Sliding Filament Theory

Dr. R. Venkatesan
M.Sc (Ex.Phy)., M.Sc (Psy)., M.P.Ed.,
M.Phil.,PGDY., Ph.D.

Contraction Sequence: Sliding Filament Theory

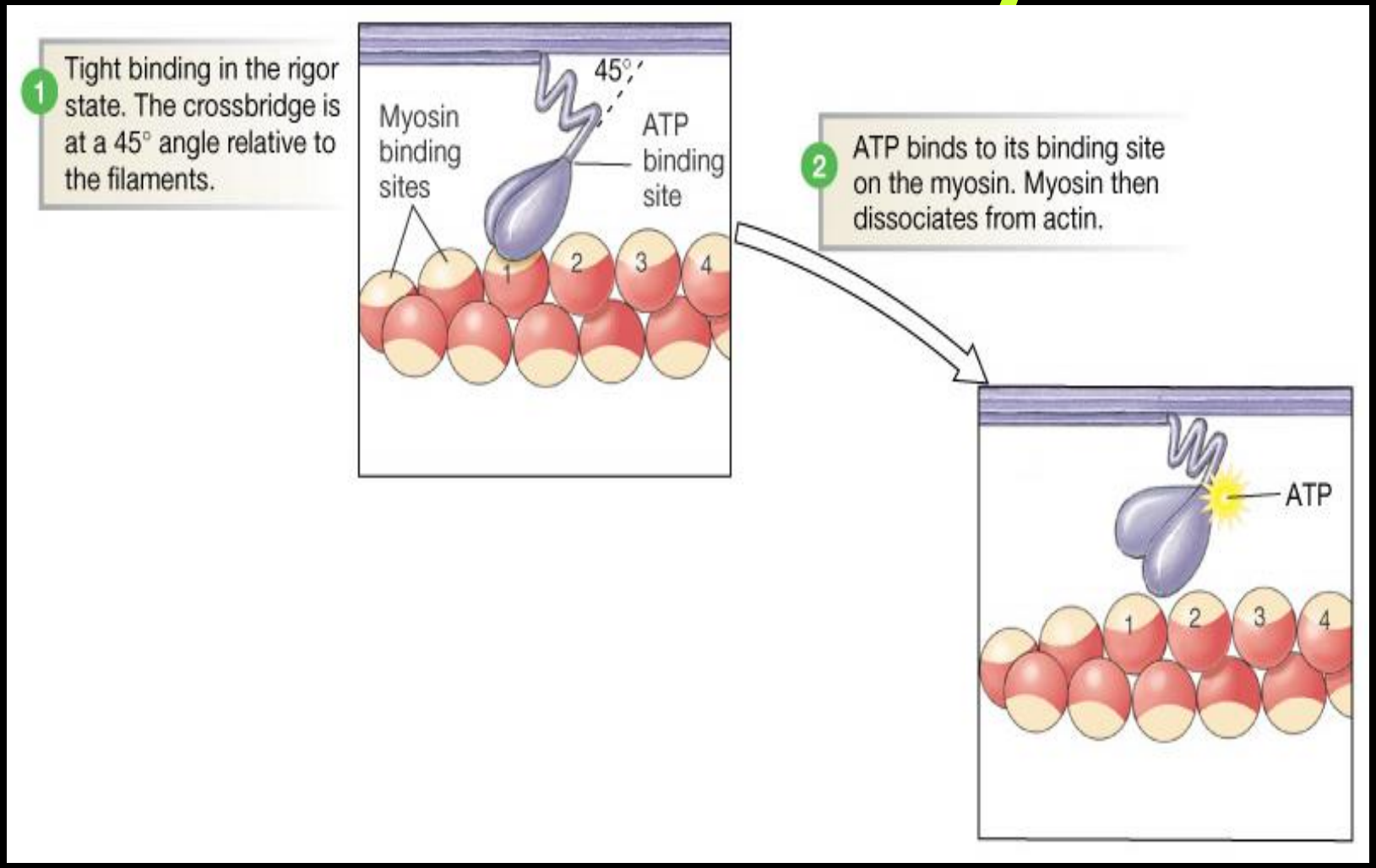


Figure 12-9 (steps 1 & 2): The molecular basis of contraction

Contraction Sequence: Sliding Filament Theory

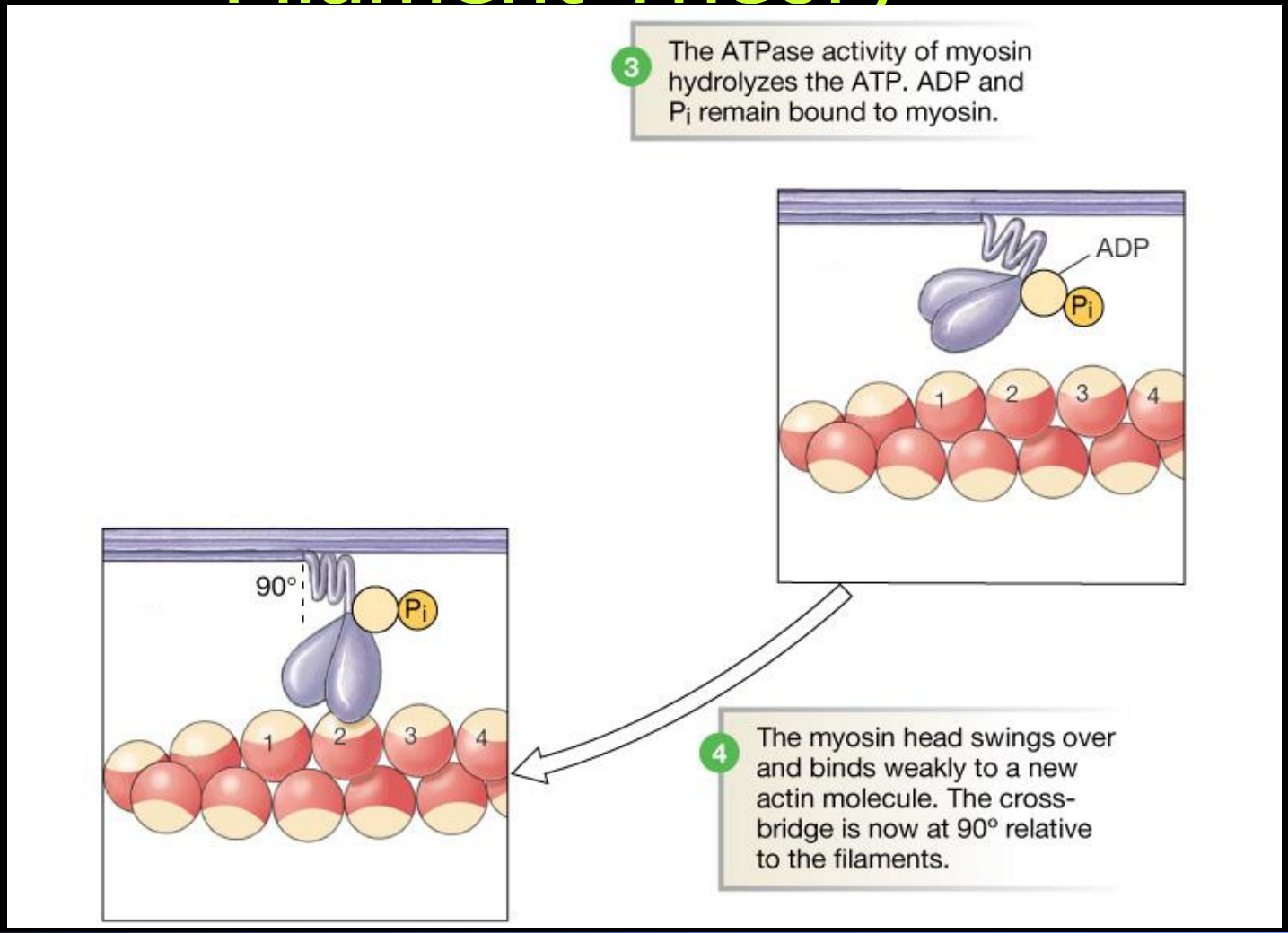


Figure 12-9 (steps 3 & 4): The molecular basis of contraction

Contraction Sequence: Sliding Filament Theory

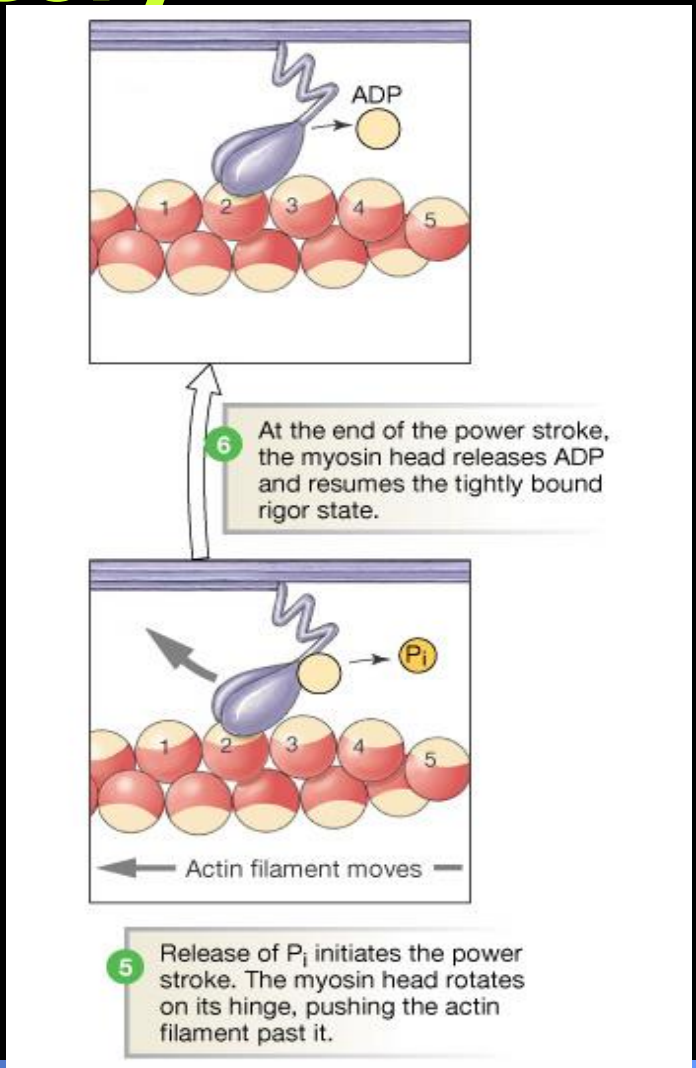
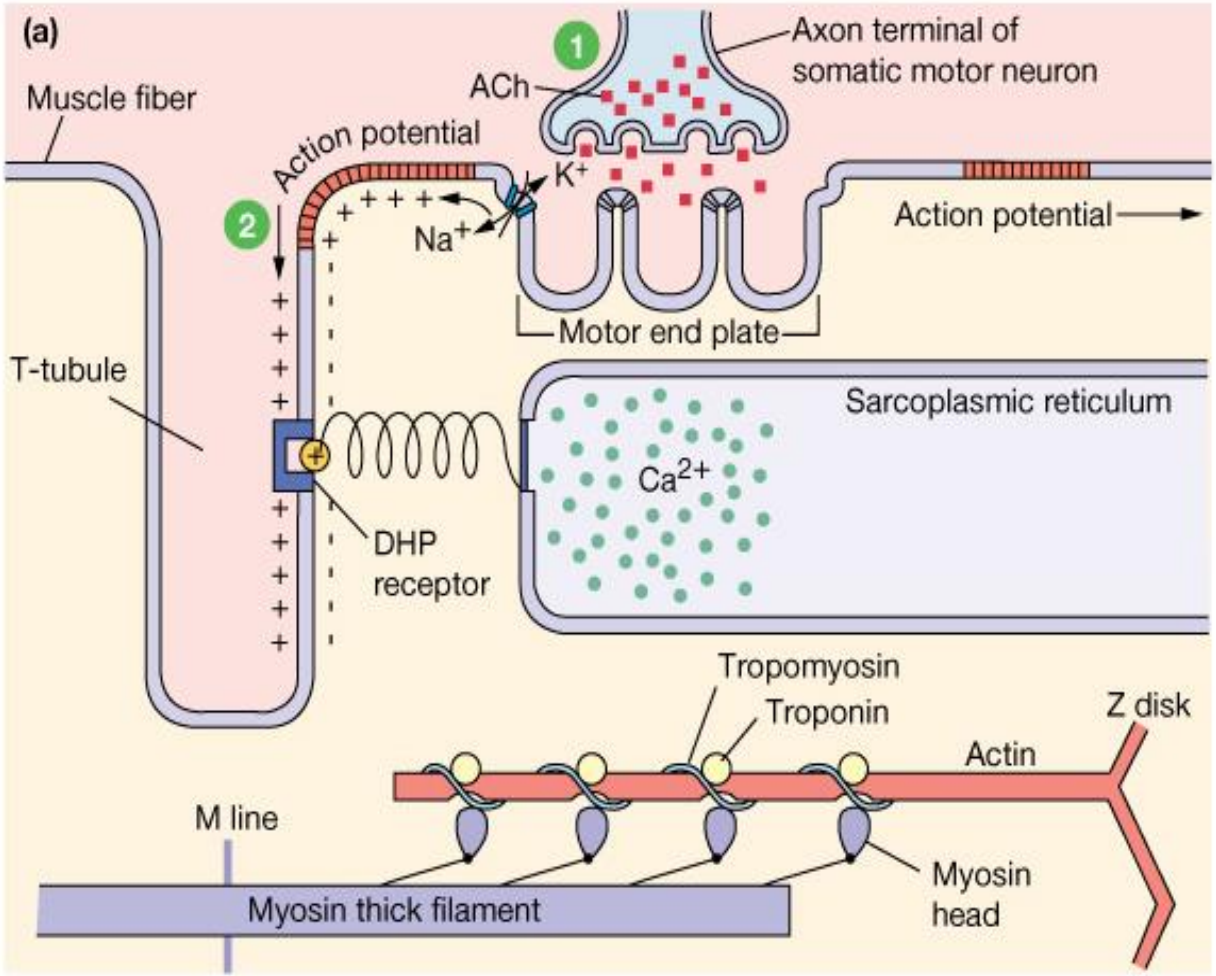


Figure 12-9 (steps 5 & 6): The molecular basis of contraction

Skeletal Muscle Contraction: Mechanism



1 Somatic motor neuron releases ACh at neuromuscular junction.

2 Net entry of Na^+ through ACh receptor-channel initiates a muscle action potential.

Figure 12-11a: Excitation-contraction coupling

Skeletal Muscle Contraction: Mechanism

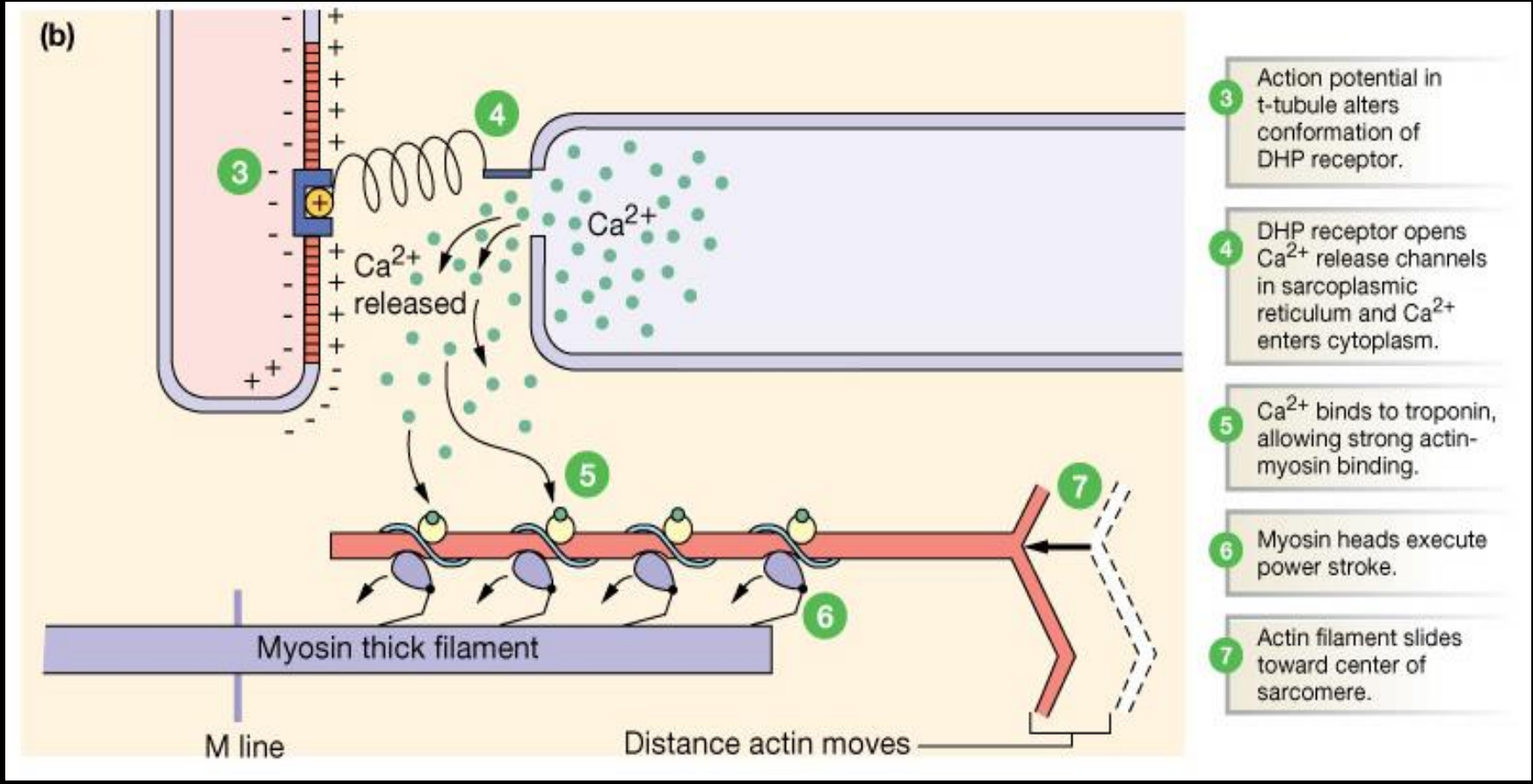


Figure 12-11b: Excitation-contraction coupling

Energy for Contraction: ATP & Phosphocreatine

- Aerobic Respiration
  - Oxygen
  - Glucose
  - Fatty acids
  - 30-32 ATPs
- Anaerobic Respiration
  - Fast but
  - 2 ATP/glucose
- Phosphocreatine →ATPs

Energy for Contraction: ATP & Phosphocreatine

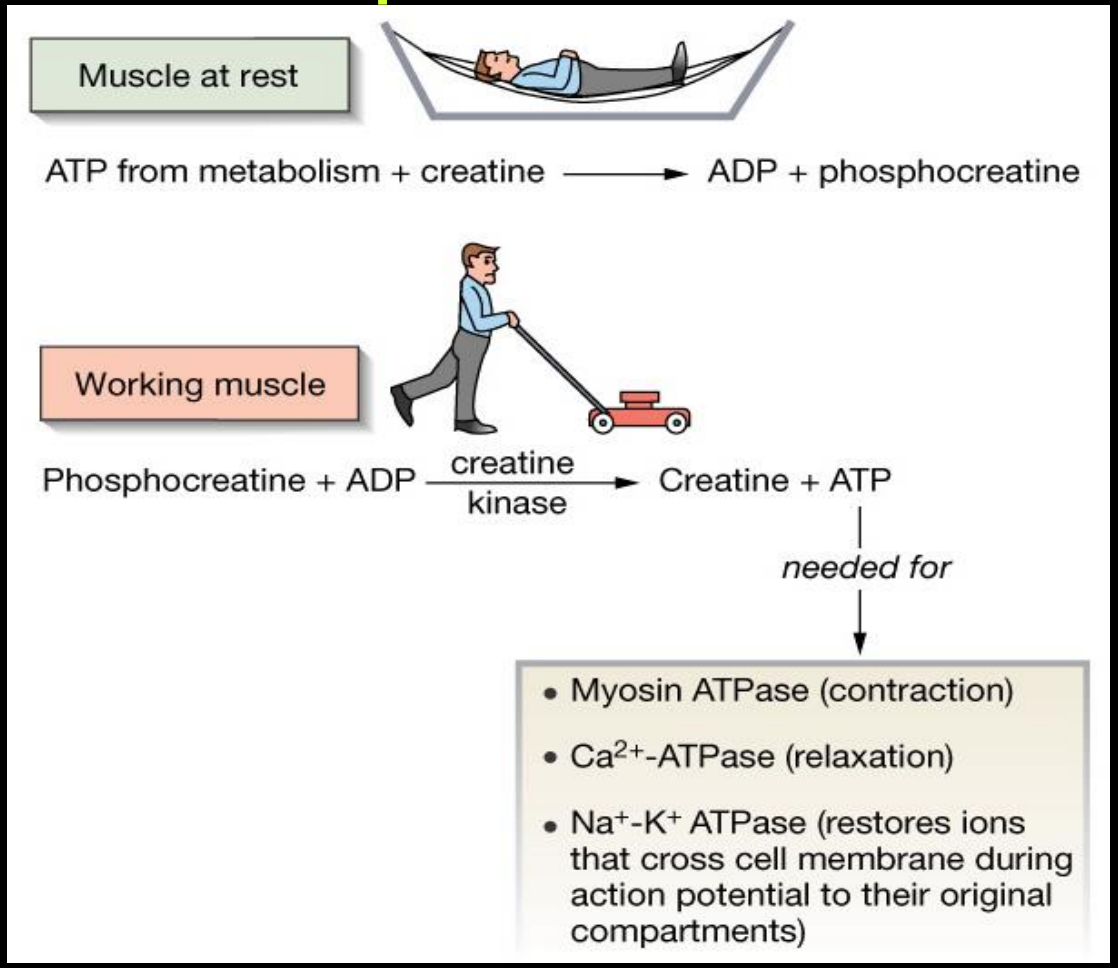


Figure 12-13: Phosphocreatine

Muscle Fatigue: Causes not well known

- Central
  - "Feeling"
  - Lactic acid
- Peripheral
  - Glycogen depletion
  - Ca^{2+} interference
  - High P_i levels
  - ECF high K^+
  - ACh depletion

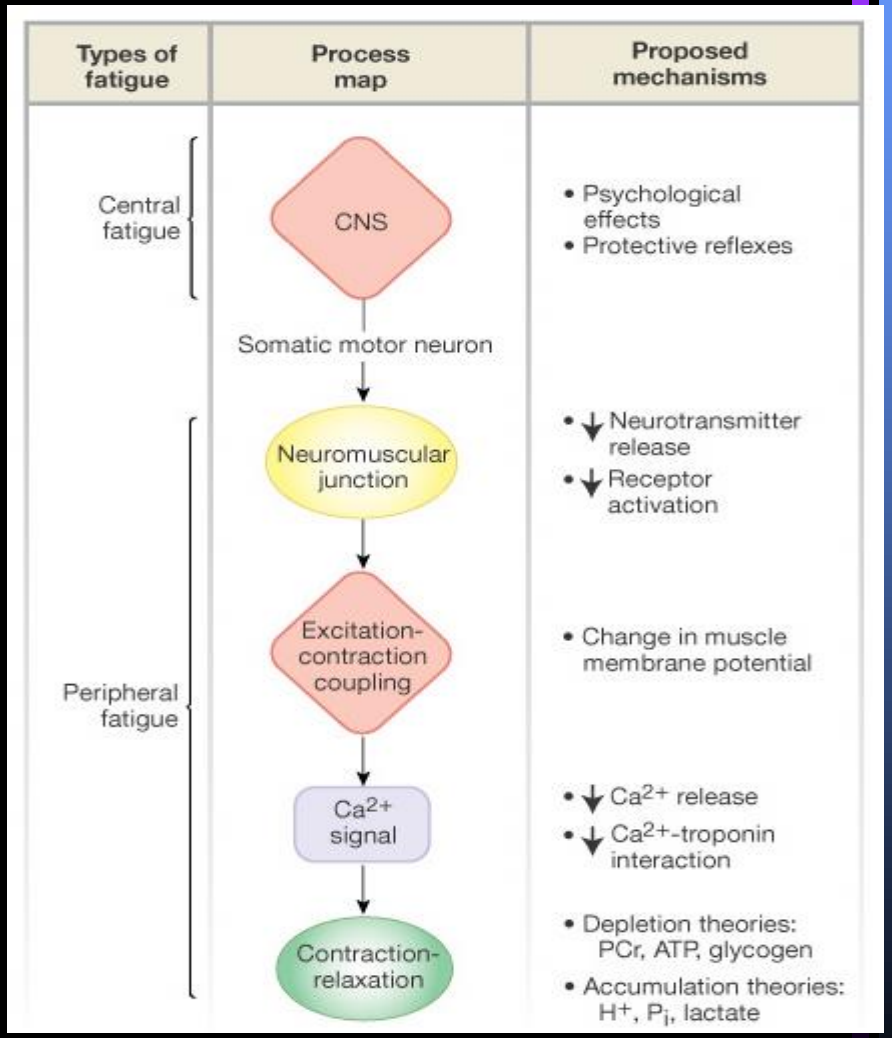
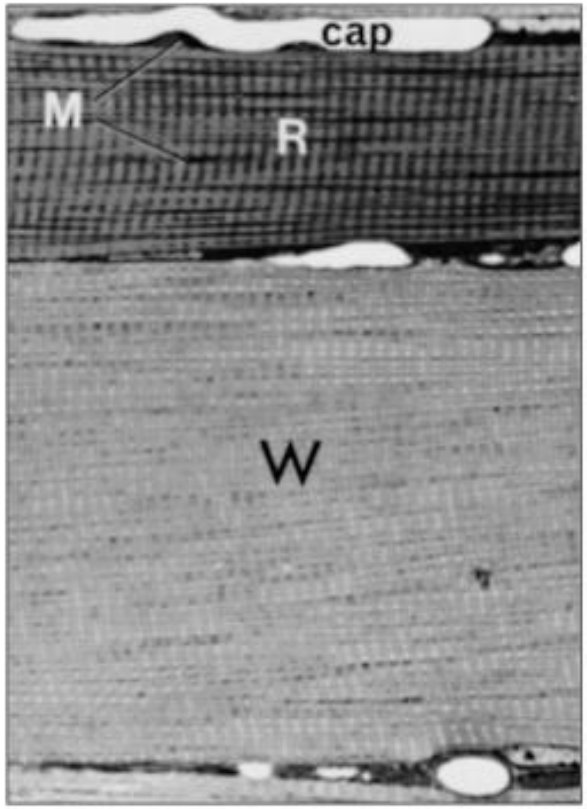


Figure 12-14: Locations and possible causes of muscle fatigue

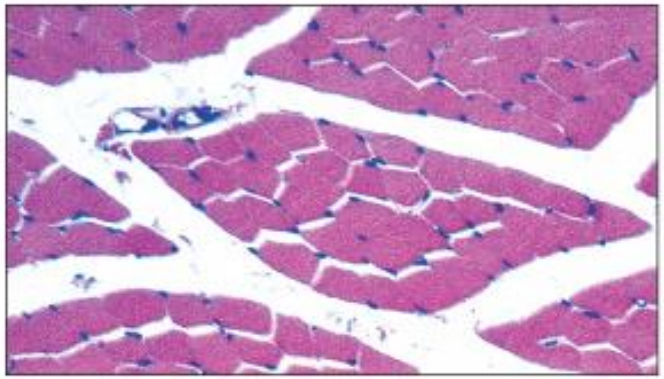
Fiber Contraction Speed: Fast Twitch

- Rate
  - 2-3 times faster
  - SR uptake of Ca^{2+}
  - ATP splitting
- Anaerobic/Fatigue easily
  - Power lifting
  - Fast/delicate
  - Sprint

Fiber Contraction Speed: Fast Twitch



Slow-twitch oxidative muscle fibers
Note smaller diameter, darker color due to myoglobin. Fatigue-resistant.



Fast-twitch glycolytic muscle fibers
Larger diameter, pale color. Easily fatigued.

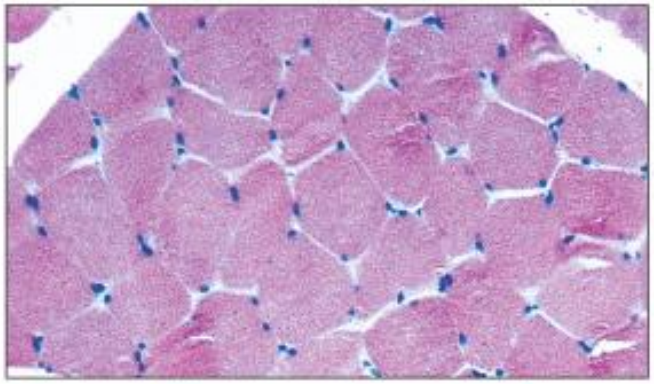


Figure 12-15: Fast-twitch glycolytic and slow-twitch muscle fibers

Fiber Contraction Speed: Oxidative Fast & Slow

- Oxidative Fast Twitch
  - Intermediate speed
  - Anaerobic & aerobic
- Slow Twitch: Aerobic, less fatigue
  - More mitochondria
  - More capillaries
  - Myoglobin
  - Endurance activities
  - Postural muscles

Coordinating the Fibers: Force of Contraction

- Excitation and Twitch
- Length–Tension: more crossbridges: more tension

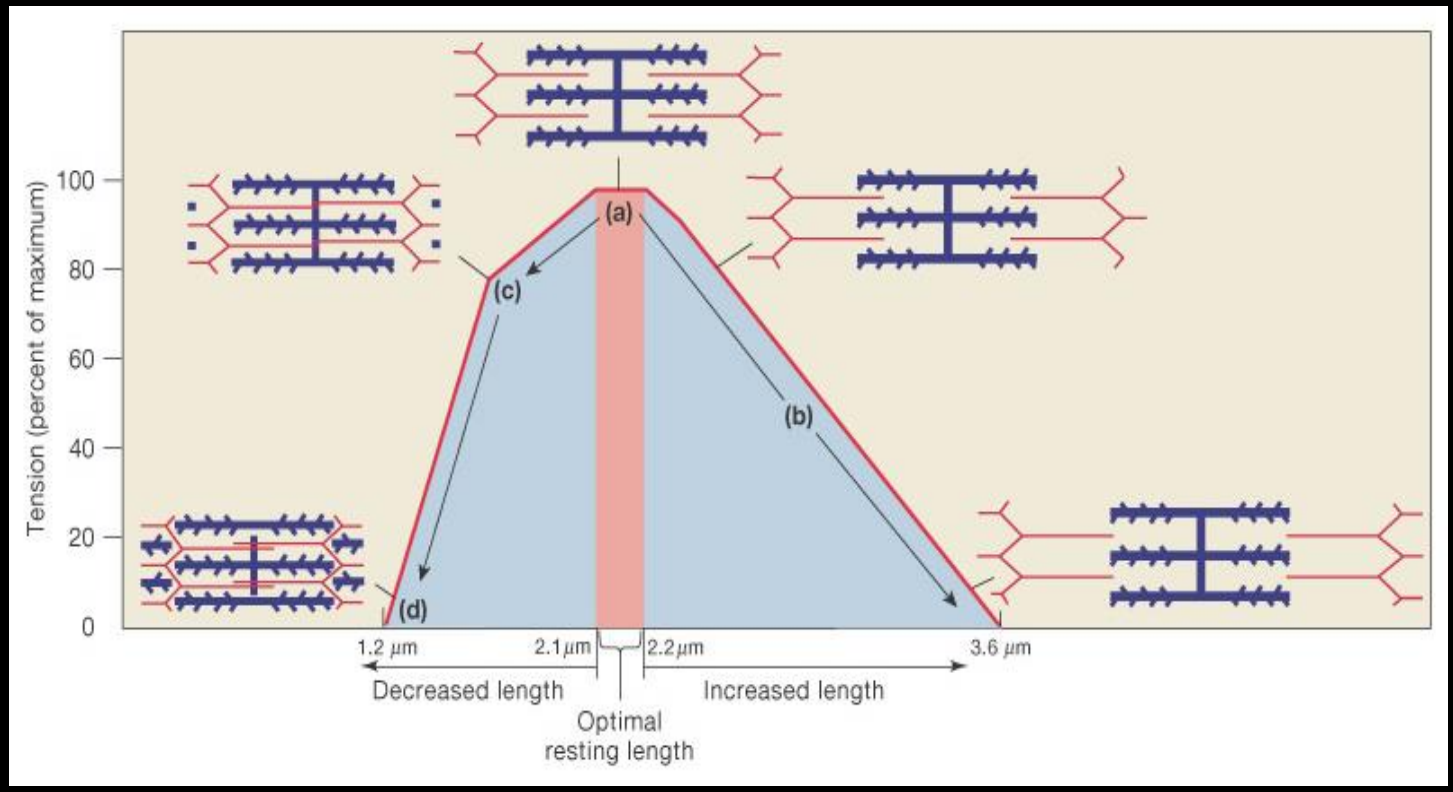
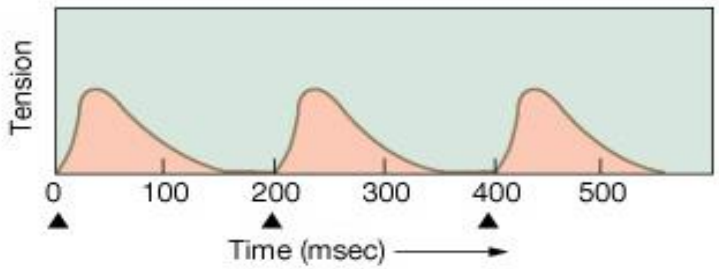


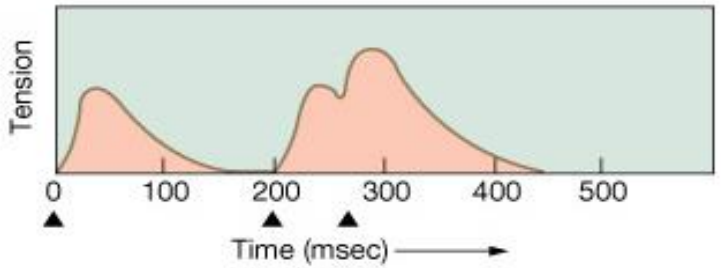
Figure 12-16: Length-tension relationships in contracting skeletal muscle

Coordinating the Fibers: Summation to Tetanus

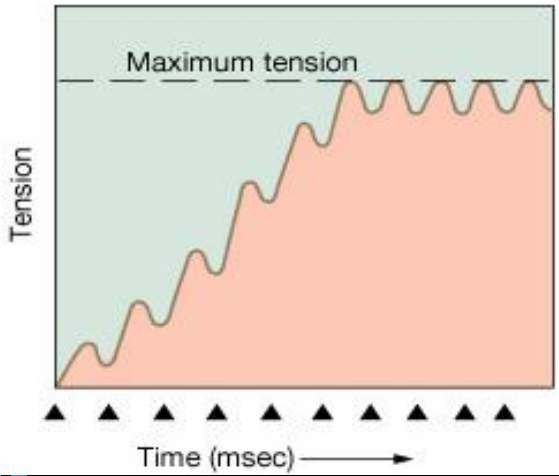
(a) Single twitches: Muscle relaxes completely between stimuli (▲).



(b) Summation: Stimuli closer together do not allow muscle to relax fully.



(c) Summation leading to unfused tetanus: Stimuli are far enough apart to allow muscle to relax slightly between stimuli.



(d) Summation leading to complete tetanus: Muscle reaches steady tension.

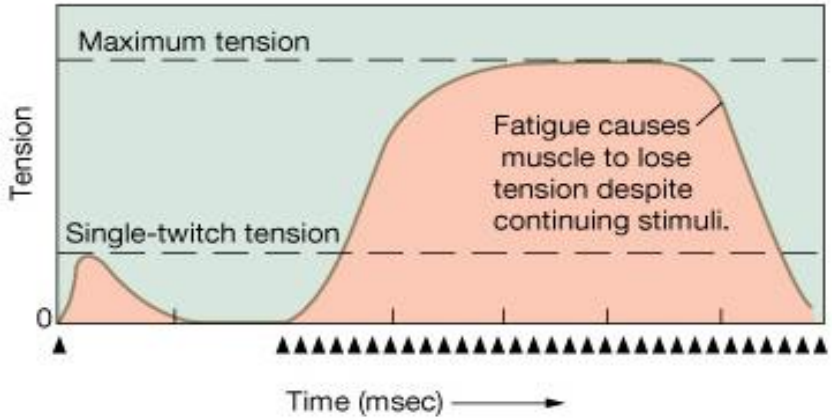


Figure 12-17: Summation of contractions