

# Department of Zoology

• Indira Mahavidyalaya Kalamb

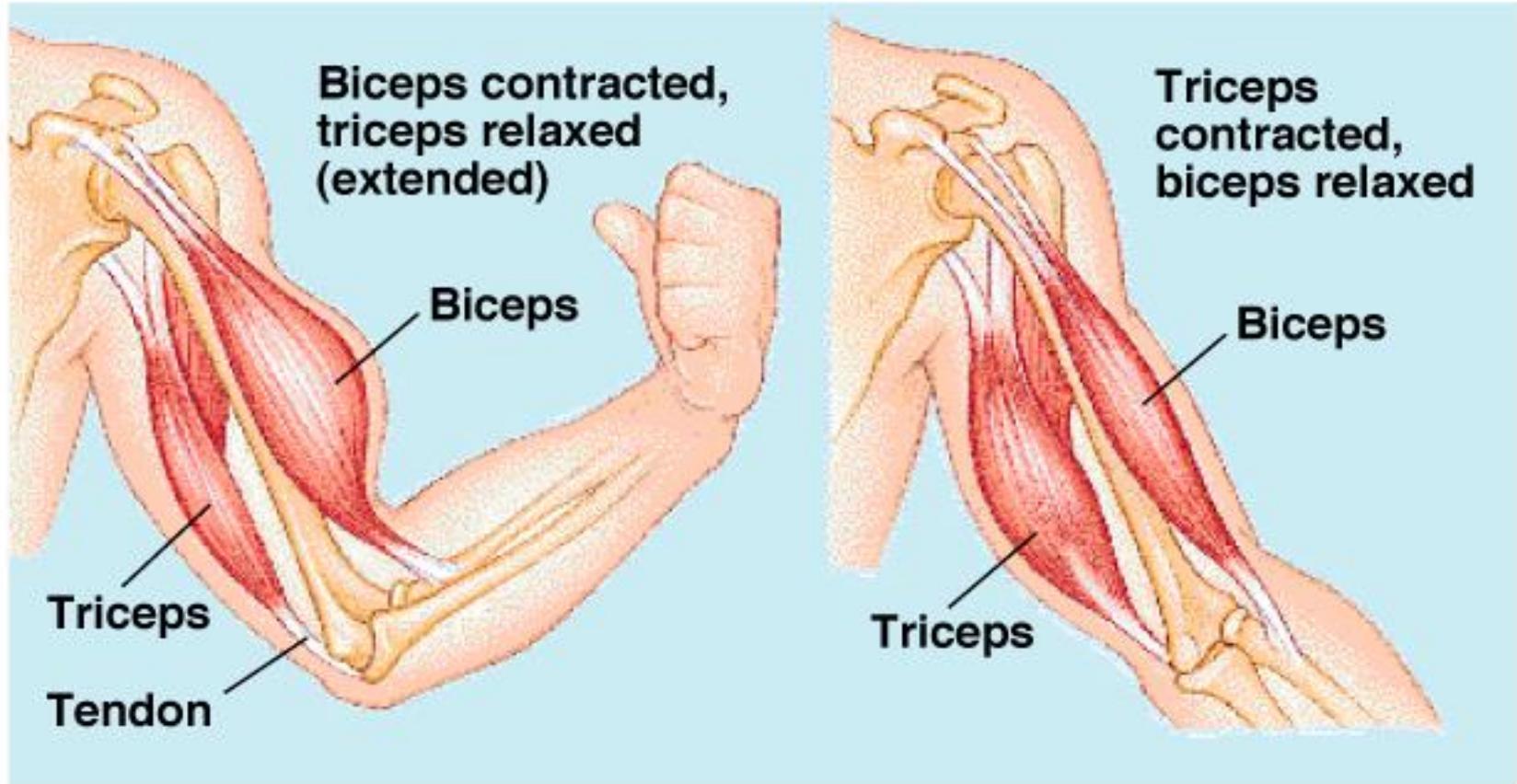
## Seminar Topic

**Mechanism of Muscle Contraction**

*by*

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**Fig 30.7**



# Muscles

- Muscles are attached to bones by tendons
- Muscles work in antagonistic pairs
  - Ex. Biceps and triceps
  - One muscle contracts while the other relaxes

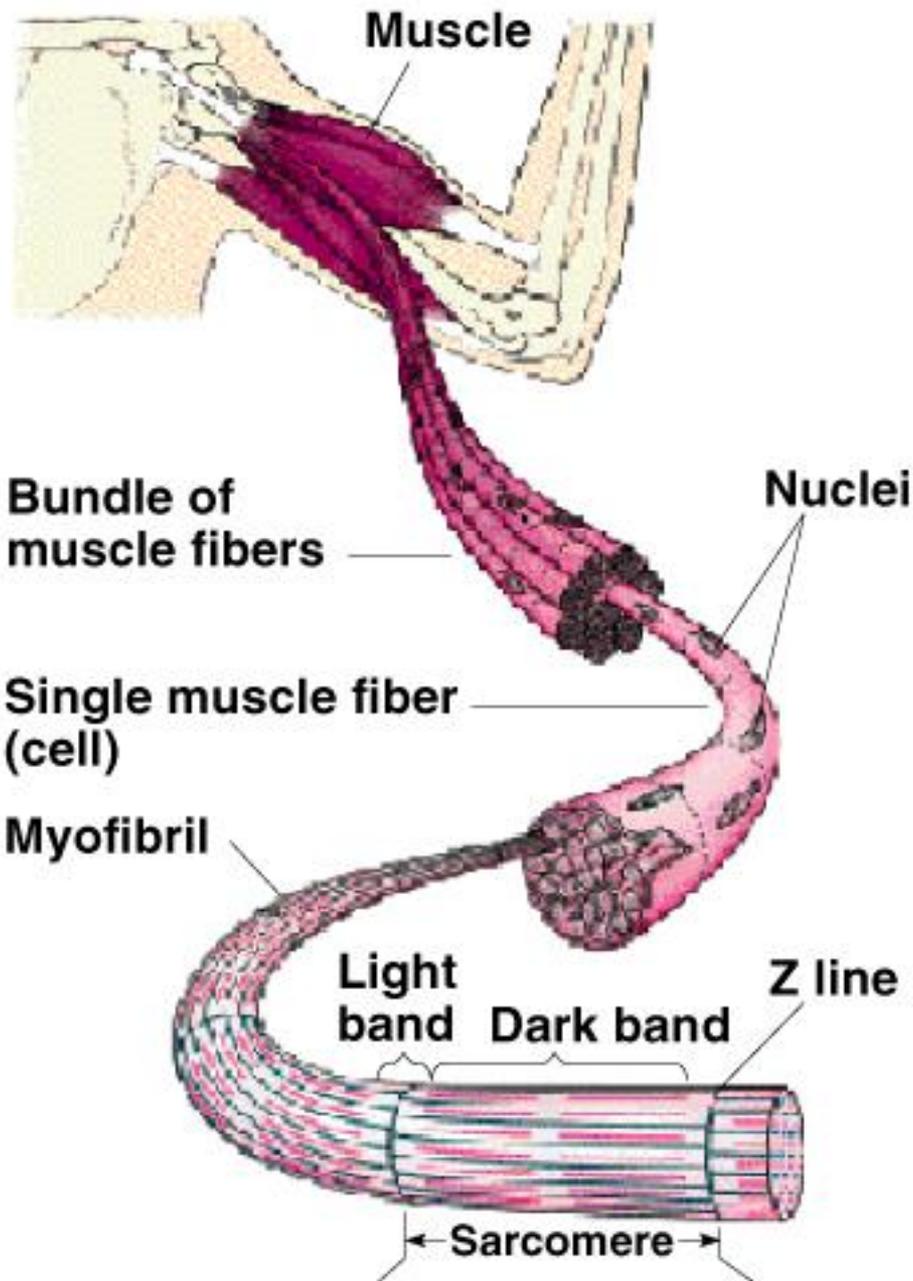


Fig 30.8

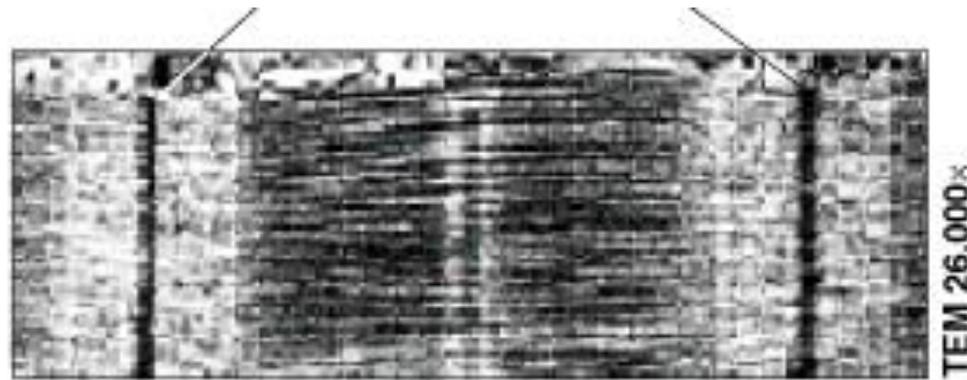
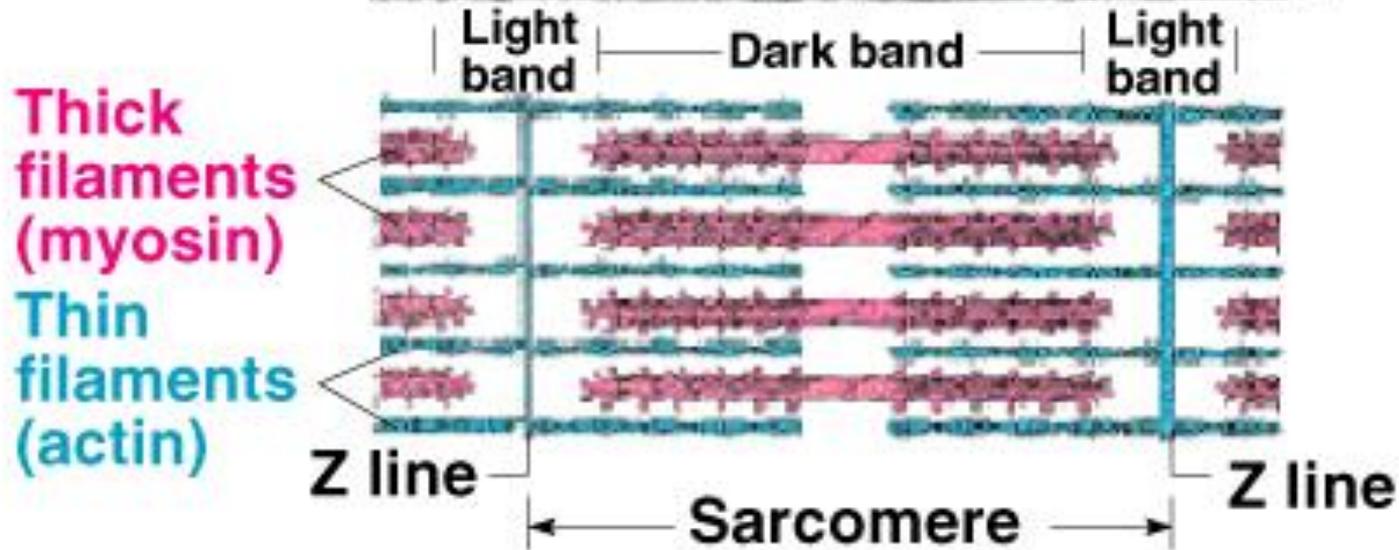


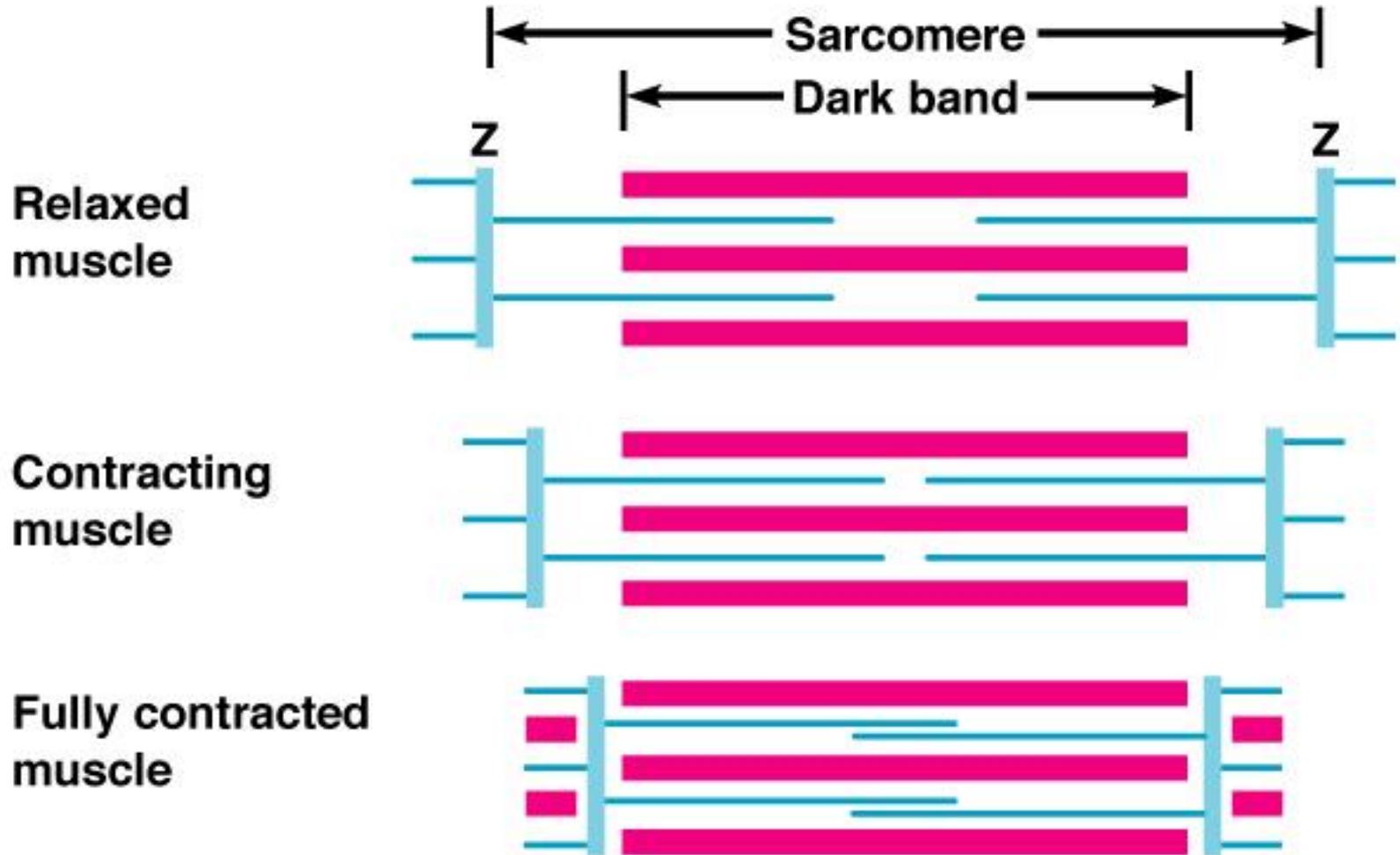
Fig 30.8



# Contractile apparatus

- Skeletal muscle
  - Muscle cell = muscle fiber (a single cell with one nucleus)
  - Muscle fibers are made of myofibrils (striated)
  - Myofibrils are made of units called sarcomeres
  - Sarcomeres are made of thick and thin filaments
  - Z line is the end of the sarcomere
  - Thick and thin filaments slide over one another to shorten the muscle during contraction

**Fig 30.9A**

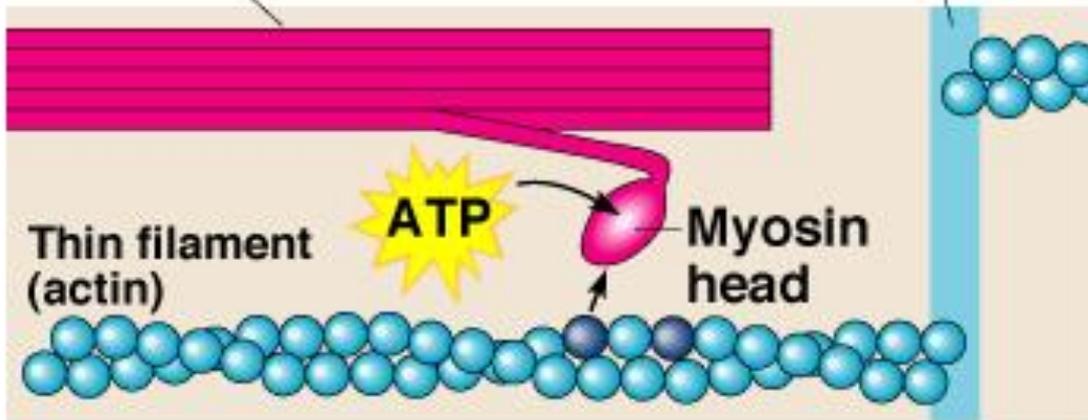


# Sliding filament theory

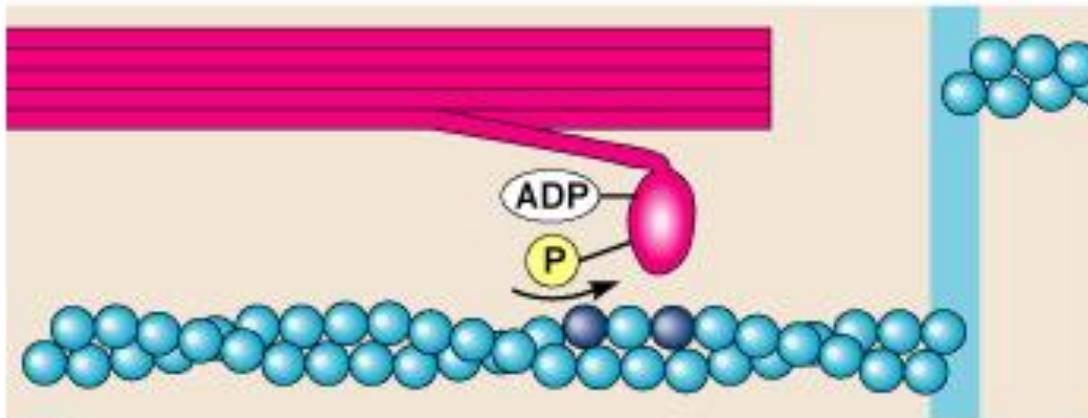
- Links the structure of a sarcomere to its function
- During contraction thin filaments slide over thick filaments
- Thick filaments= myosin and have “heads”
- Thin filaments = actin, these slide
- Ca and ATP required for sliding and attachment

Thick filament (myosin)

Z line



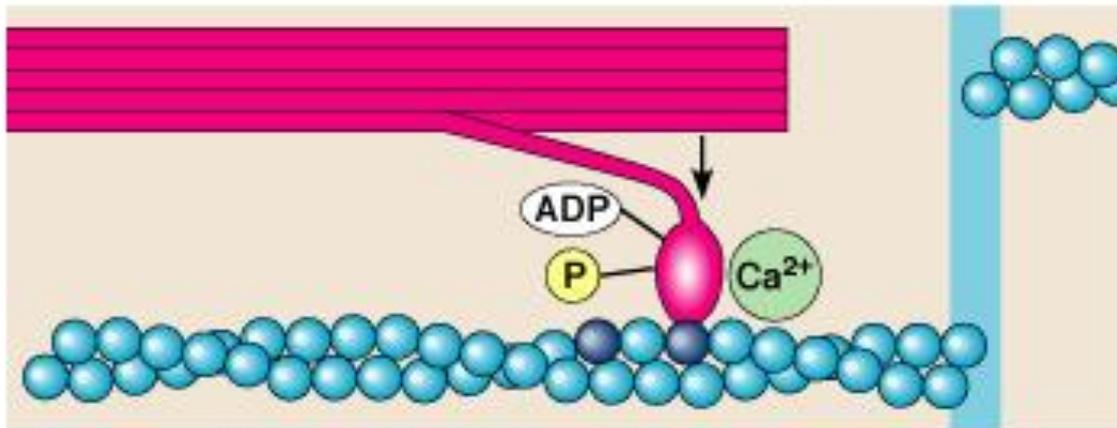
**1** ATP binds to a myosin head, which is released from an actin filament.



**2** Hydrolysis of ATP cocks the myosin head.

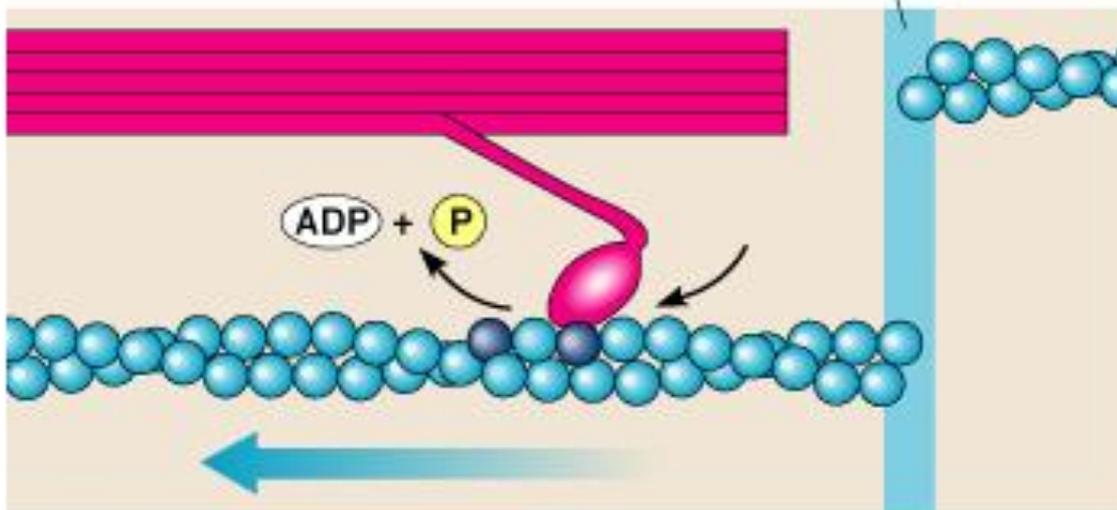
Fig 30.9A

Fig 30.9B

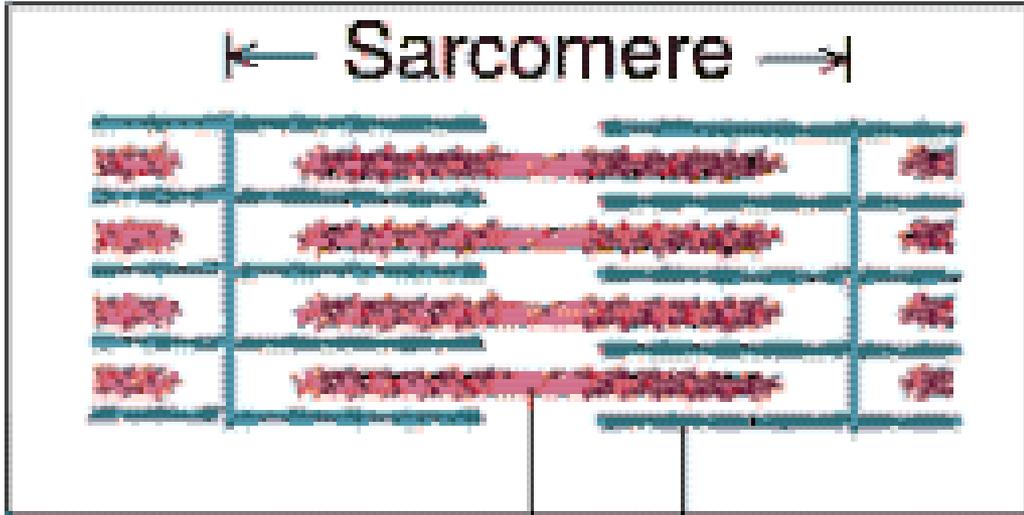
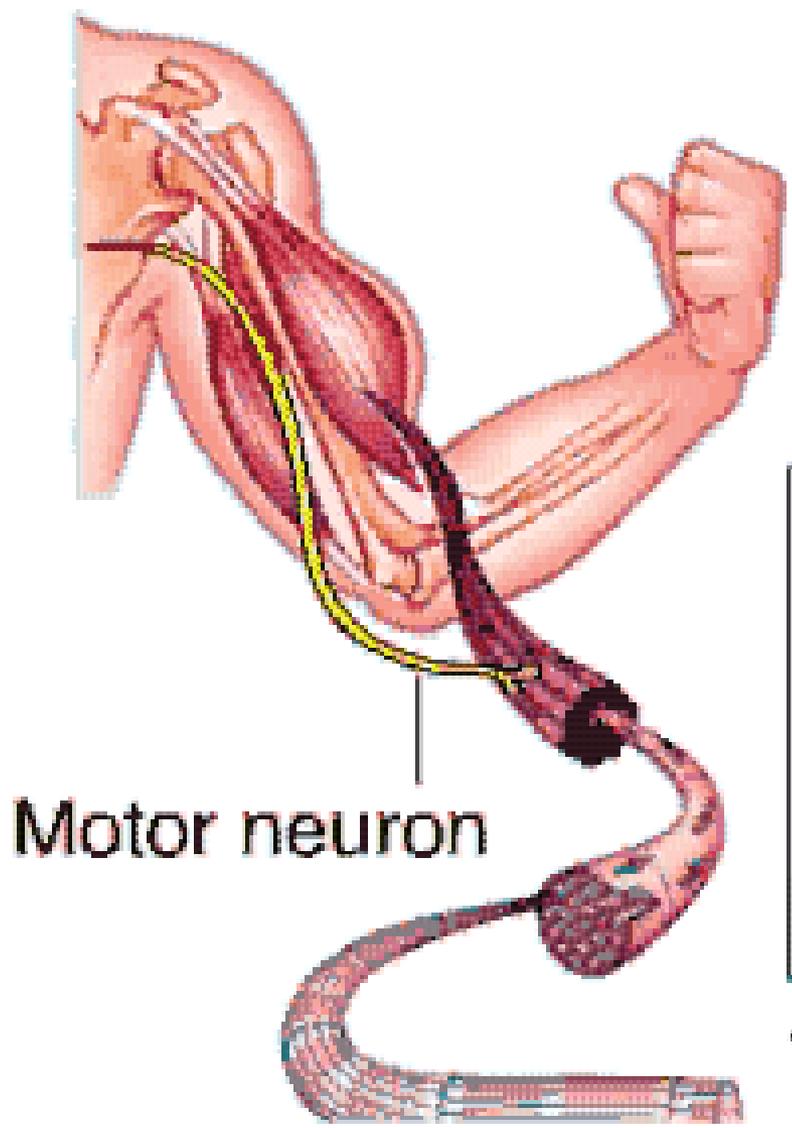


**3** The myosin head attaches to an actin binding site, with the help of calcium.

New position of Z line



**4** The power stroke slides the actin (thin) filament.



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# Sliding filament theory

- ATP binds to a myosin head, which is released from an actin filament
- Hydrolysis of ATP cocks the myosin head
- The myosin head attaches to an actin binding site with the help of Calcium
- The power stroke slides the thin filament when ADP and Pi are released from it

# Sliding filament theory

- 350 myosin heads per thick filament
- Can bind and unbind to thin filament up to 5 times per second

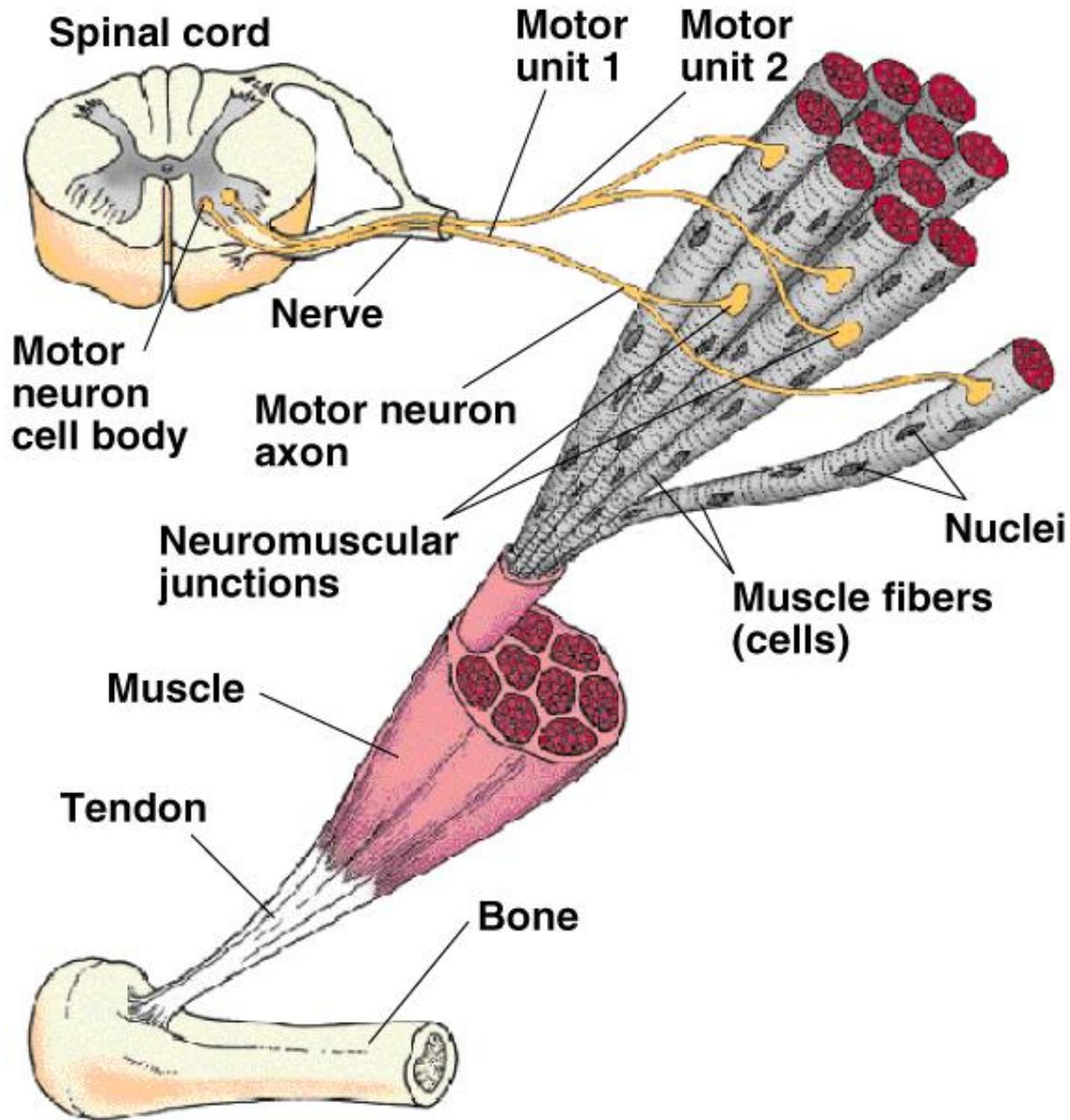


Fig 30.10A

# Motor neurons and muscle contraction

- Motor neurons stimulate muscle contraction
- Motor neurons are branched and can stimulate more than one muscle fiber
- Motor unit = motor unit and all the muscle fibers it controls
- Neuromuscular junctions = the synapse between a motor neuron and a muscle fiber

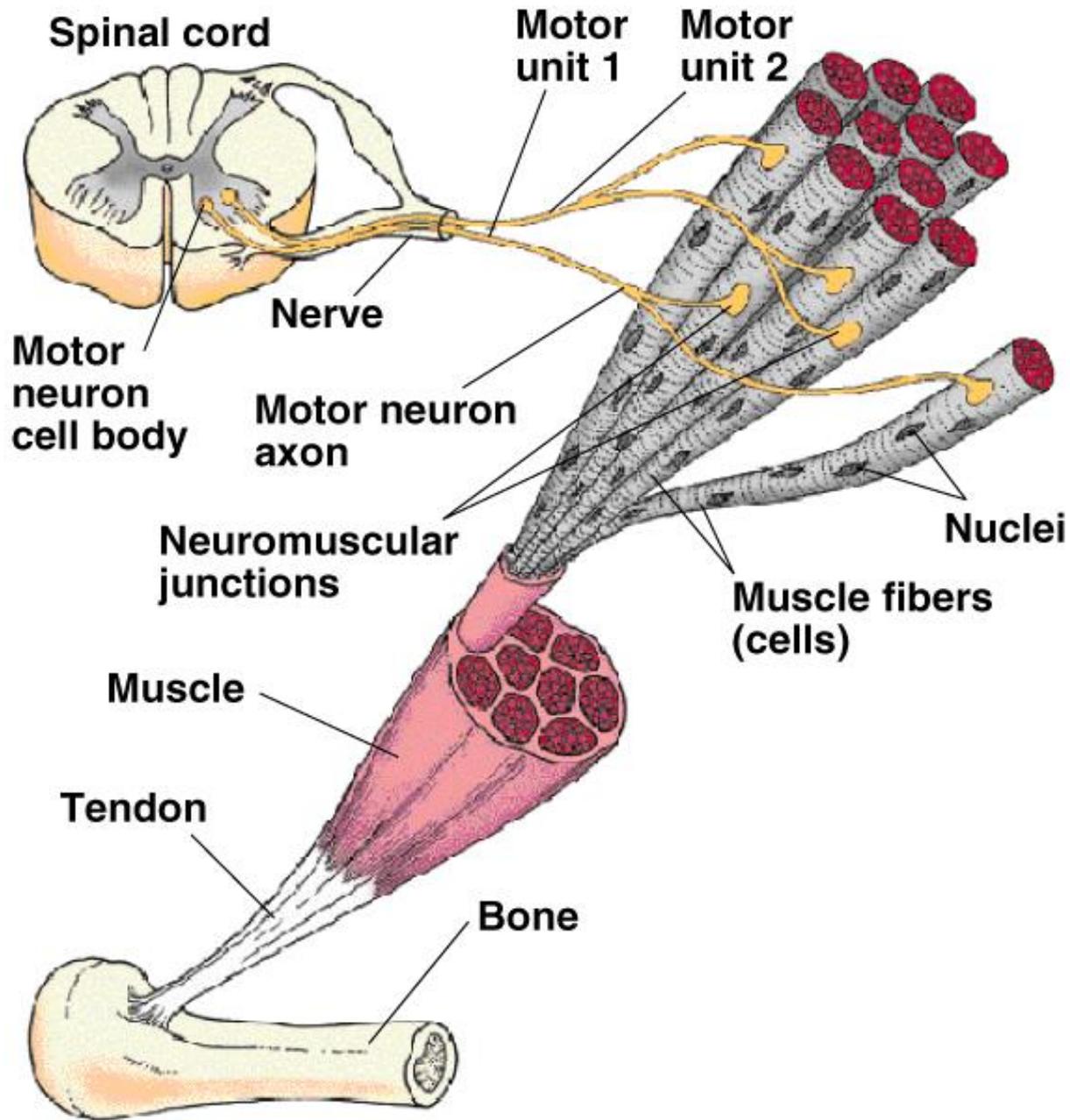


Fig 30.10

# Motor neurons and muscle contraction

- The strength of a muscular contraction is controlled by the number of motor units activated. More motor units = stronger contractions
- Muscles requiring precise control have one motor neuron per muscle fiber

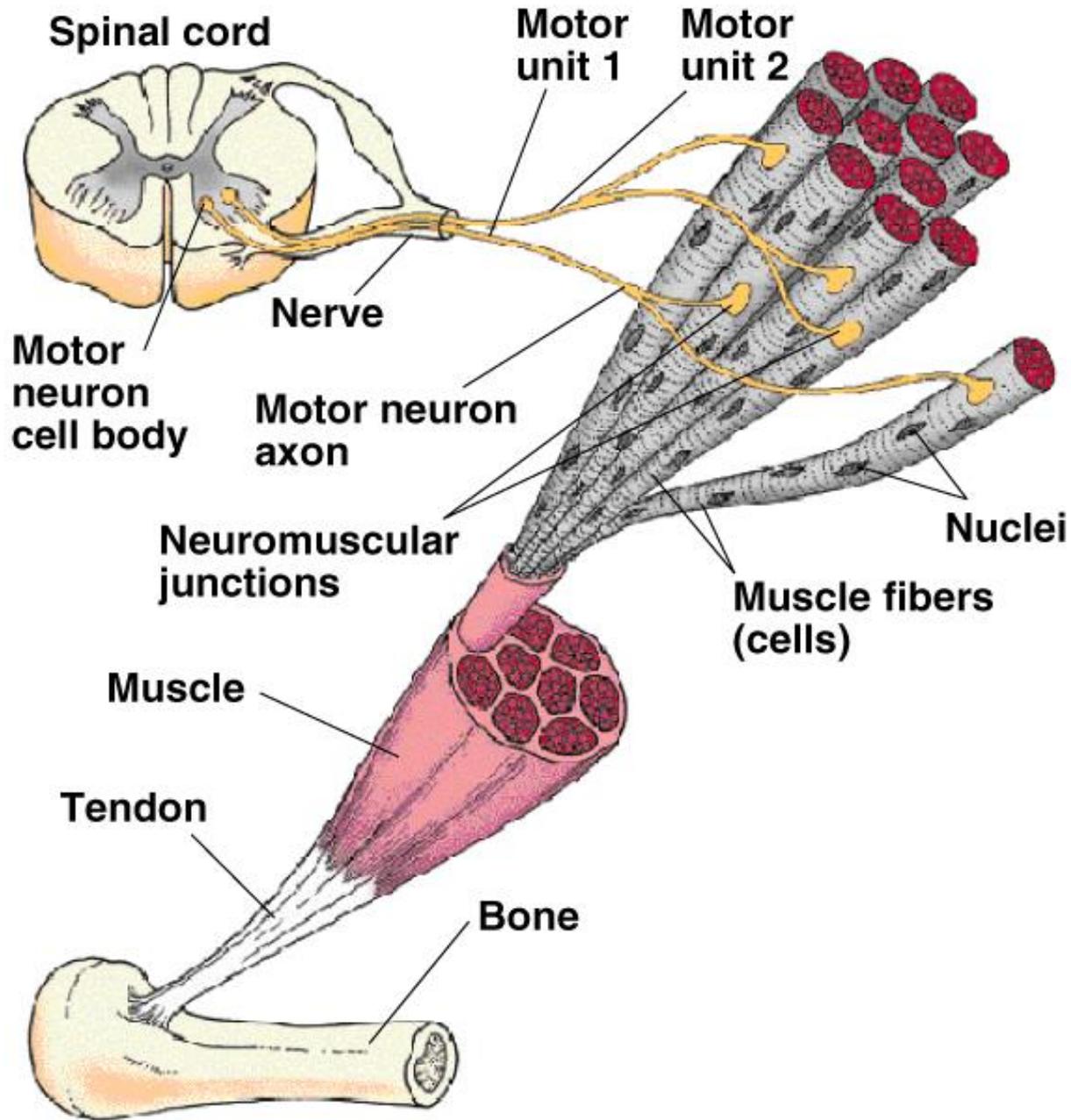
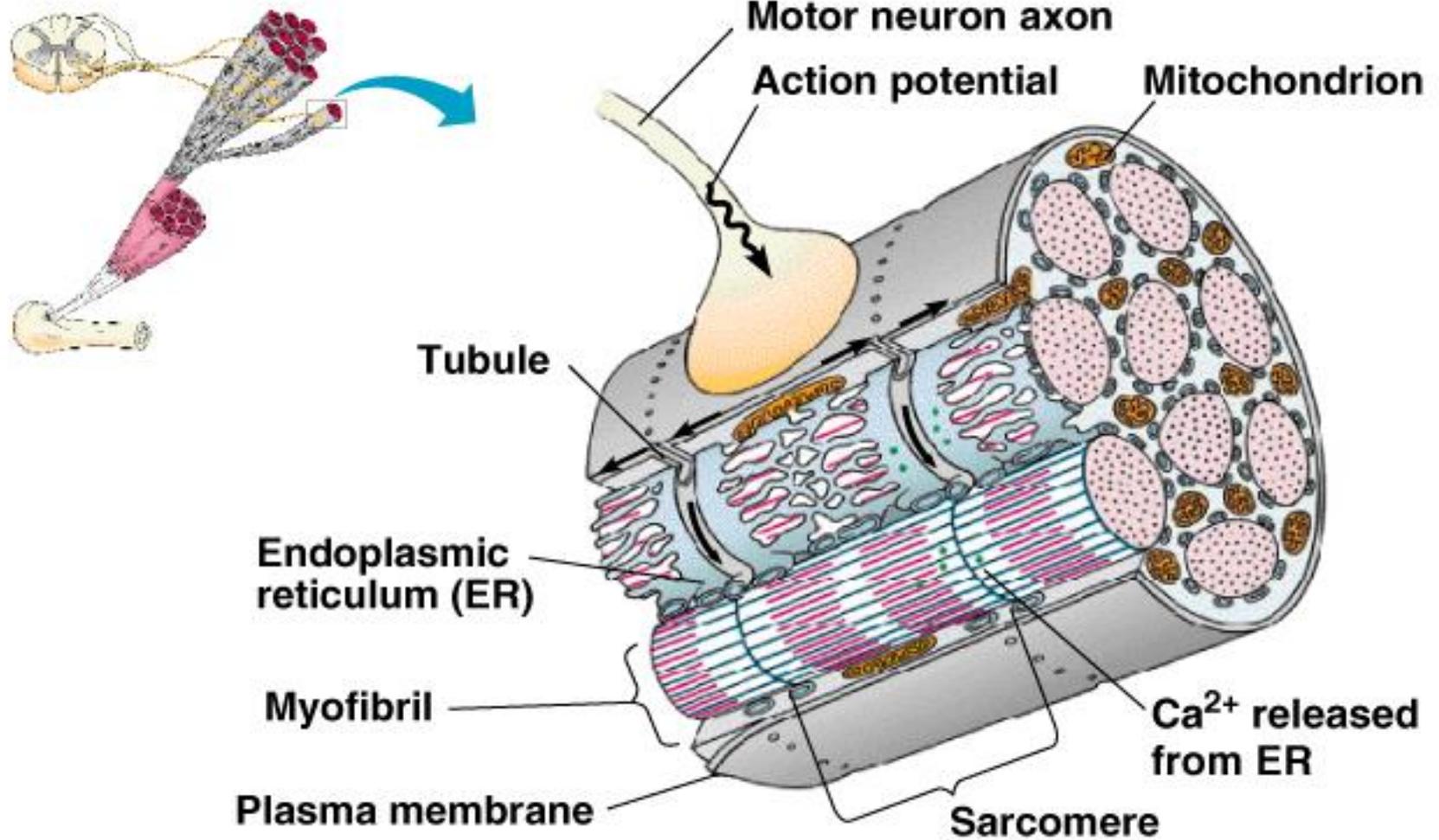


Fig 30.10A

# Motor neurons and muscle contraction

- Mechanism of stimulation:
  - An action potential releases acetylcholine into the neuromuscular junction
  - Acetylcholine depolarizes the muscle cell channels inside on the sarcoplasmic reticulum release Ca so it can reach the contractile apparatus
- Mechanism of relaxation
  - Motor neuron stops firing
  - Ca pumped back into the SR

**Fig 30.10B**



# Muscle injuries

- **The Injury** The term 'pulled muscle' comes from the description of how the injury takes place. Usually the muscle is forcibly stretched beyond its limits and the muscle tissue becomes torn. Depending upon its severity it is classified as a first, second or third degree strain:
  - a first degree strain is damage to a few muscle fibres.
  - a second degree strain is damage to a more extensive number of muscle fibres.
  - a third degree strain is a complete rupture of the muscle itself.

# Muscle injuries

## Signs and Symptoms Grade 1

- With a grade 1 calf strain the signs may not be present until after the activity is over.
- There may be a sensation of cramp or tightness and a slight feeling of pain when the muscles are stretched or contracted.

## • **Grade 2**

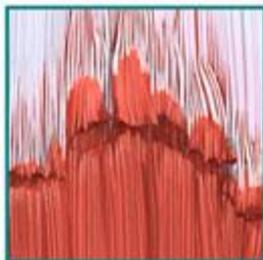
- With a grade 2 calf strain there is immediate pain which is more severe than the pain of a grade one injury.
- It is confirmed by pain on stretch and contraction of the muscle.
- A grade 2 calf strain is usually sore to touch.

## • **Grade 3**

- A grade 3 calf strain is a catastrophic injury.
- There is an immediate burning or stabbing pain and the athlete is unable to walk without pain.
- The muscle is completely torn and there may be a large lump of muscle tissue above a depression where the tear is.

# PULLED MUSCLE FIBRES

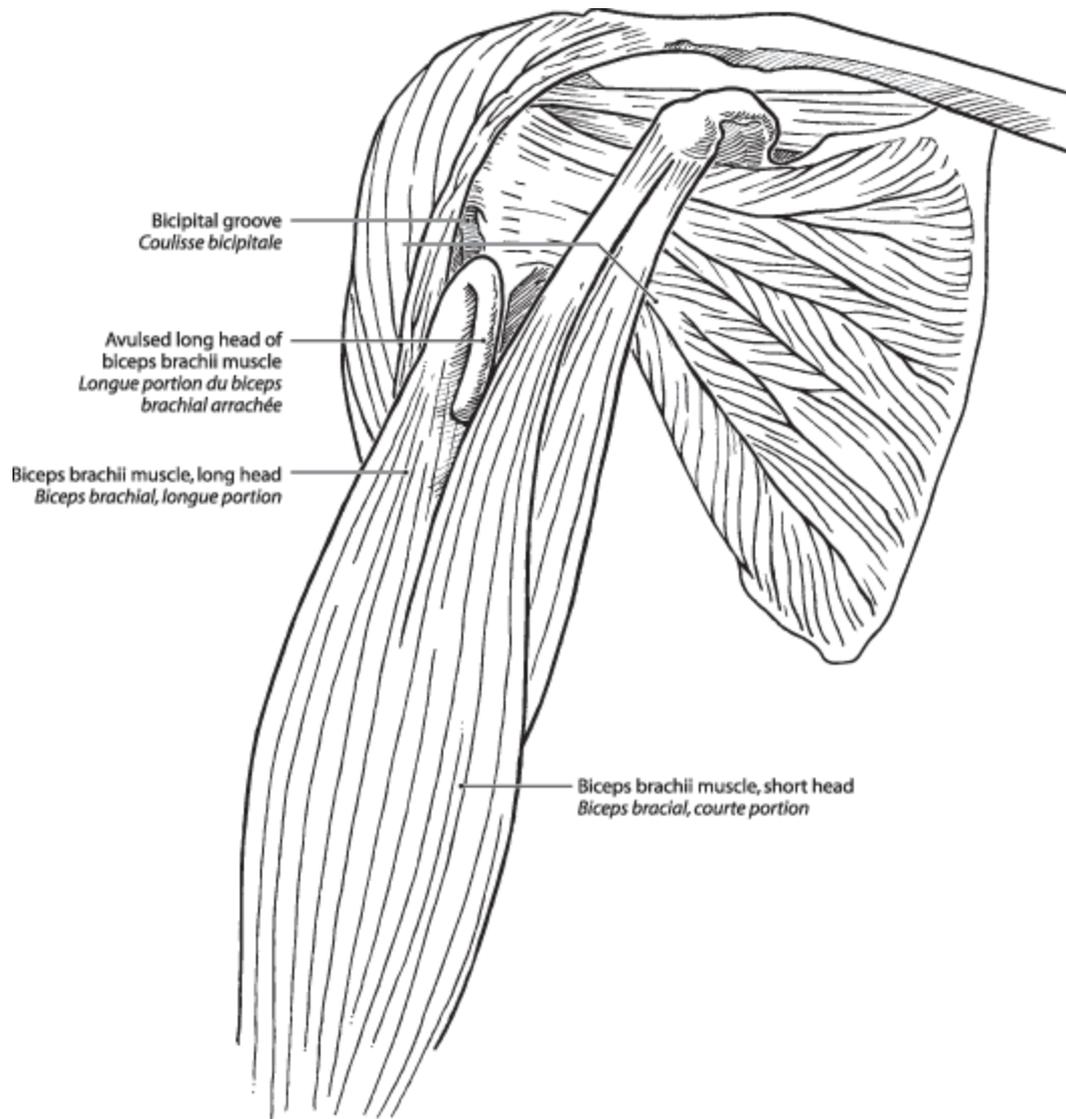
Grade three injury



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FIGURE 26. Decolorized muscle from Case 70. The patient died 4 days after injury. The muscle cells, which should stain intensely with the phosphotungstic acid hematoxylin, employed stain weakly. Cross-striations are exaggerated and numerous transverse clefts have appeared. An occasional cell has become hyalinized and lost all evidence of striation. There is much hemorrhage into the interstitial connective tissue.



**Tear of the long head of the biceps**  
**Déchirure de la longue portion du biceps**



Thank you !