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Organization of skeletal muscle, Physiology of muscle contraction & Neuromuscular junction



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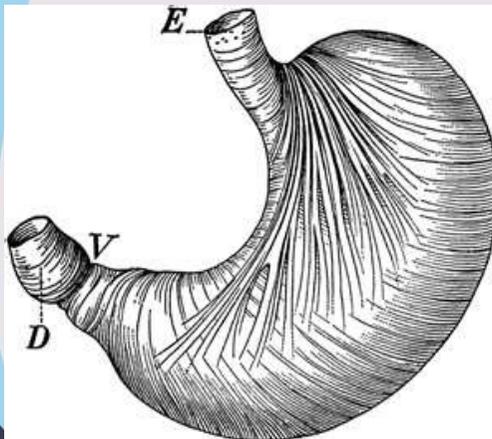
Muscular System



Three Types of Muscle Tissues

Skeletal Muscle

- usually attached to bones
- **voluntary**- under conscious control
- striated



Cardiac Muscle

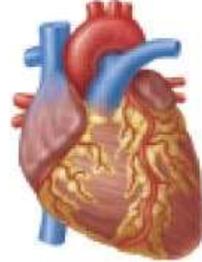
- wall of heart
- **involuntary** - not under conscious control
- striated

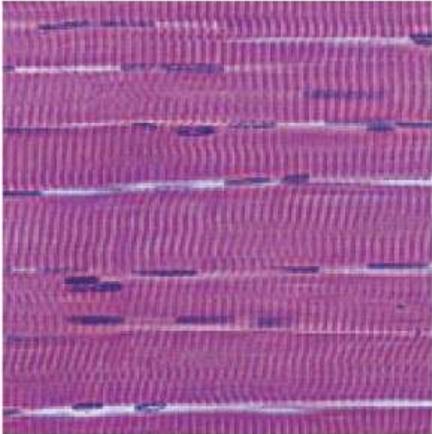
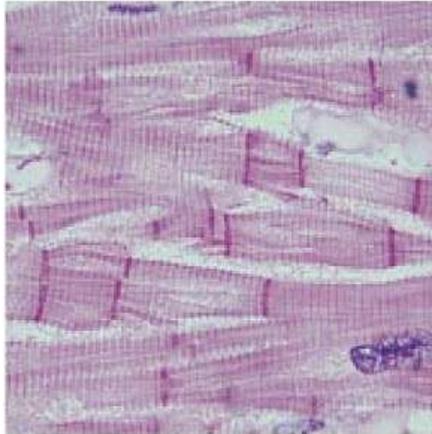
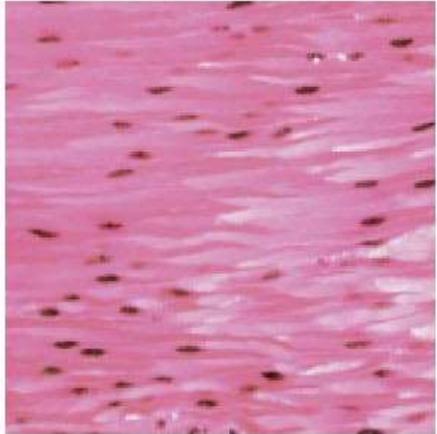
Smooth Muscle

- walls of most viscera, blood vessels, skin
- **involuntary** - not under conscious control
- not striated

TABLE 9.3**Comparison of Skeletal, Cardiac, and Smooth Muscle**

CHARACTERISTIC	SKELETAL	CARDIAC	SMOOTH
Body location	Attached to bones or (some facial muscles) to skin	Walls of the heart	Single-unit muscle in walls of hollow visceral organs (other than the heart); multiunit muscle in intrinsic eye muscles, airways, large arteries
Cell shape and appearance	Single, very long, cylindrical, multinucleate cells with obvious striations	Branching chains of cells; uni- or binucleate; striations	Single, fusiform, uninucleate; no striations

		
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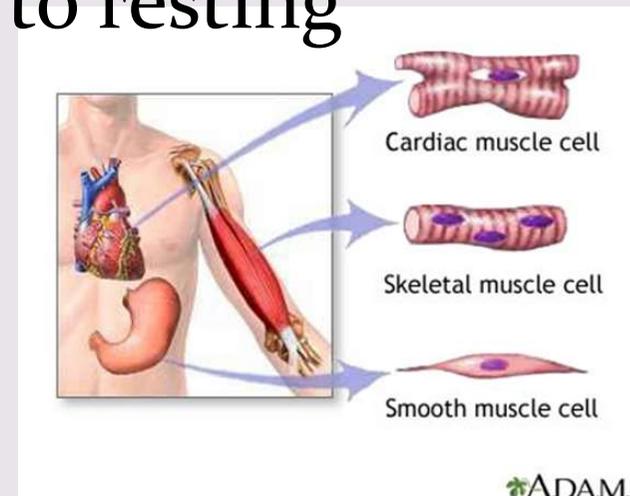
Special Characteristics of Muscle Tissue

Excitability (responsiveness or irritability): ability to receive and respond to stimuli

Contractility: ability to shorten when stimulated

Extensibility: ability to be stretched or extended without damage

Elasticity: ability to recoil to resting length (bounce back)





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Functions of a Muscle Tissue

Movement:

Skeletal- locomotion, vision, facial expression

Cardiac- blood pumping

Smooth- food digestion

Posture: (skeletal)

Joint Stability: (skeletal)

Heat Generation:(skeletal)

A. shivering to increase heat production

B. contract muscle to provide heat

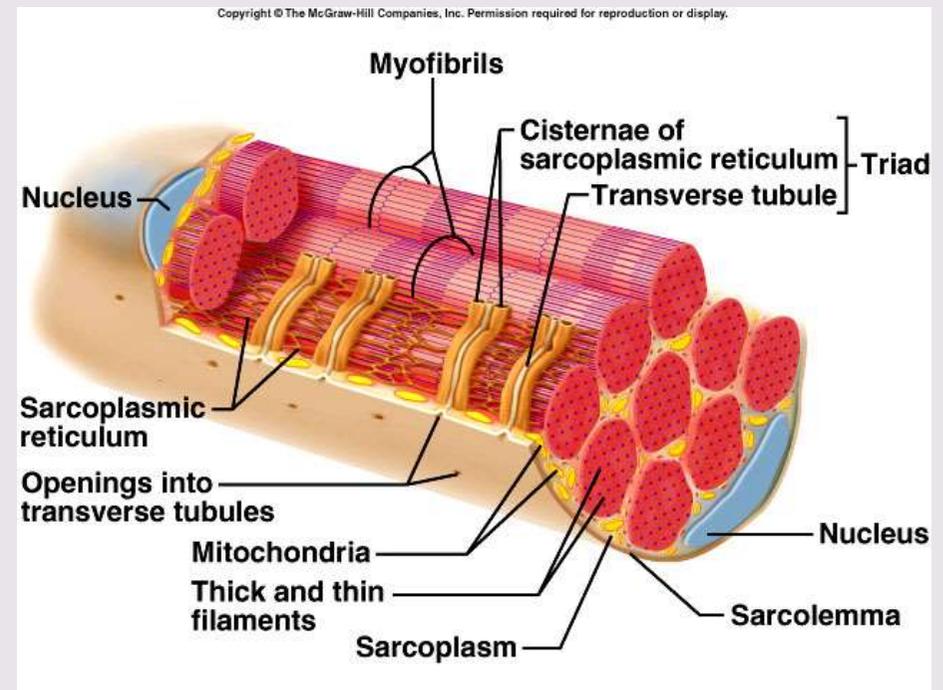


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Microscopic Anatomy of Skeletal Muscle Fiber

- sarcolemma
- sarcoplasm
- sarcoplasmic reticulum
- transverse tubule
- triad
 - cisterna of sarcoplasmic reticulum
 - transverse tubule
- myofibril
- actin filaments
- myosin filaments
- sarcomere





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Microanatomy of a Muscle Fiber (Cell)

transverse
(T) tubules

sarcoplasmic
reticulum

sarcolemma

terminal
cisternae

mitochondria

myoglobin

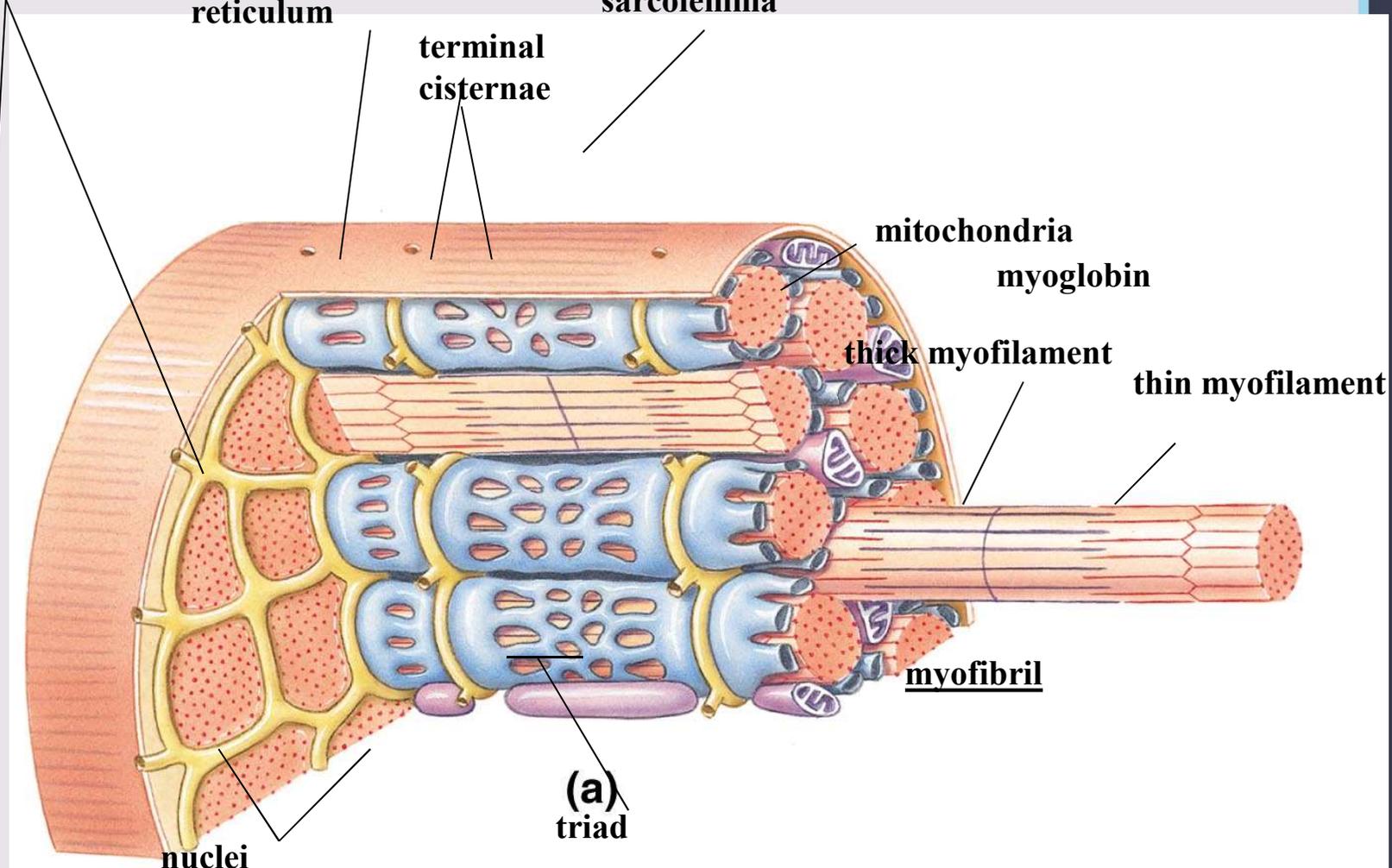
thick myofilament

thin myofilament

myofibril

(a)
triad

nuclei





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Skeletal Muscle Tissue

Muscle Proteins

Myofibrils are built from three kinds of proteins

1) **Contractile proteins**

Generate force during contraction

2) **Regulatory proteins**

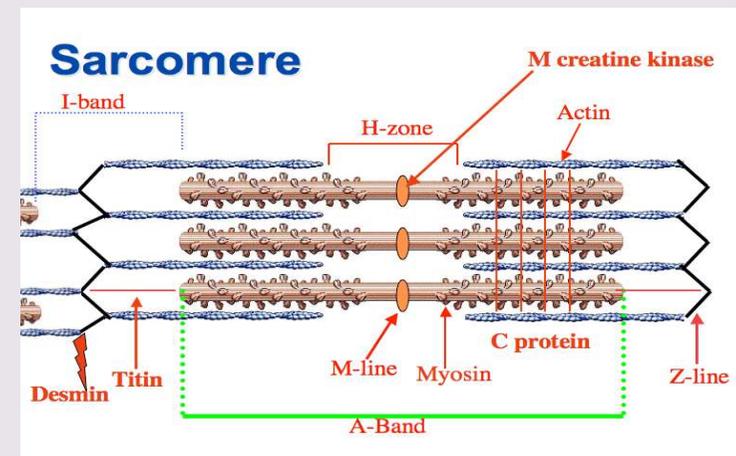
Switch the contraction process on and off

3) **Structural proteins**

Align the thick and thin filaments properly

Provide elasticity and extensibility

Link the myofibrils to the sarcolemma





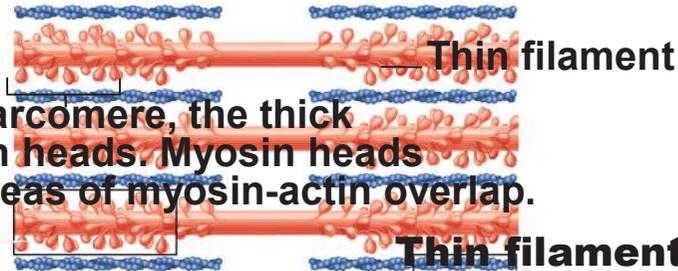
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Longitudinal section of filaments within one sarcomere of a myofibril

Thick filament —

In the center of the sarcomere, the thick filaments lack myosin heads. Myosin heads are present only in areas of myosin-actin overlap.



Thick filament

Each thick filament consists of many myosin molecules whose heads protrude at opposite ends of the filament.

Thin filament

A thin filament consists of two strands of actin subunits twisted into a helix plus two types of regulatory proteins (troponin and tropomyosin).

Portion of a thick filament

Myosin head

Portion of a thin filament

Tropomyosin

Troponin

Actin

Actin-binding sites

ATP-binding site

Heads

Tail

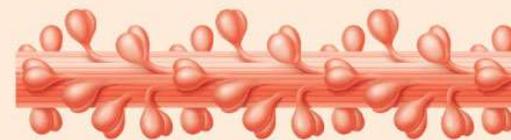
Flexible hinge region

Myosin molecule

Actin subunits

Actin subunits

Active sites for myosin attachment





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Contraction & Relaxation of Skeletal Muscle

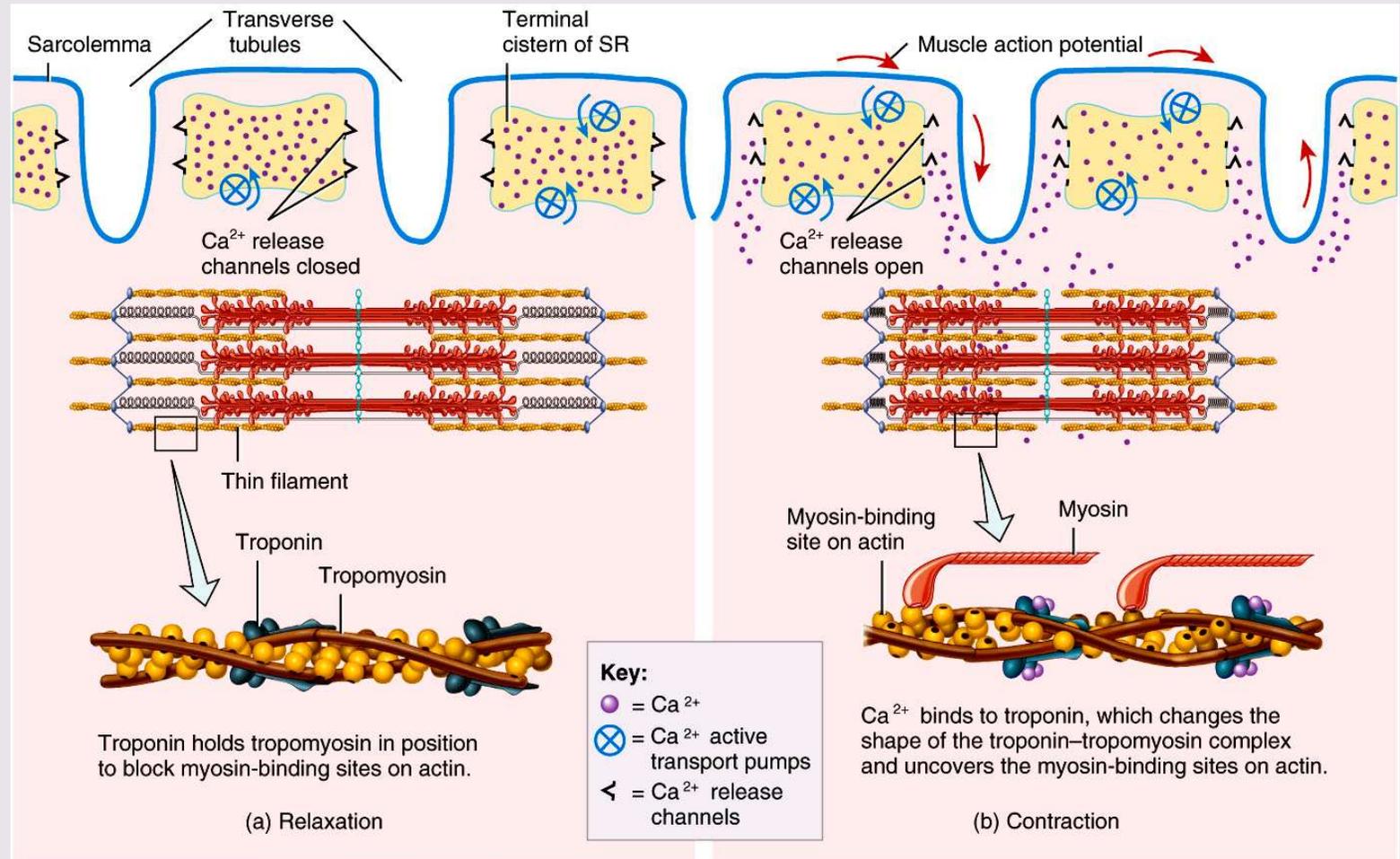


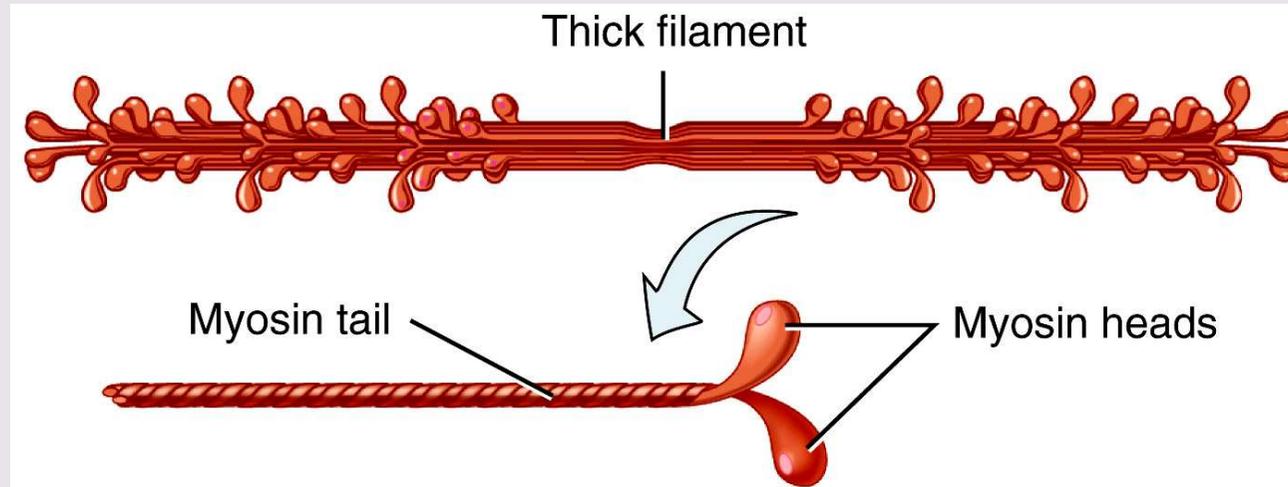
Figure 10.08 Tortora - PAP 12/e
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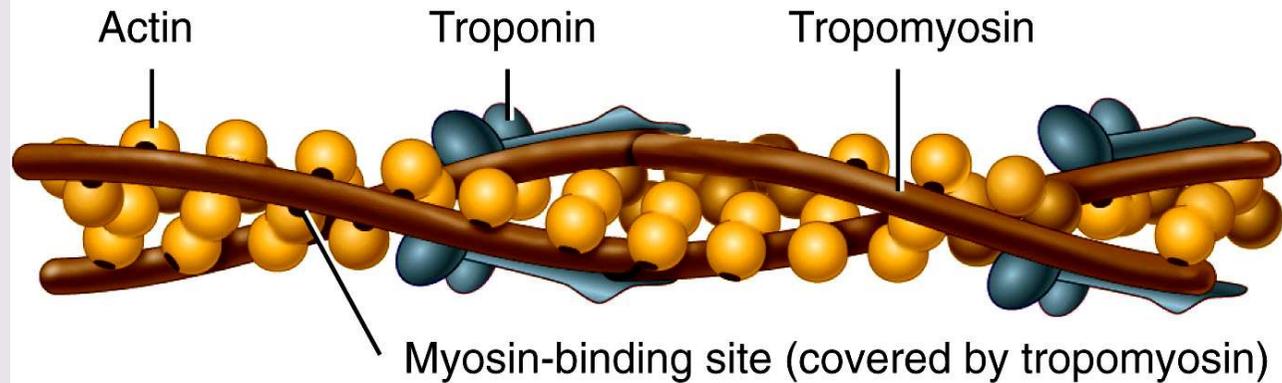
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Contraction & Relaxation of Skeletal Muscle



(a) One thick filament and a myosin molecule



(b) Portion of a thin filament



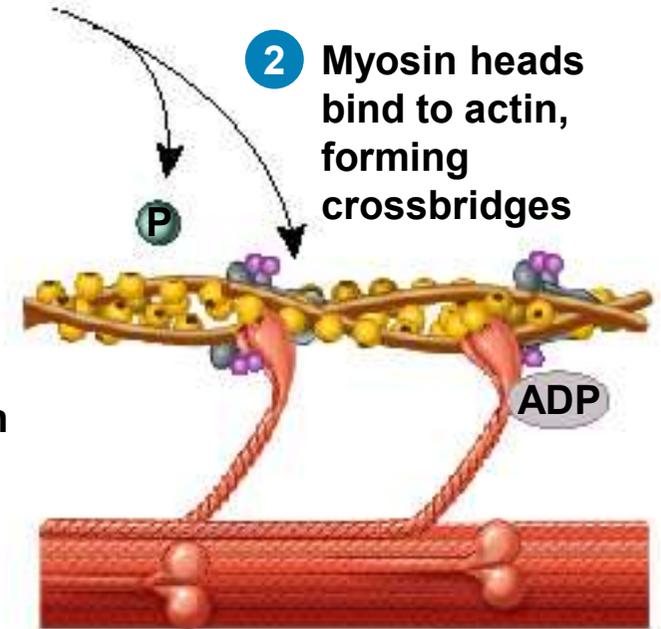
Key:

 = Ca^{2+}

1 Myosin heads hydrolyze ATP and become reoriented and energized



2 Myosin heads bind to actin, forming crossbridges



Contraction cycle continues if ATP is available and Ca^{2+} level in the sarcoplasm is high

3 Myosin crossbridges rotate toward center of the sarcomere (power stroke)



4 As myosin heads bind ATP, the crossbridges detach from actin

