

# **Neuro-electrical Muscle Stimulation**



TEXTBOOK OF

# Medical Physiology

ELEVENTH EDITION



GUYTON & HALL

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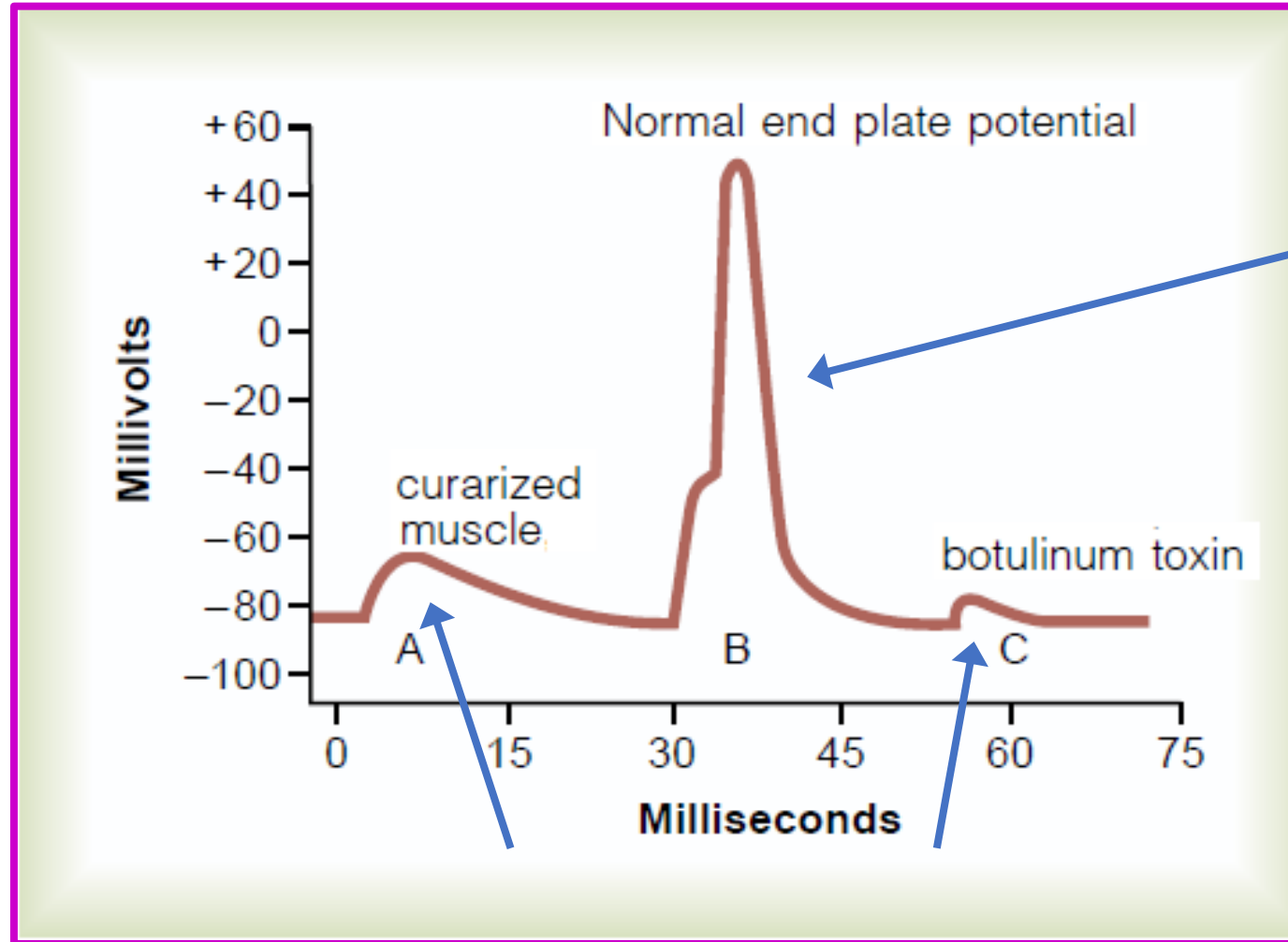
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**Recap:** Only End-plate Potential having normal amplitude (+60 mV) contracts a Muscle



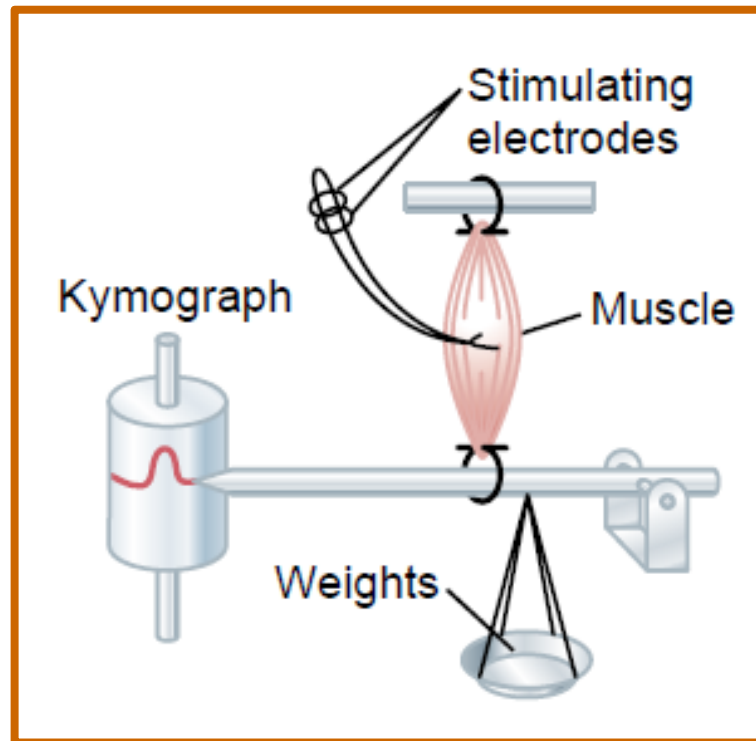
**Muscle Contracts**

**No Muscle Contraction**

## 2 types of Muscular activity

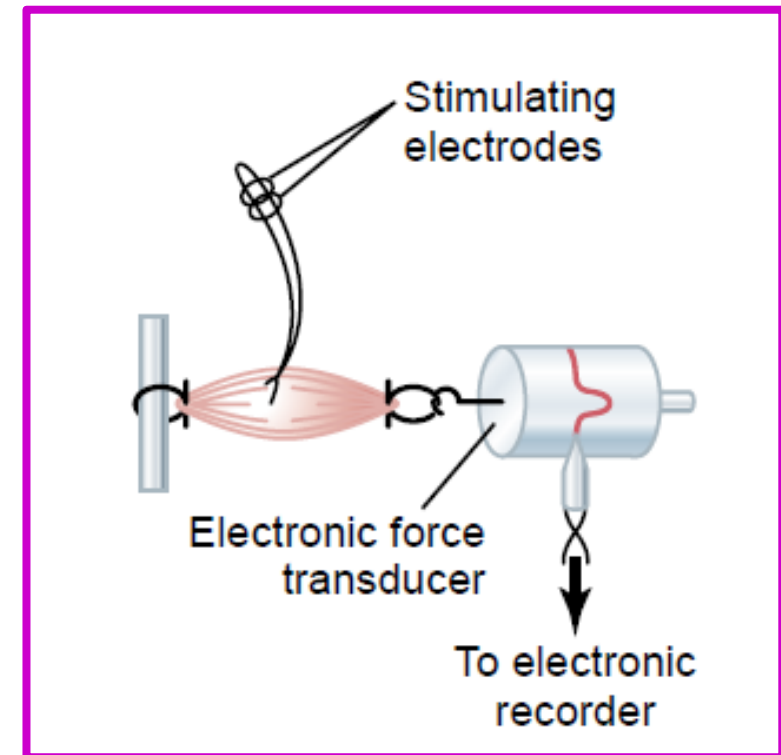
### Isotonic Activity

**Isotonic:** Muscle pulls with constant force (tone)



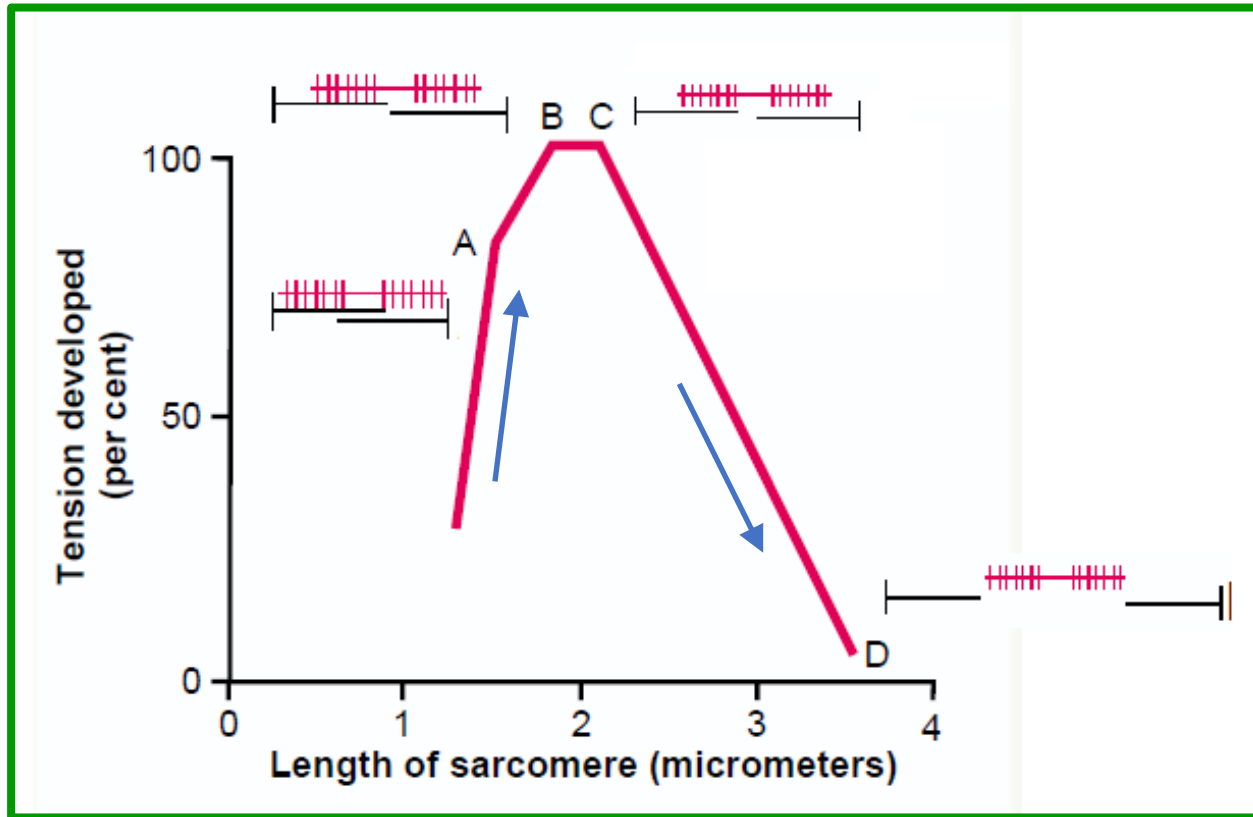
### Isometric Activity

**Isometric:** Muscle pulls with constant length (metric)



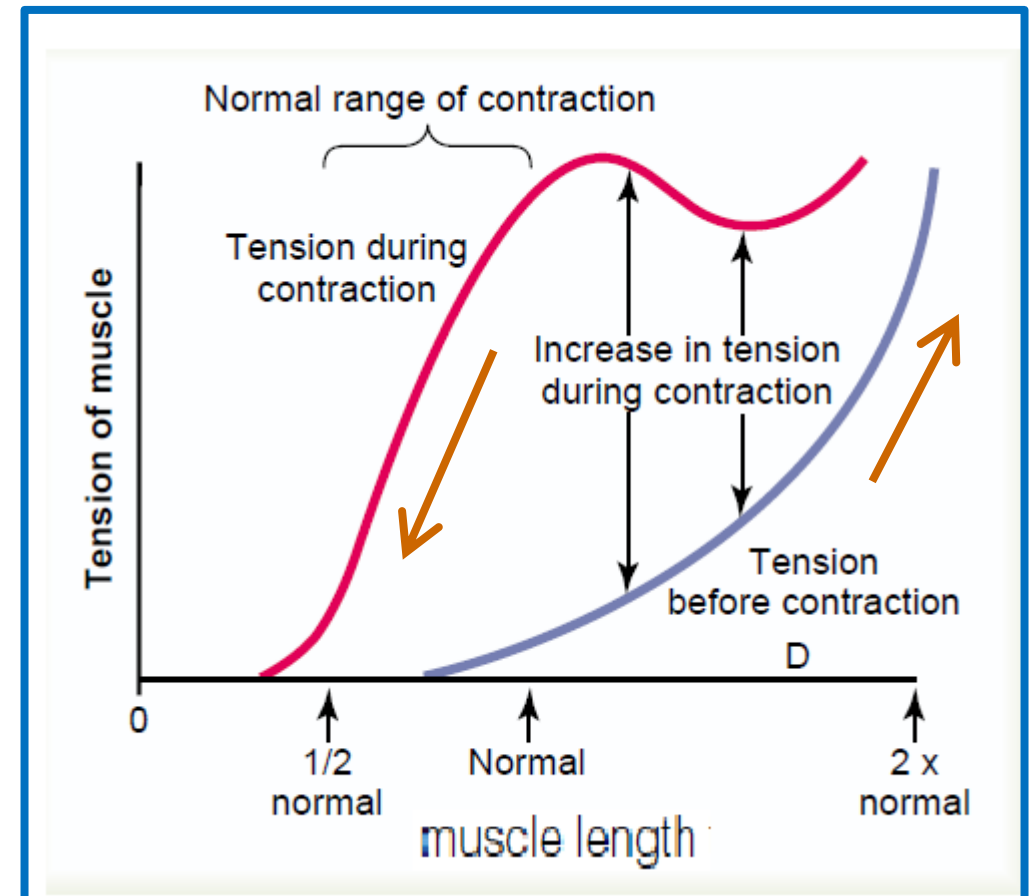
## Muscle Relaxation

← **Length - Tension Diagram : Optimality**



Expansion

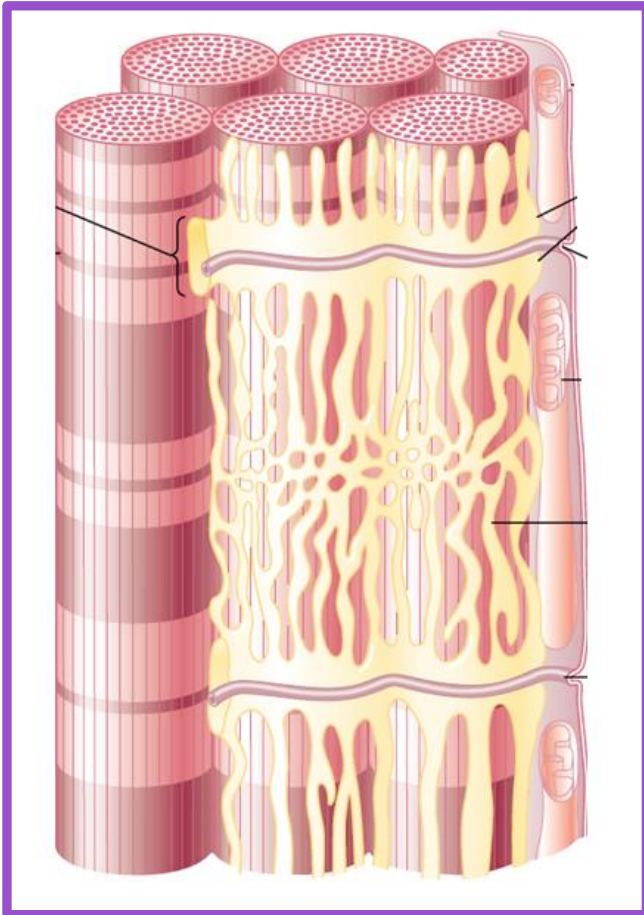
**Hysteresis-type Dynamics: Relax/Contract Cycle →**



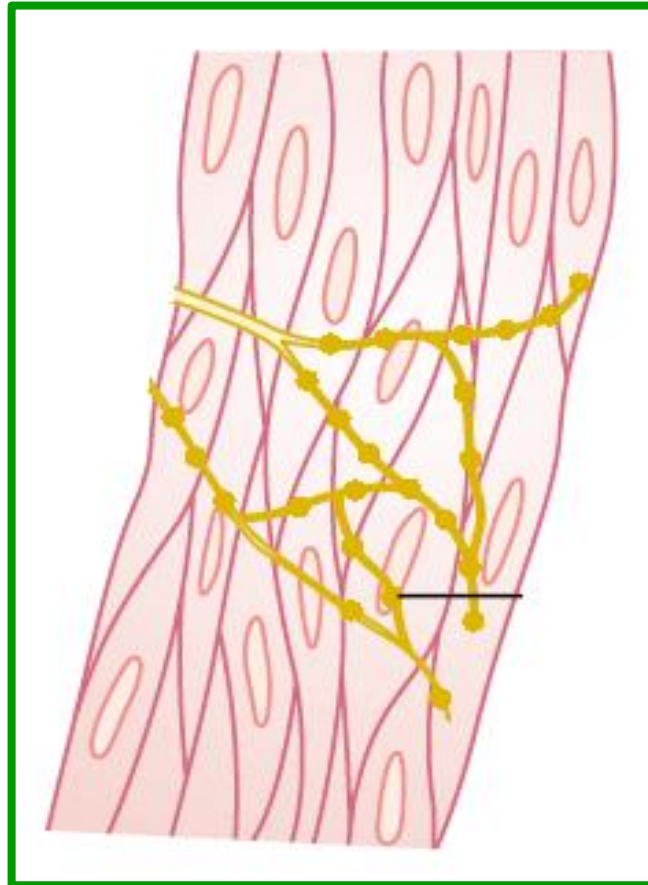


## Three Muscle Systems in Comparison

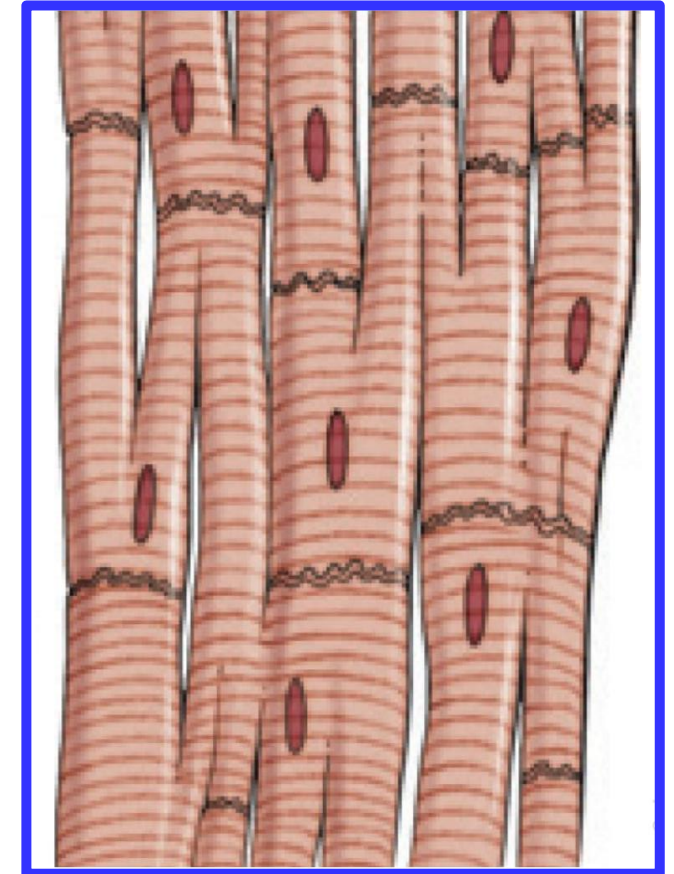
**Skeletal**



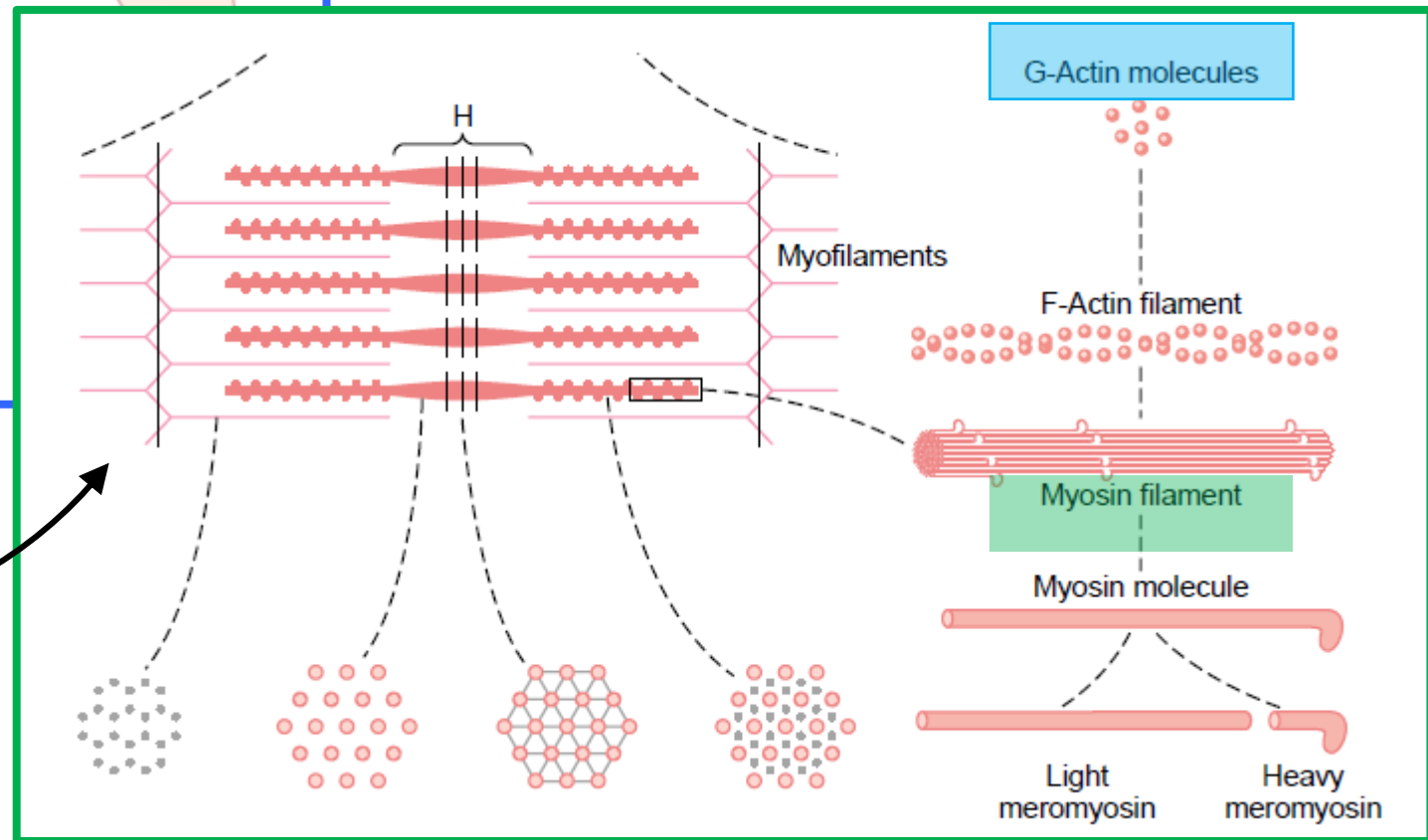
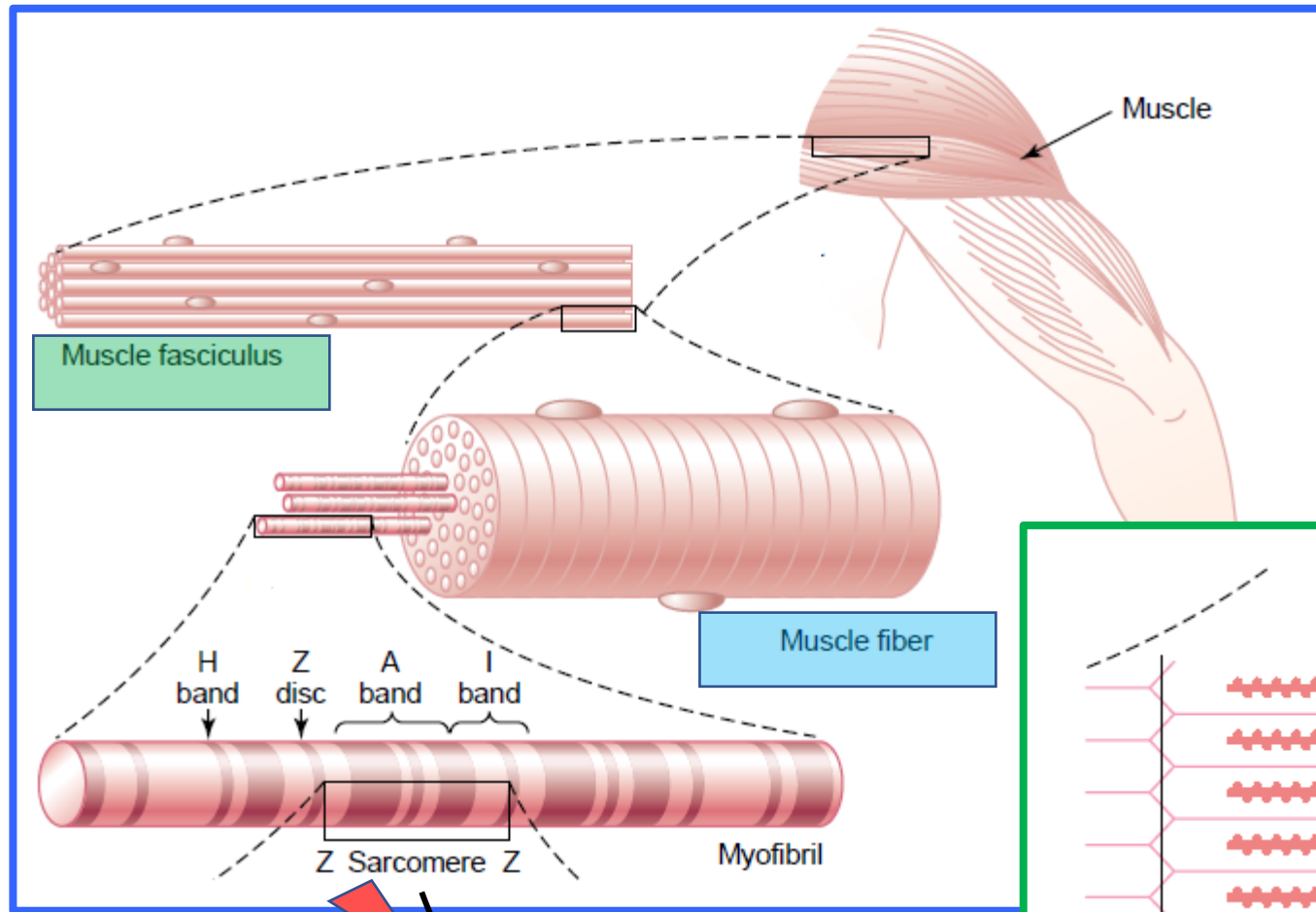
**Smooth (Organ-based)**



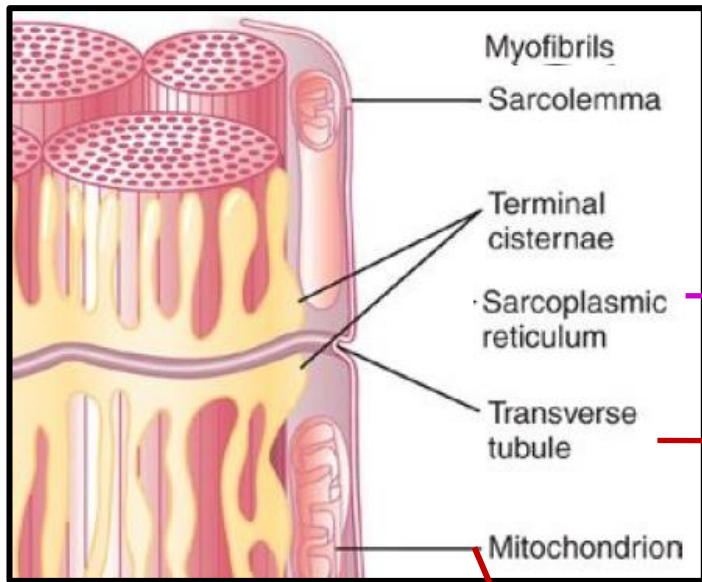
**Heart**



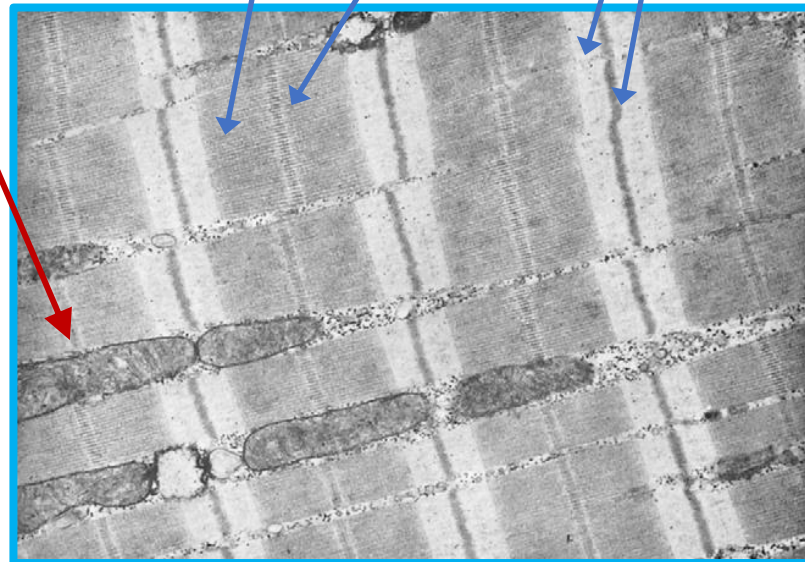
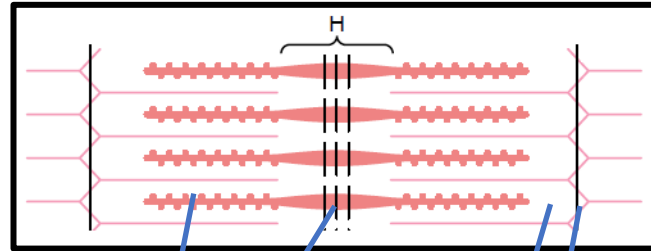
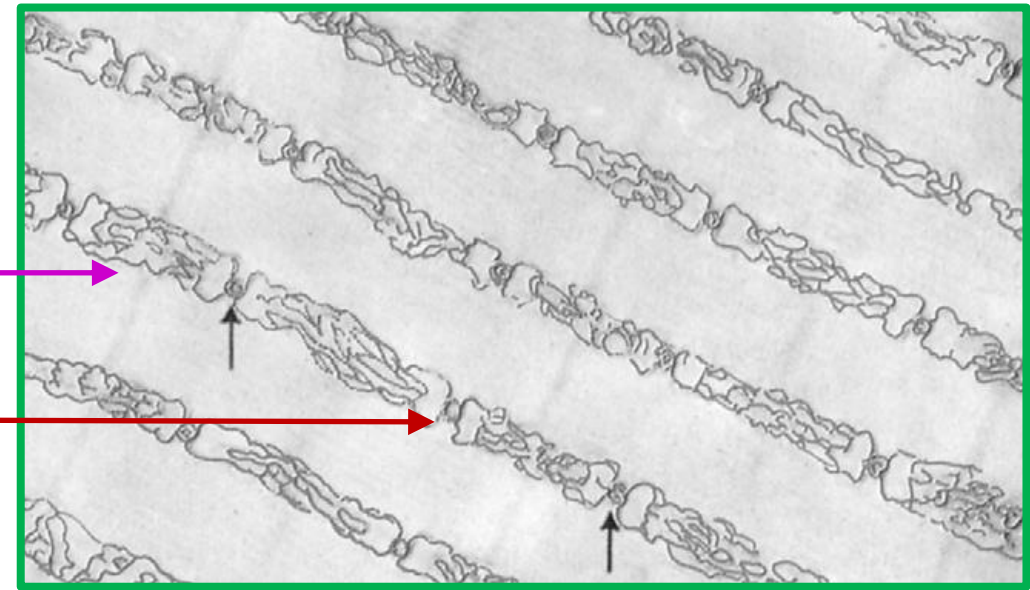
# Micro-organization of Skeletal Muscle







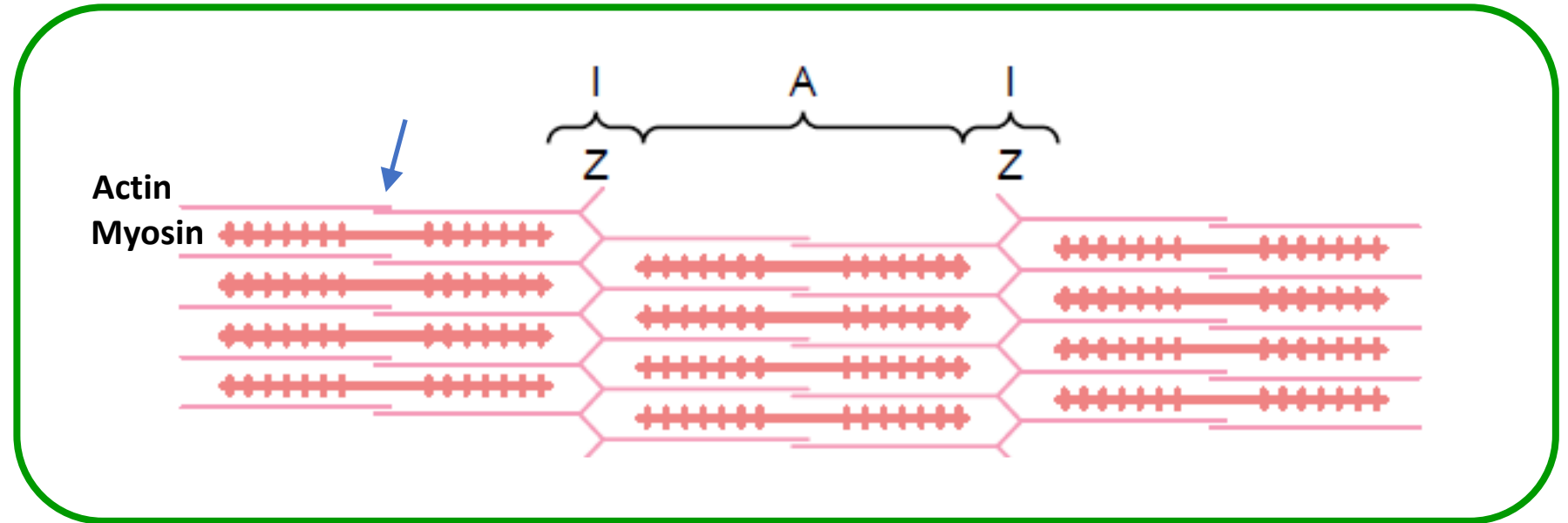
## Myofibril Structure



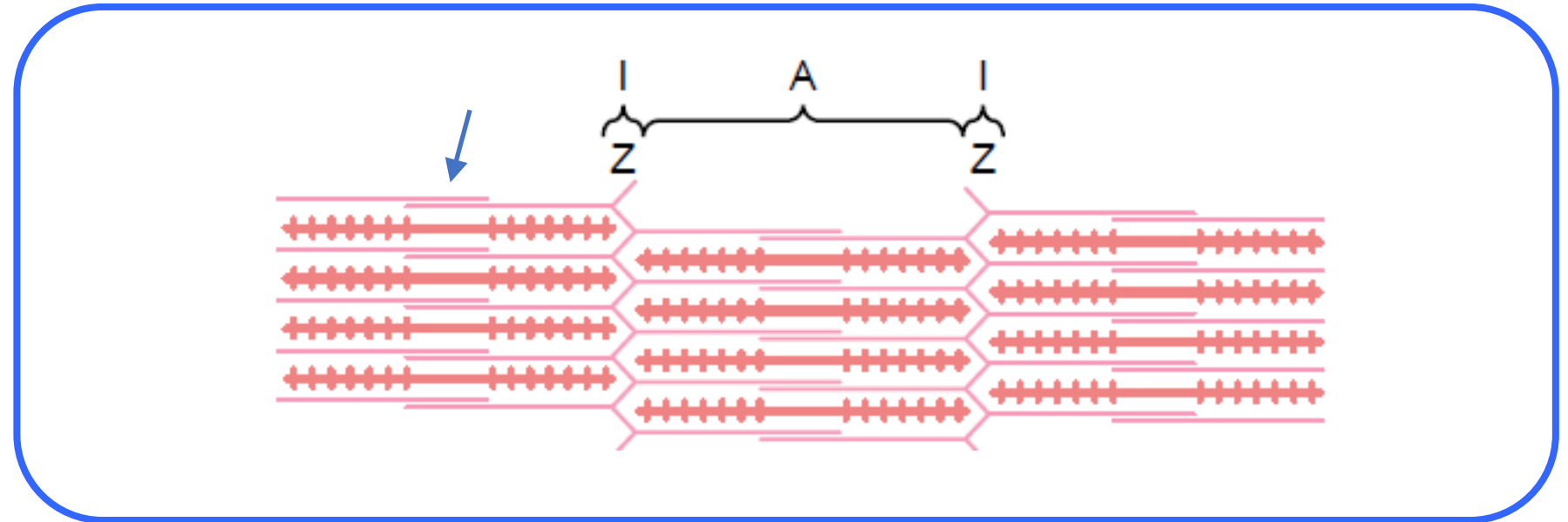
Electron  
Microscopy

# Myofibril Dynamics

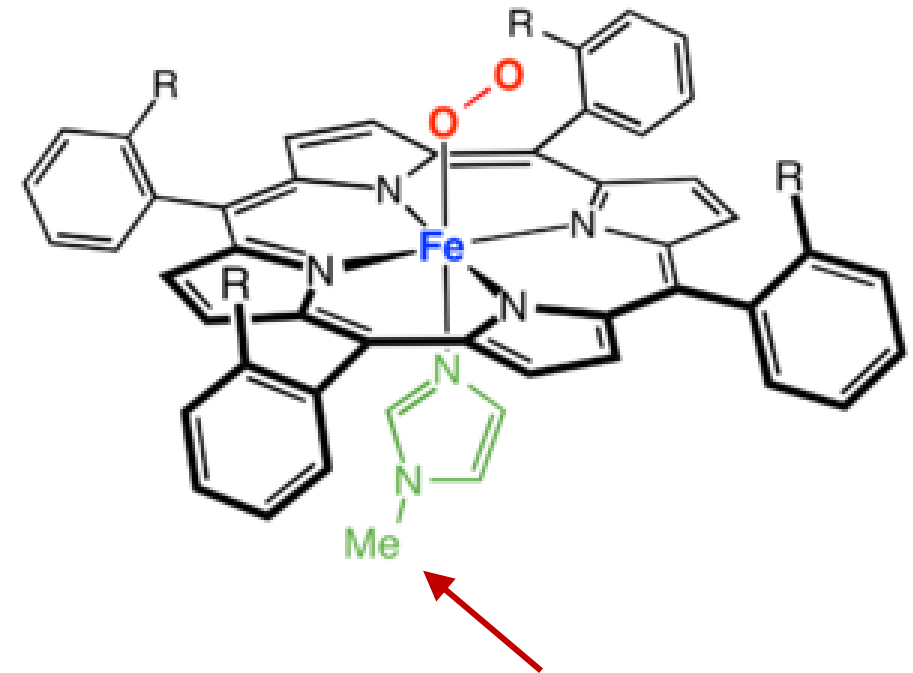
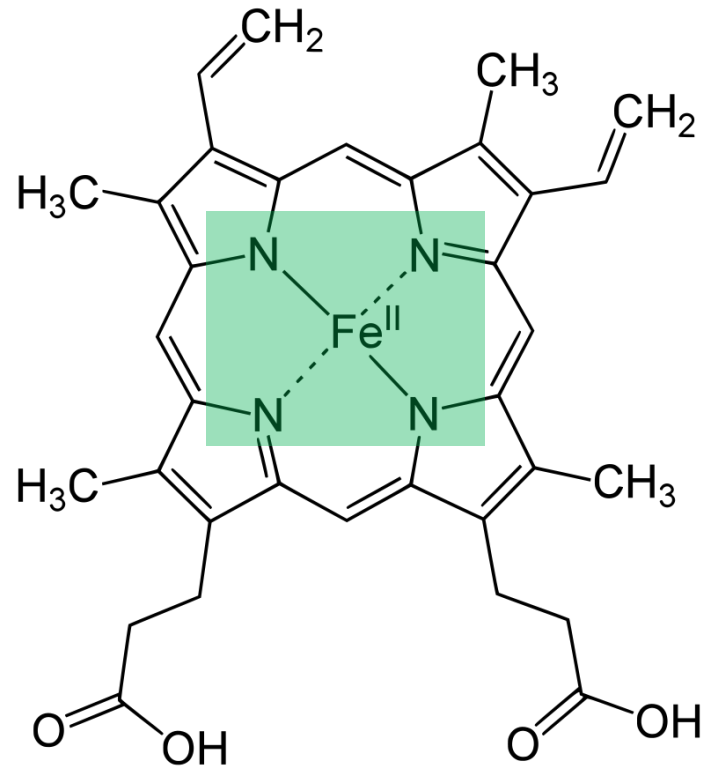
RELAXED



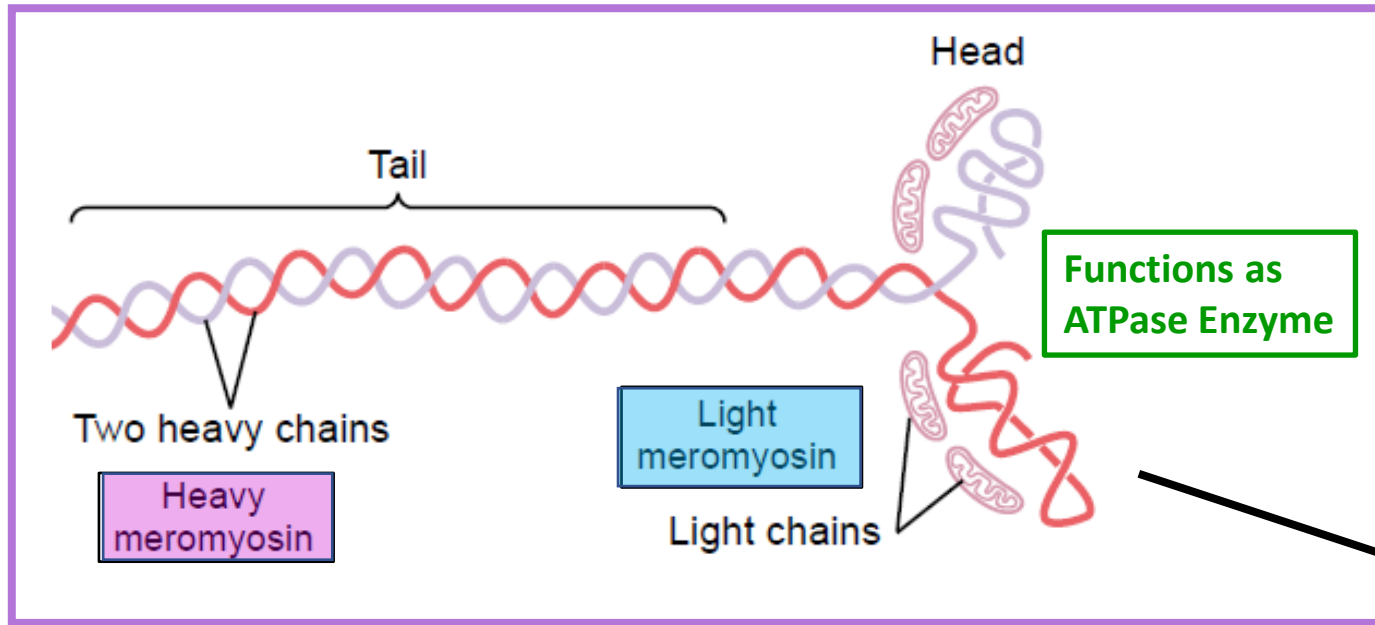
CONTRACTED



# Myosin



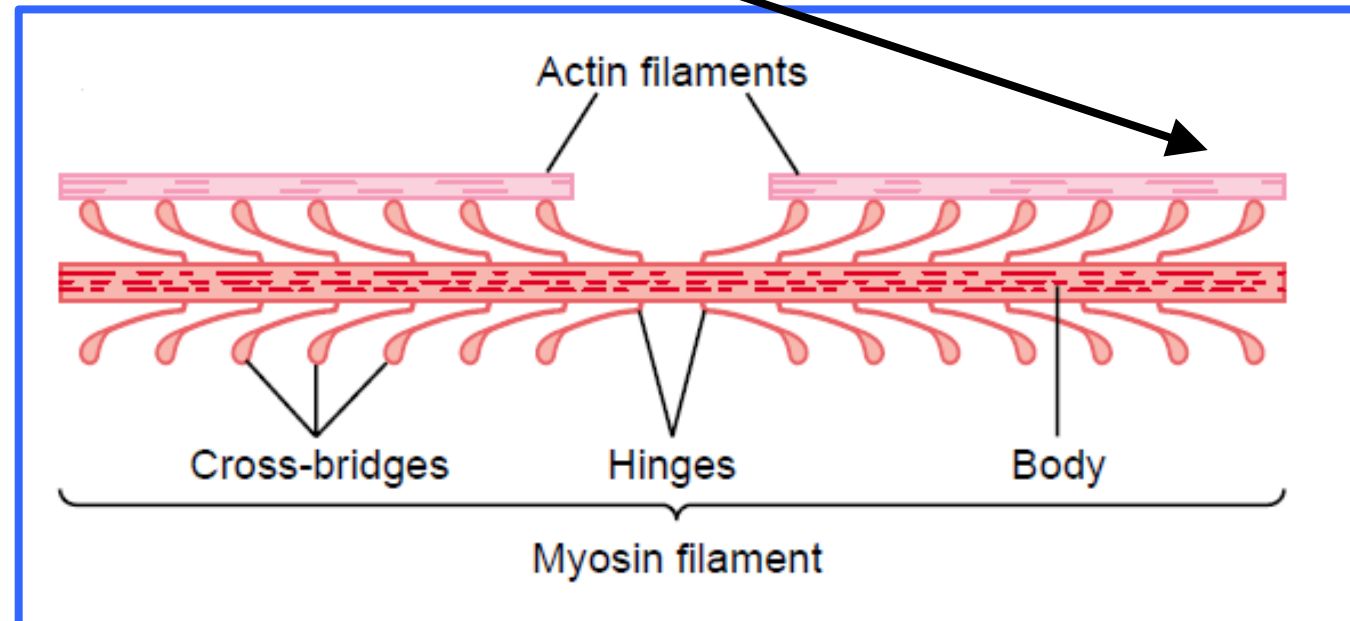
# Actin - Myosin Interaction



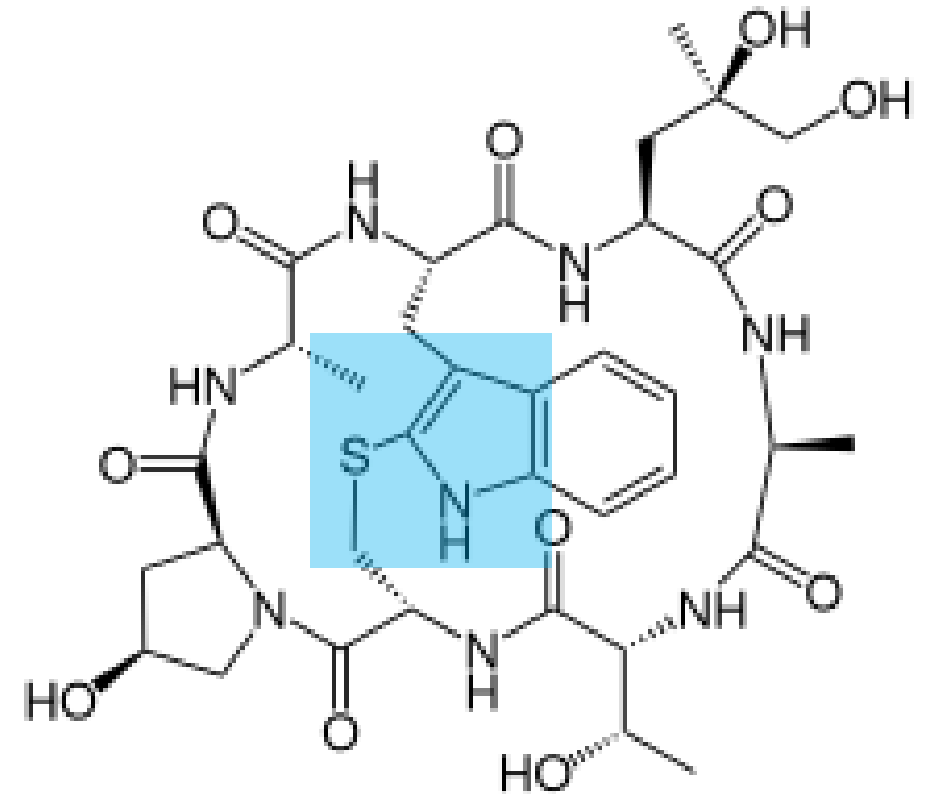
## Myosin Molecule

*Fenn effect*

- **Many Actin Molecules** → **Actin Filament**
- **Many Myosin Molecules** → **Myosin Filament**



# Actin

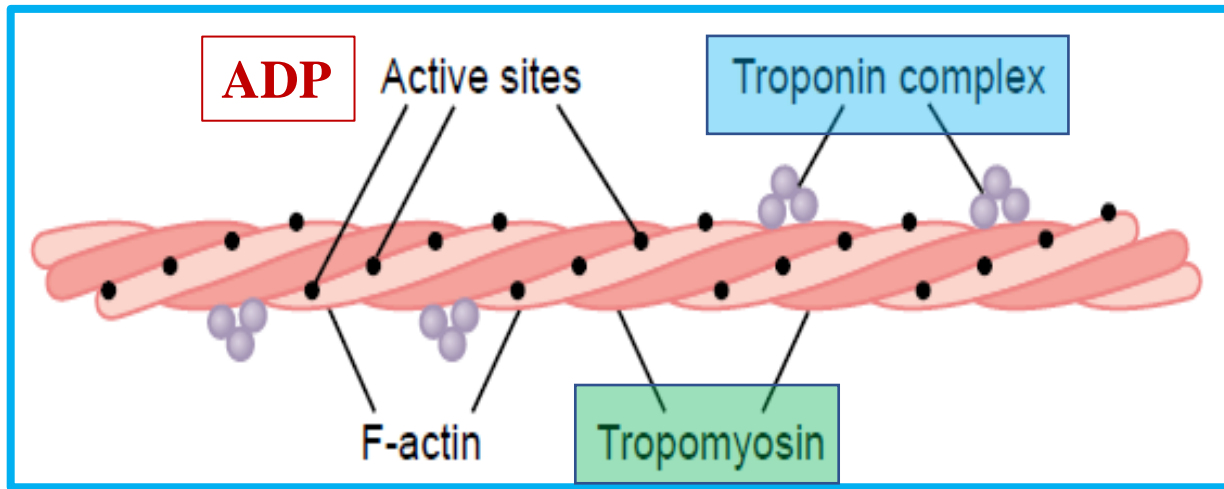




# Contraction Mechanism

## Actin Filament

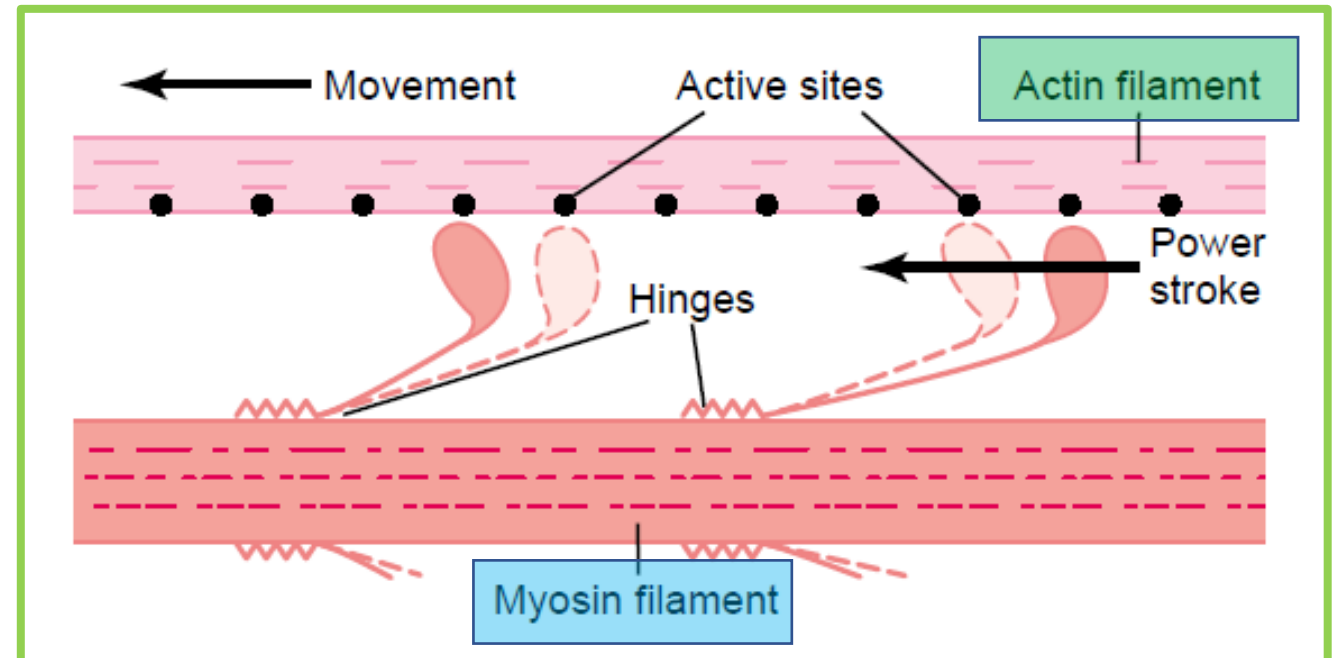
( 3 molecules Helix, like Collagen )



## “Walk-along” Mechanism: Muscle Contraction

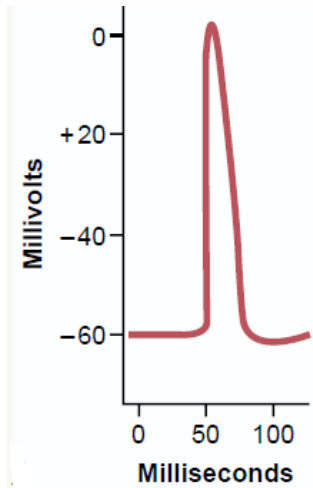
*A: Actin Filament*

**M: Myosin Filament**

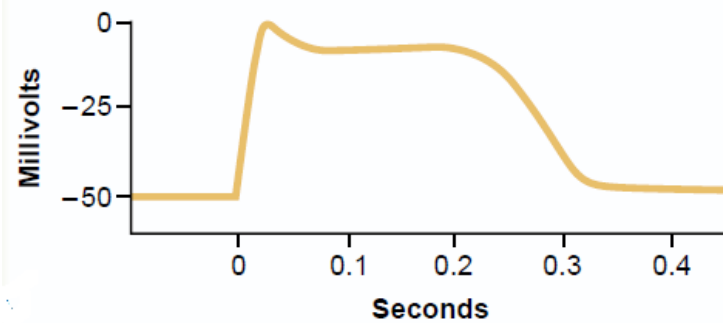
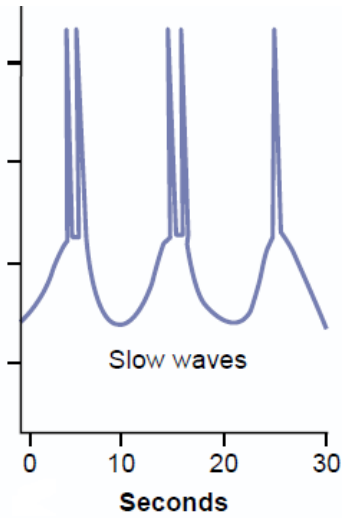


## Action Potentials of Smooth Muscle

### "Spike" Potential By External stimulus



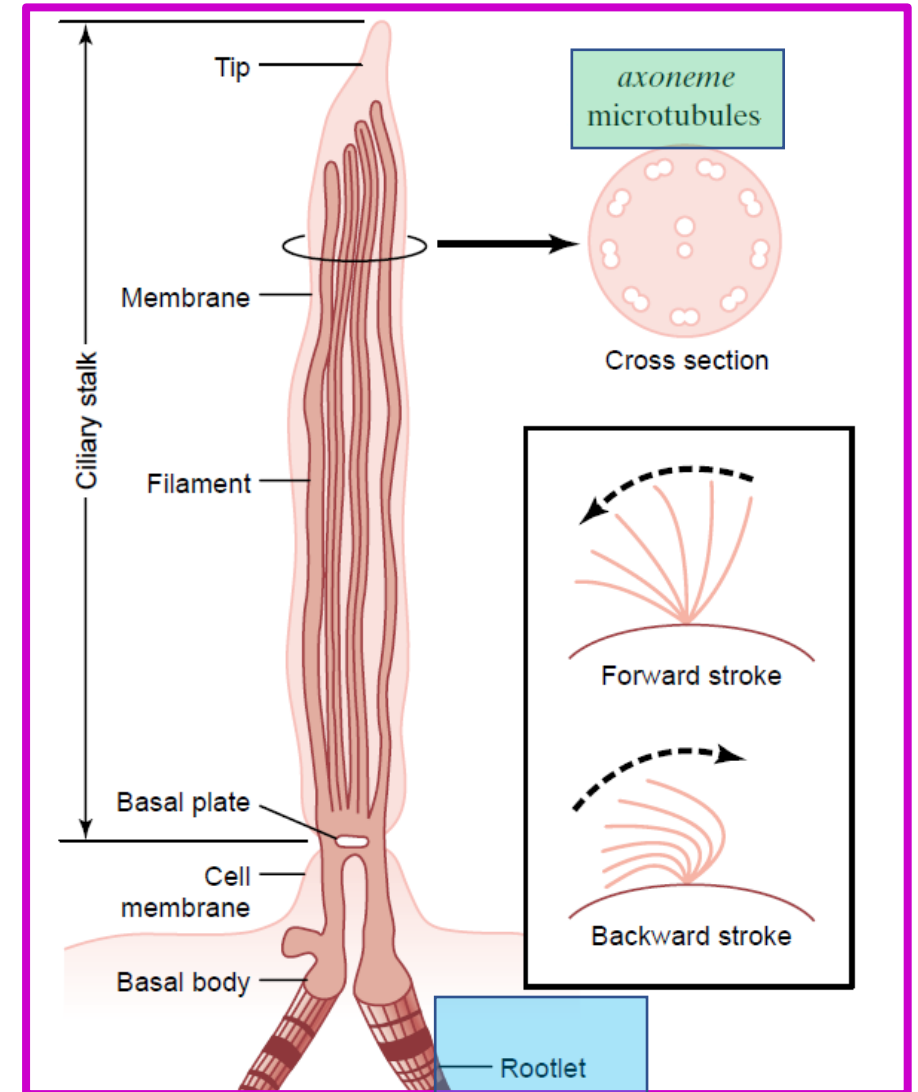
### Repetitive Spikes: Intestinal Peristalsis



**“Plateau” Potential - Prolonged contraction of Uterus:  
Expelling baby at birth**

## Ciliary Myofilament: Whip Movement

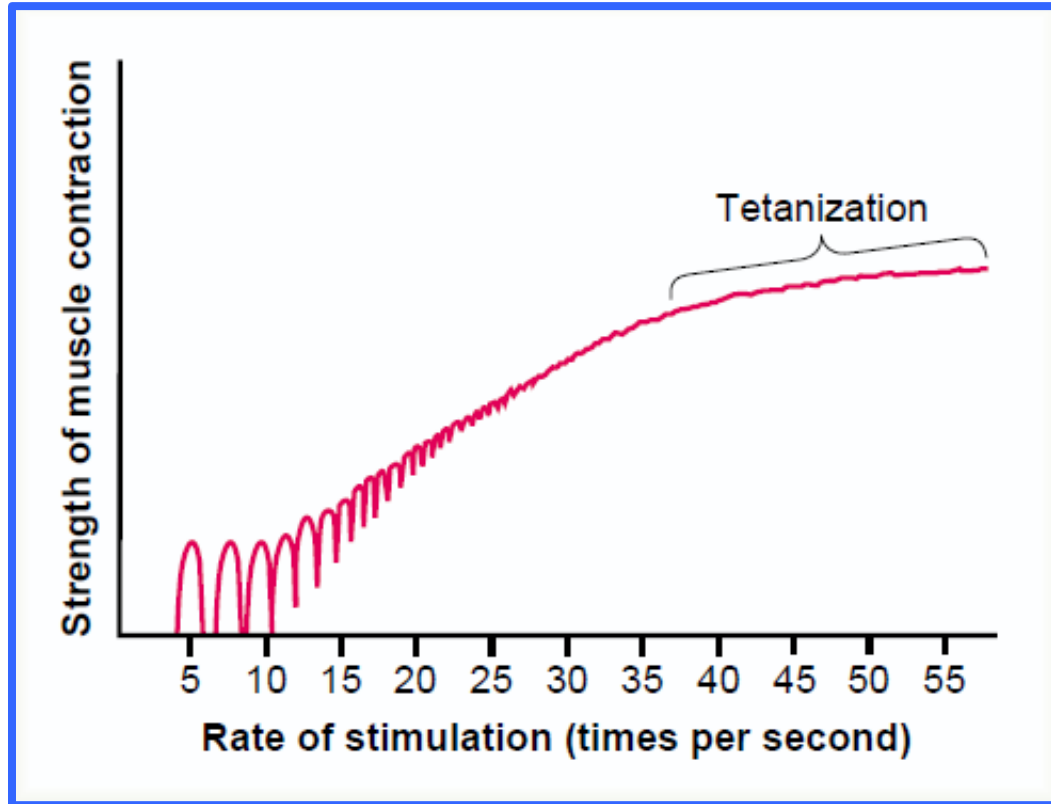
**10 Hertz : Nose, Lung, Ovarian Tube, Sperm**



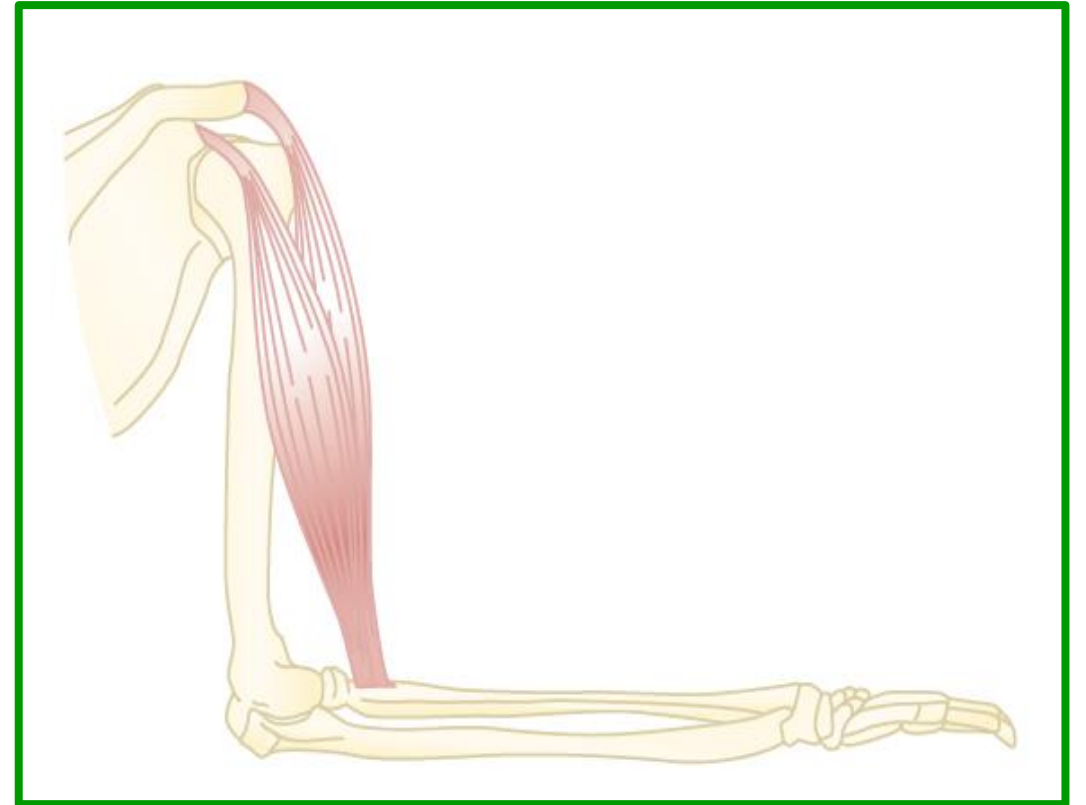


# Distributed Operations

## Repetitive Activity Summation: Tetanization



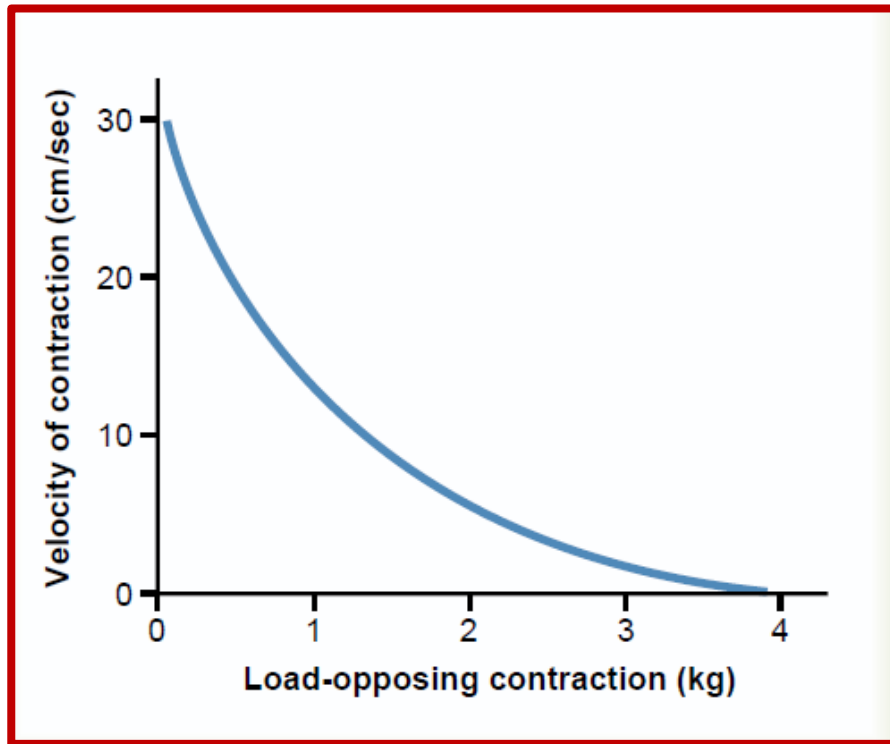
## Lever Action: Muscle → Tendon → Bone



# Muscle Activation Characteristics

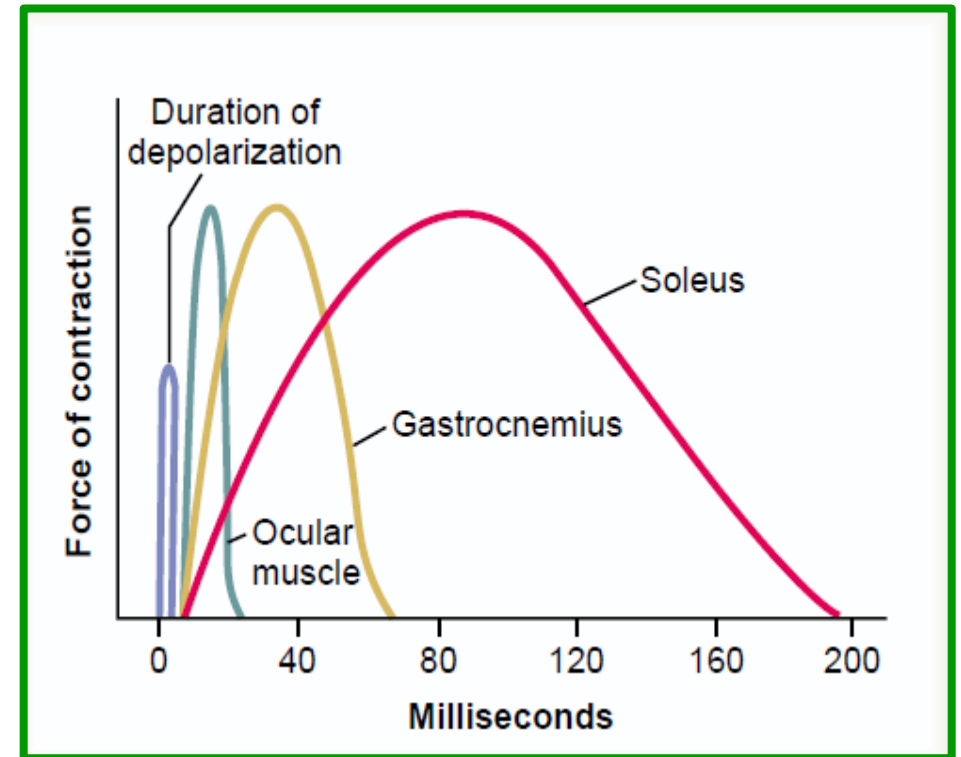
## Velocity - Force Diagram in Muscle Activity

### Reciprocity



## Response Latency in Muscle Activity:

### More peripheral the muscle: More the Slowness



Performance:  $W = L \times D$