin + Yang)

### Pontine Reticulospinal Tract

Descends ipsilateral ventral funiculus

Facilitates: LMNs limb extensor mus.

Inhibits: LMNs limb flexor muscles

Net function: facilitate extensor mus.



### Medullary Reticulospinal Tract

Descends ipsilaterally lateral funiculus

Facilitates: LMN for limb flexion mus.

Inhibits: LMN for limb extension mus.

Net function: facilitation of flexor muscles

## Vestibulospinal Tract

Medial



VS

Lateral

Facilitates: Accessory + cervical spinal LMN

Neck + Shoulders

\* Maintain head position

Facilitates: Cervical, thoracic, lumbar spinal LMN

Trunk + Limbs

\* Stabilize body posture

## Tectospinal Tract

Visual + auditory stimulus evokes

head turn towards stimulus

Facilitates: LMN for Cervical extensor muscles

\* decussates in midbrain



Clinical Signs of UMN disease

Excessive extensor tone!

↑ resistance to passive manipulation

Paresis ↓ voluntary movement

Delayed or absent protraction

- hyperreflexia PTR

- Opisthotonus

- crossed extensor reflex in lat rec.

- coma

- Release phenomenon: LMN of extensor musc.

released from inhibition



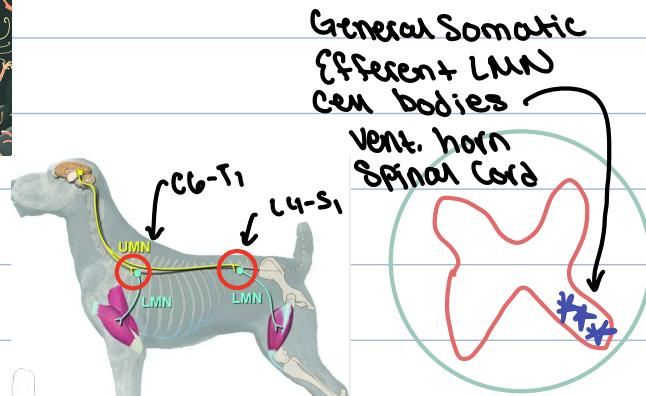
## Part a: Lower Motor Neurons

"All about me (LMN)"



Nickname: "The Orchestra"

Address: Cervical and lumbar intumescence



Professional Responsibilities

Efferent neuron of PNS

Connects the CNS to the muscle to be innervated

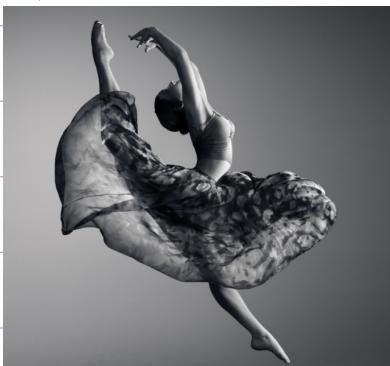


## Motor Unit

- ↳ Single motor neuron and all the muscle fibers it innervates
- Motor endplate, & motor neuron, Skeletal muscle fiber
- ↳ Myofiber gets input from 1 motor neuron

Vary in size based on function

### Small motor unit



↳ lots of precision

little force  
(oculomotor nerve)

### Large motor unit



little precision  
lots of force  
(musculocutaneous nerve)

# Motor Unit Types

## SLOW

Contract: Slowly  
Generated force: Small  
fatigue: resistant

Aerobic Resp.

Mitochondria rich

Tonic - Provide tone

## Fast fatigue-resistant

Intermediate speed  
2x slow  
resistant

## Fast-fatigable

Quickly  
large

easily fatigued

Anaerobic Resp.

Mitochondria Poor

Phasic - Short bursts

## Alpha Motor Neuron



- movement + posture
- large heavily myelinated axons
- \*fast
- Supplies muscle w/ power

## Gamma Motor Neuron



Supplies sensitivity to Stretch

. facilitates stretch reflex

med. size heavily myelinated

slower than alpha

Innervates intrafusal myofibers

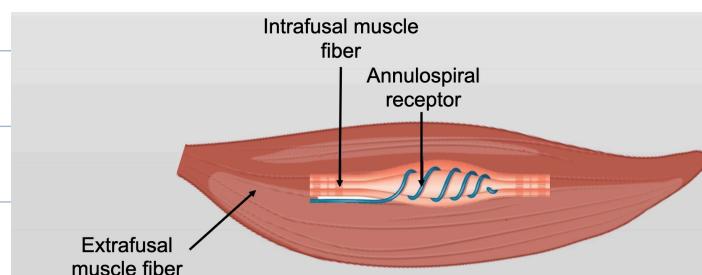
Innervates extrafusal myofibers

at motor endplate

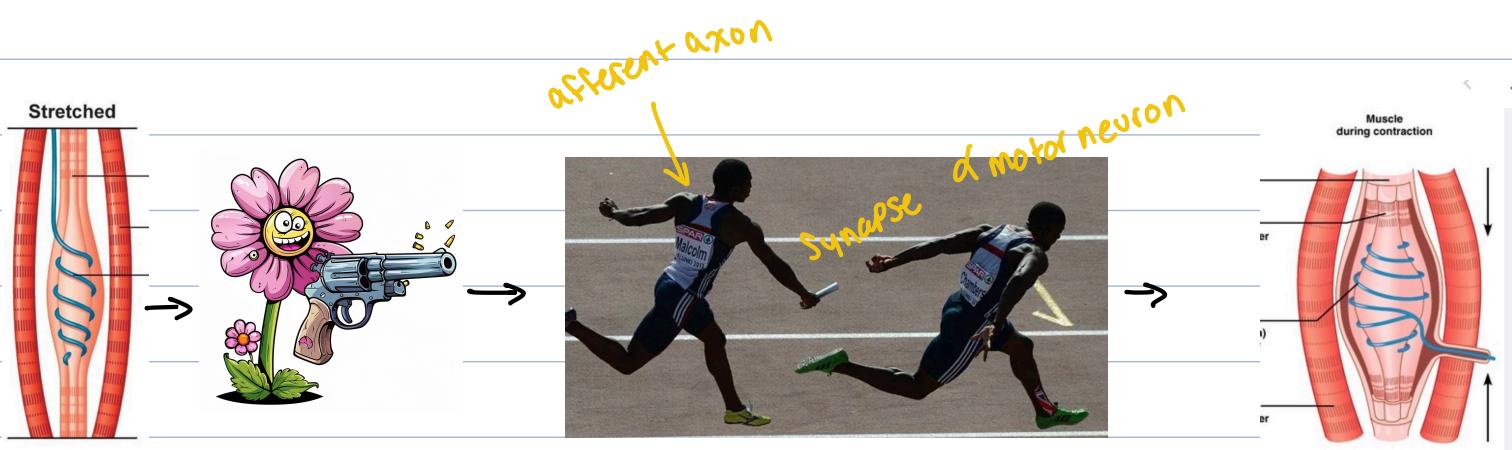
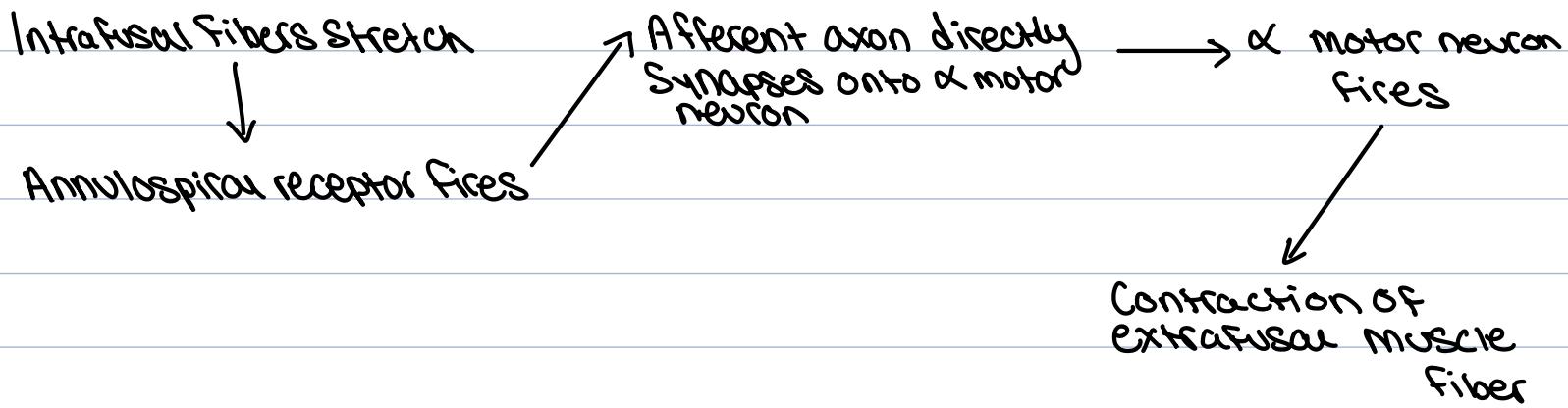
## Muscle Spindle

2 Parts: Intrafusal muscle fiber innervated by gamma motor neuron

Annulospiral receptor w/ afferent axon



# Passive Muscle Spindle Activation Patellar Reflex



Joint flexion = Intrafusal fiber stretch

\* key for body + head position

Gamma motor neurons are activated or inhibited by VNN to elicit movement

Rubrospinal and Pontine Reticulospinal tract facilitate gamma motor neurons

Medullary Reticulospinal tract INHIBITS gamma motor neurons

Activation in locomotion

Alpha-gamma co-activation: simultaneous VNN activation of alpha and gammas

Gamma bias - neuron activity set @ different levels for different behavior

Static vs dynamic

## TO Fire or NOT to Fire



## Clinically Assessing Spinal LMN "Neuro RAT"

Gait: LMN provide support and complete limb advancement

- look for weakness / short choppy gait

Mult.  
limbs - bunny hopping, difficulty raising

Single  
limb - lameness inability to support weight

+/- tremors standing



Reflexes ↓↓↓

Hypo to areflexia

Atrophy degeneration atrophy  
rapid (5-7 days)  
loss of axonal impulses

Tone flaccid muscle tone

