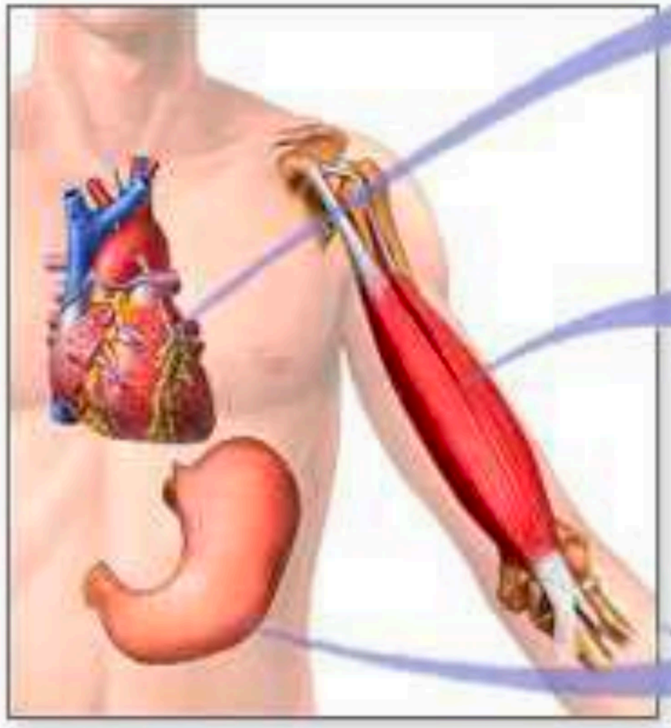
Movement

CNS directs the coordinated actions of the hundreds of muscles that enable us to move

Jim Zhao 20231030

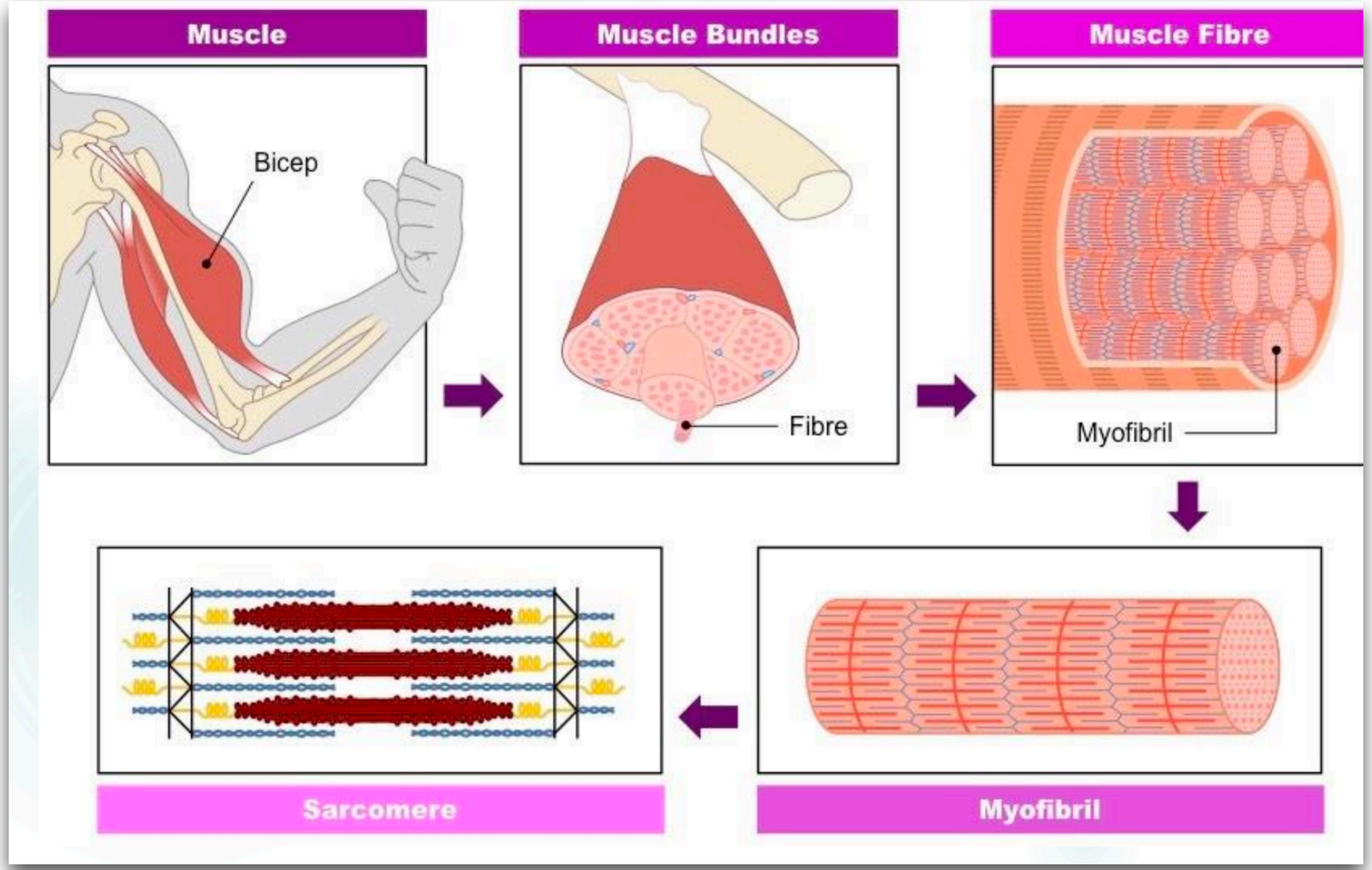


Cardiac muscle cell

Skeletal muscle cell

Smooth muscle cell

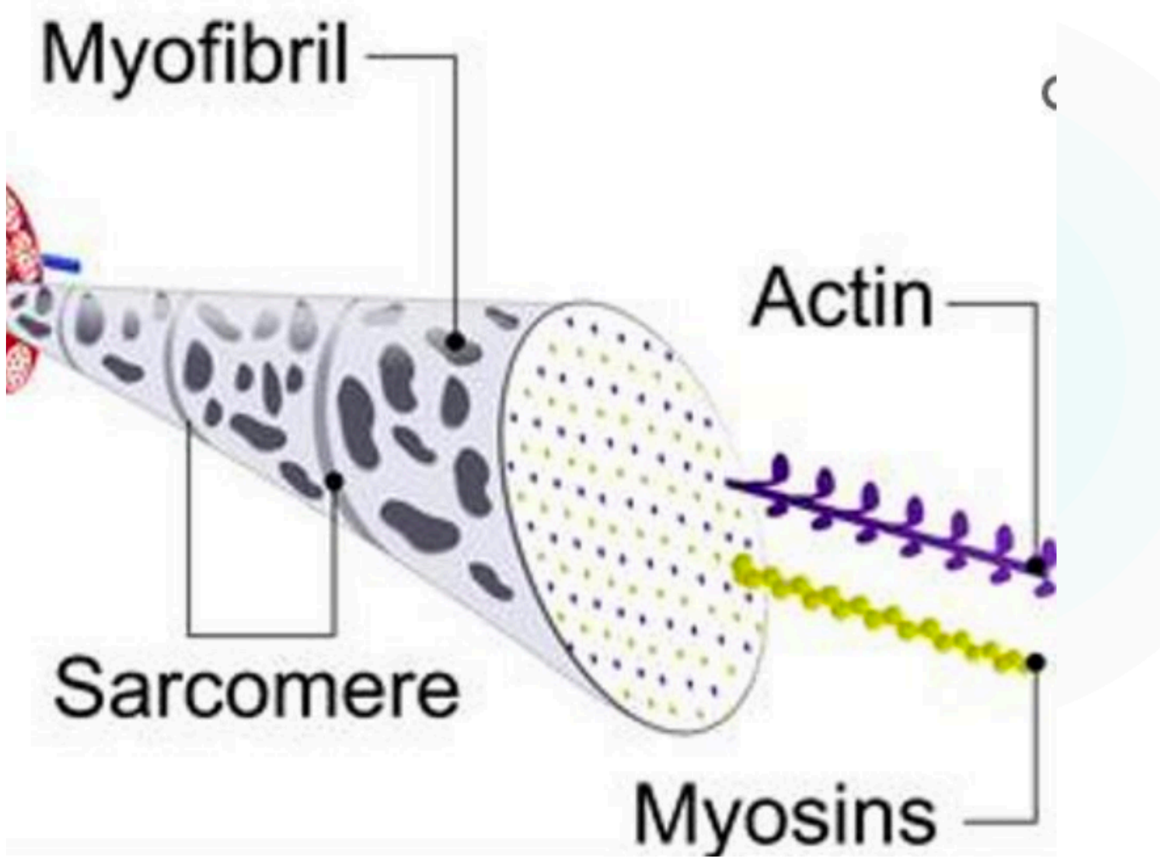
A.D.A.M.


Muscle
Bicep
Muscle Bundles
Fibre
Muscle Fibre
Myofibril
Myofibril
Sarcomere

Sarcomere

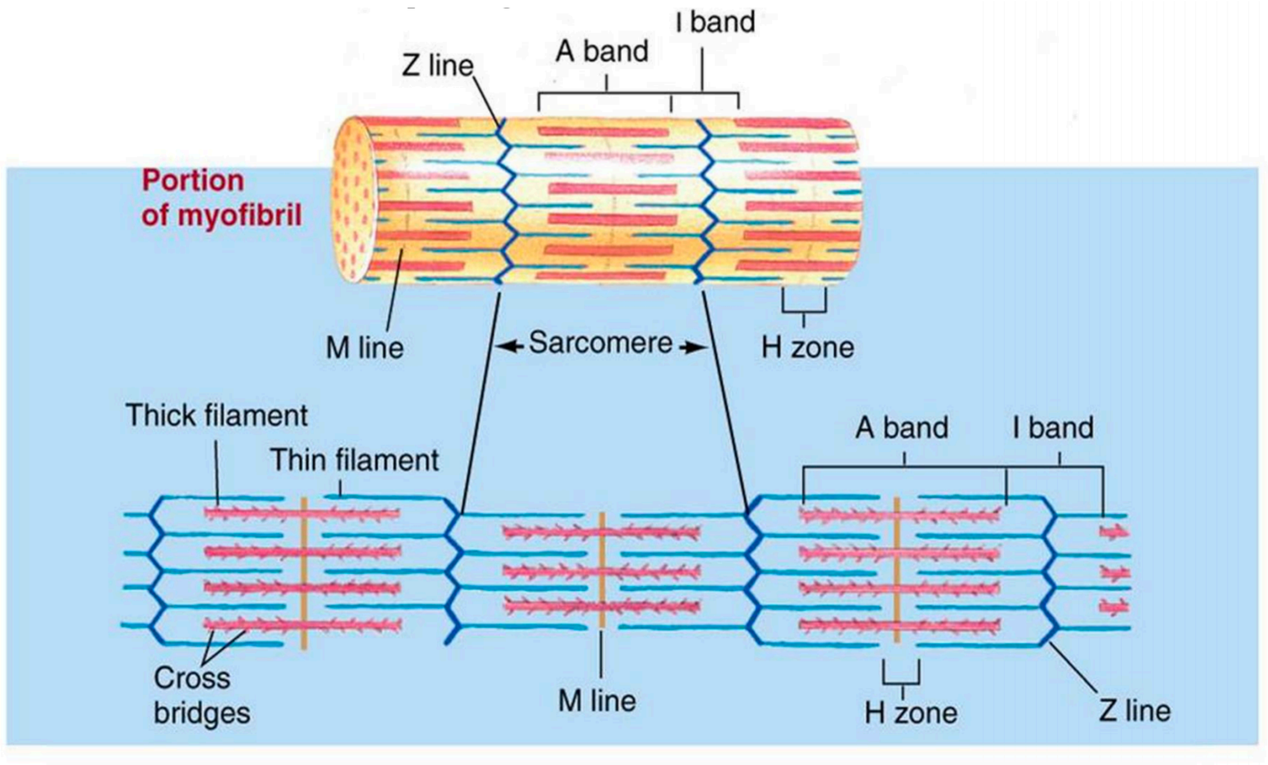
- Basic contractile unit of skeletal muscle, made of thick and thin filaments
- Thick filaments: myosin
- Thin filaments: actin

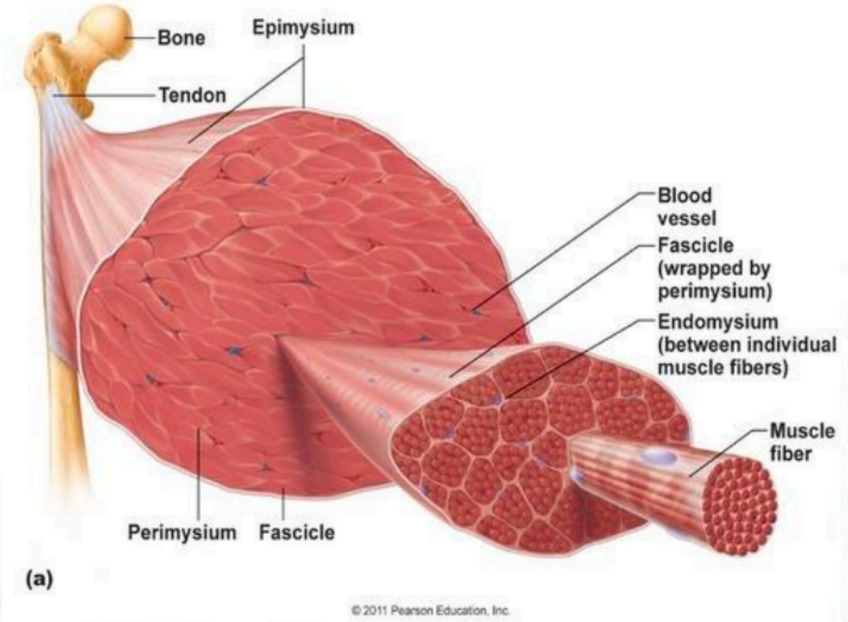
  (with two regulatory proteins: troponin and tropomyosin)

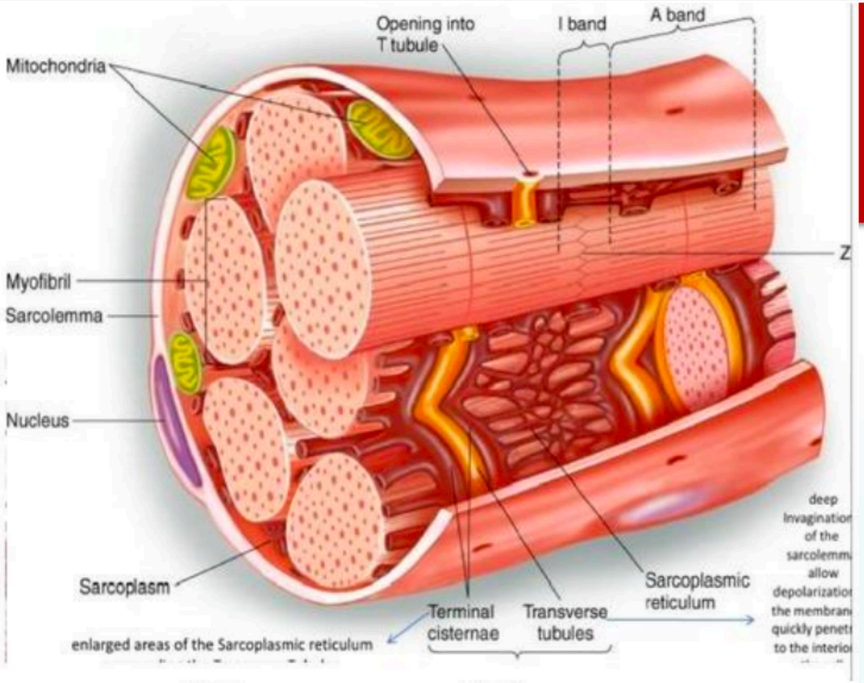


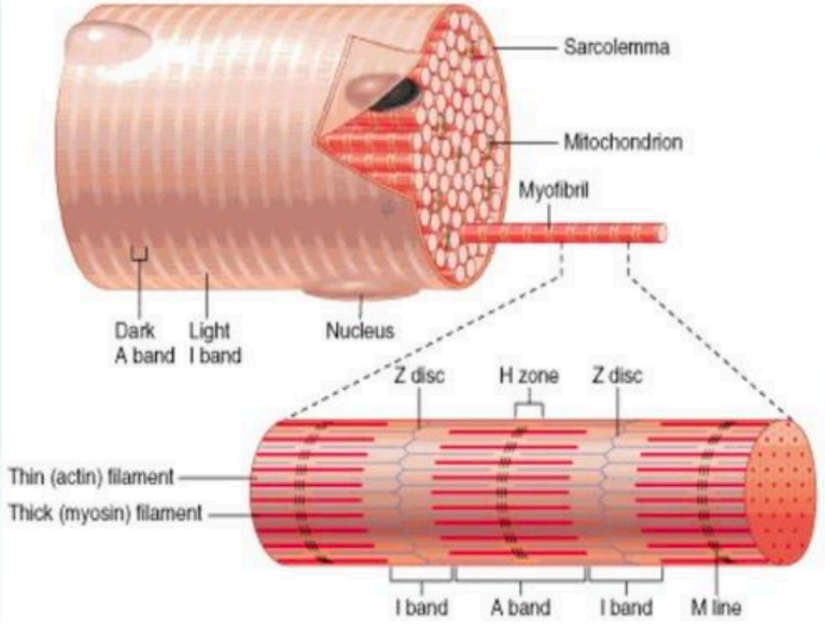
Structure of myofibril portion

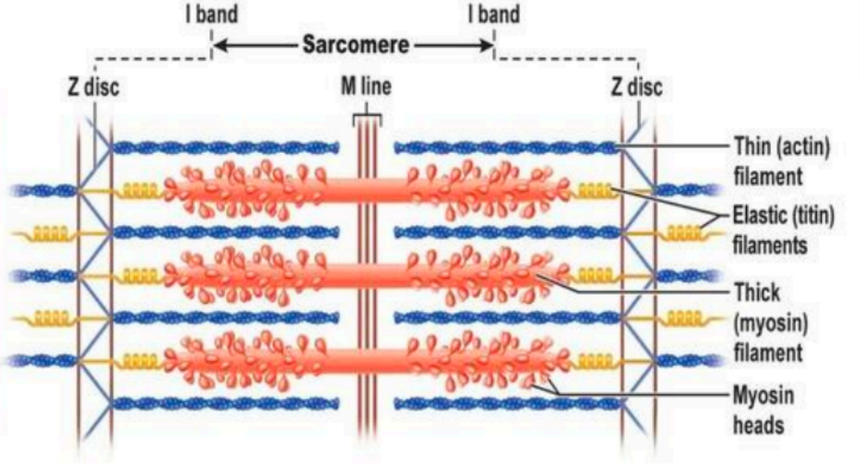
- A band: contains both thick and thin filaments. Centre of sarcomere that spans the H zone
- I band: region containing only thin filament
- H zone: region containing only thick filament
- M line: run down the middle of sarcomere
- Z line: boundary of each sarcomere







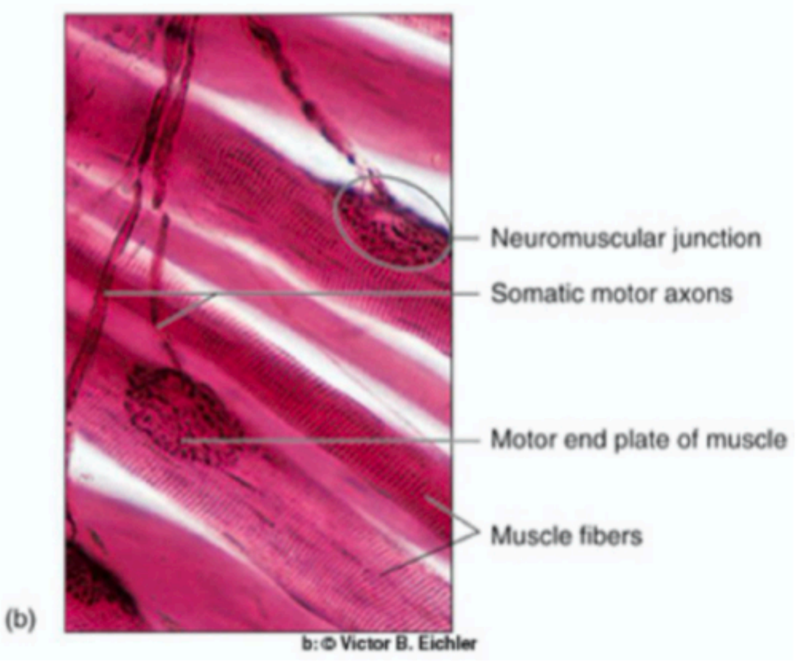




(d) **Enlargement of one sarcomere** (sectioned lengthwise). Notice the myosin heads on the thick filaments.

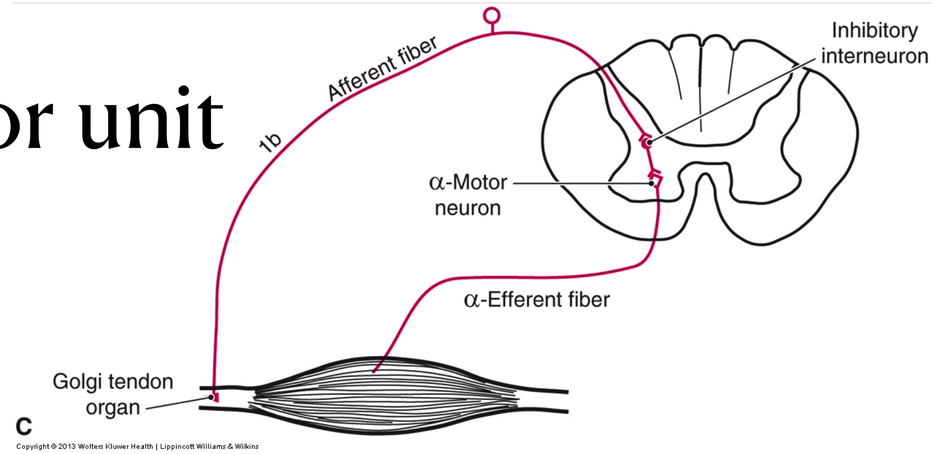
Neuromuscular Junction

- Synapse where nerves meet muscle tissue
- AP → **ACh** release → ACh bind muscle receptors → AP in muscle →
- **AChE** break down ACh



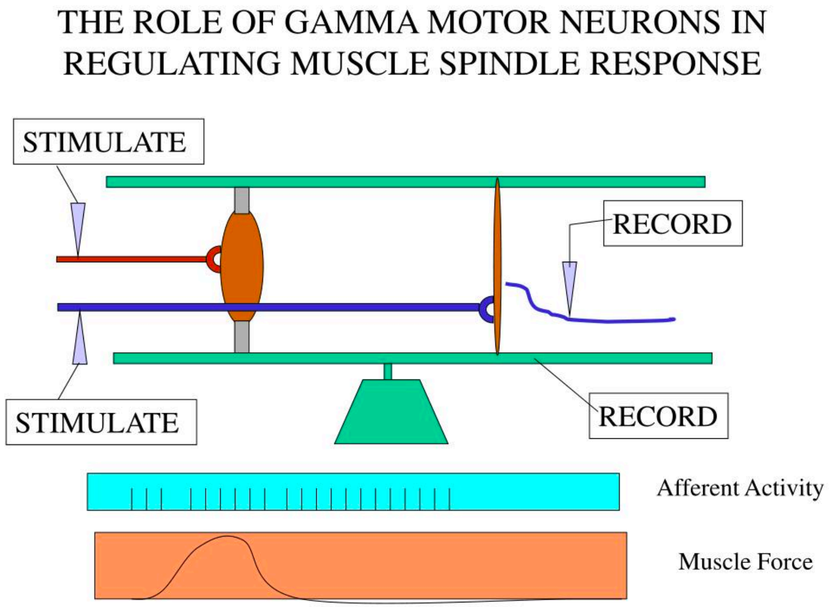
Alpha motor neurones

- Each muscle fibre is controlled by a single α motor neurone in spinal cord and brain.
- A single α motor neurone can control multiple muscle fibres (from several to hundreds)
- α motor neurone + muscle fibre = motor unit



Gamma motor neurones

- There are receptors within muscle called muscle spindles.
- The spindles sense the extent and speed of the stretch, and stimulate sensory neurones, which send a barrage of impulses into the spinal cord.
- γ motor neurones regulate the sensitivity of the system.



Mechanism of muscle contraction

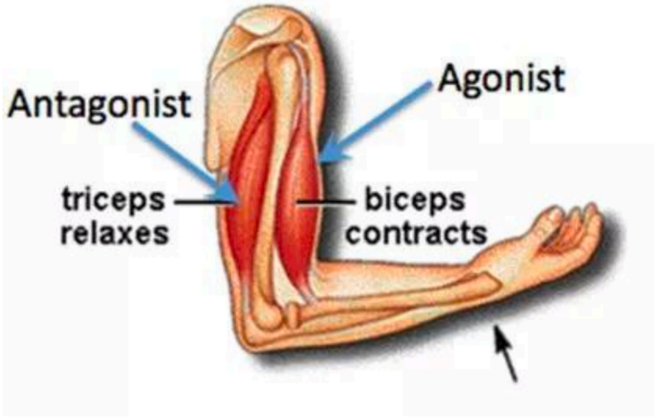
Sliding filament theory

- https://www.bilibili.com/video/BV1PW411d7aU/?spm_id_from=333.788.recommend_more_video.-1&vd_source=1fec0e5796c965e5fbf5fb3a1843c520

Flexor and Extensor

- 使骨骼靠得更近，从而减小骨骼之间角度的肌肉称为屈肌 flexors
- 反之，使得骨骼靠的更远，并增大骨骼之间角度的肌肉称之为伸肌 extensor

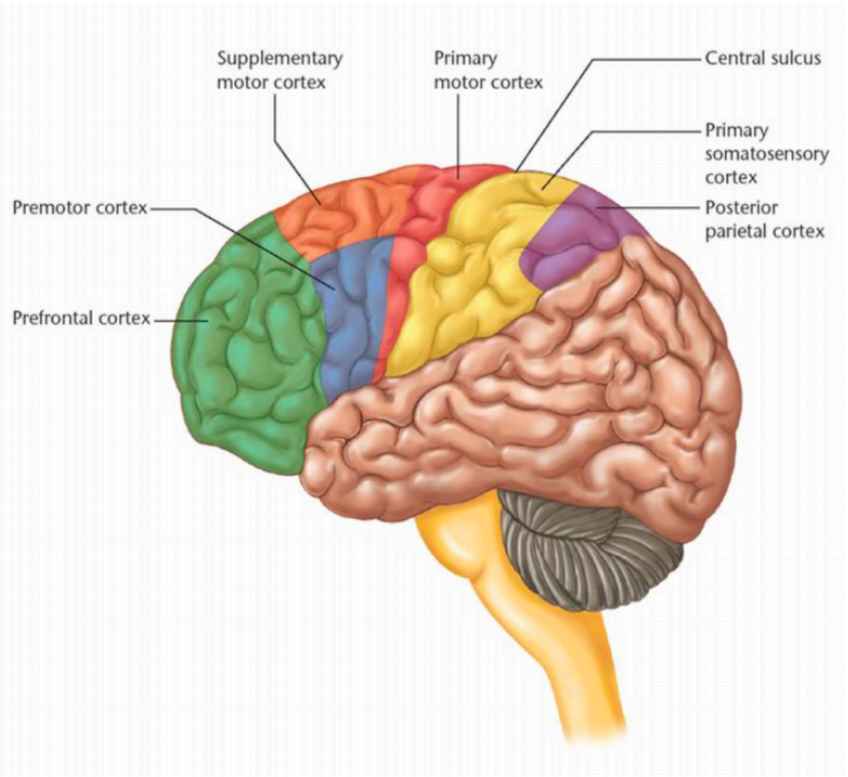
- 弯曲肘部需要**肱二头肌（bicep）屈肌 flexor**的收缩 contraction
- 和**肱三头肌（tricep）伸肌 extensor**的松弛relax。
- 对于这样的运动，促进运动的肌肉被称为主动肌agonists，而那些反对或抑制运动的肌肉则是拮抗肌antagonists。



CNS - PNS - Neuromuscular junction - Muscles

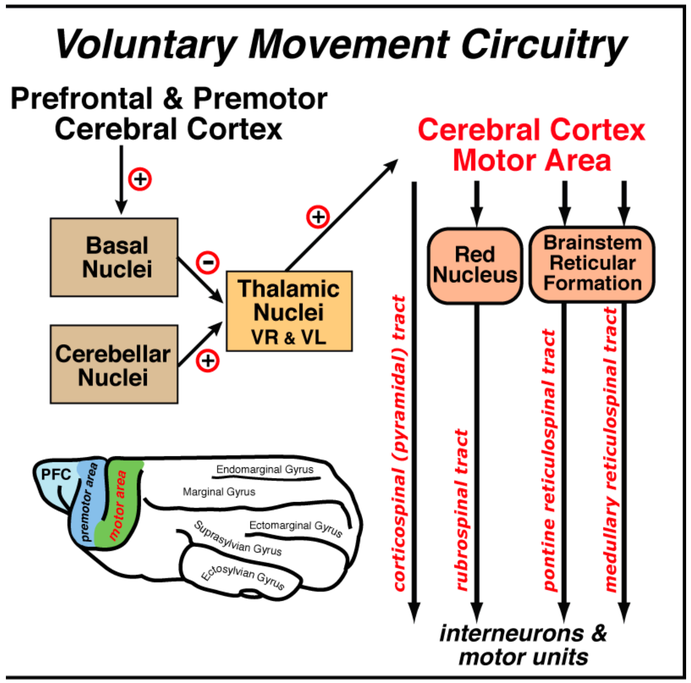
CNS - Cortex

- Cortex
  - Primary motor cortex (Area 4)
    - Execution of motor commands
  - Secondary motor cortex (Area 6)
    - Premotor area (PMA)
    - Supplementary motor area (SMA)
    - Motor planning
  - Prefrontal cortex
    - Decision making & anticipation
  - Parietal cortex
    - Spatial relationship



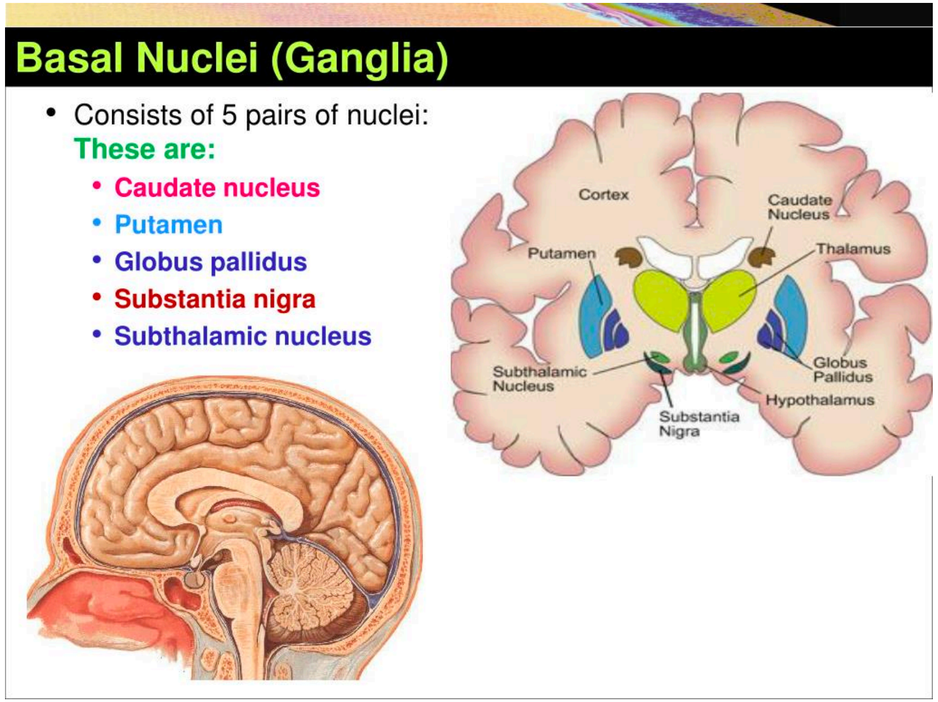
Voluntary movement

- Motor cortex neurones send signals, directly controlling activation of α motor neurone in spinal cord.
- Certain brain regions the part in the circuit/loop that controls motor cortex.
- These brain regions include - basal ganglia, hypothalamus and cerebellum.

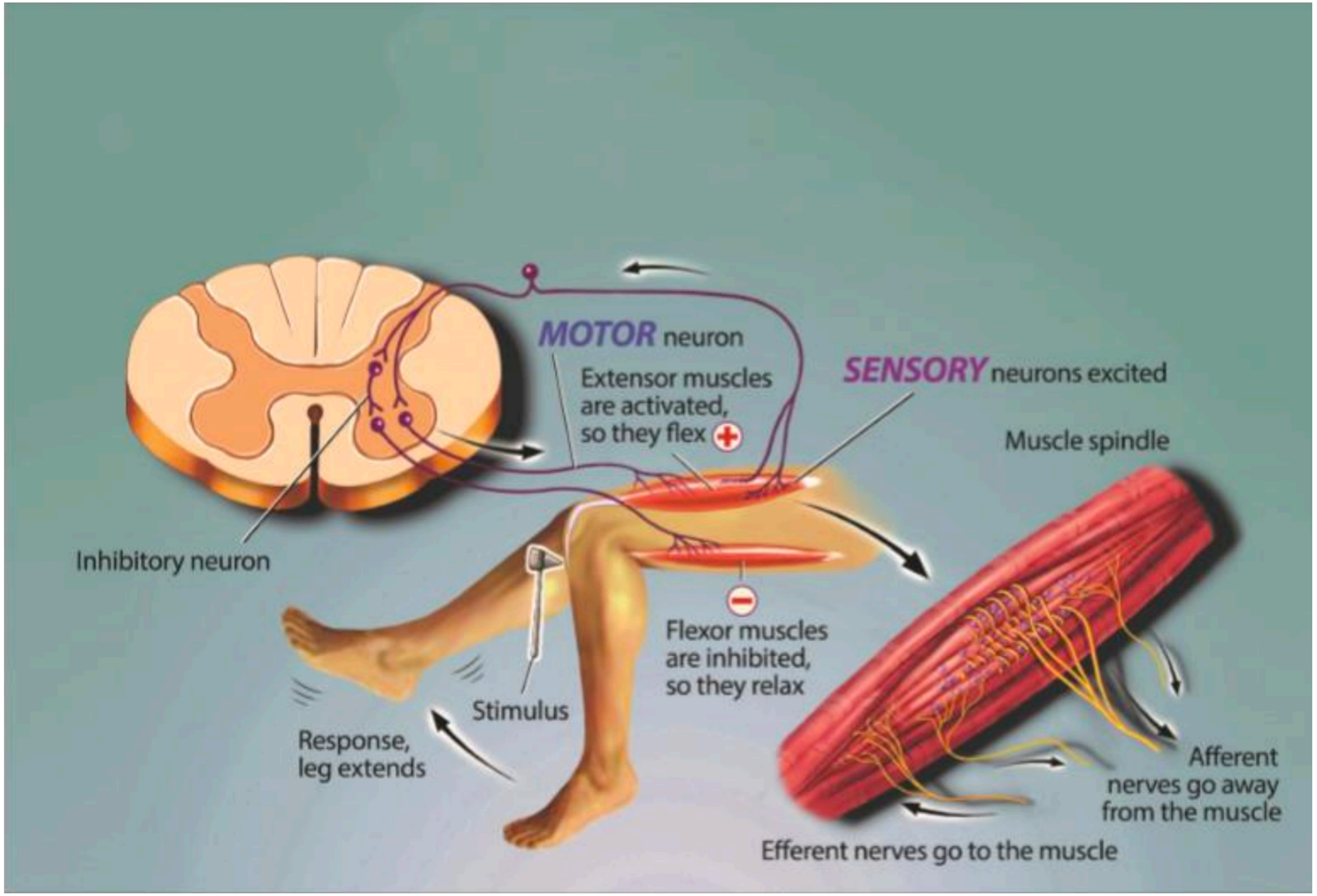


Basal ganglia lesion

- Selective loss of basal ganglia inhibitory neurones, loss of inhibition of random involuntary movements —— Huntington disease
- Deficiency of dopamine —— Parkinson's disease



Involuntary movement



Cerebellum

- Neurones in cerebellum integrate the sensory inputs, making sure the correct combination and timing of muscular movement, producing fluid movements.
- Adapts to unexpected circumstances, hence adjusting movement e.g. so that you can lift up a big and heavy box.
- Can also adapt to growth change, disability and calibrate movement and posture
- Long-term alcoholism is a common cause of acquired cerebellar degeneration

Some diseases

Sensory Ataxia:

Staggering gait, instability compensated by wider base of support

Inaccuracy in range of Movement

Dysmetria