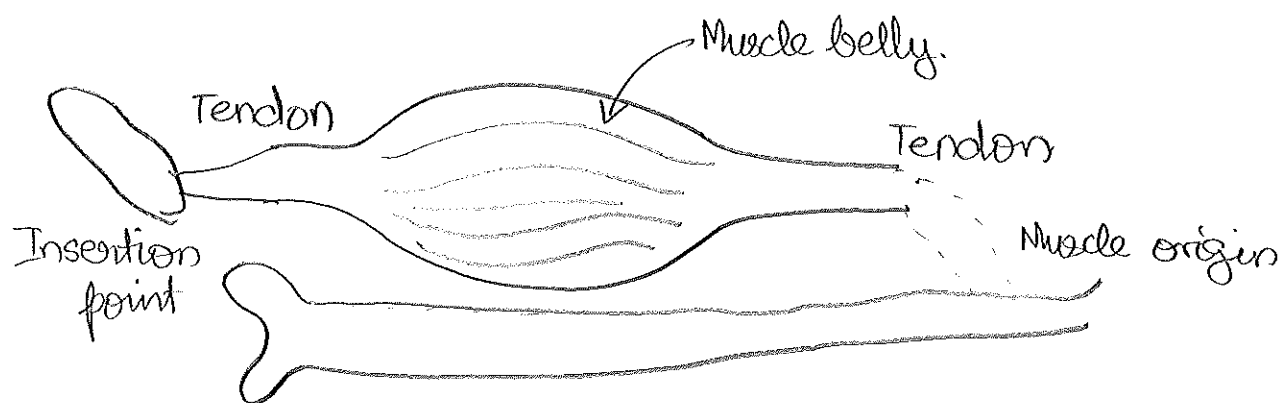


Lecture Notes 3

## Muscles and Sensors.



Muscles - move joints

- Stabilize "
- can only contract (shorten) w/ activation
- Require 2 muscles to move in +/- direction.

Antagonist muscles : opposing muscles (biceps/triceps)

Agonist " : muscles on same side

Extensor " : muscles that extend joints } Antagonist muscles.

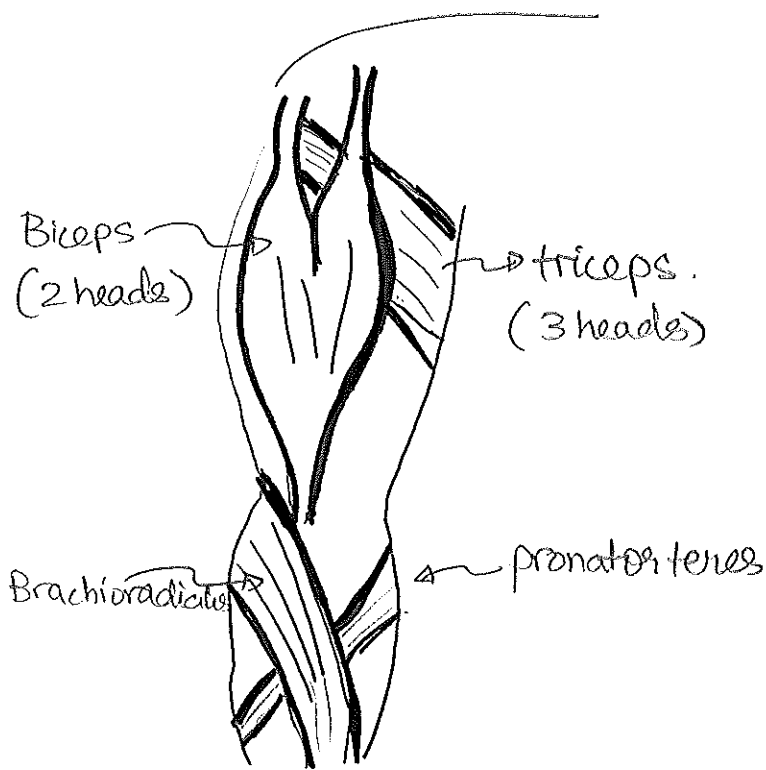
Flexor " : " " flex " }

Abductor " : " " move joints away from centerline

Adductor " : " " " " toward centerline

## Example: Elbow

(p2)



Agonist

Biceps + B.R  $\Rightarrow$  flexor.

Triceps  $\Rightarrow$  Extensor.


Pronator Teres  $\Rightarrow$  Adductor.

Biceps + Triceps  $\Rightarrow$  Antagonist.


Muscle belly  $\rightarrow$  Full of muscle fibers

- Fibers do not necessarily run  $\parallel$  to the axis

  
Parallel

  
Unipennate  
Tendon

  
Bipennate  
(Chicken Strip)

  
Multipennate

Pennate muscles typically are more powerful than  $\parallel$  muscles of same weight (more fibers work together in  $\parallel$ )

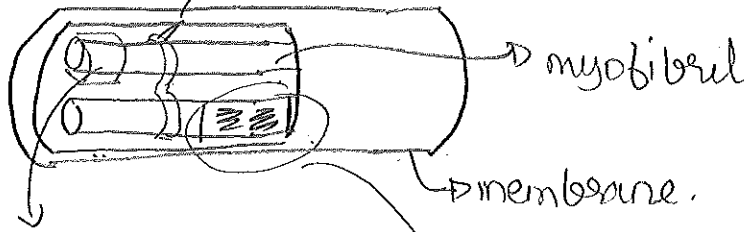
But shorter moving distance + slower velocity

# Muscle Fibers

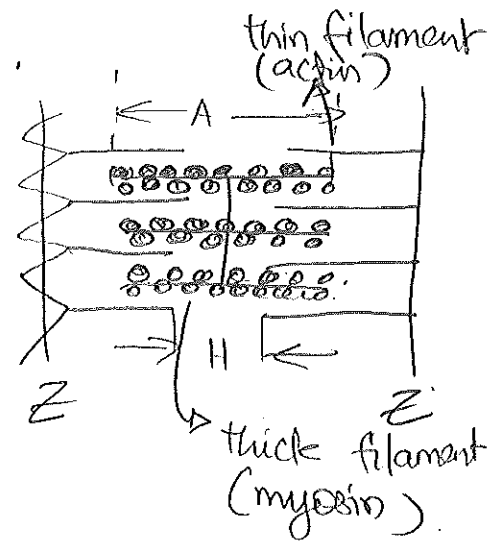
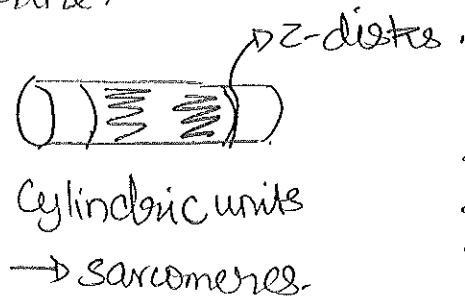
(p3)



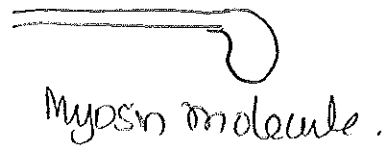
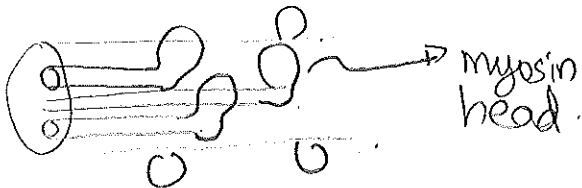
Transverse tubules (T-tubule) - distributes the nerve signal to the entire myofibril



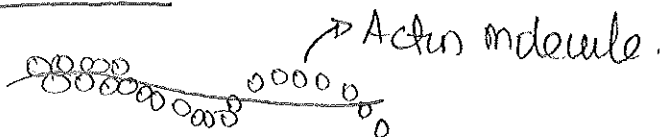
Sarcoplasmic reticulum contains  $Ca^{2+}$  ions necessary for muscle contraction



## Myosin filament (n 250 myosin molecules)

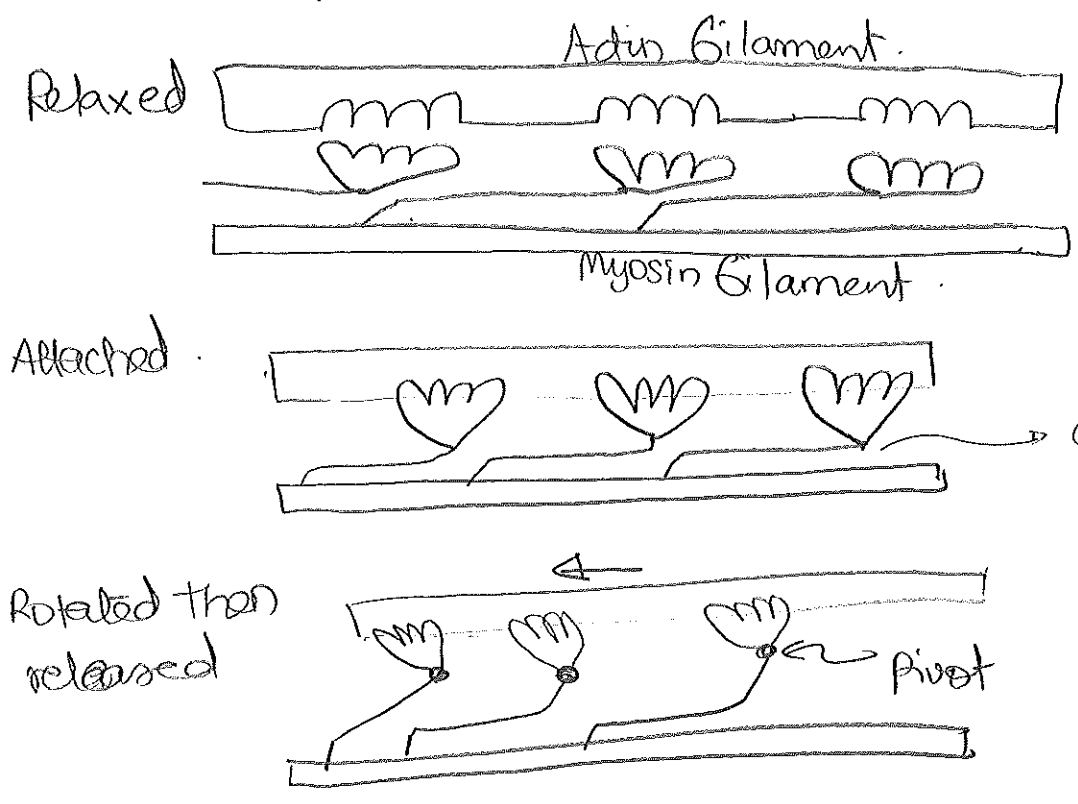


## Actin filament



# Sliding Filament theory.

{ Hugh Huxley : U Camb  
 { Andrew Huxley : U College London  
 Not related!



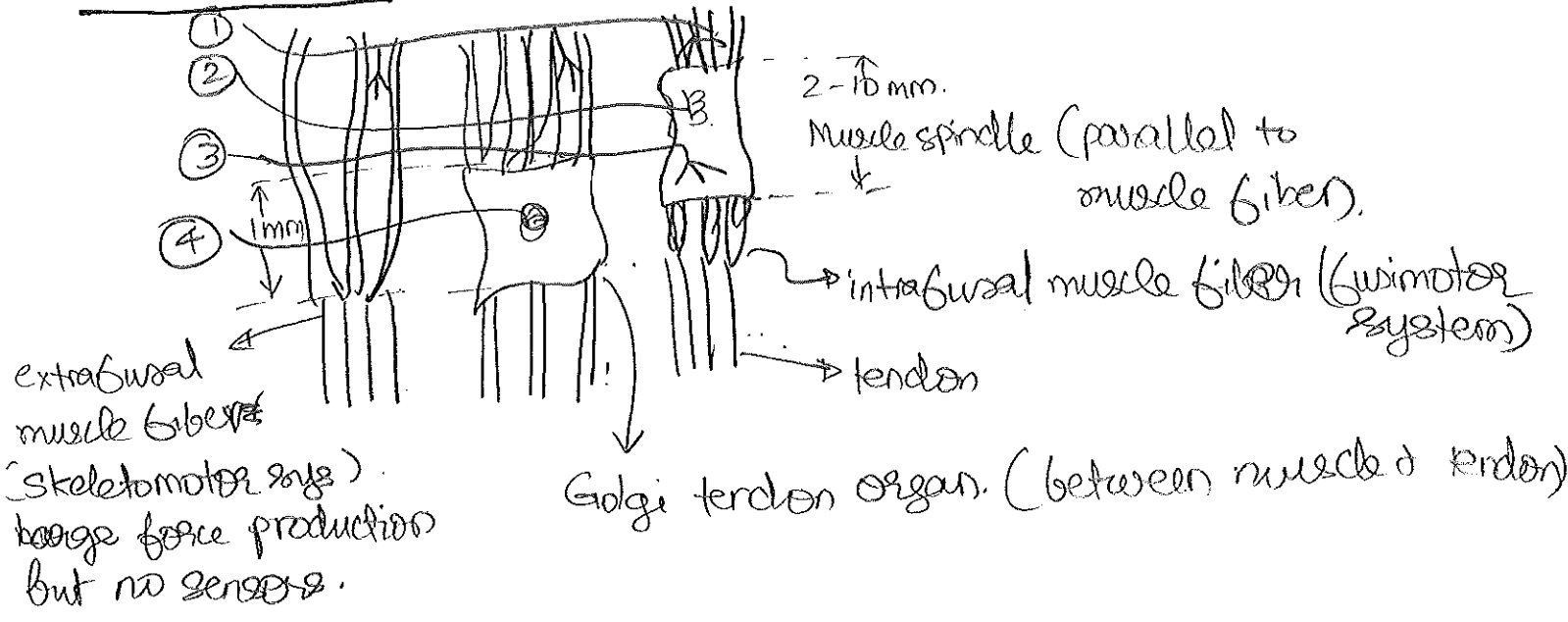
↓ Muscle depolarization by nerve signals  
 ↓ conducts thru T-tubules

cross bridge link.

Ca<sup>2+</sup> released from Sarcoplasmic reticulum into the intracellular area  
 ↓  
 Ca<sup>2+</sup> goes back.

Important: fiber does not shrink but slides

## Muscle sensors (Proprioceptive sensors)



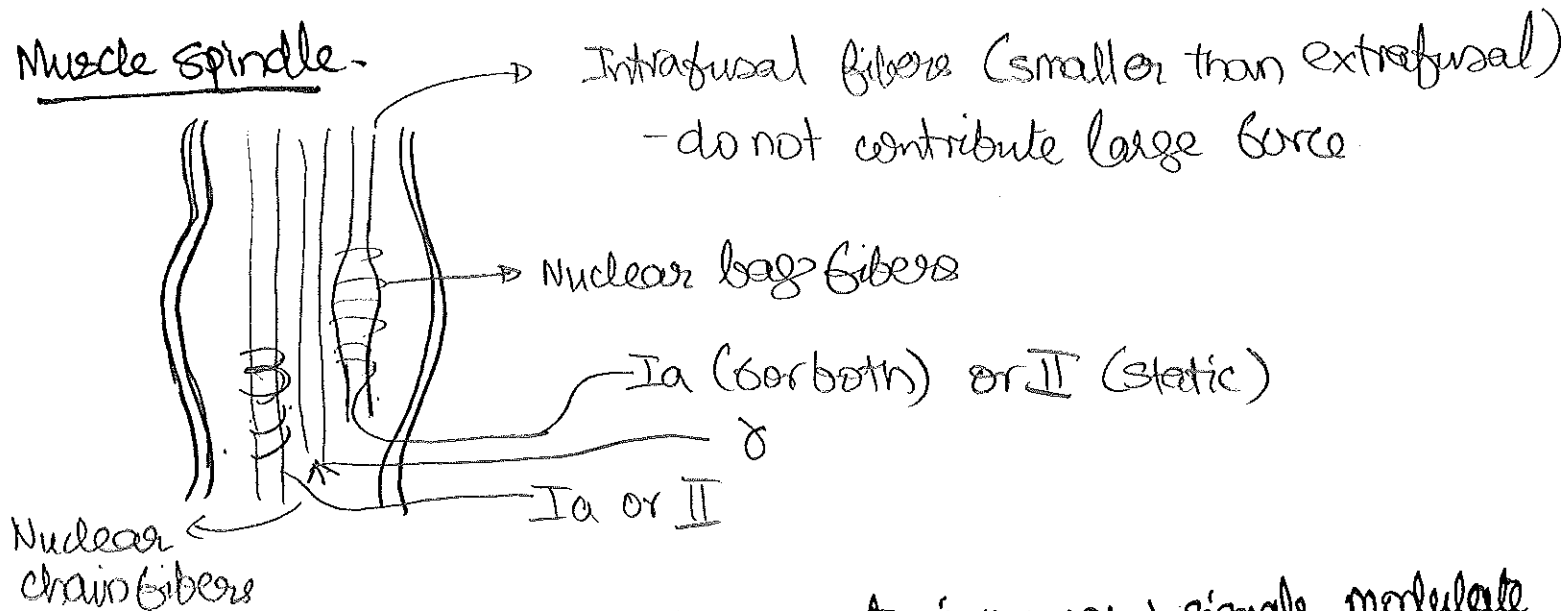
- ① Alpha ( $\alpha$ ) motor axon : effluent pathway to muscle fibers  
↳ central to peripheral.
- ② Spindle afferent pathways (Ia afferent axon  
Some II " " ) . ↳ detect stretch
- ③ " efferent " (Gamma  $\gamma$  axon). Gain can be controlled
- ④ Tendon organ afferent pathway (Ib afferent axon)

Ia > Ib > II

$\alpha > \gamma$

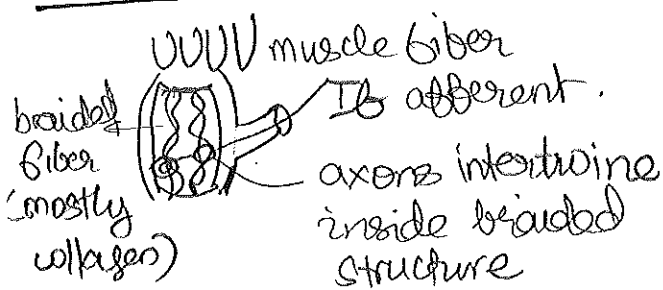
Larger axons conduct faster.

### Muscle spindle.



When stretched, nerve firing rate increases & signals modulate the discharge of spindle afferent.

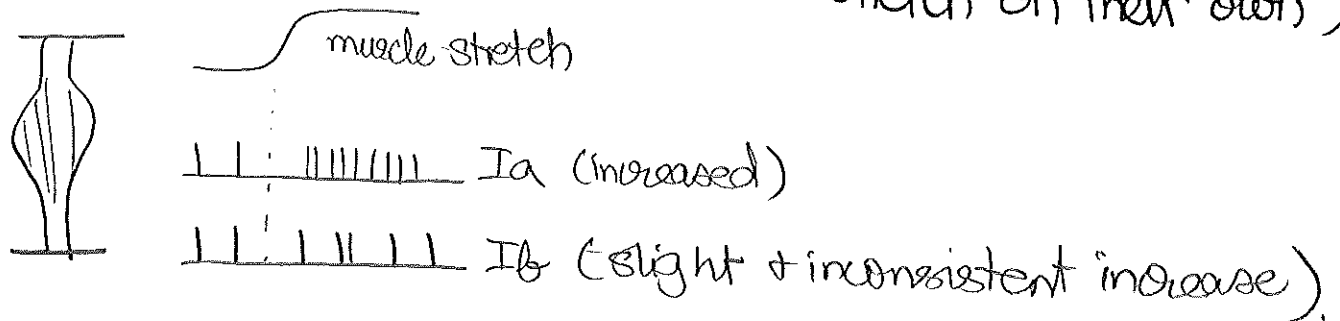
Golgi Tendon organ :- generally detect tension



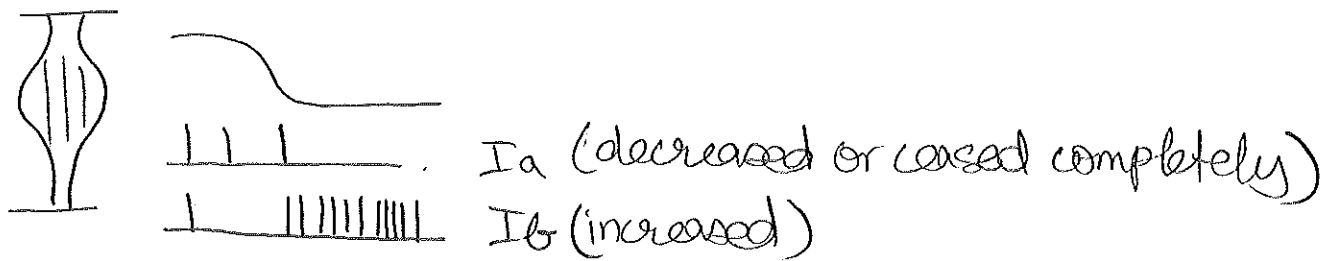
Compression of Ib axons caused them to fire.

# Functional differences between spindles & tendon organs

Muscles stretched by weight (remember muscles do not stretch on their own)



Muscle contracted (stimulating  $\alpha$  axon)



Why are they asymmetric?

- When passively stretched, softer muscle fibers stretch more than harder tendon (stretches intrafusal fibers but not too much braided fibers)
- When muscle fibers themselves contract, the braided fibers do get tense & are stretched.

Why golgi tendon important?

- Maintain steady grip
- Compensate for fatigue

Sneak preview of reflex system.

