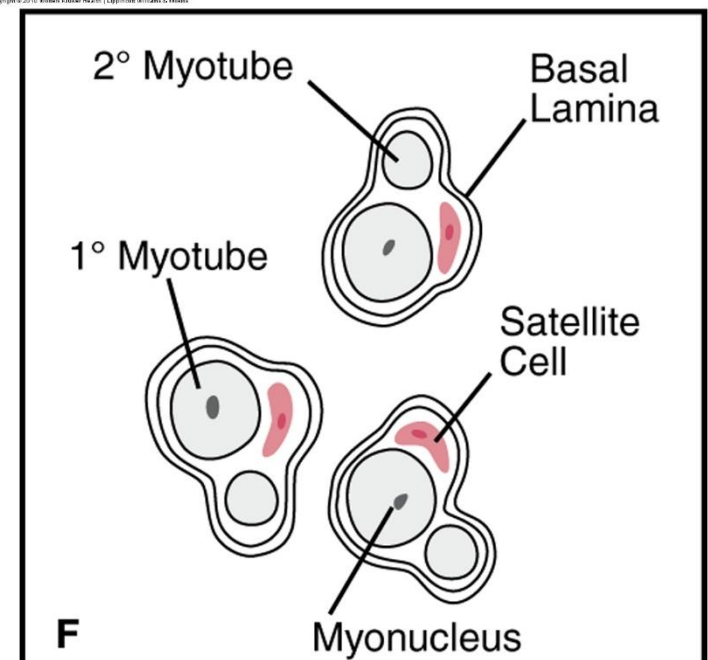
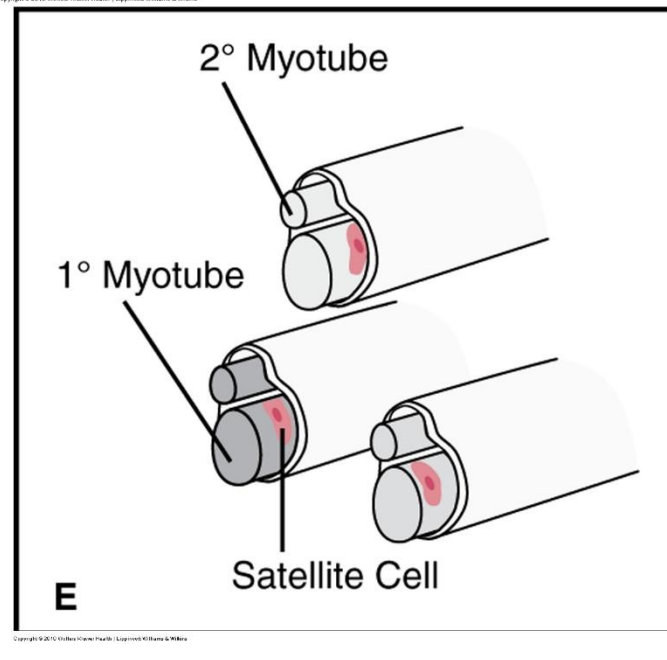
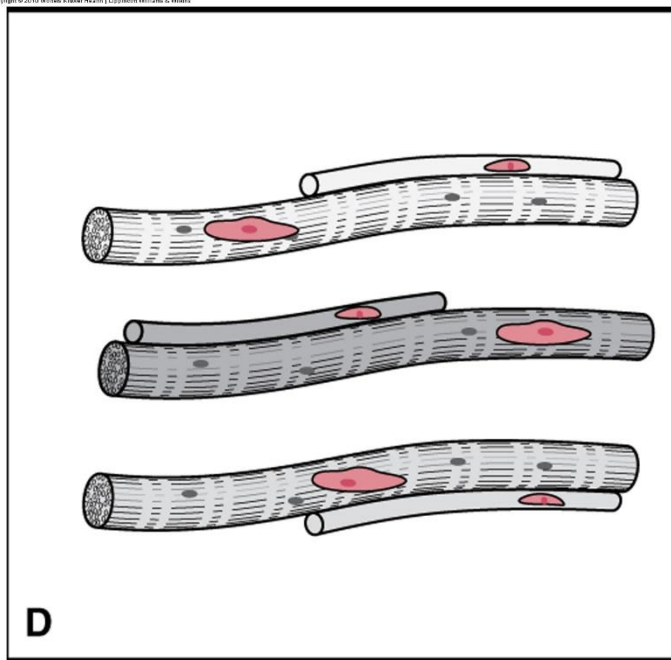
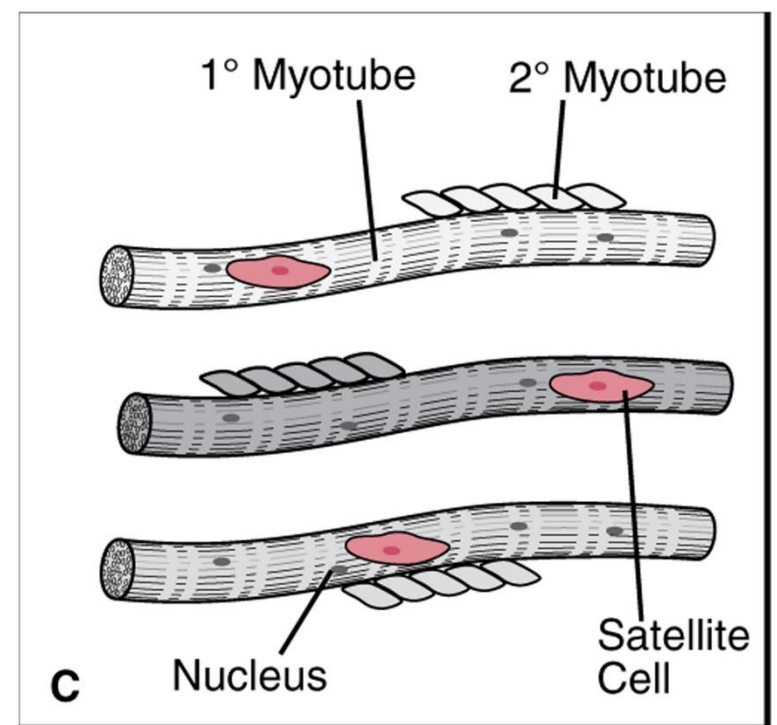
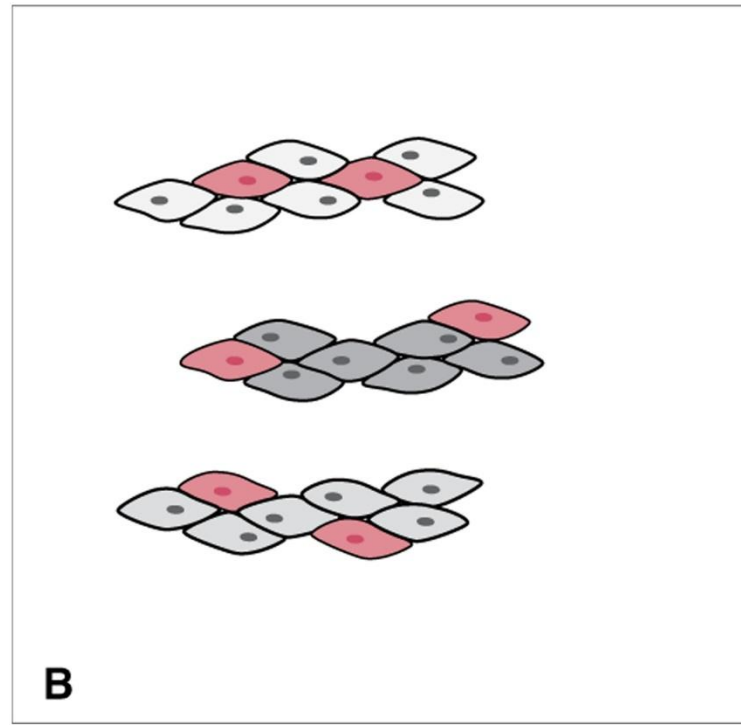
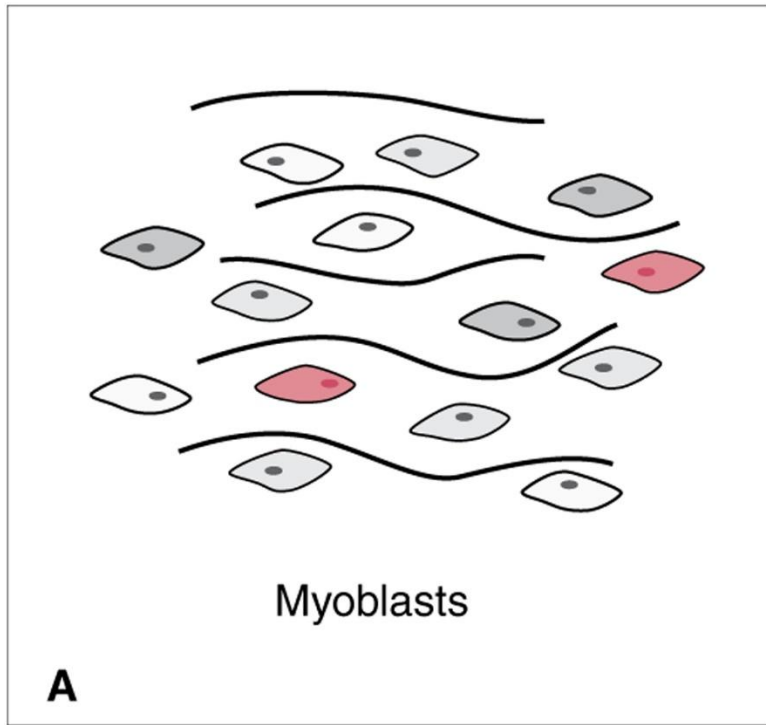
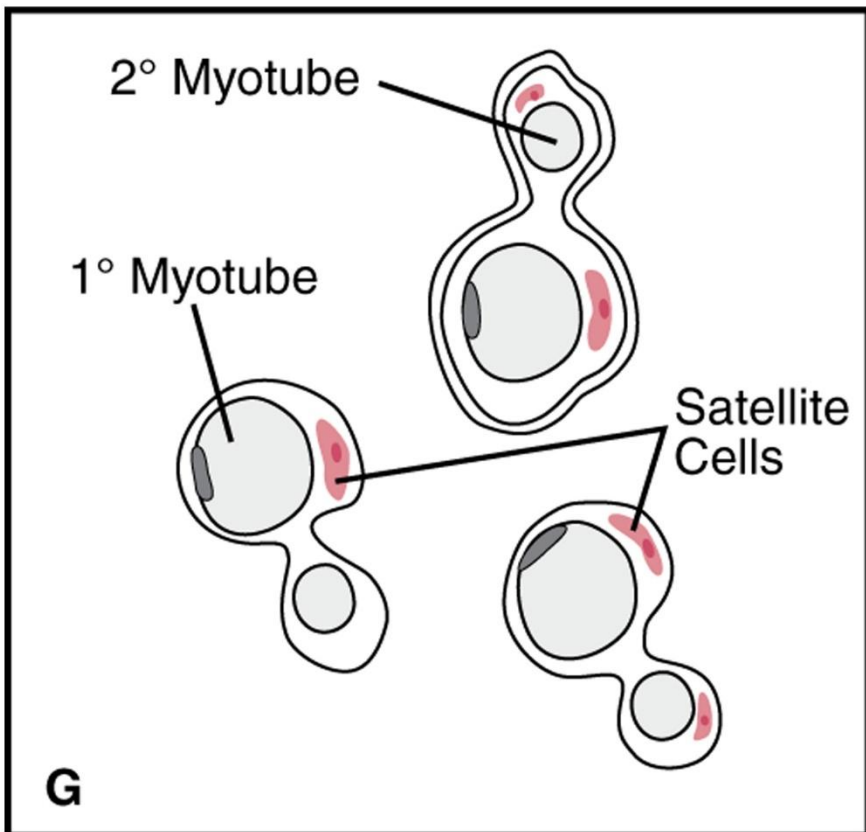
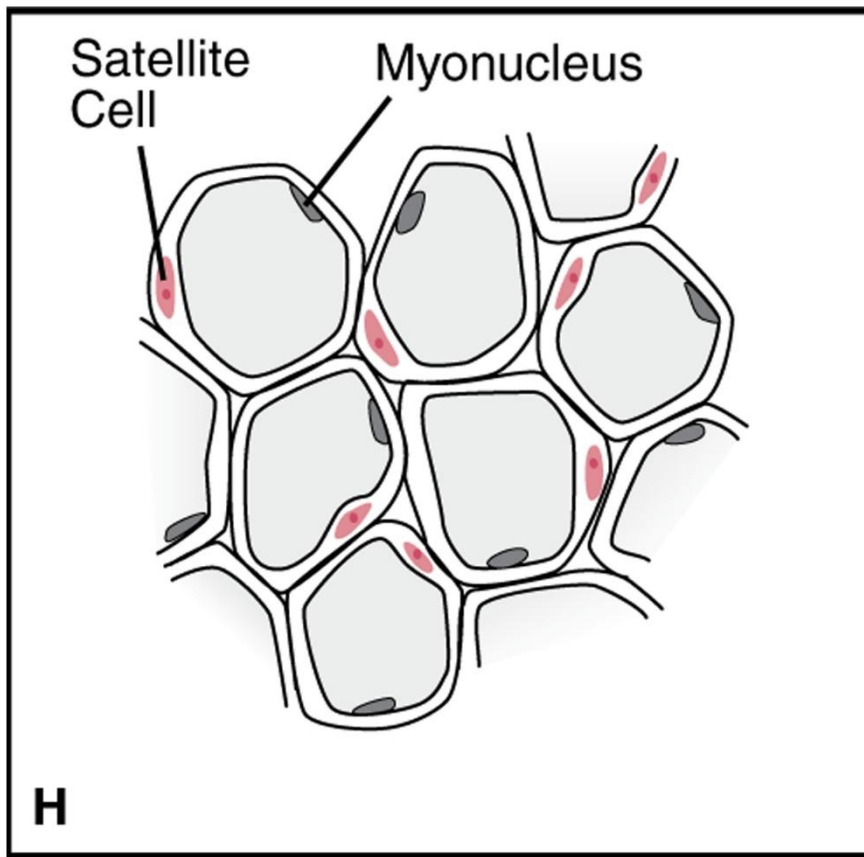


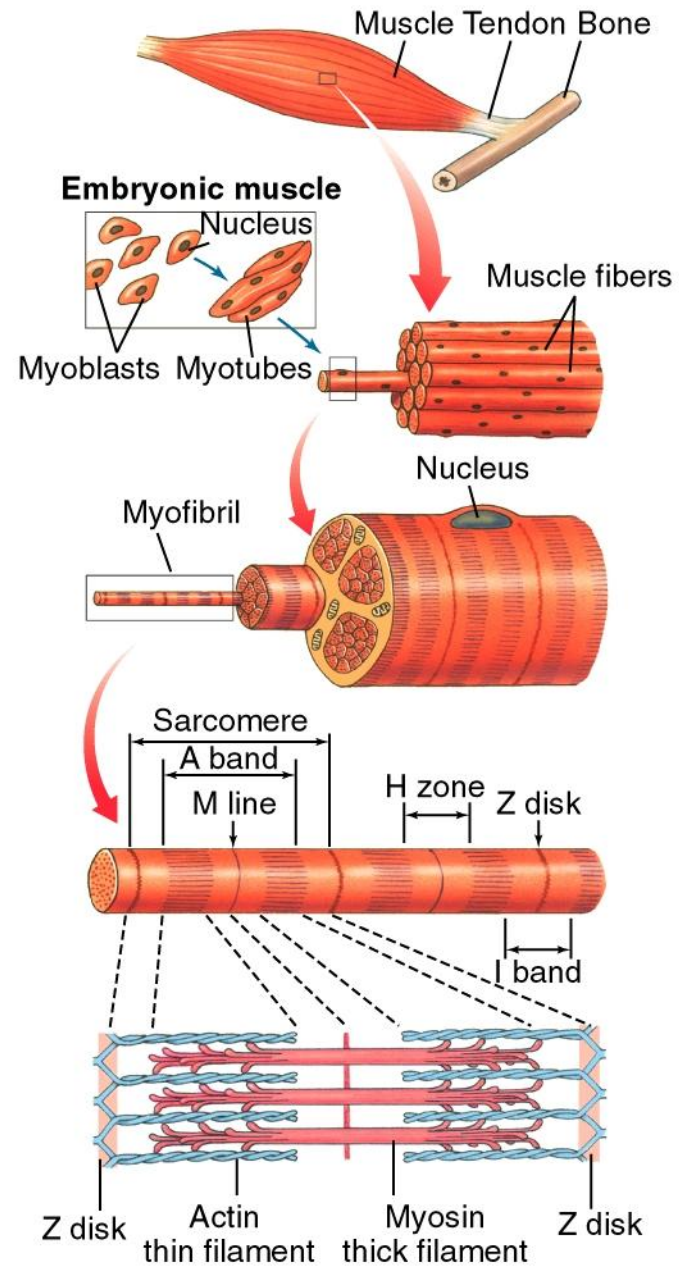


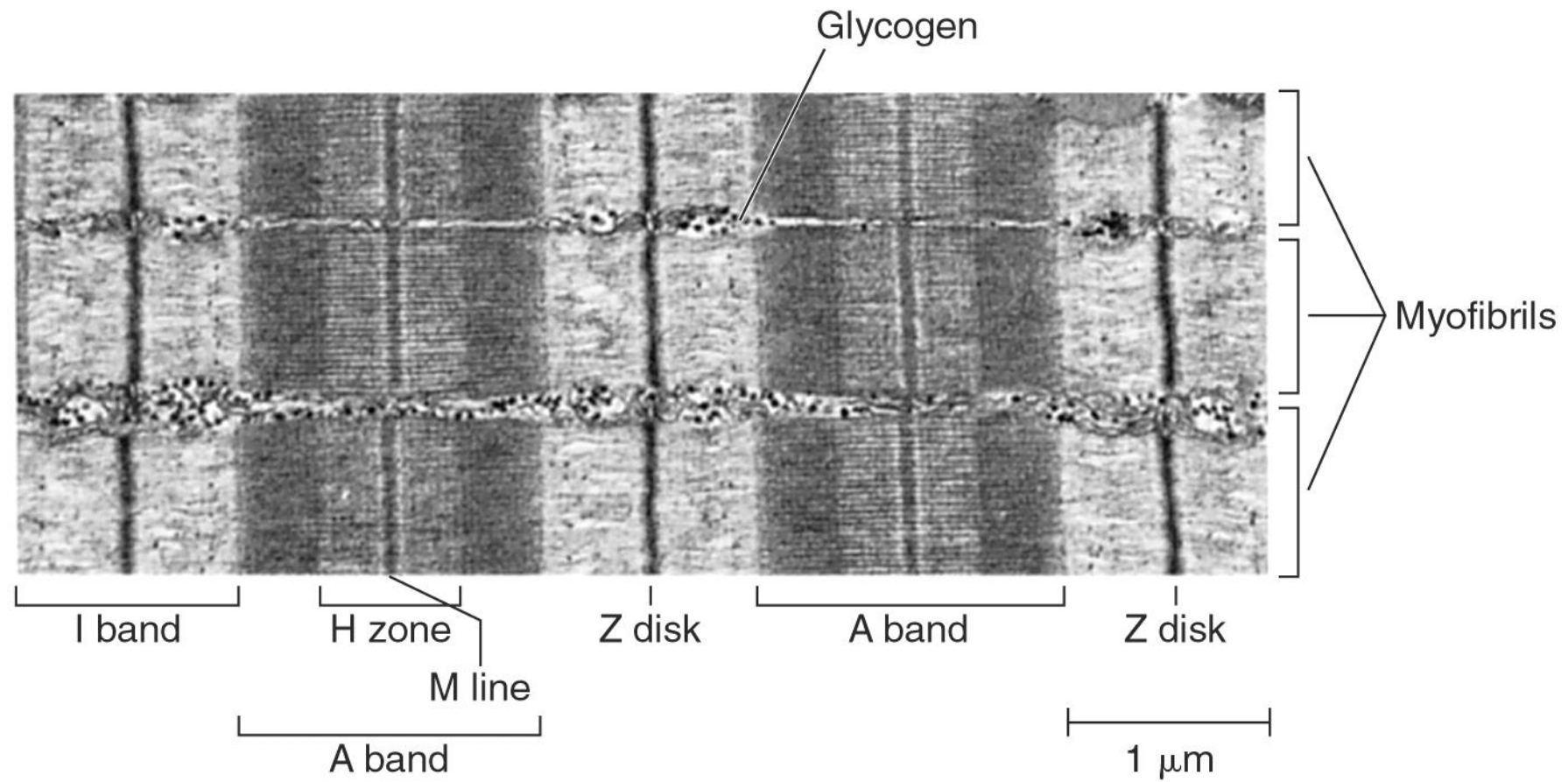


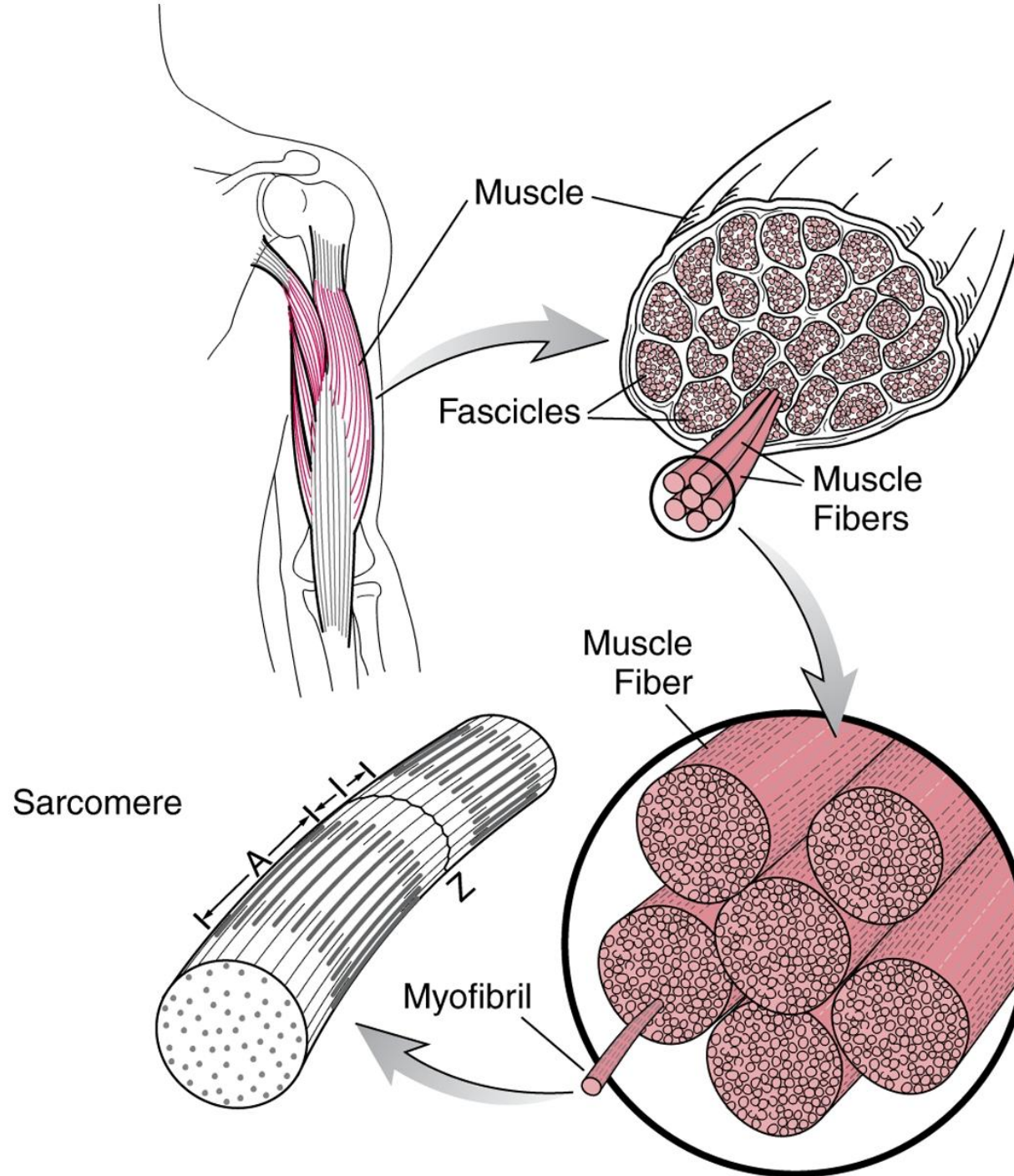
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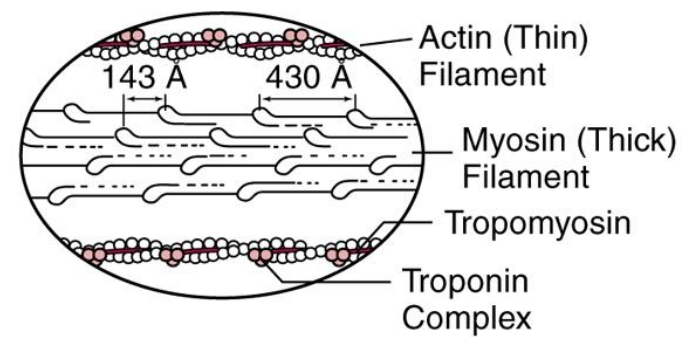
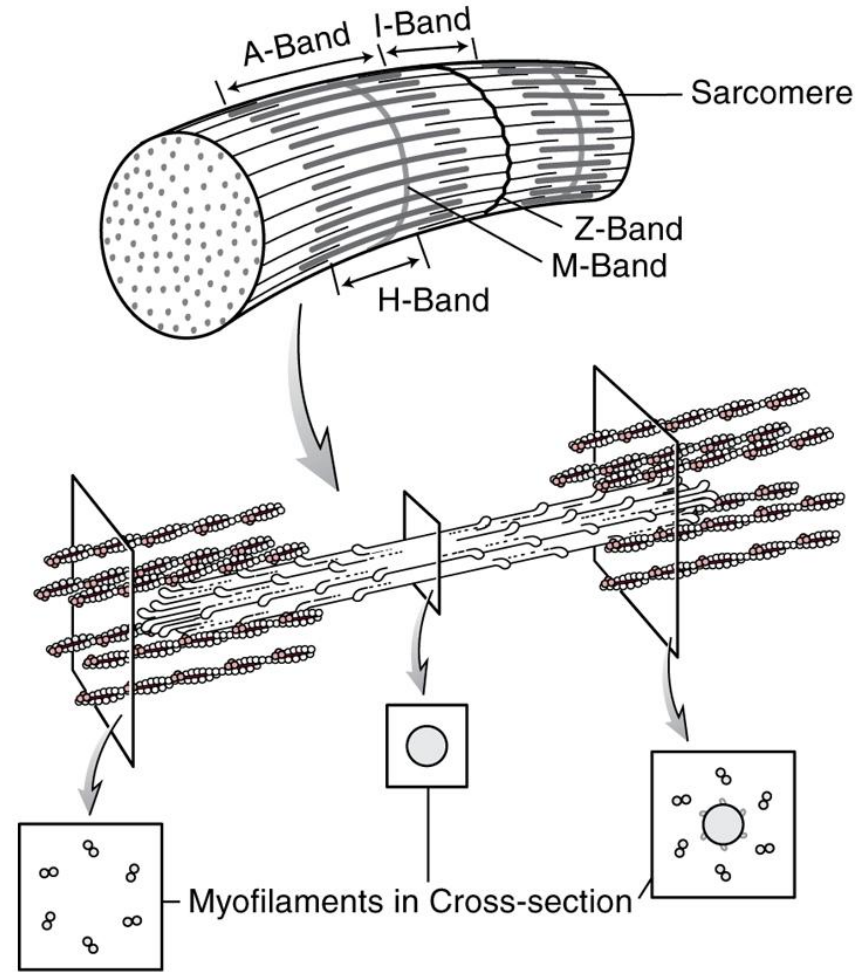


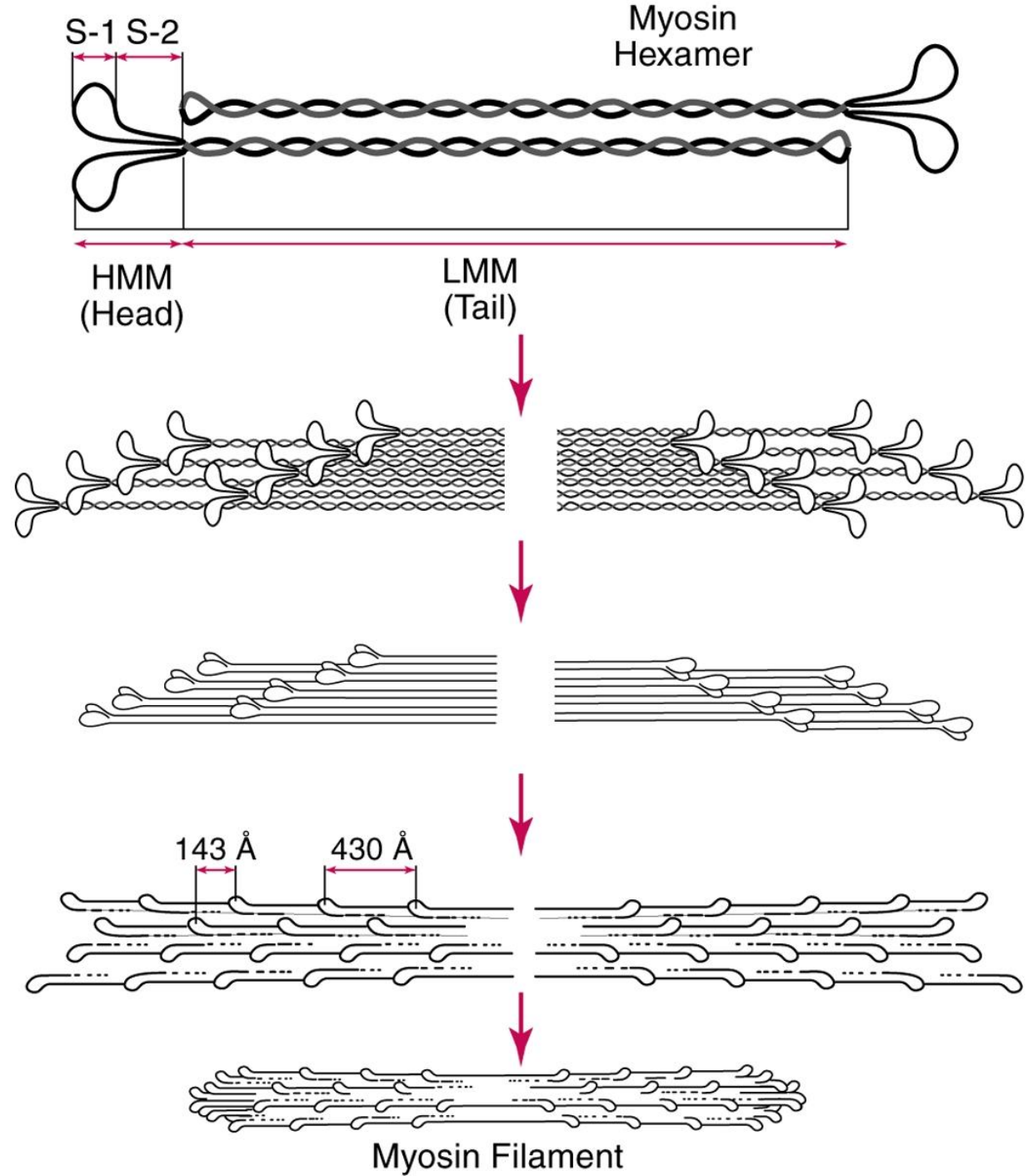
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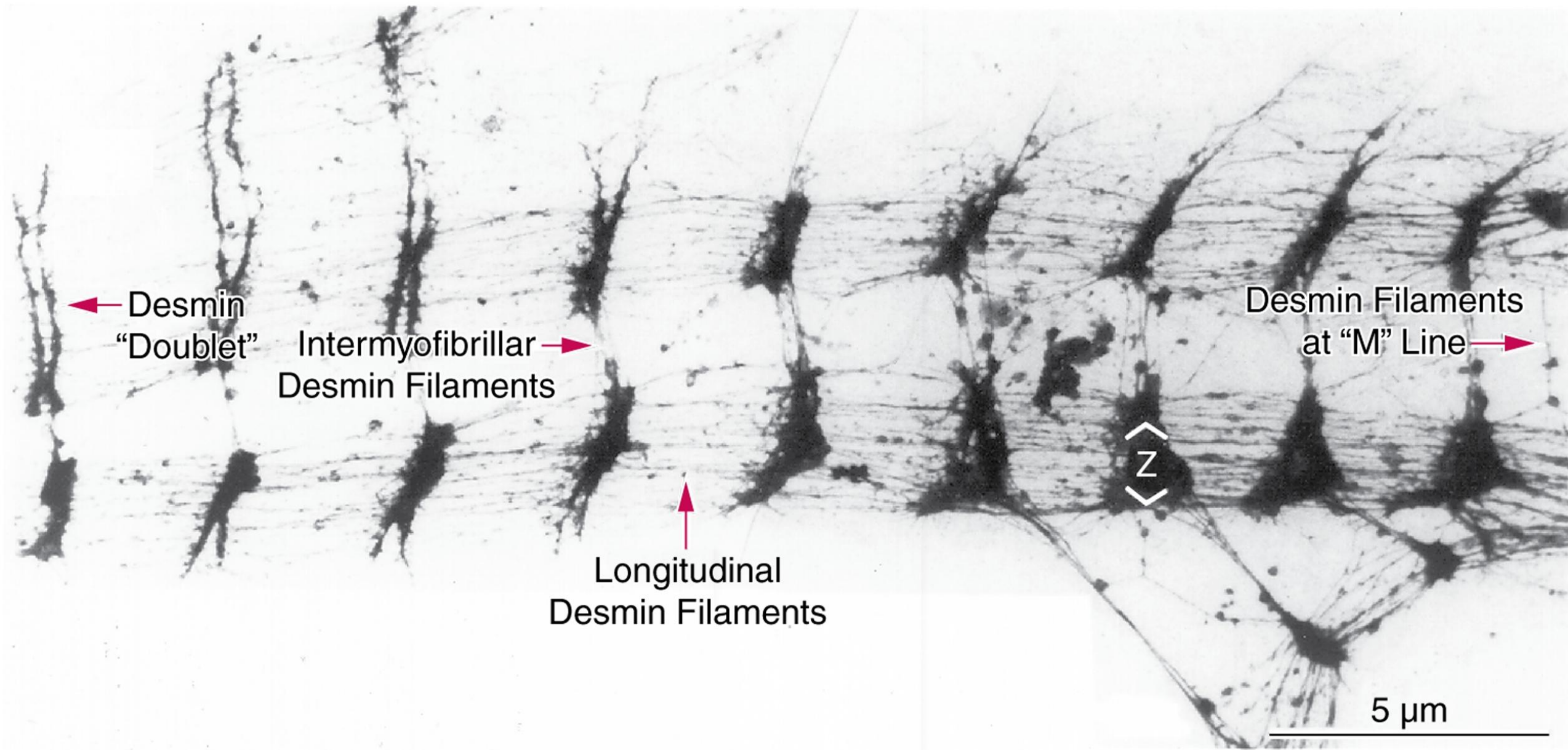


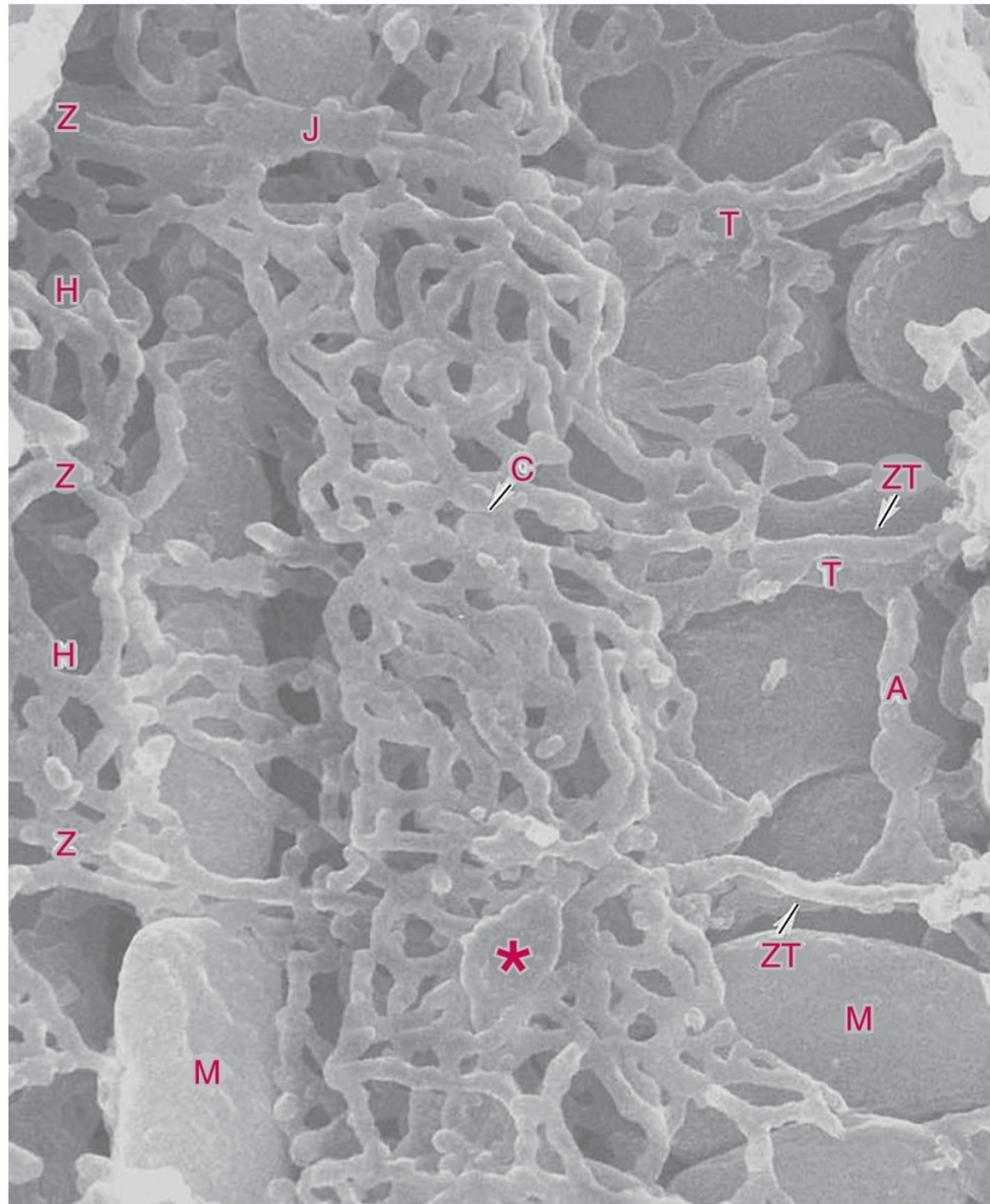


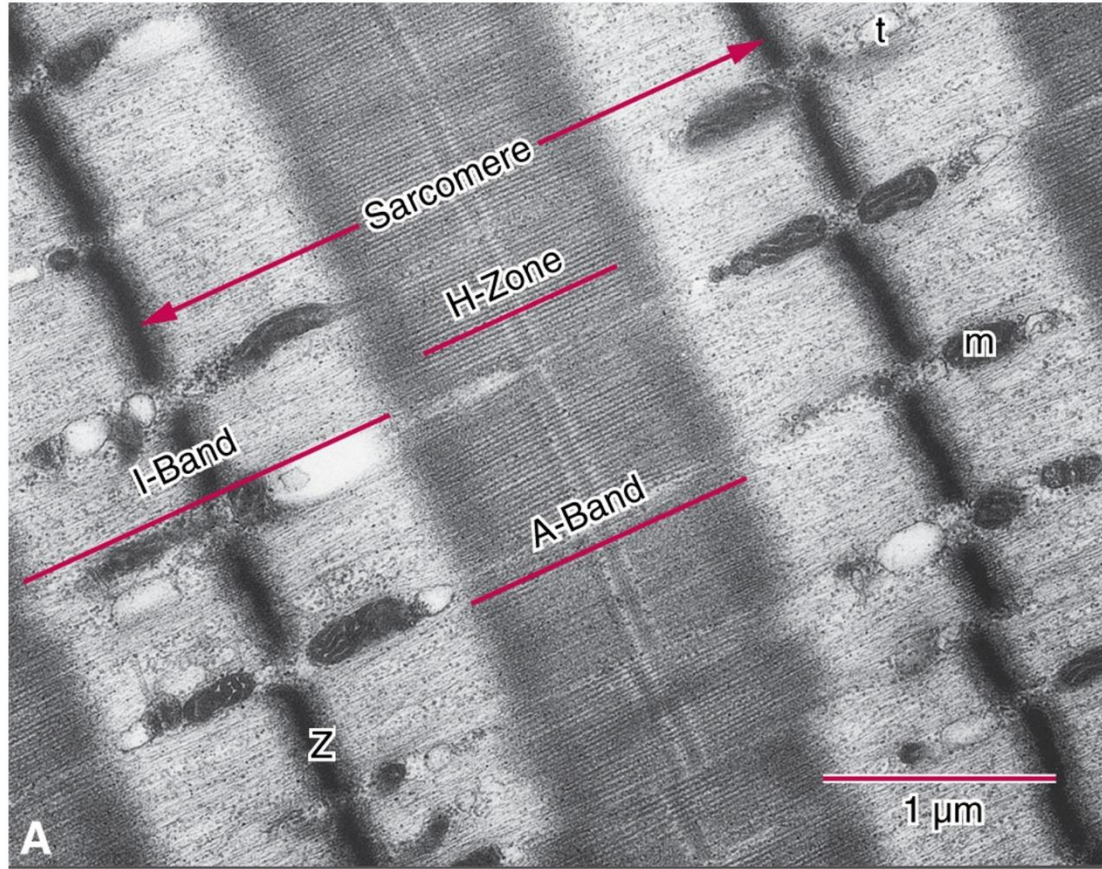




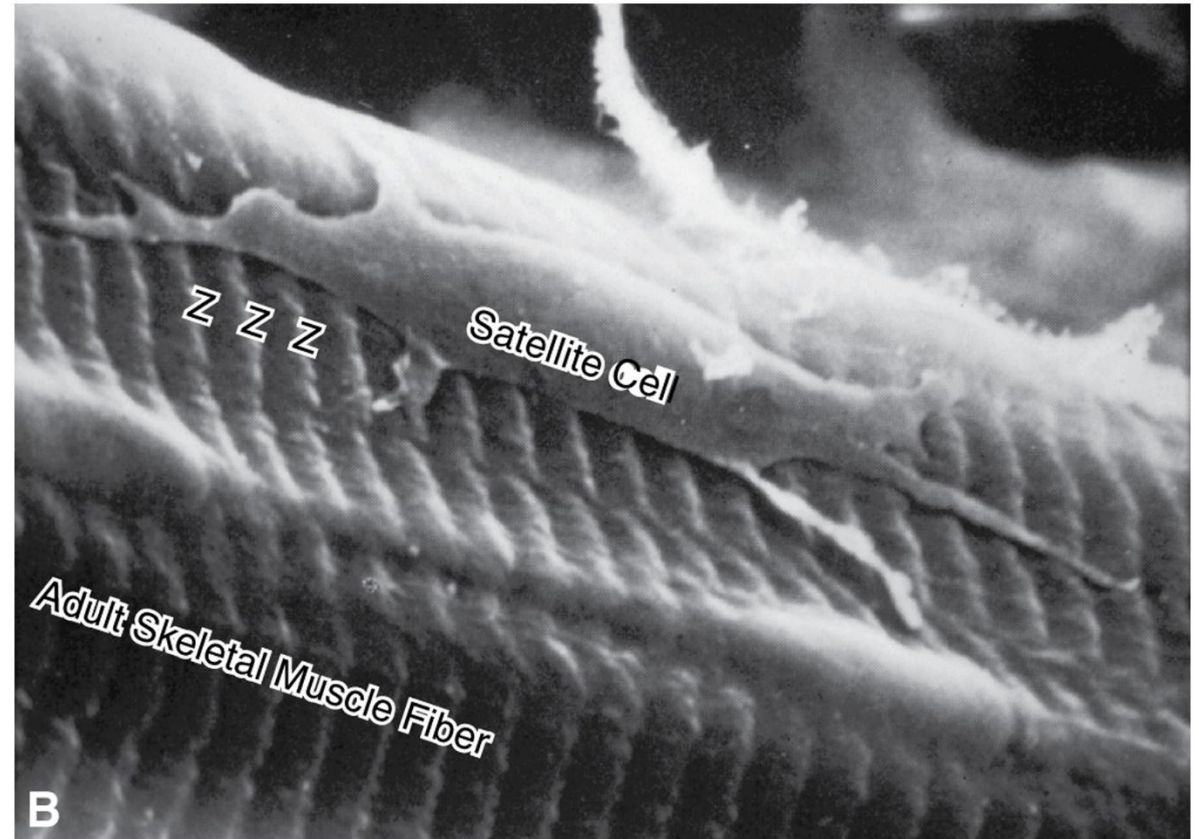




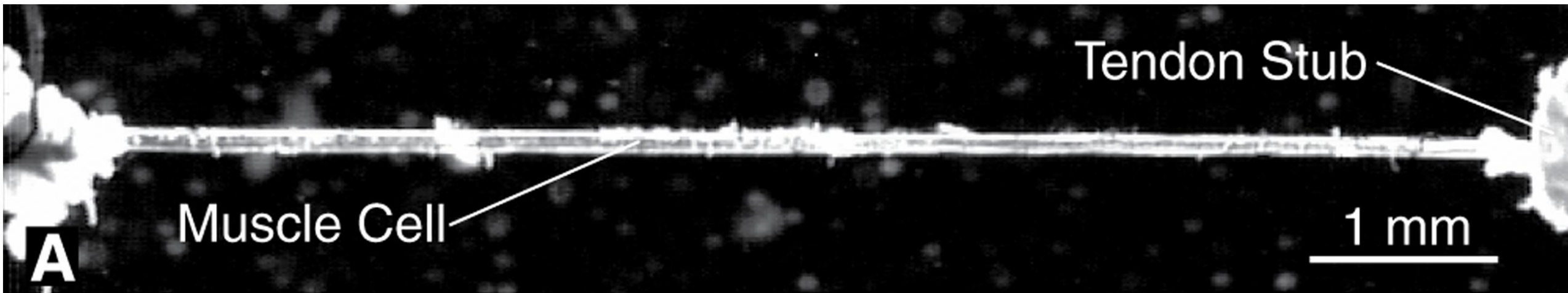




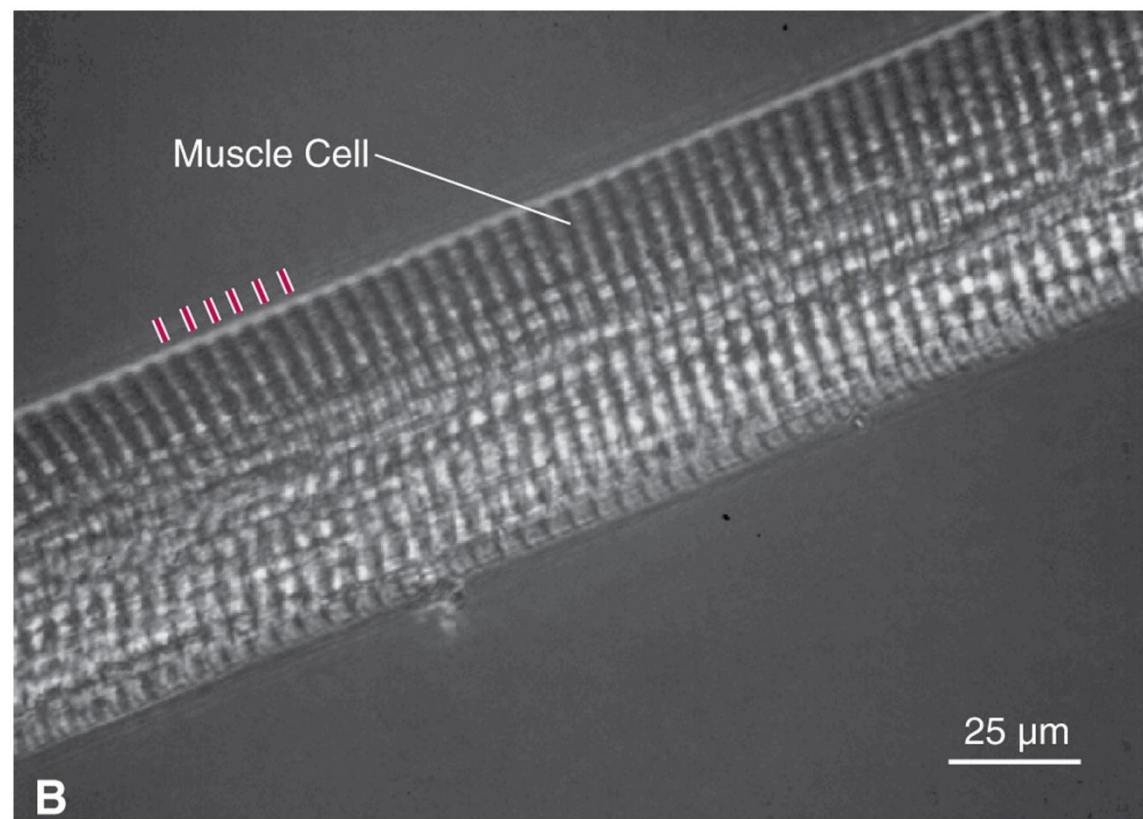
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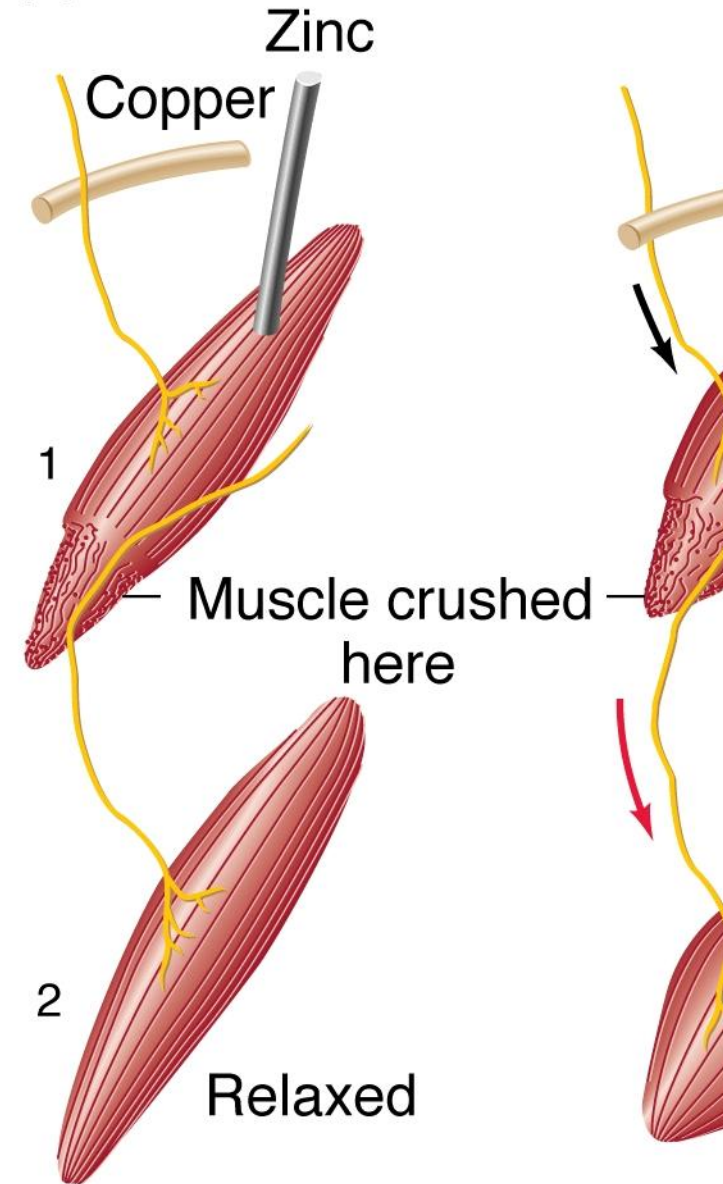


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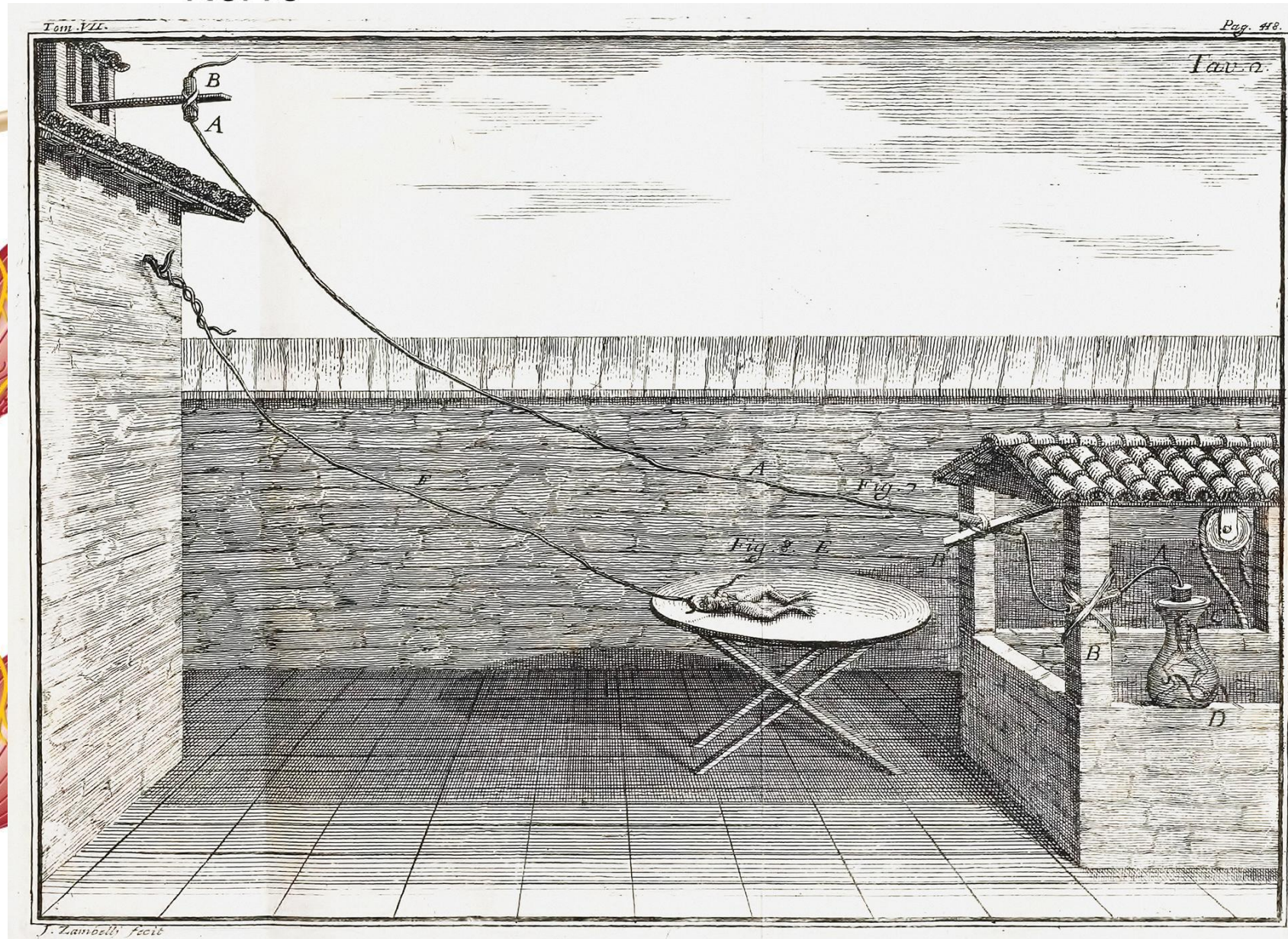
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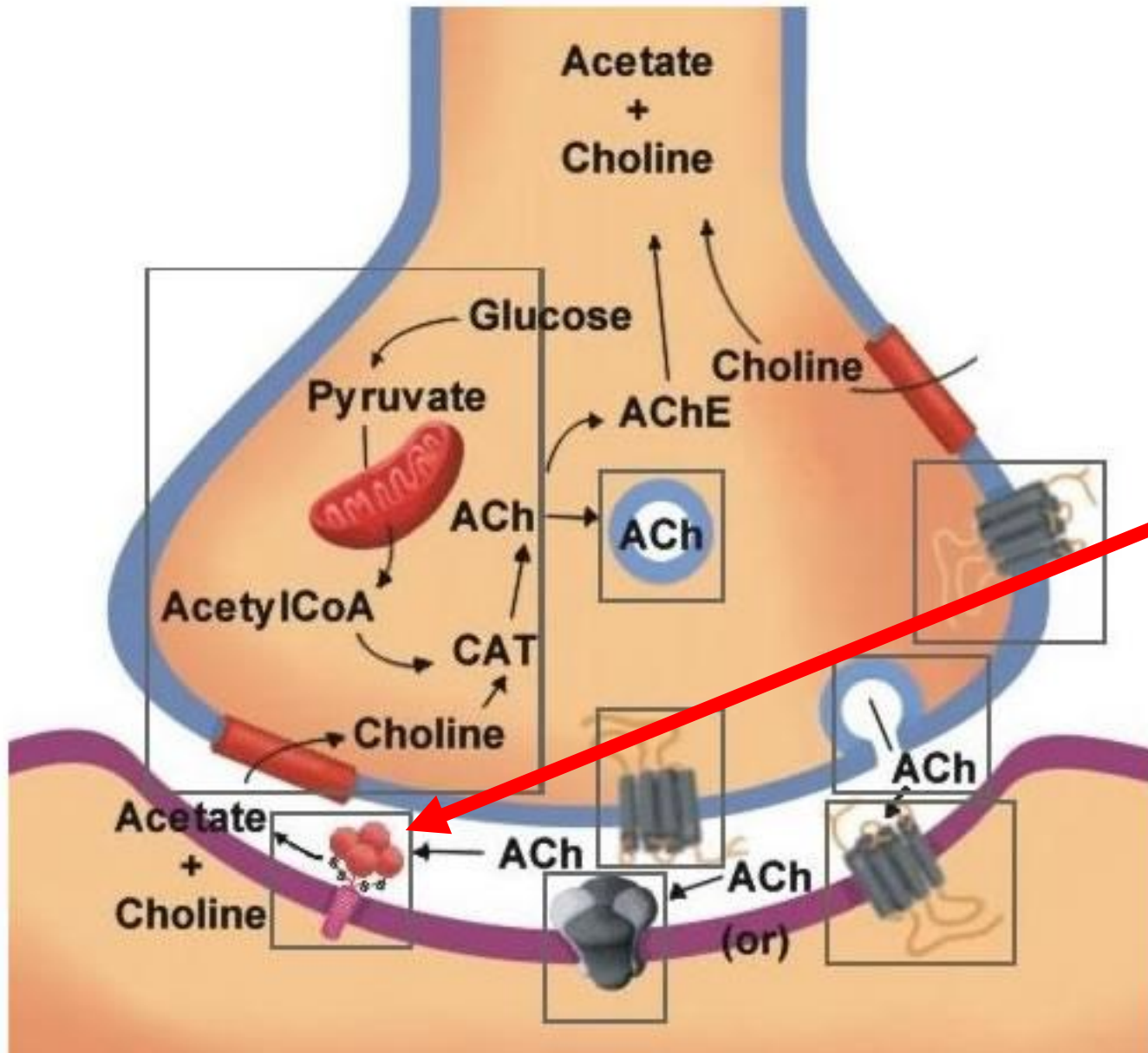
(b)



Nerve

Benjamin Franklin 1706 – 1790





Acetylcholinesterase

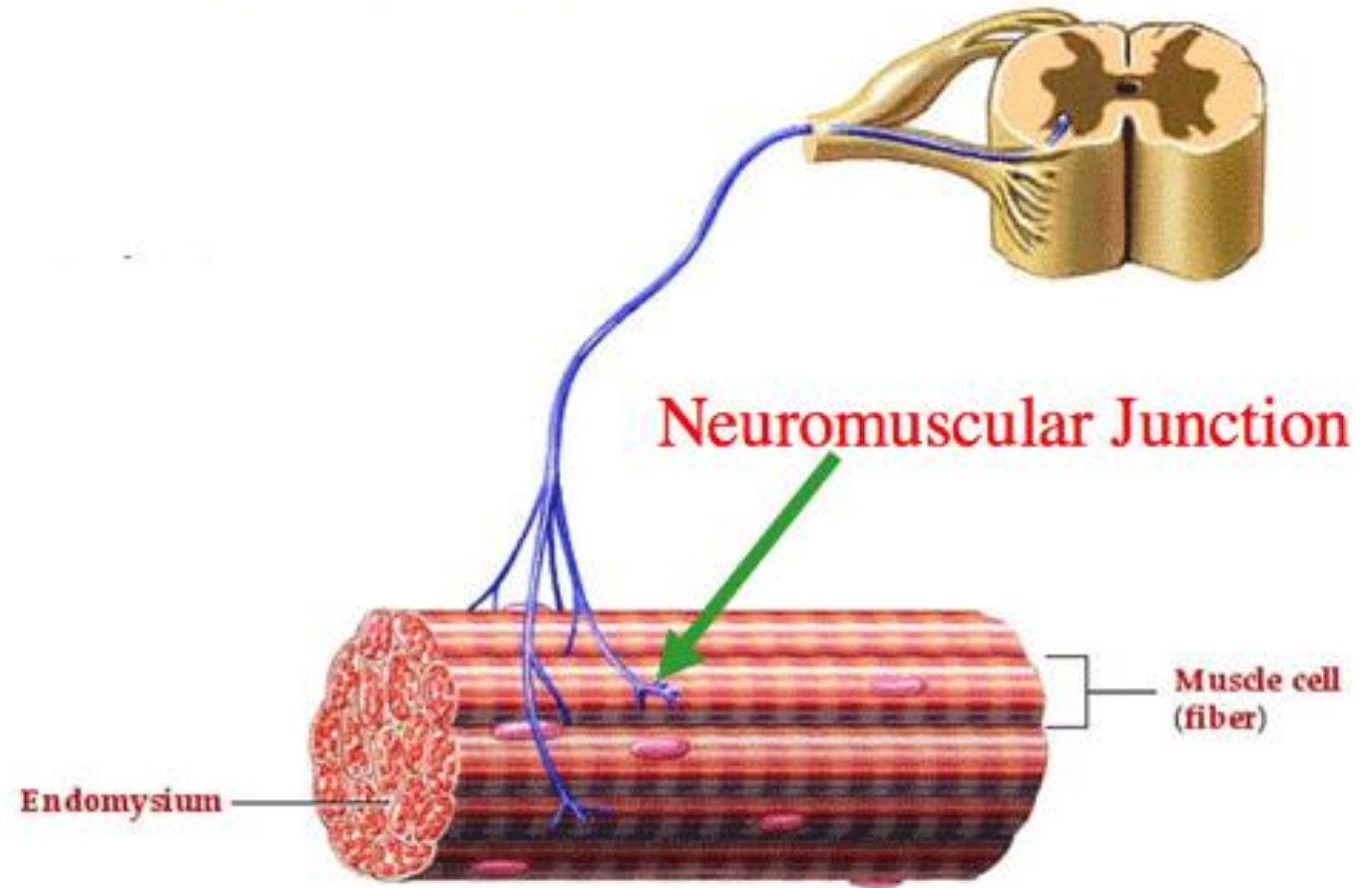
- [Acetylcholine Receptors](#)
 - a. [Nicotinic](#)
 - b. [Muscarinic](#)

Motor Neurons

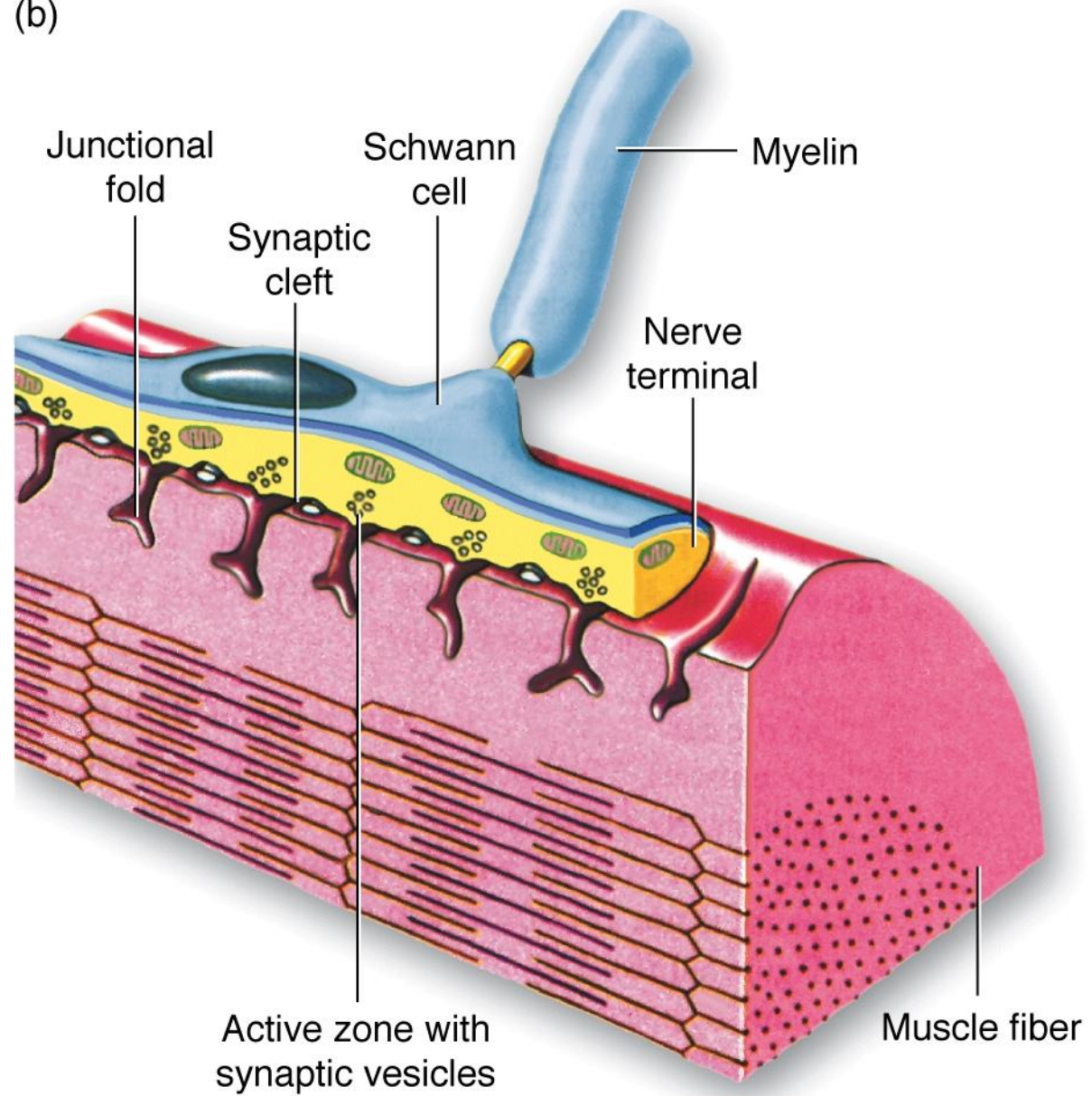
Mammals : Ach

Crayfish/Drosophila : glutamate

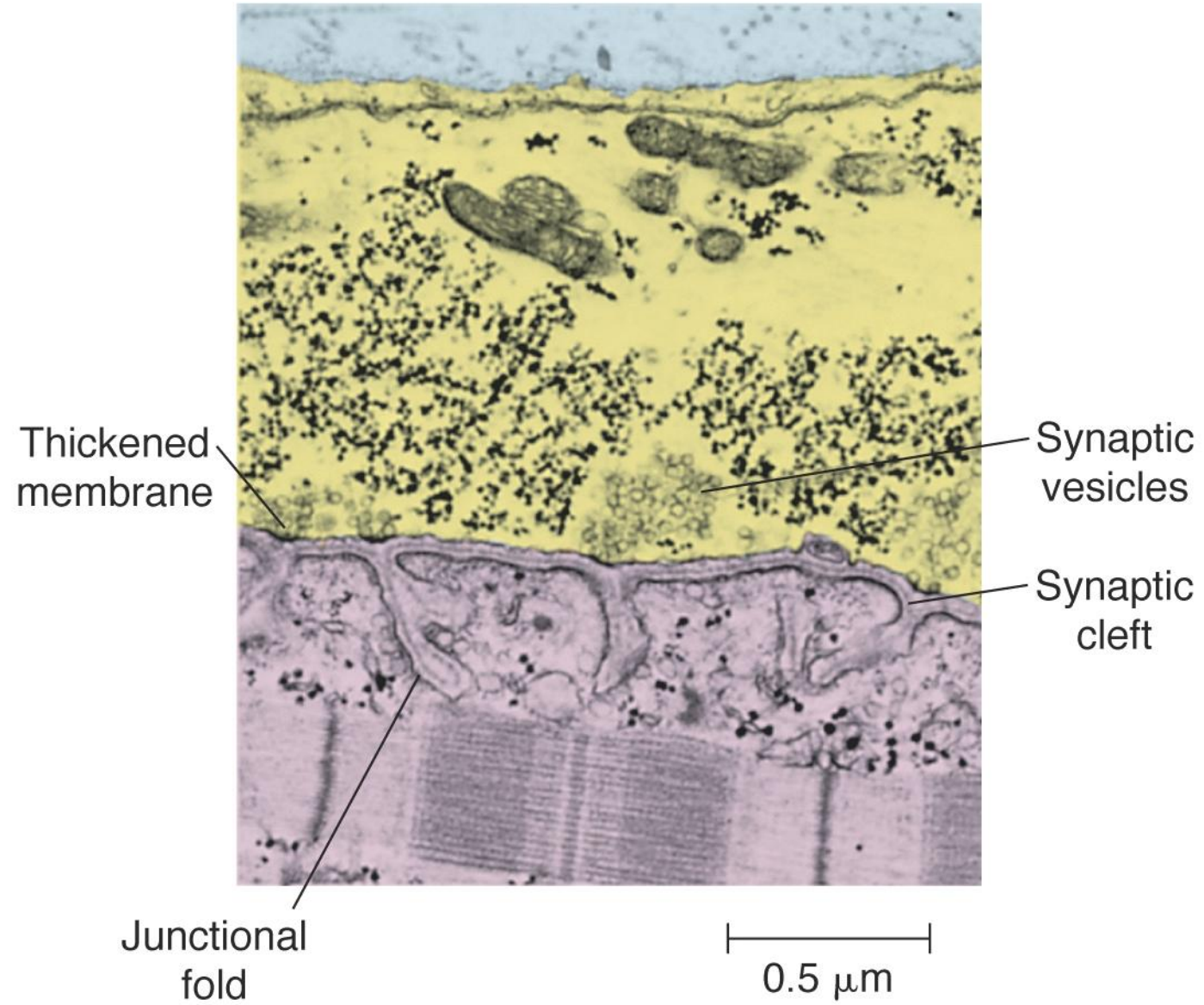
Neuromuscular Junction



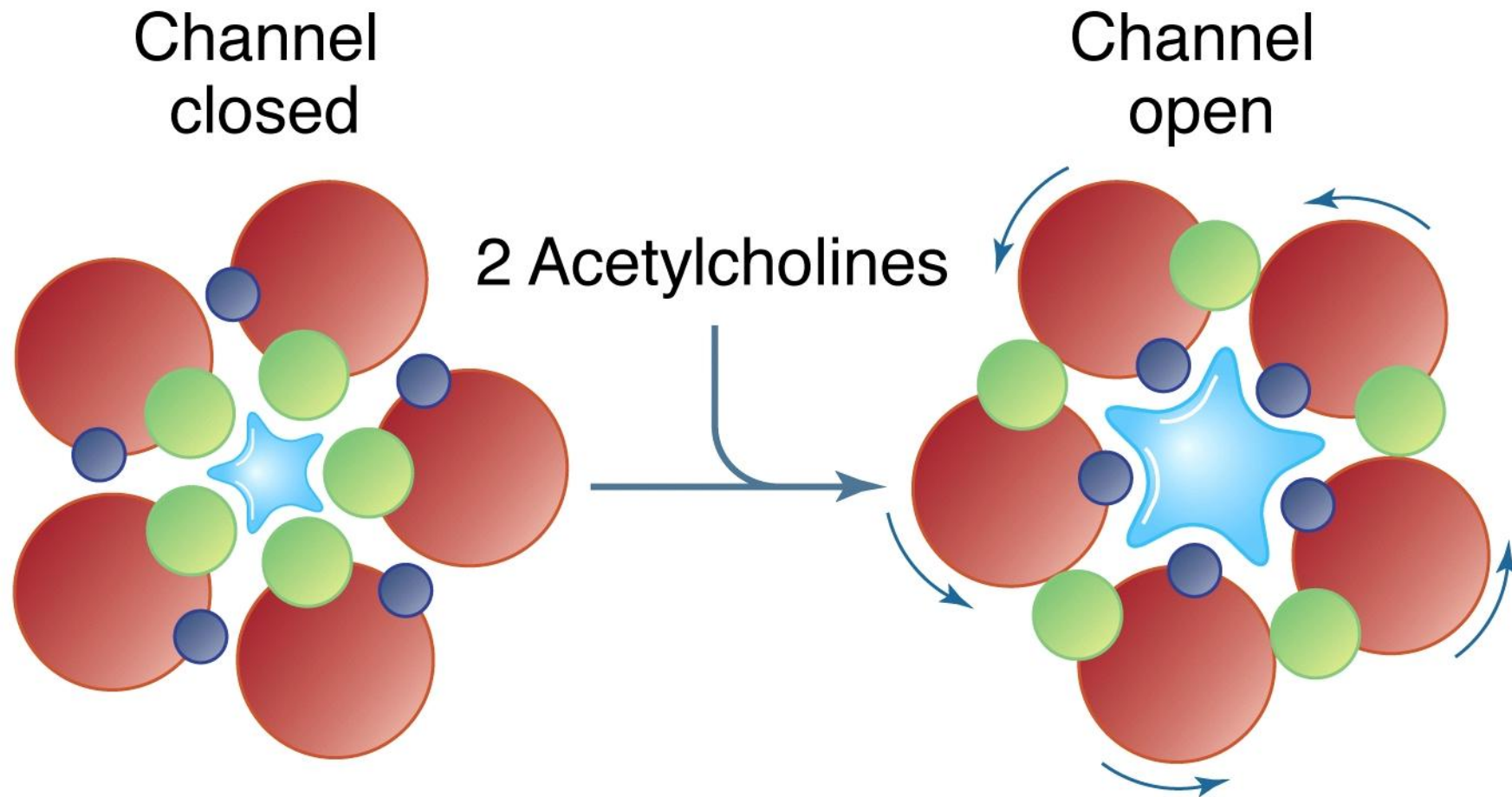
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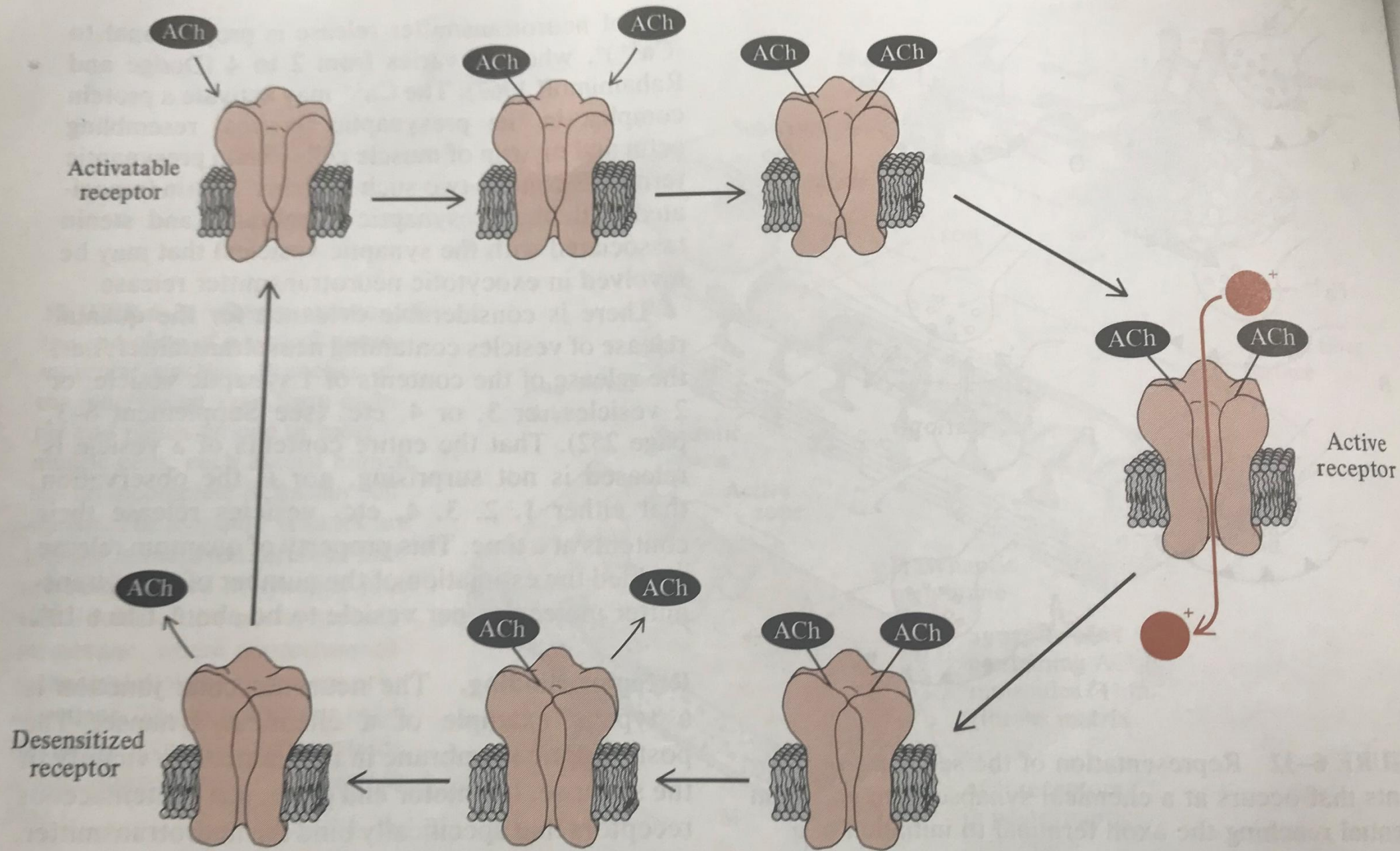


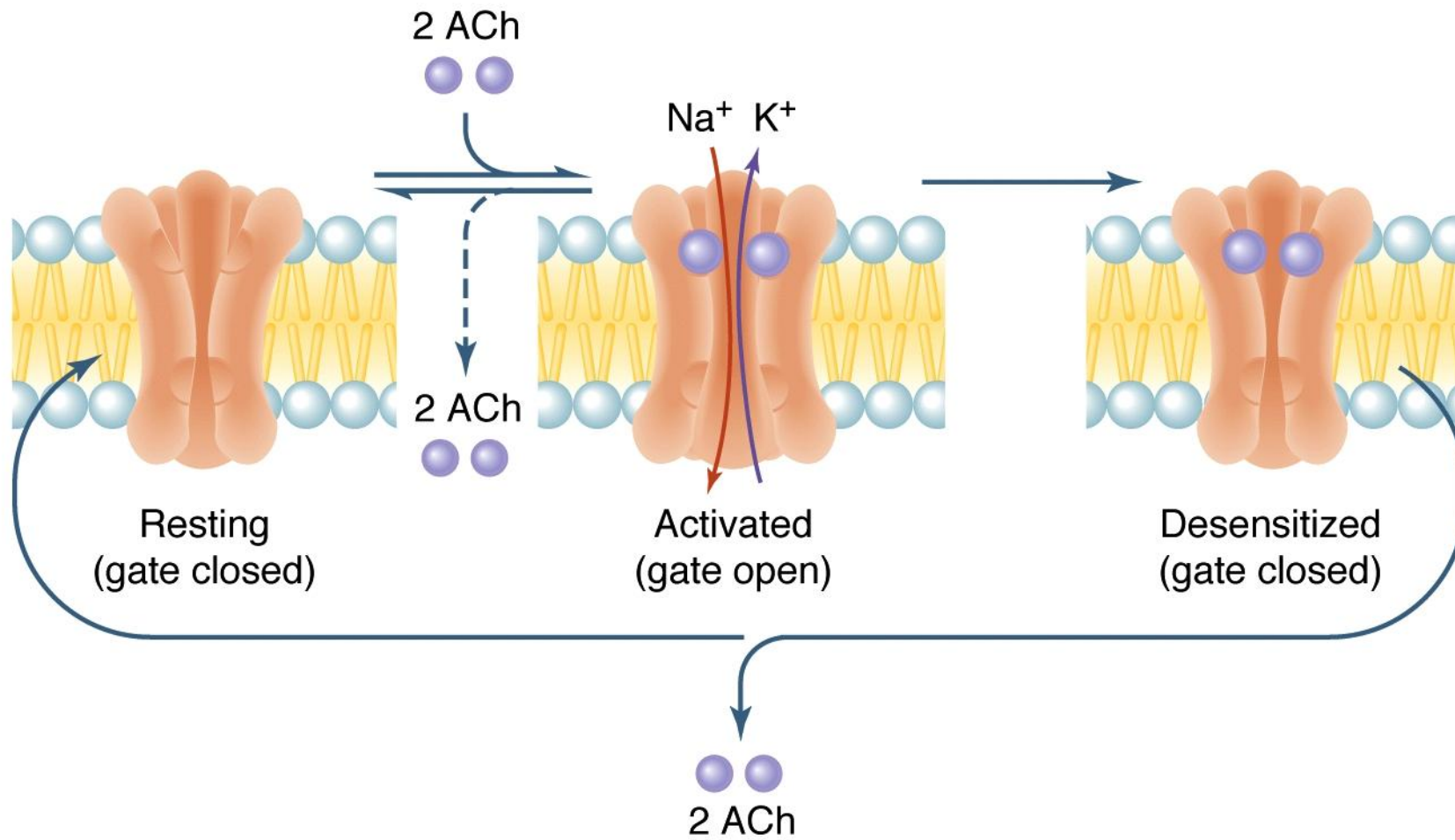
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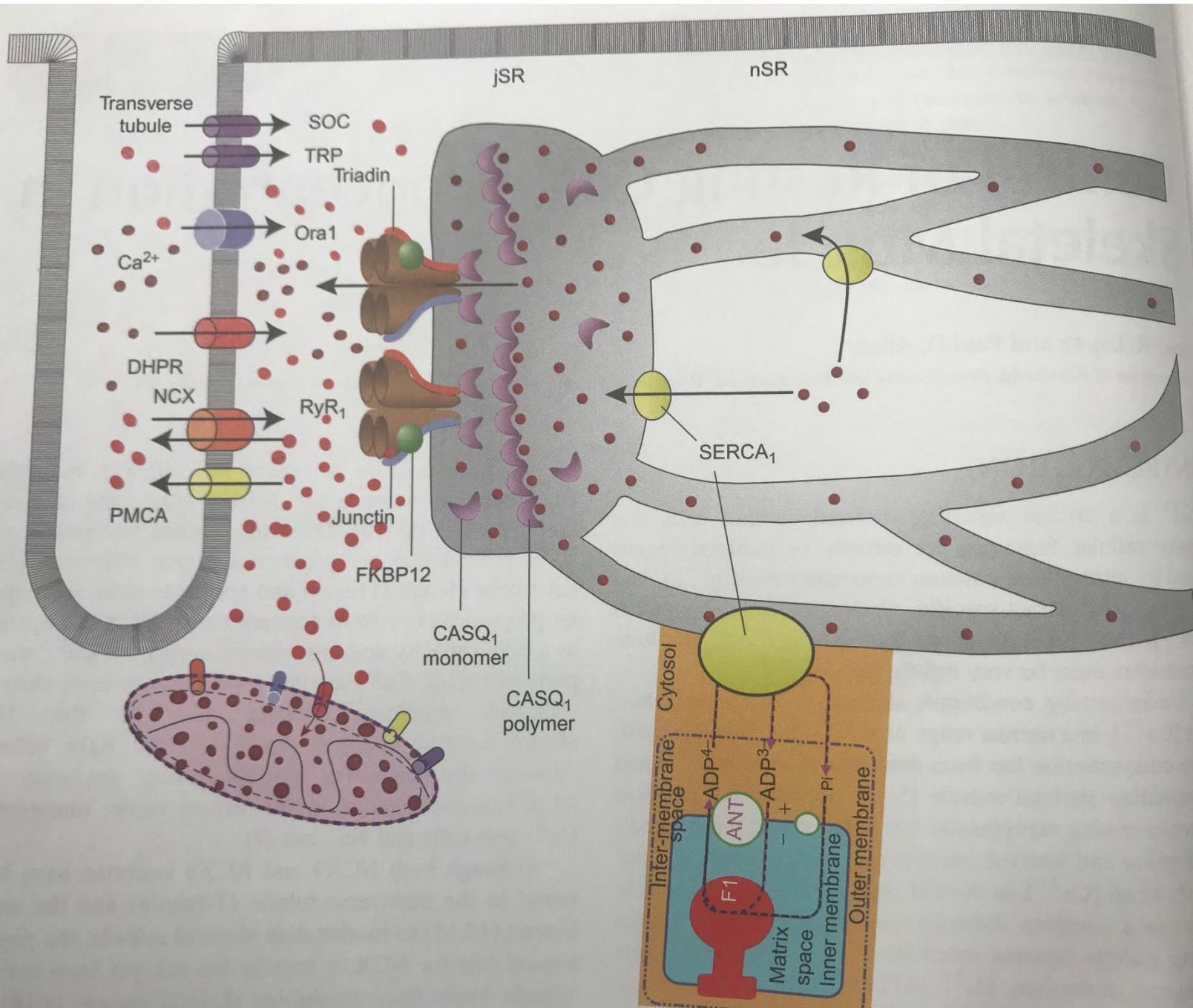


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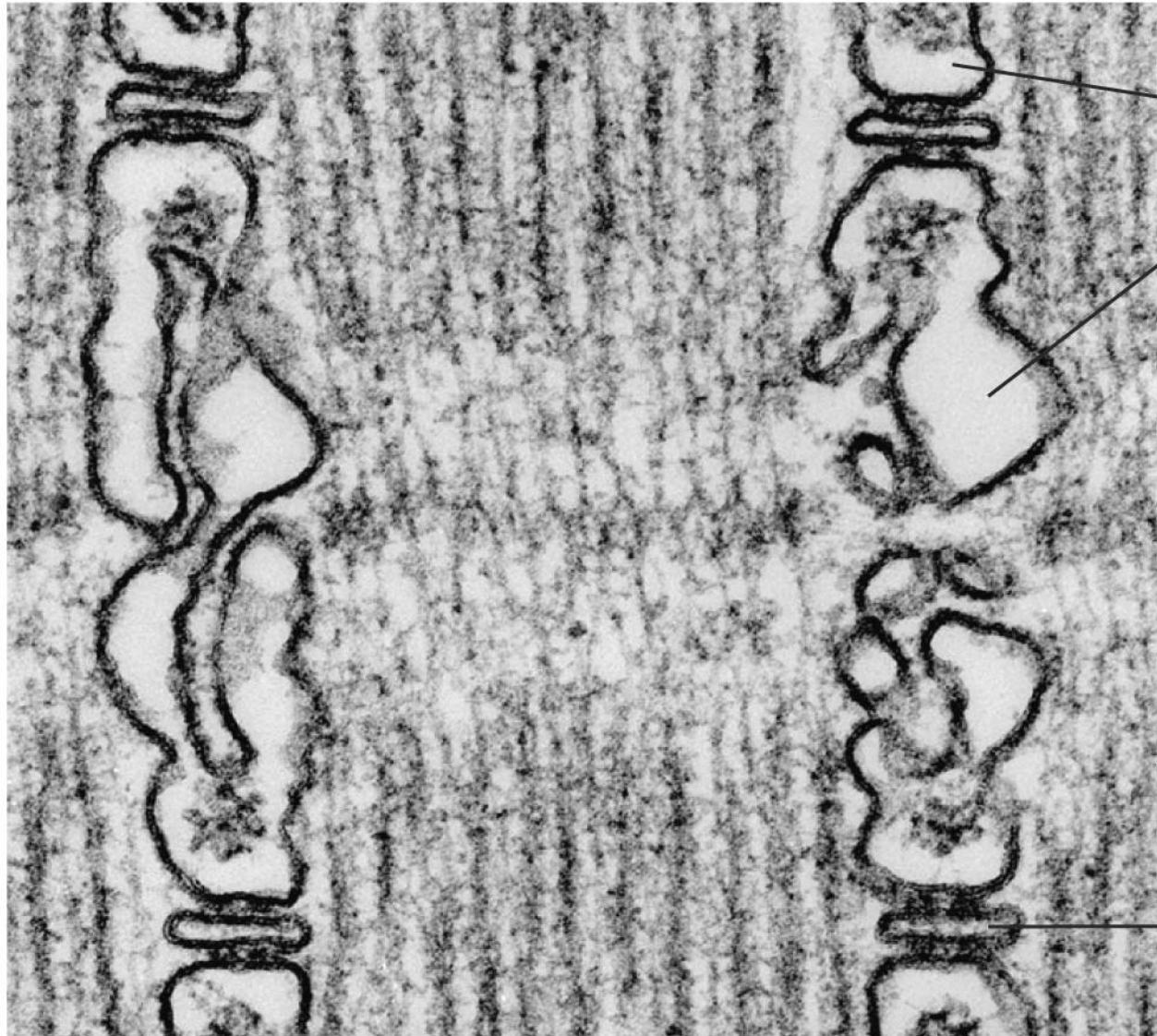








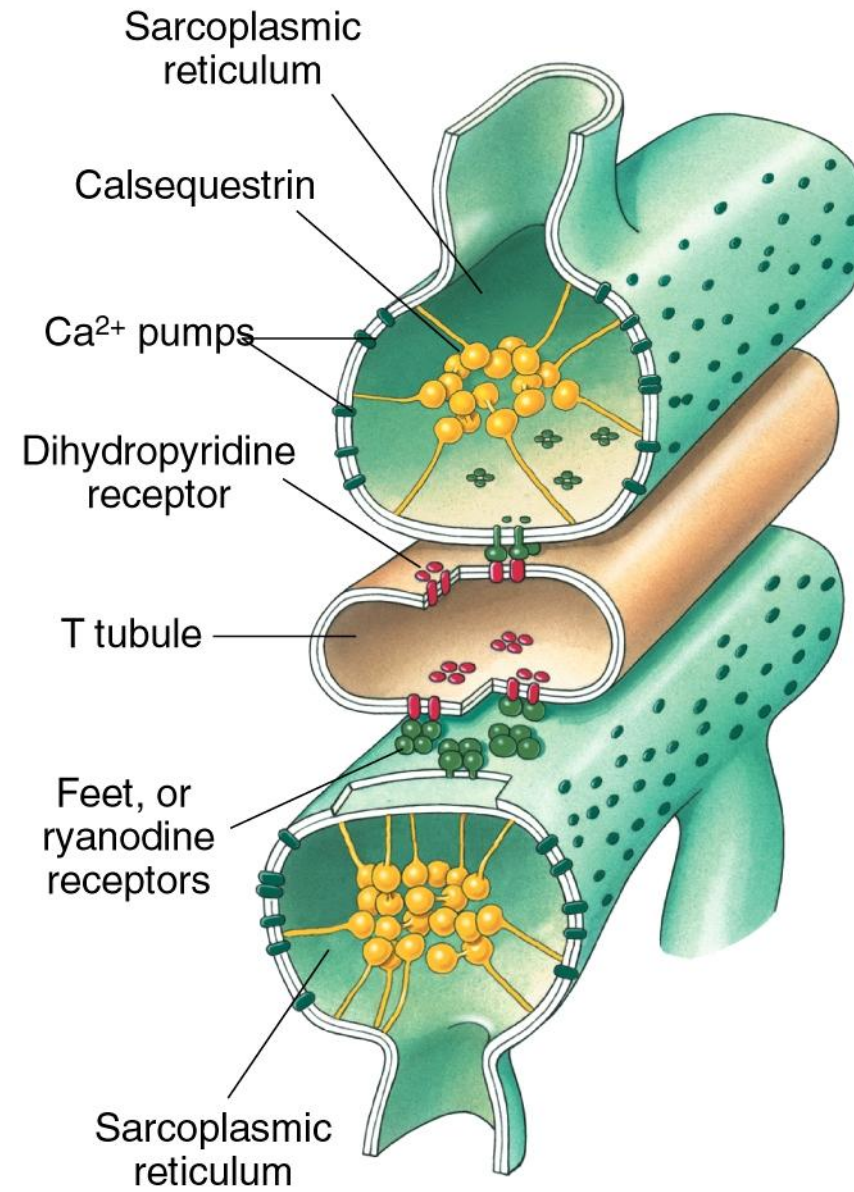
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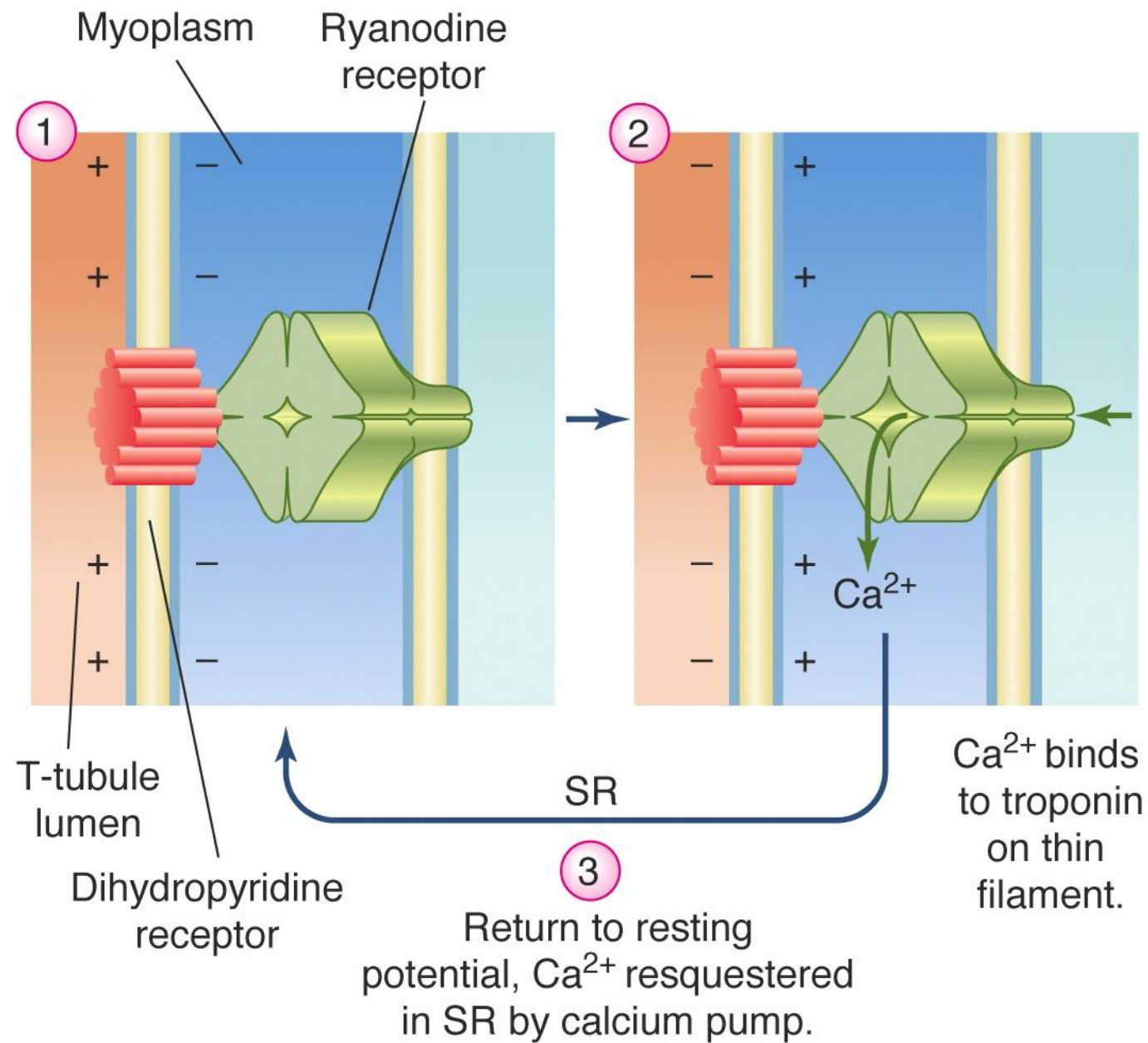


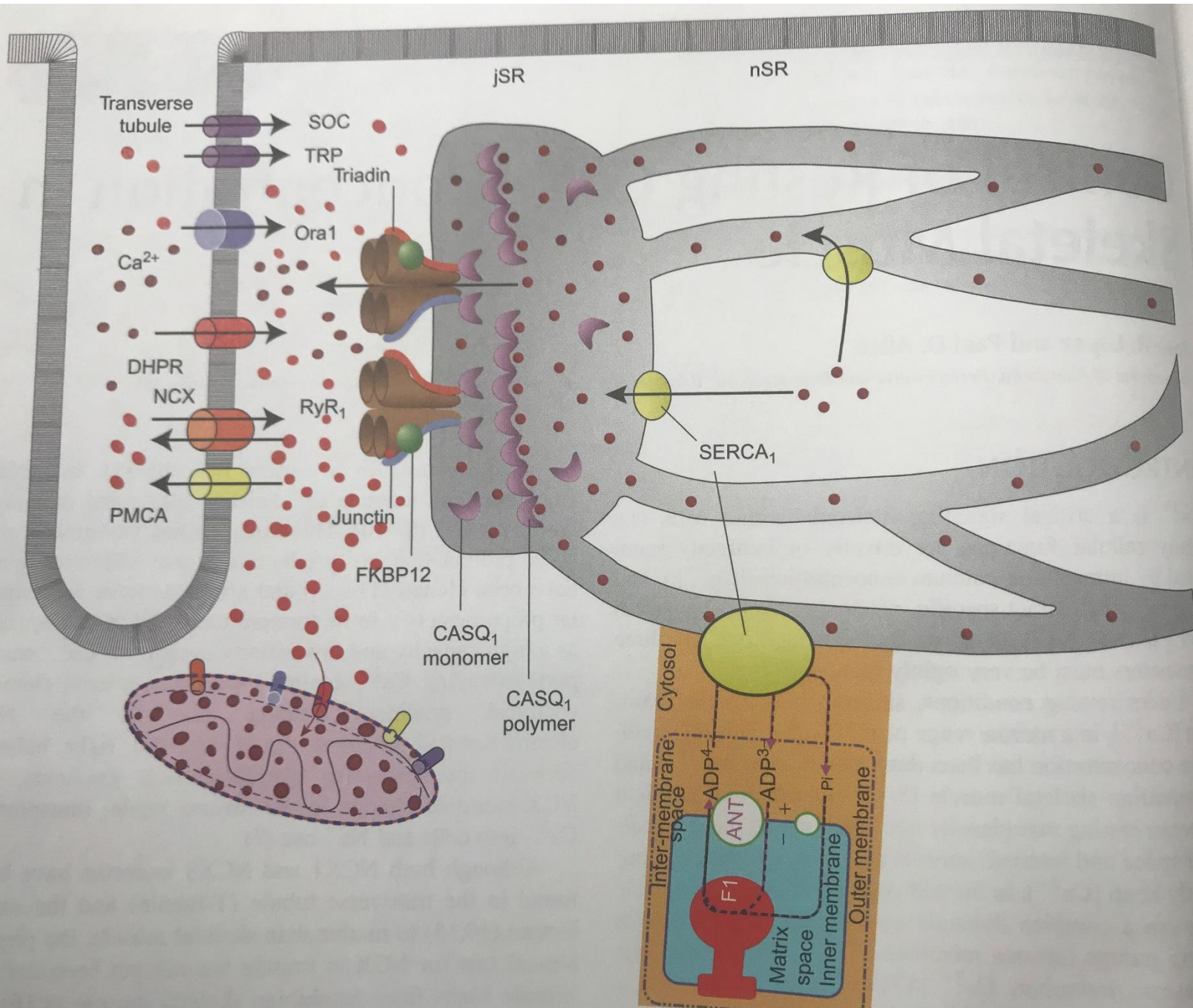
Terminal
cisternae

T tubule

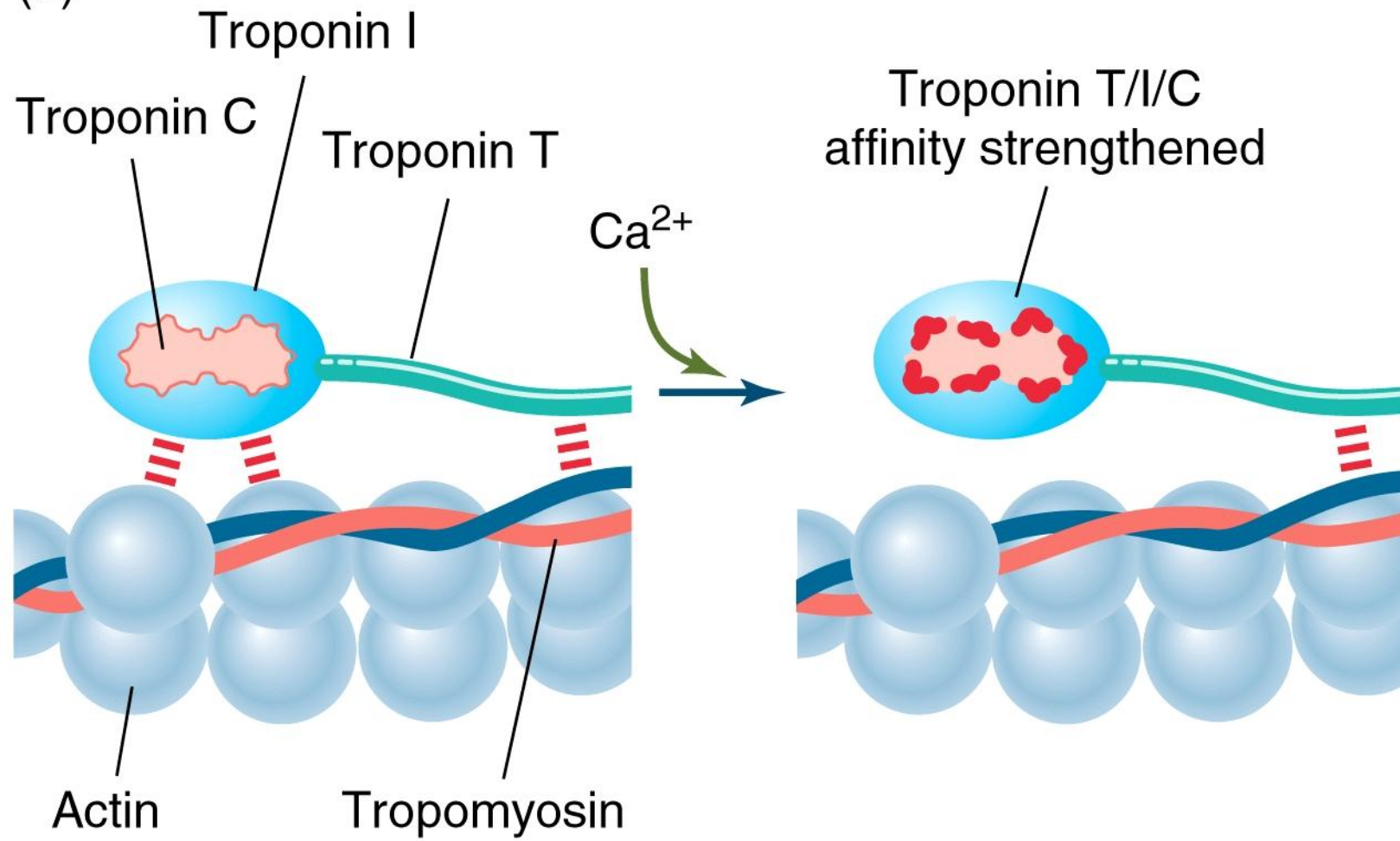
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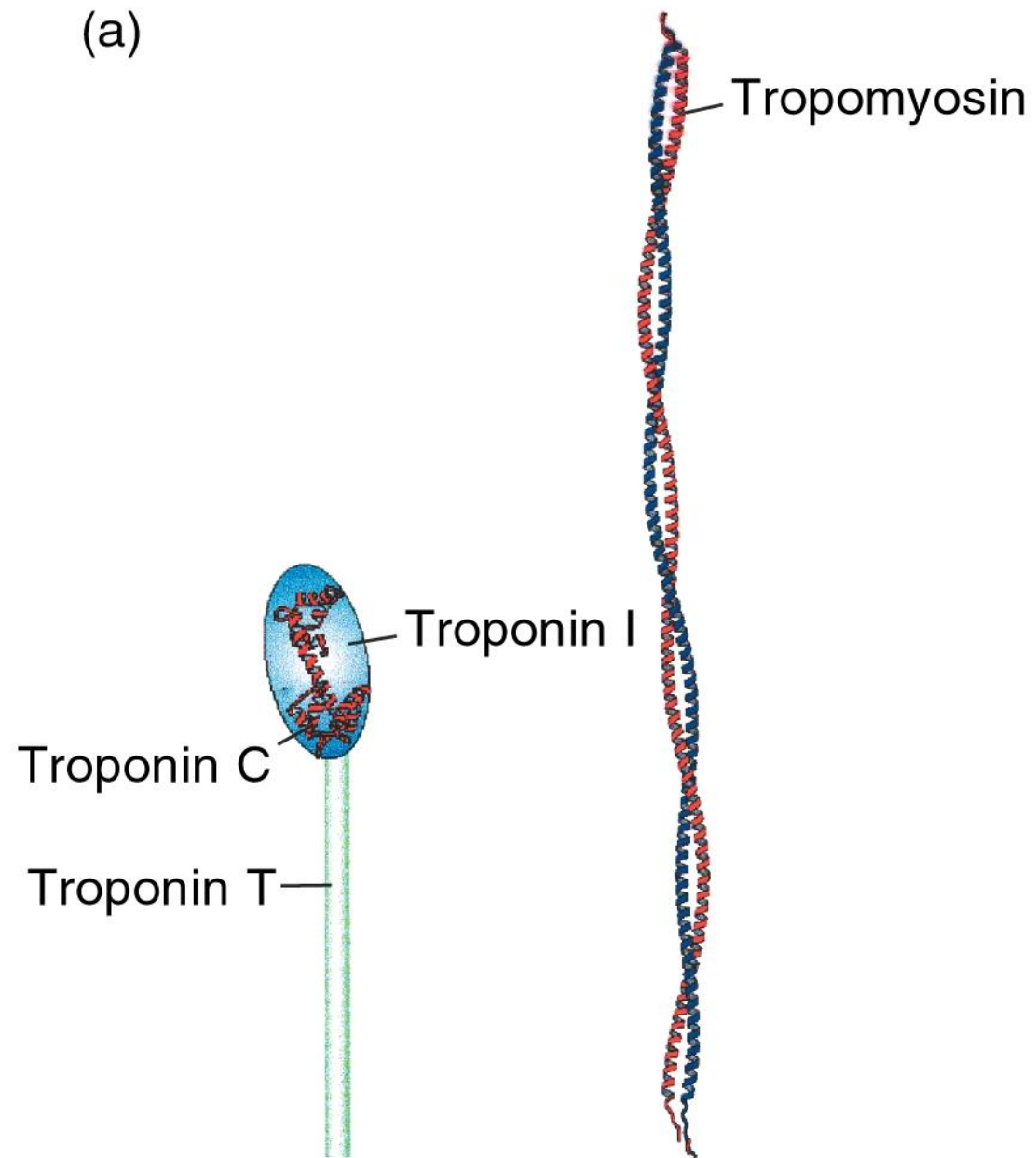


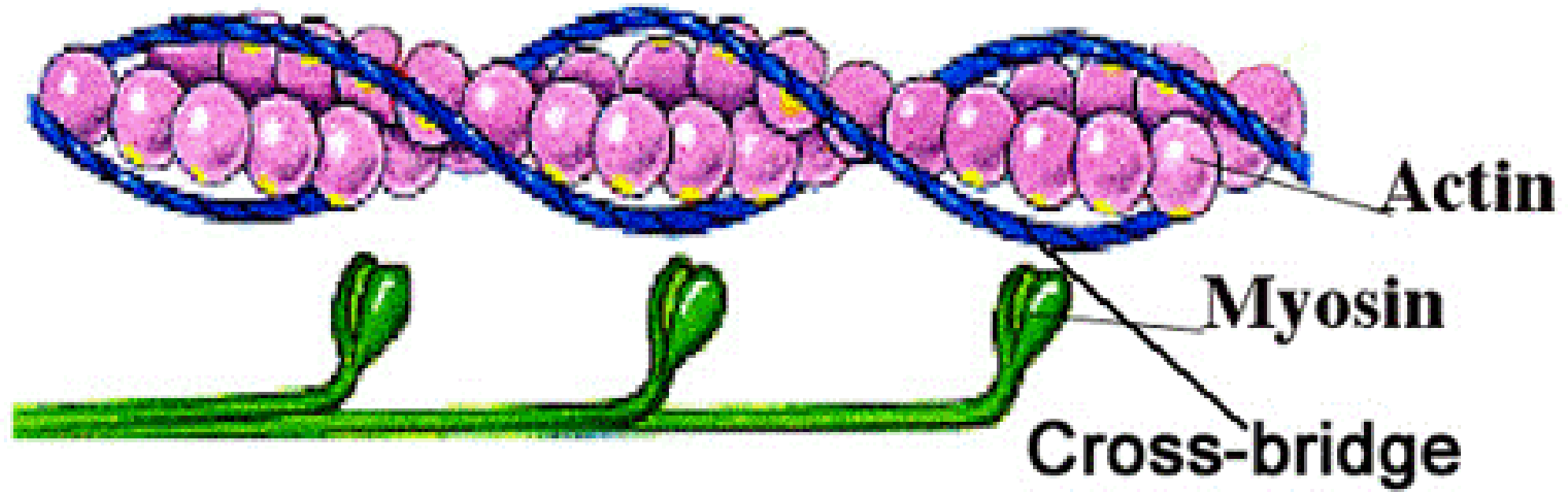


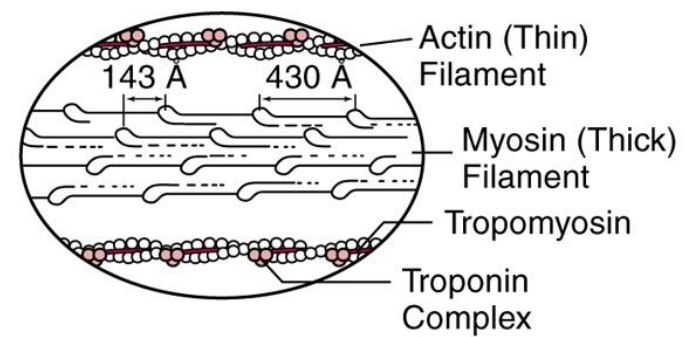
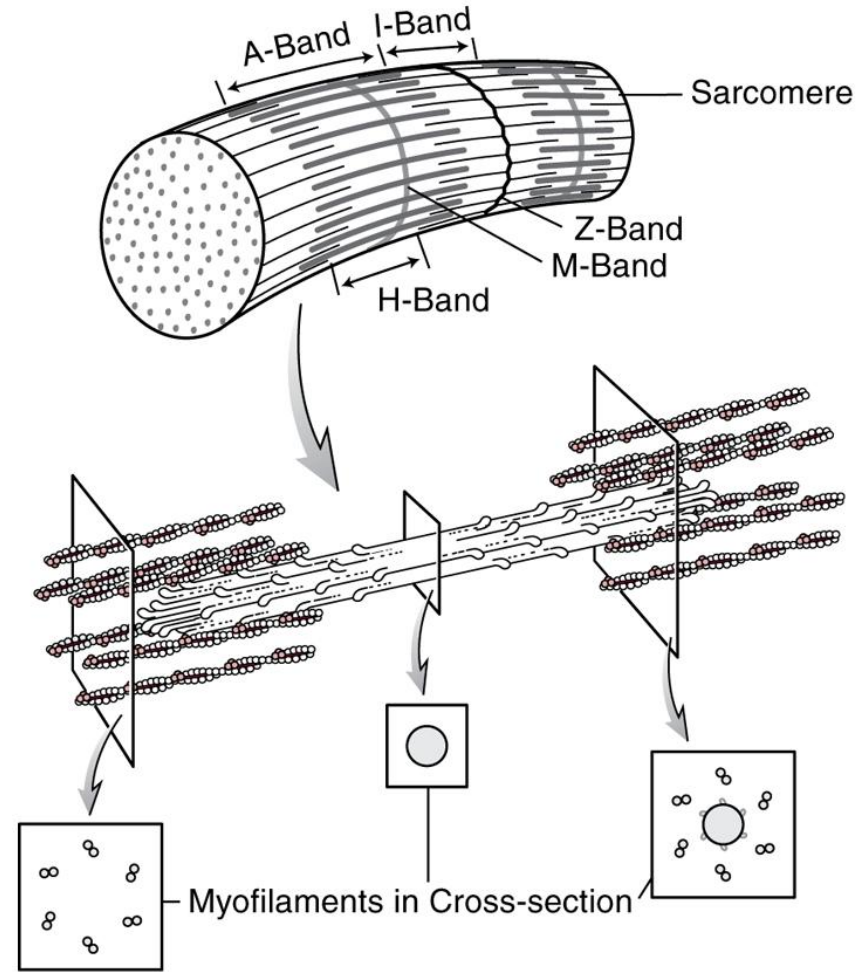
(b)



(a)







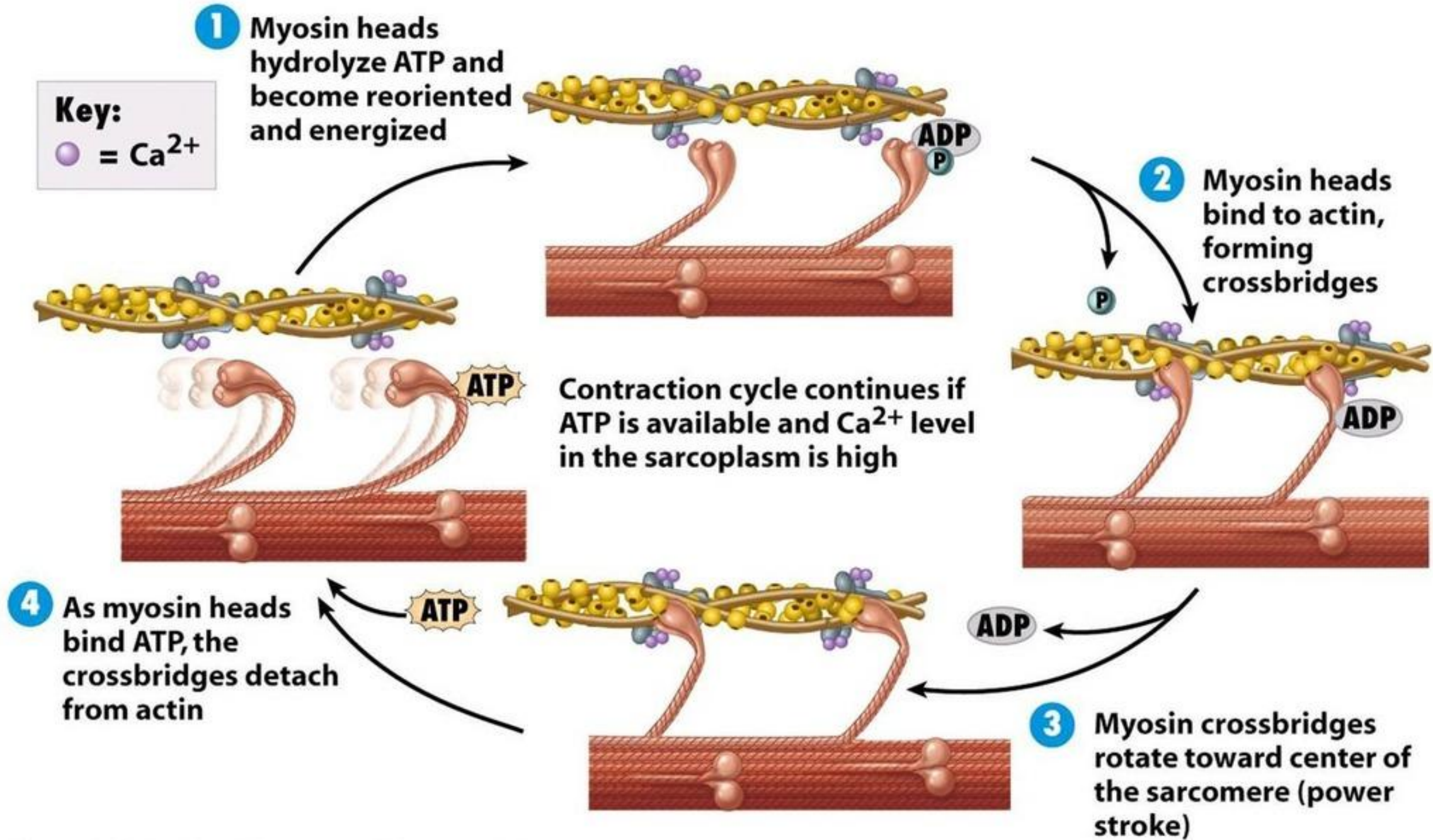
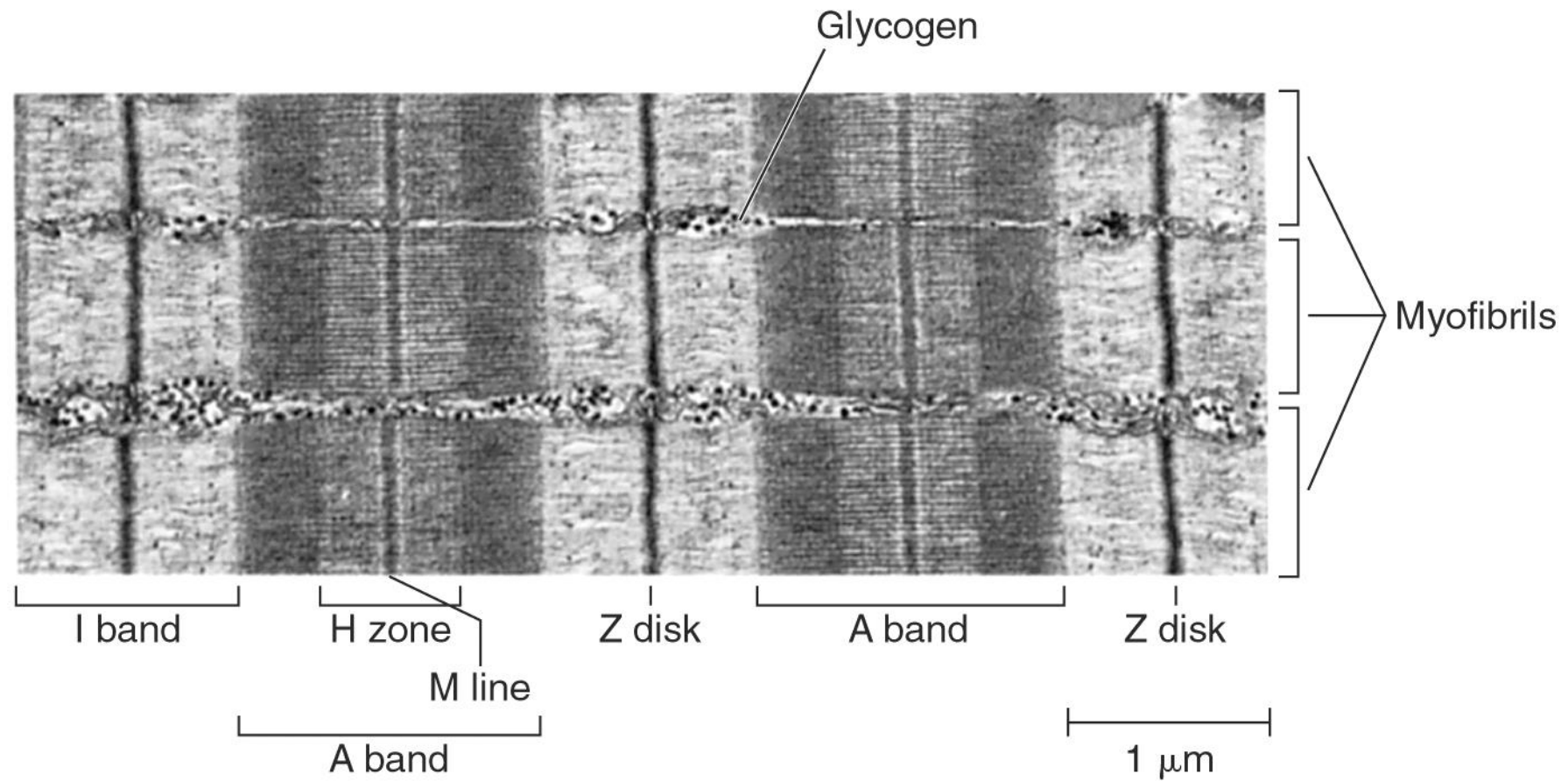
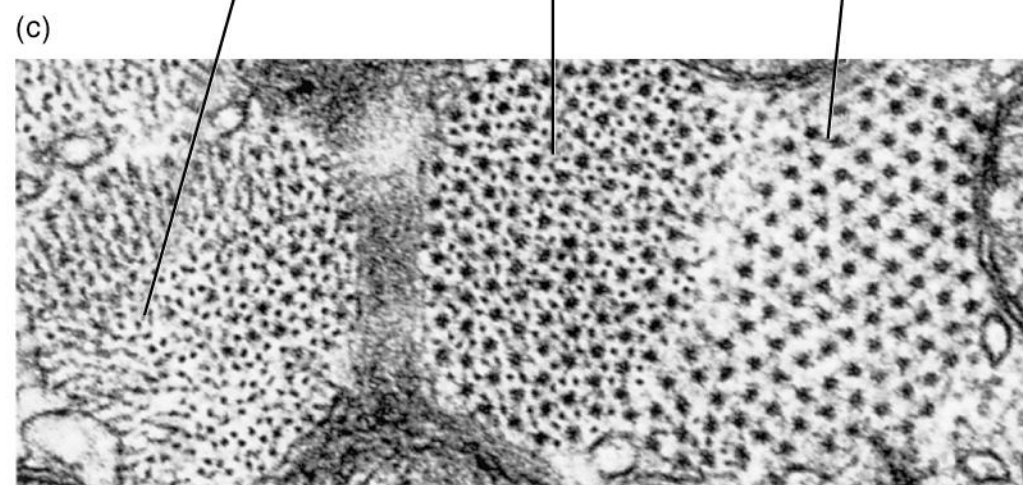
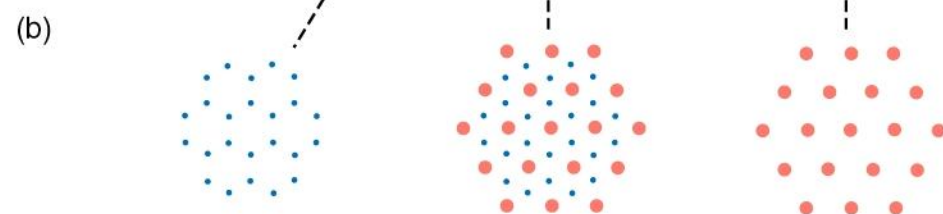
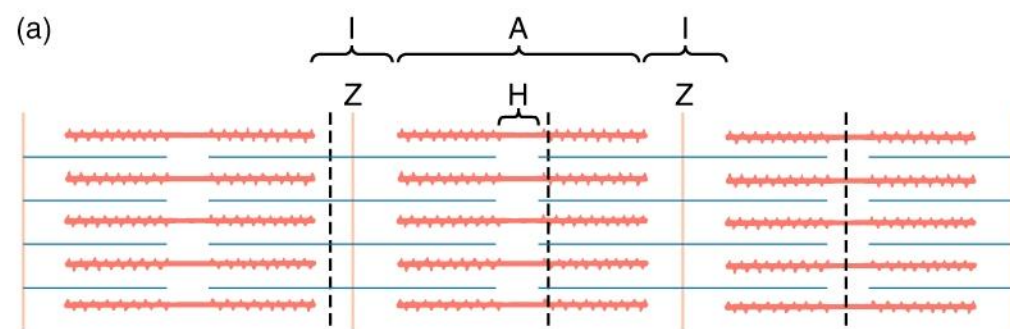


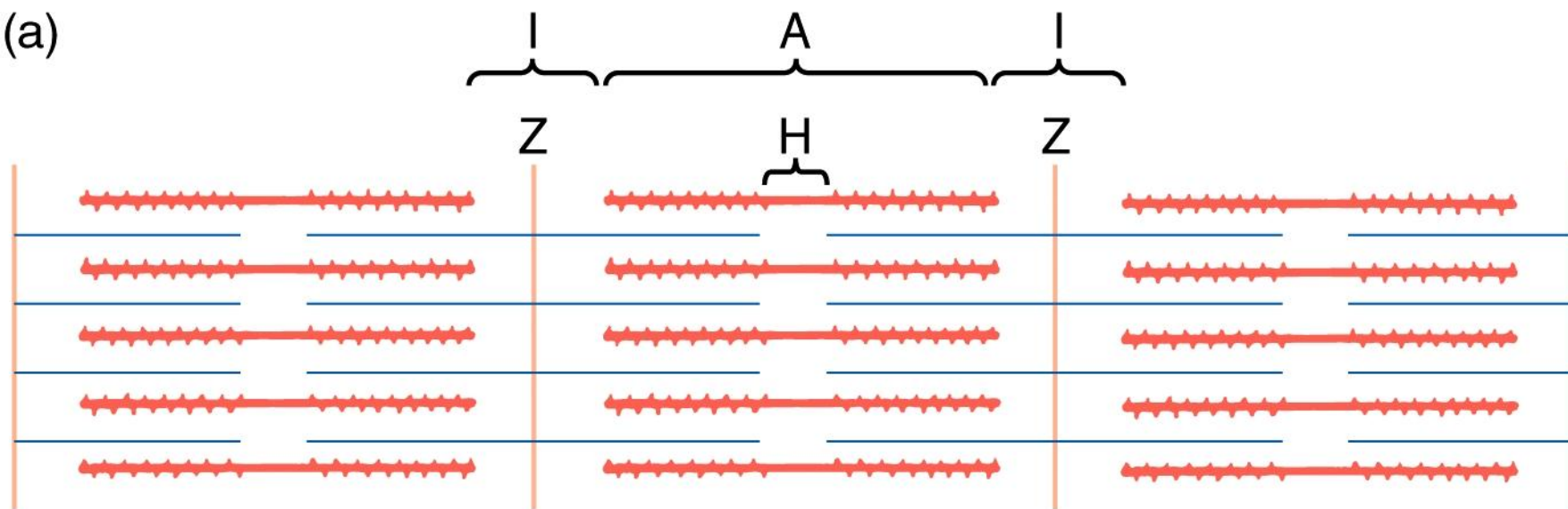
Figure 10-7 Principles of Anatomy and Physiology, 11/e
© 2006 John Wiley & Sons



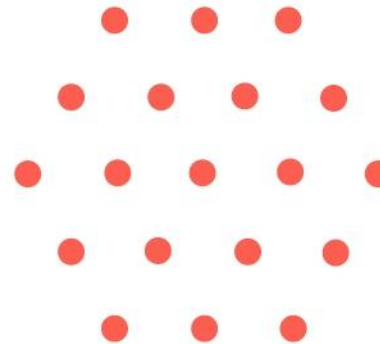
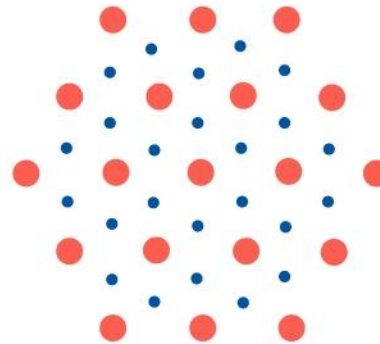
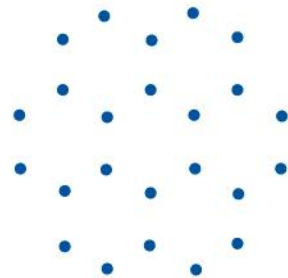


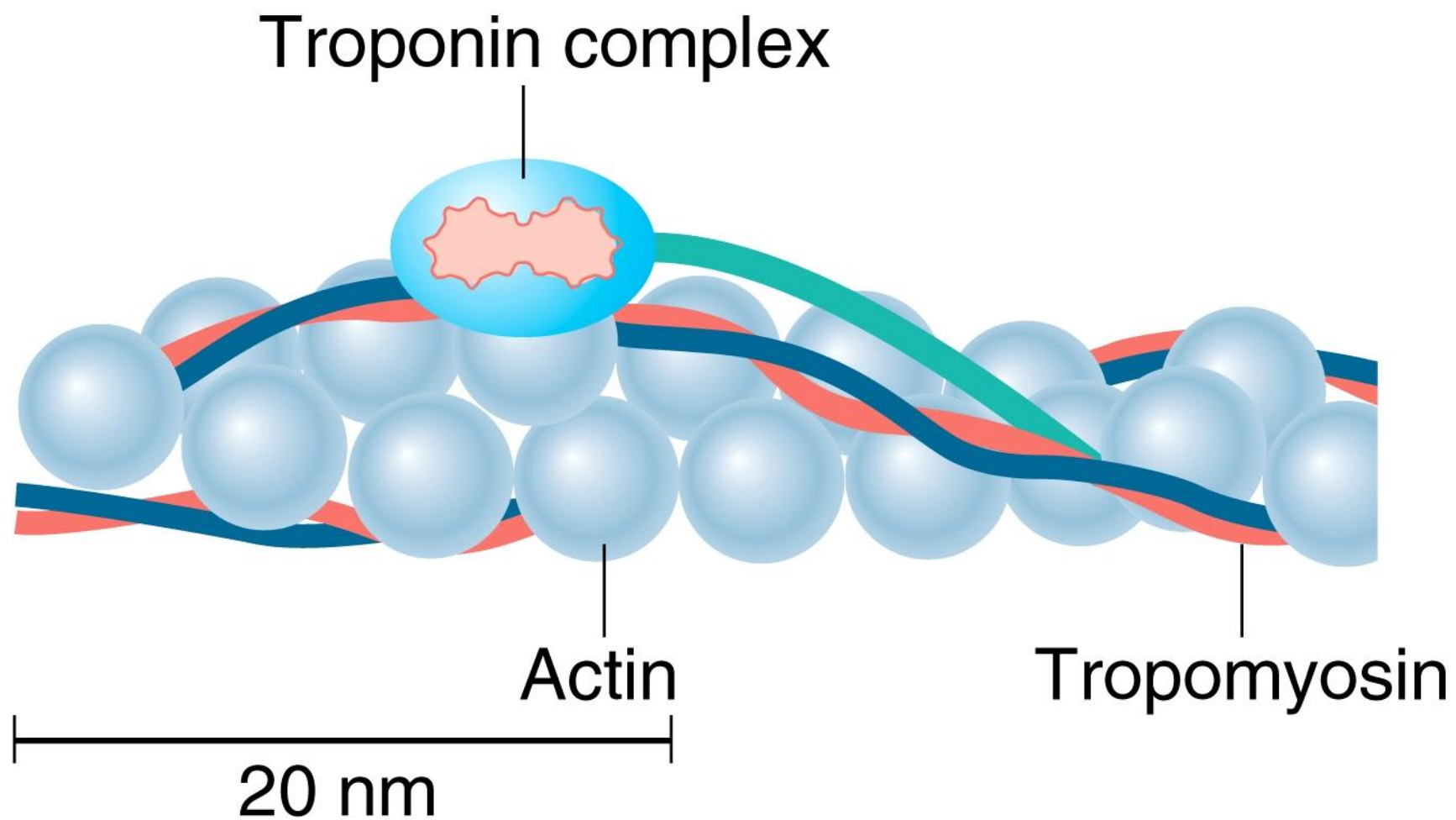
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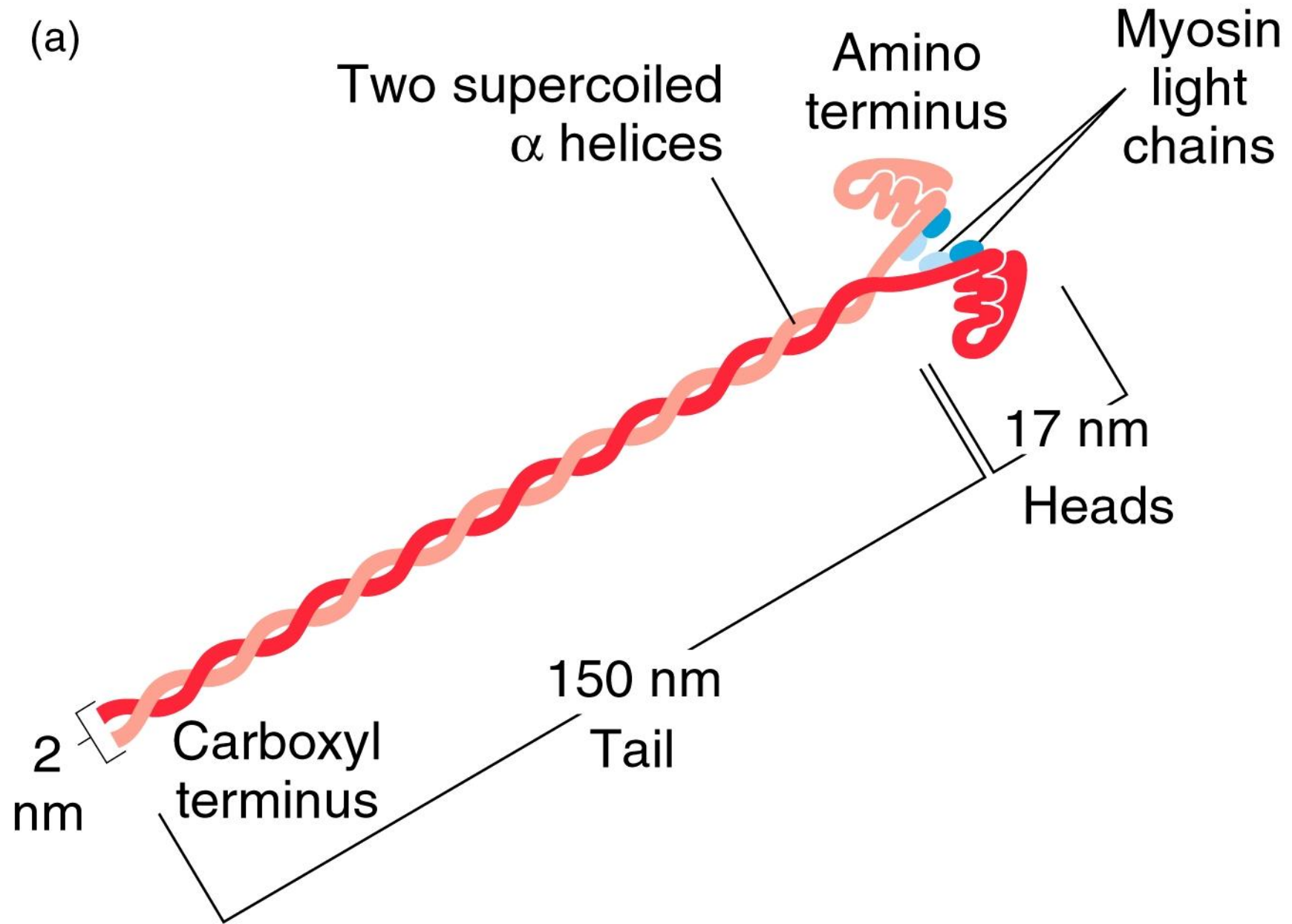
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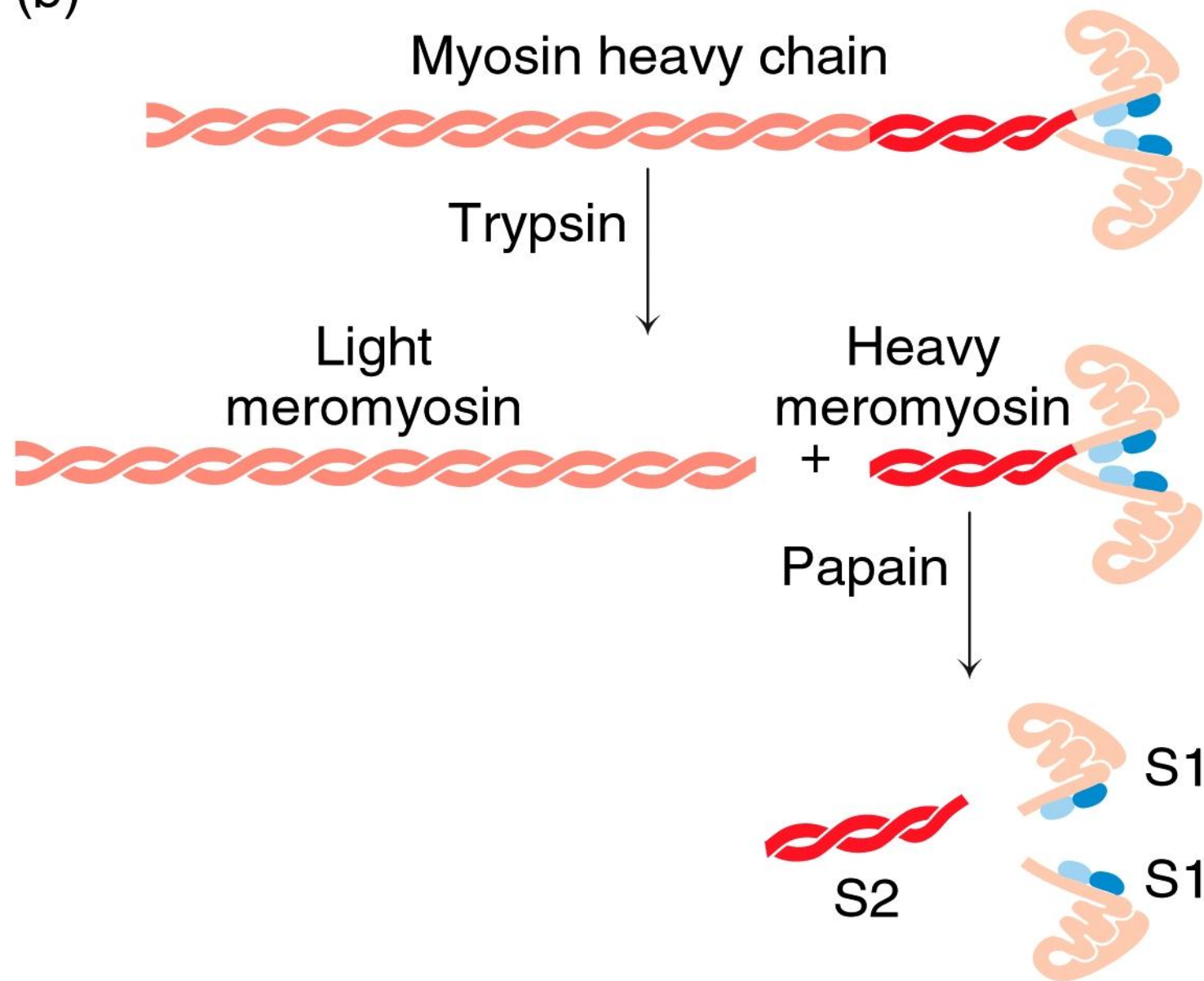
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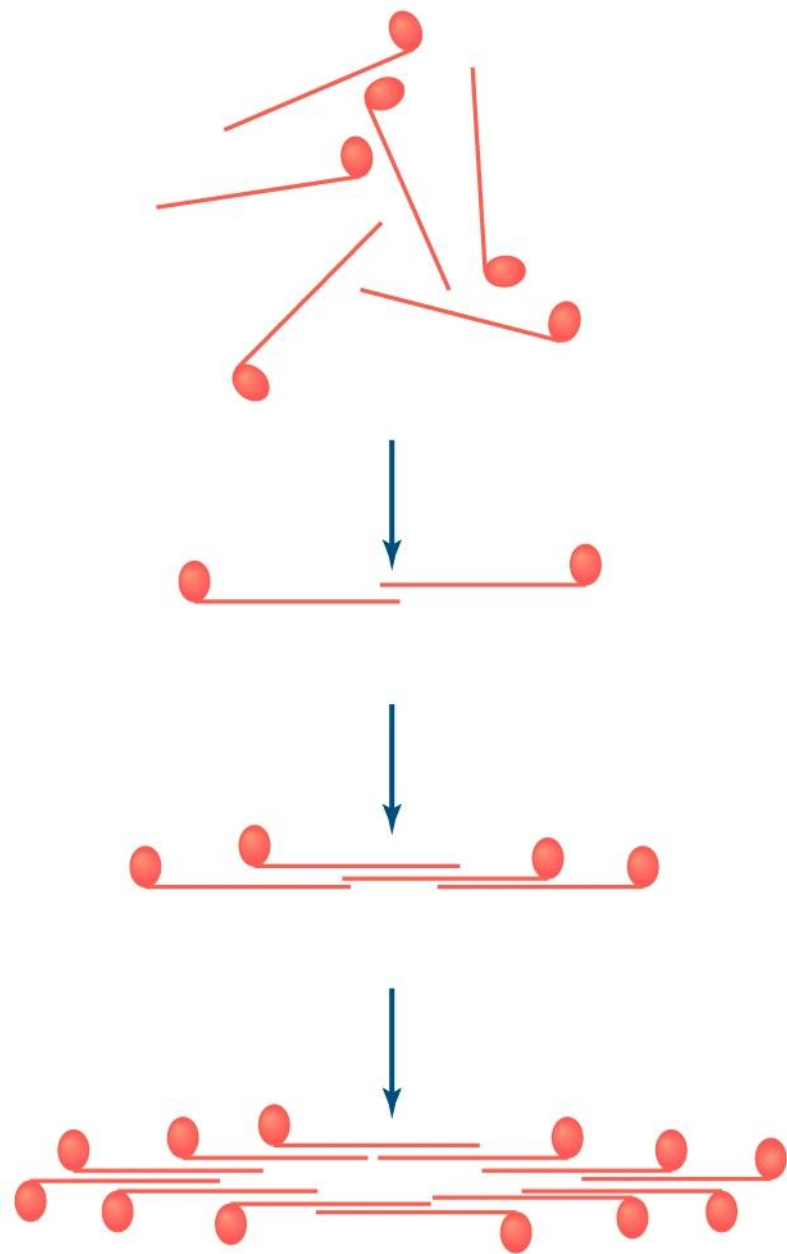






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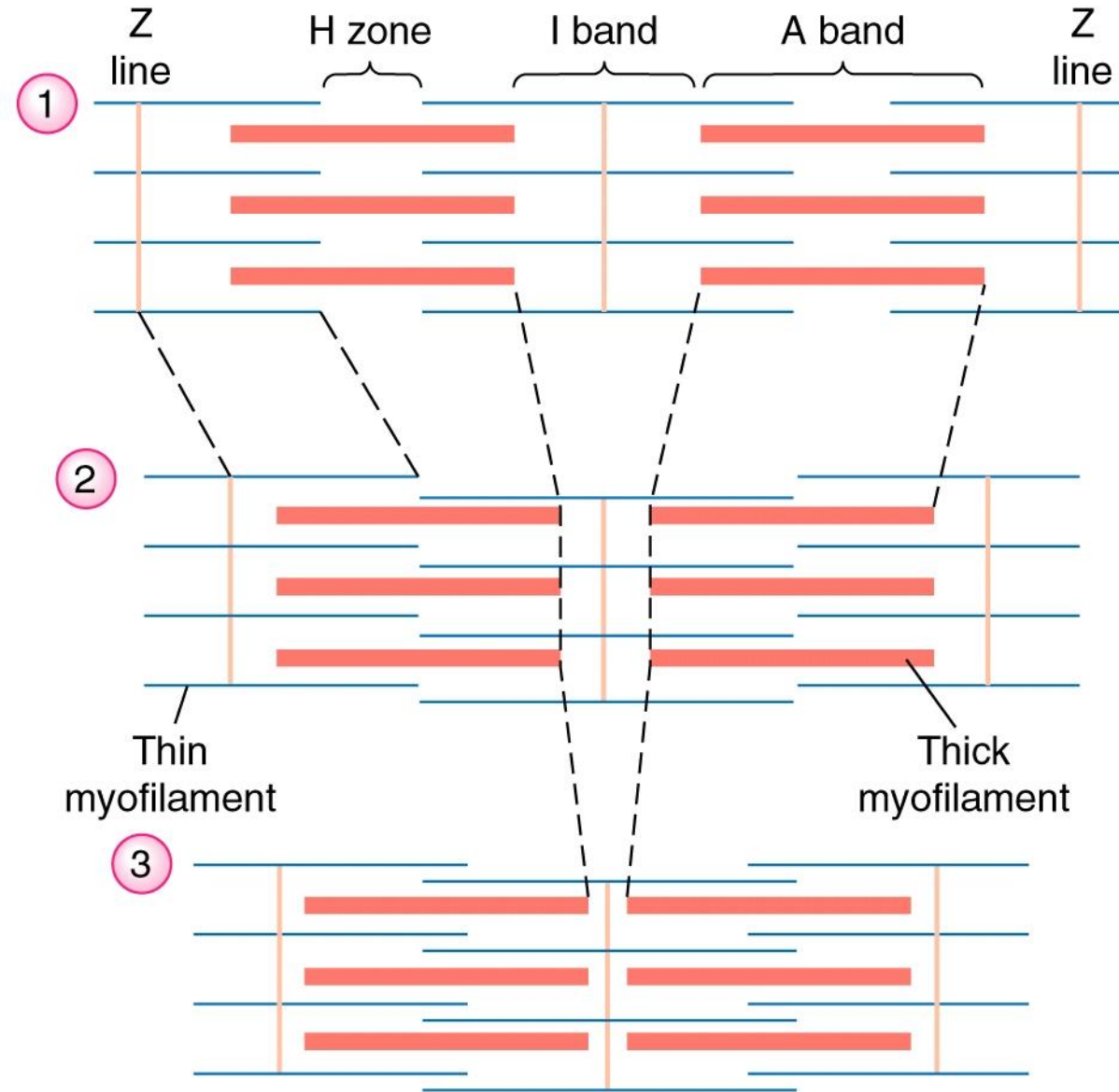




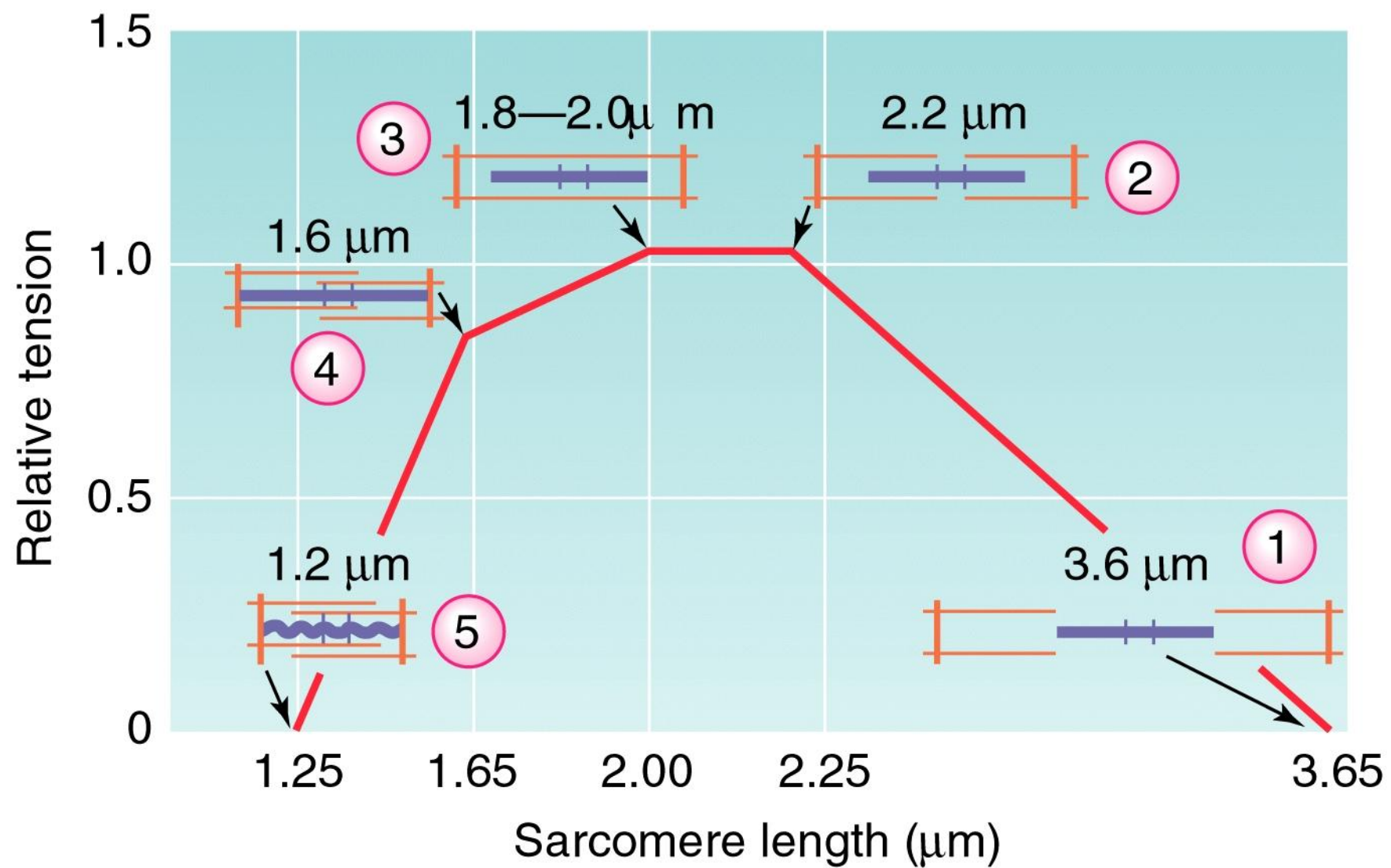
Albert Szent-Györgyi

https://en.wikipedia.org/wiki/Albert_Szent-Gy%C3%B6rgyi

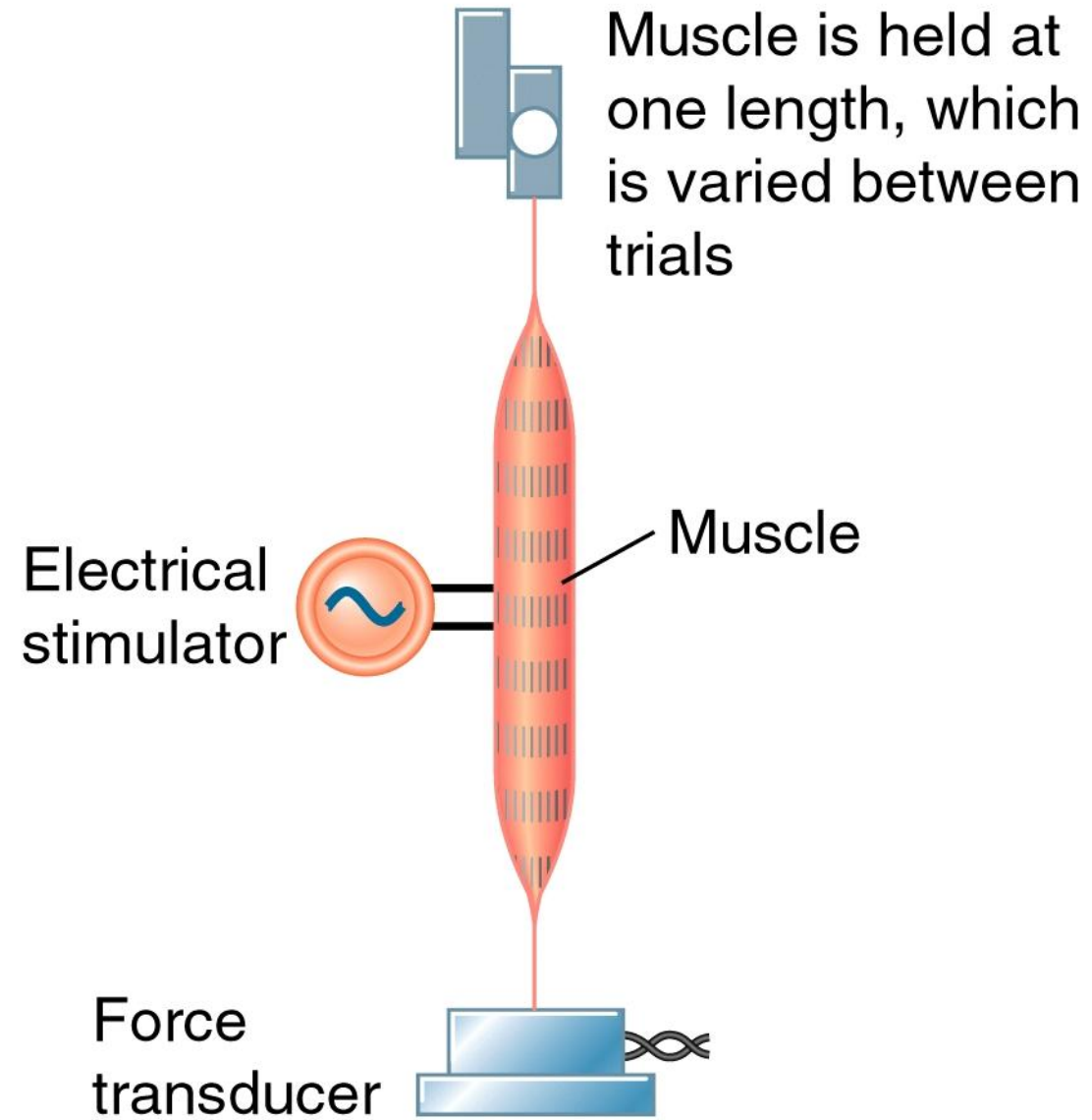
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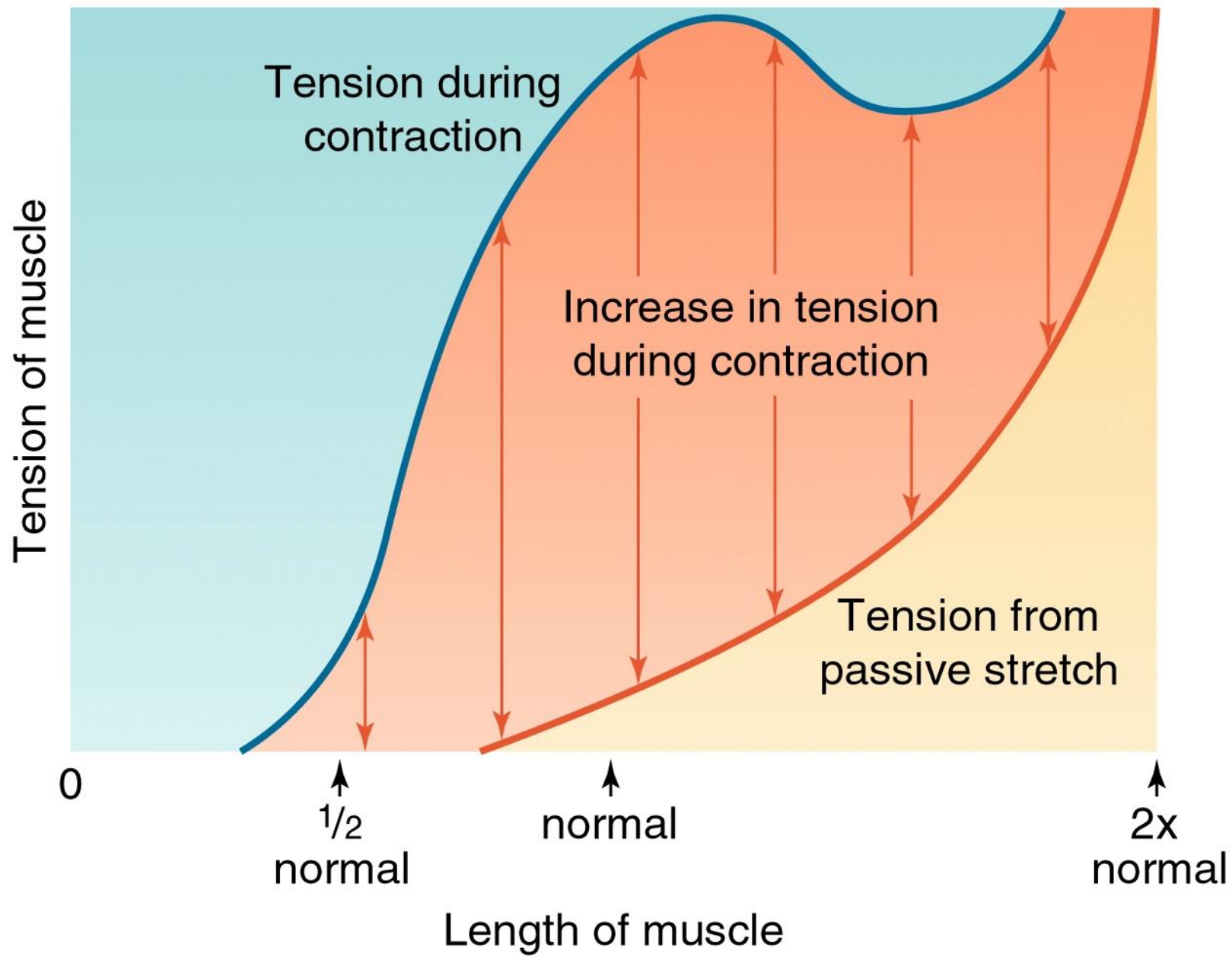


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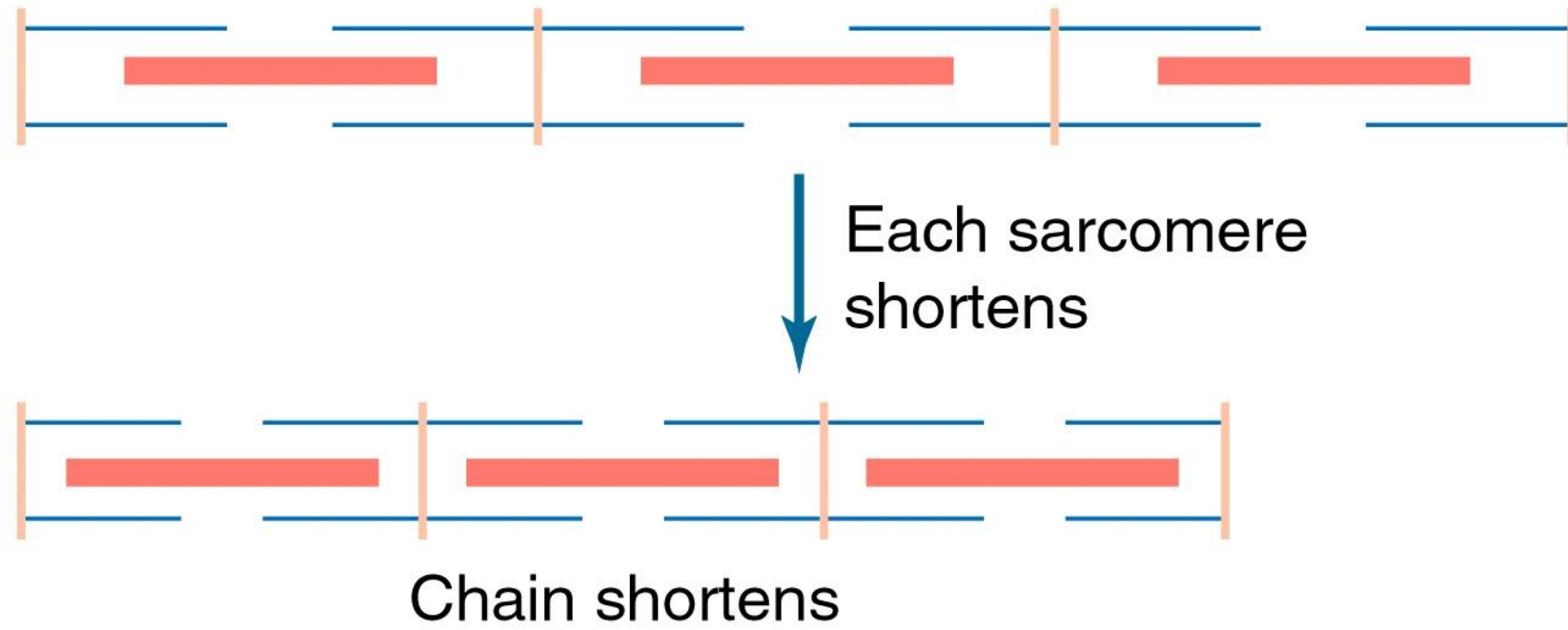


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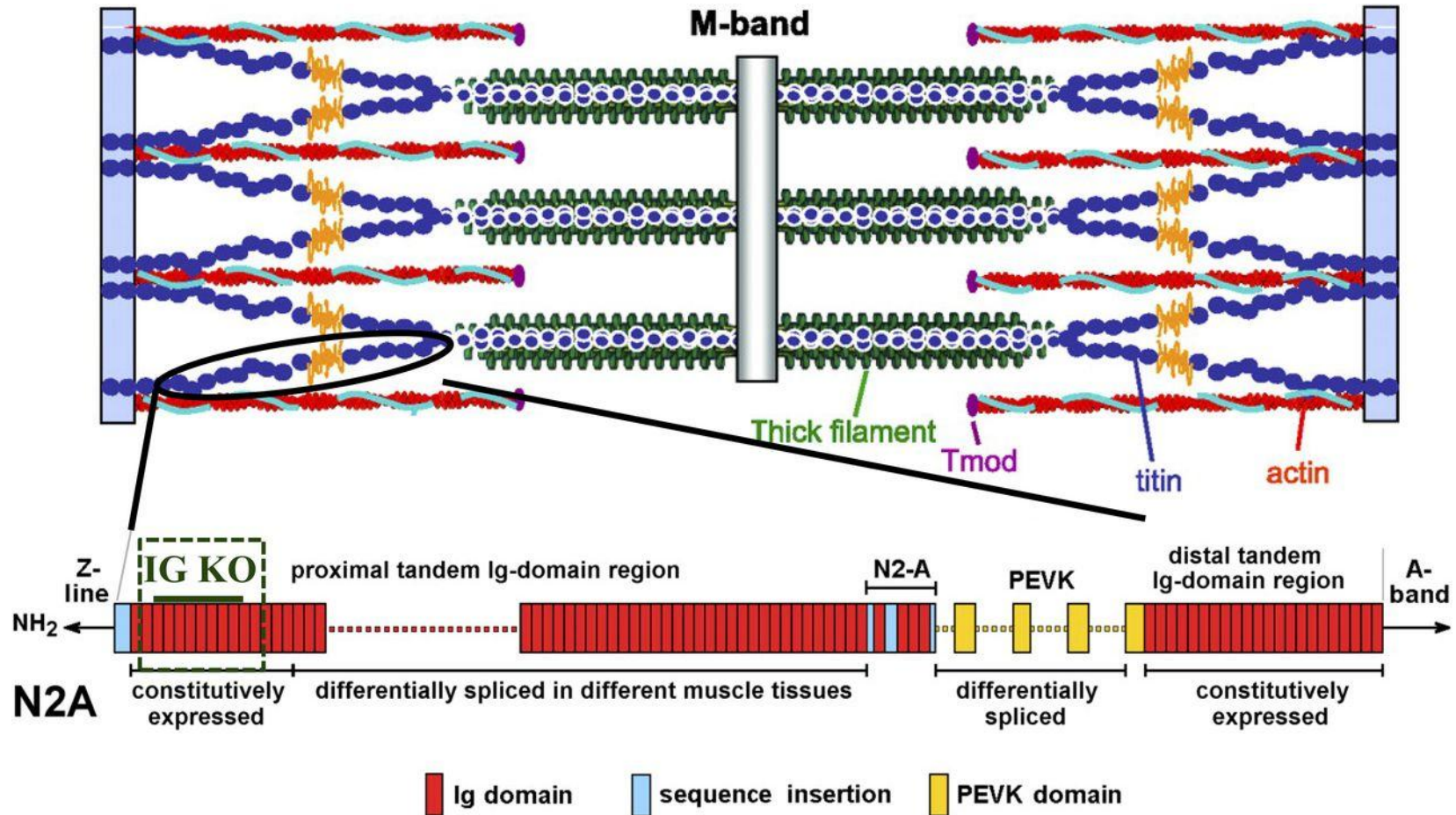




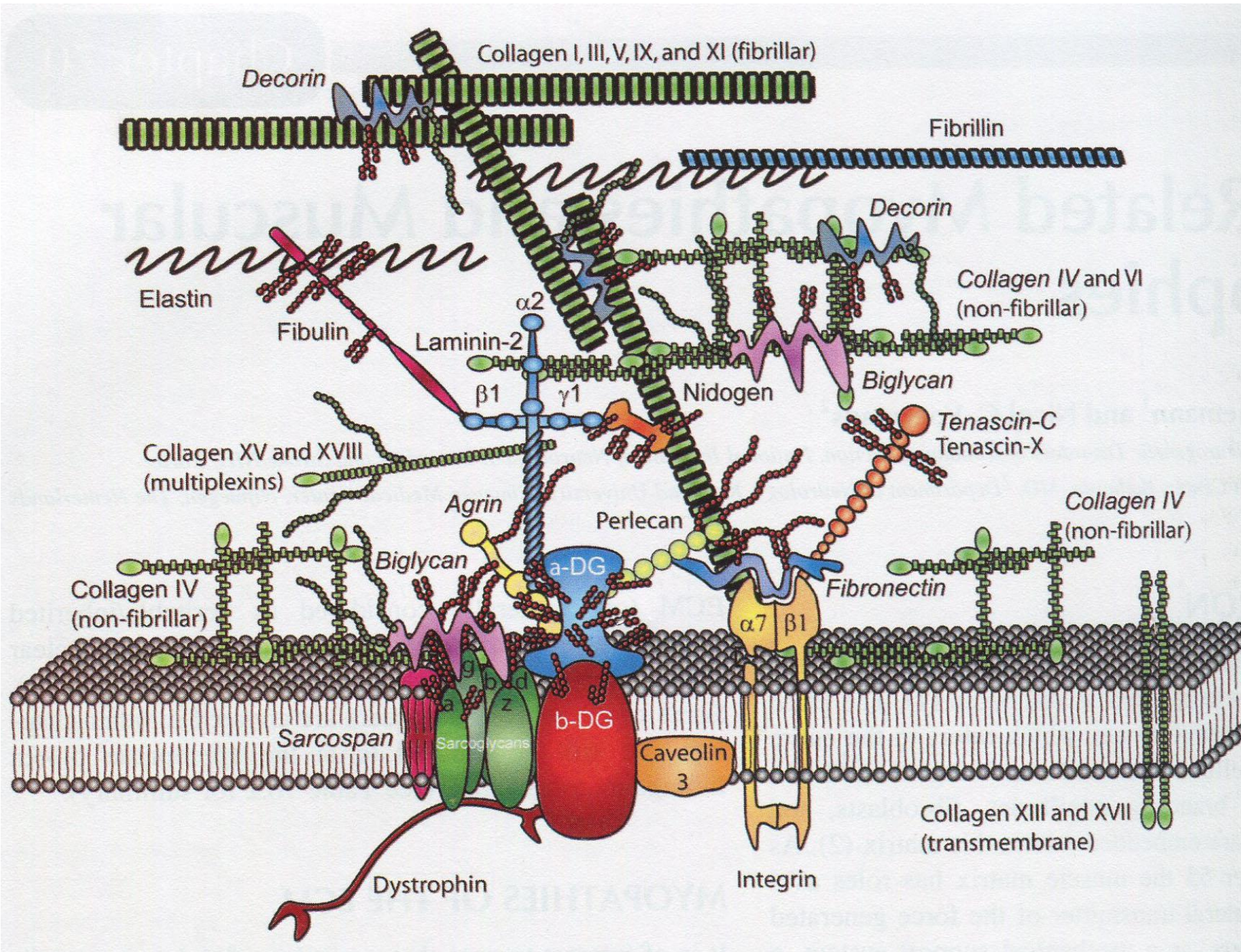
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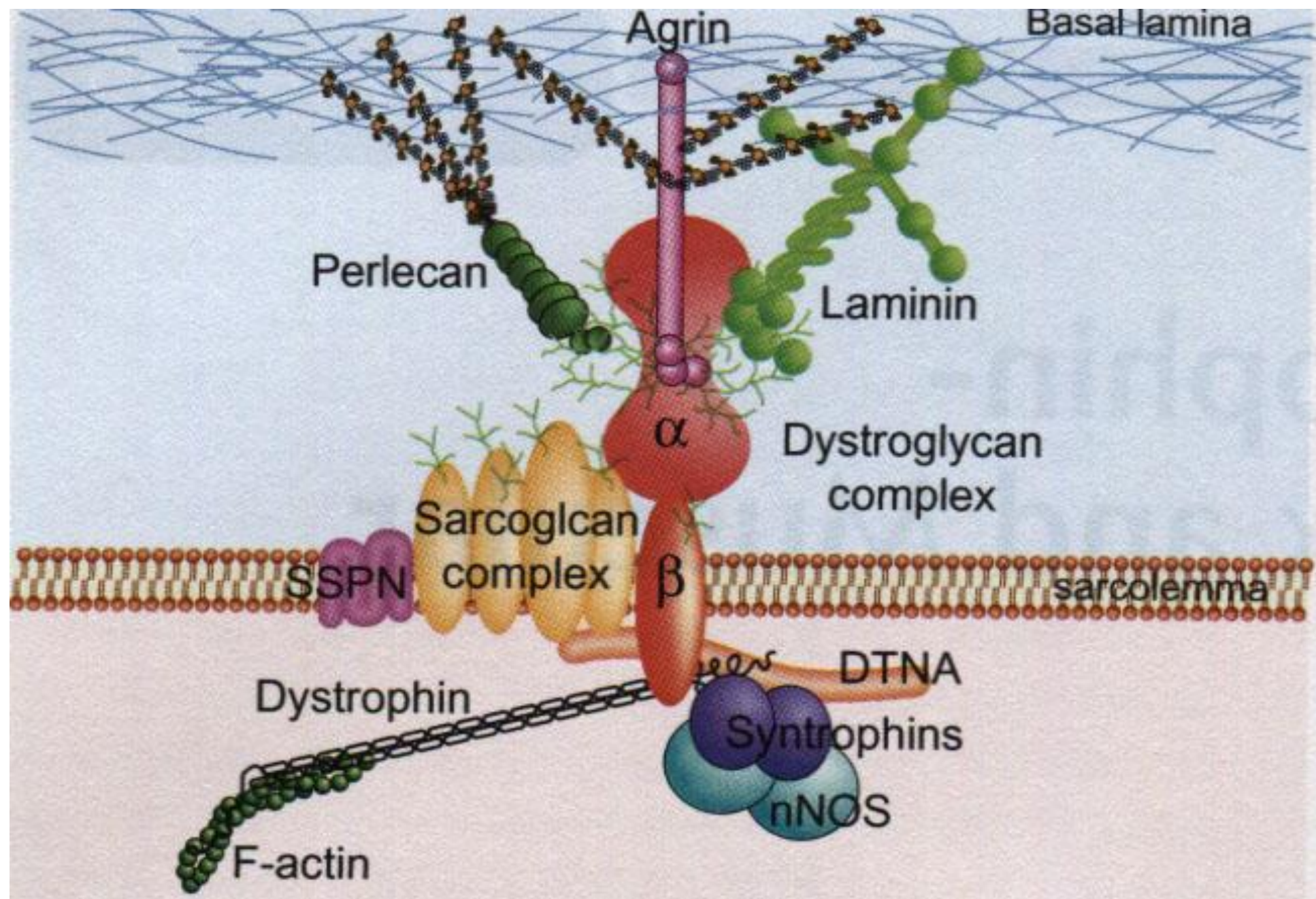


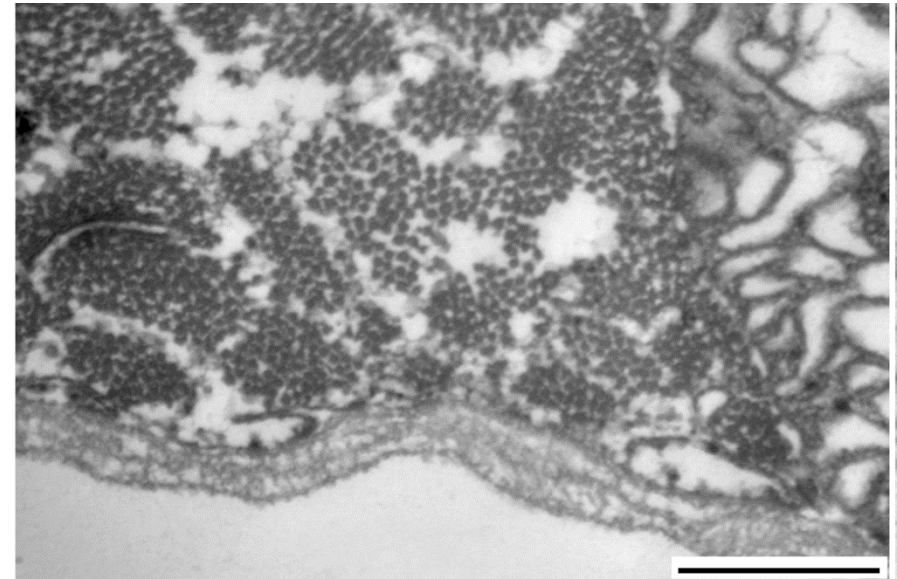
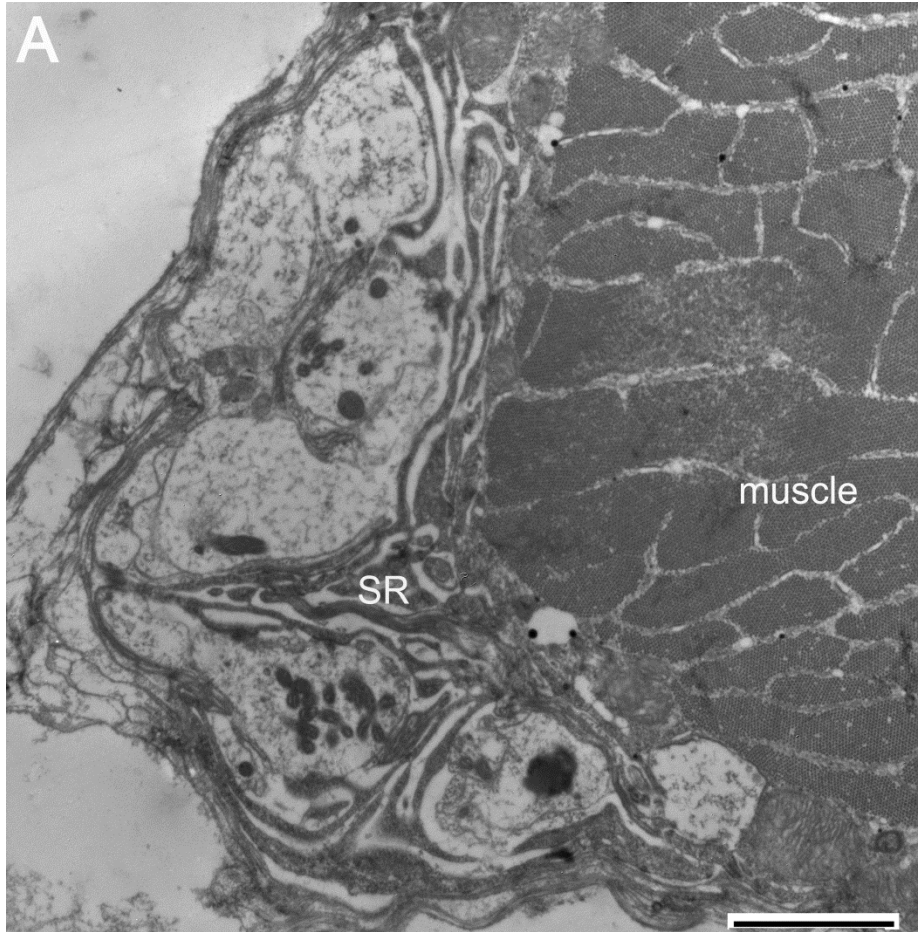
Layout of titin in the sarcomere.

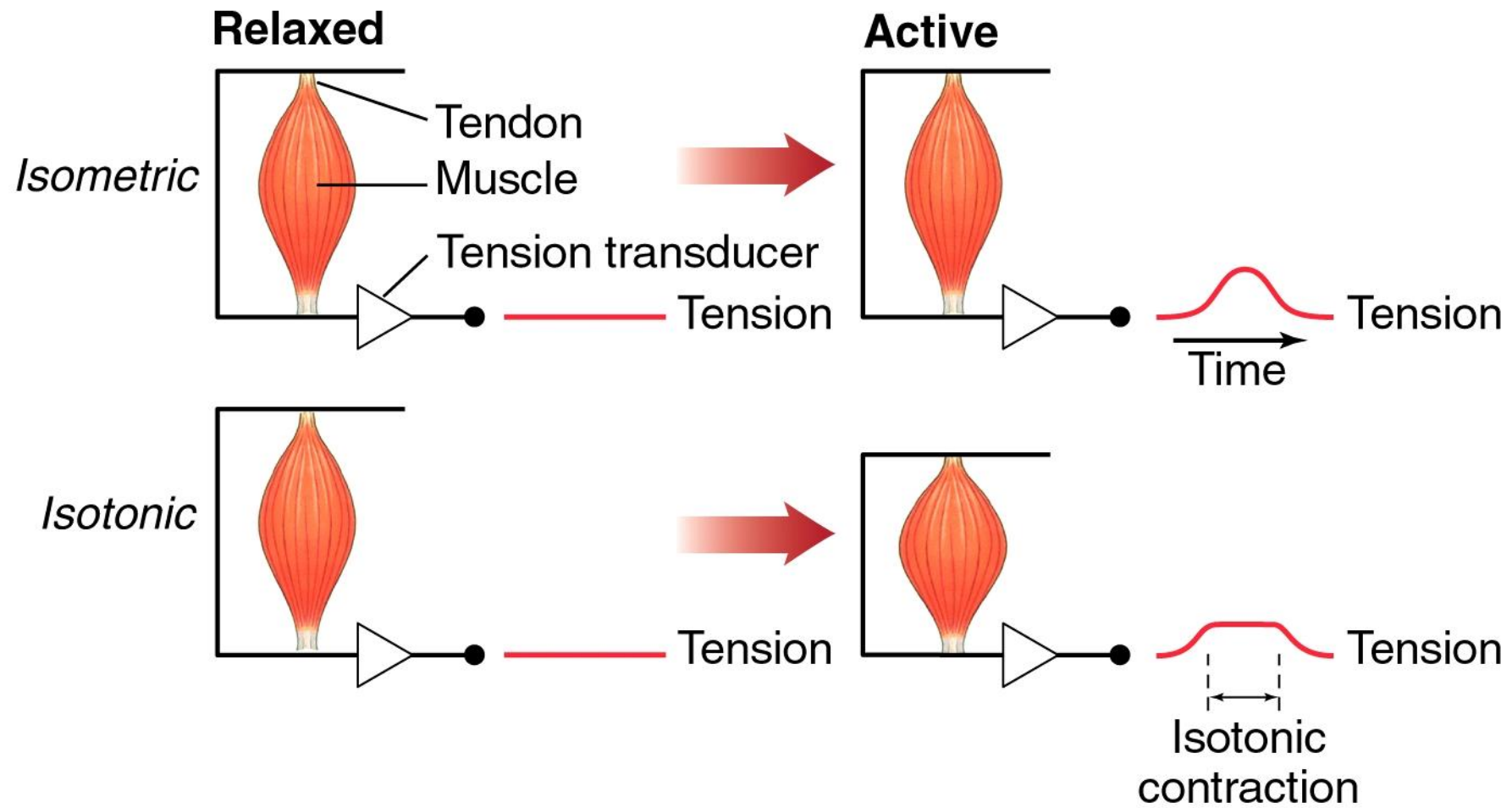


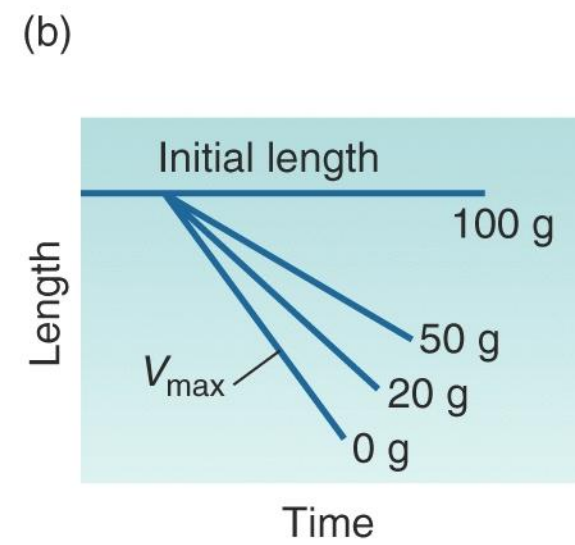
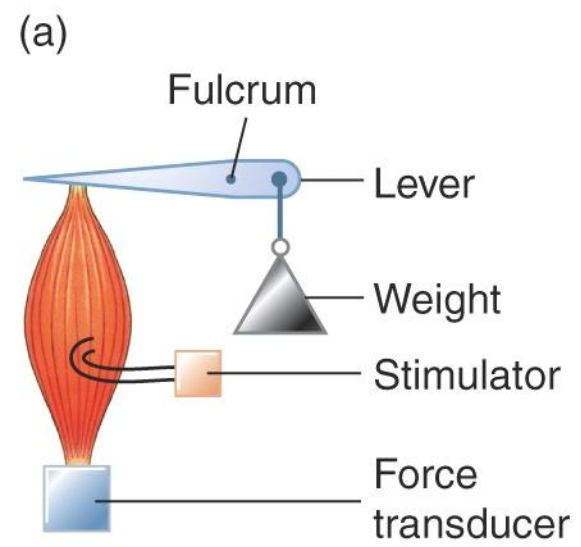
Danielle Buck et al. J Gen Physiol 2014;143:215-230



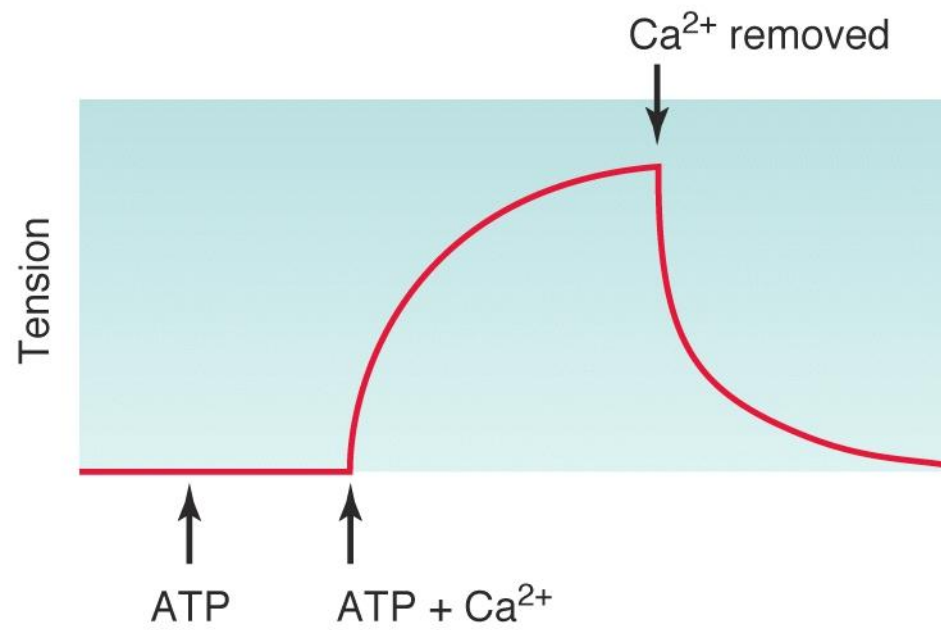




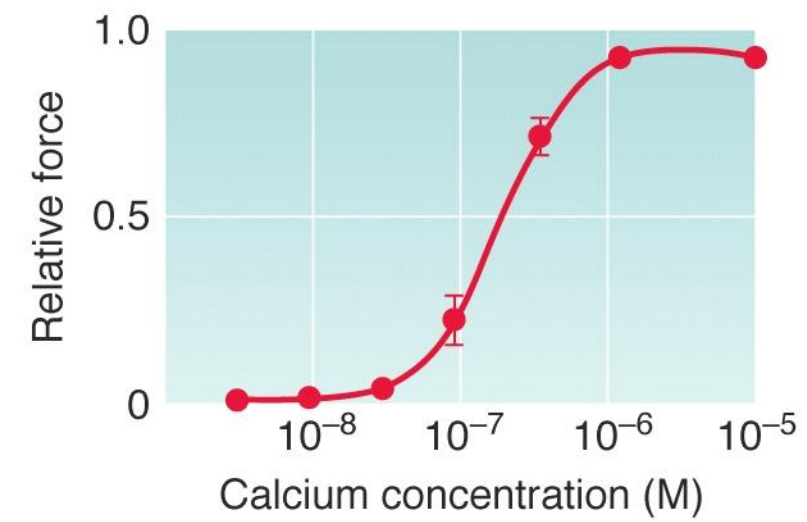




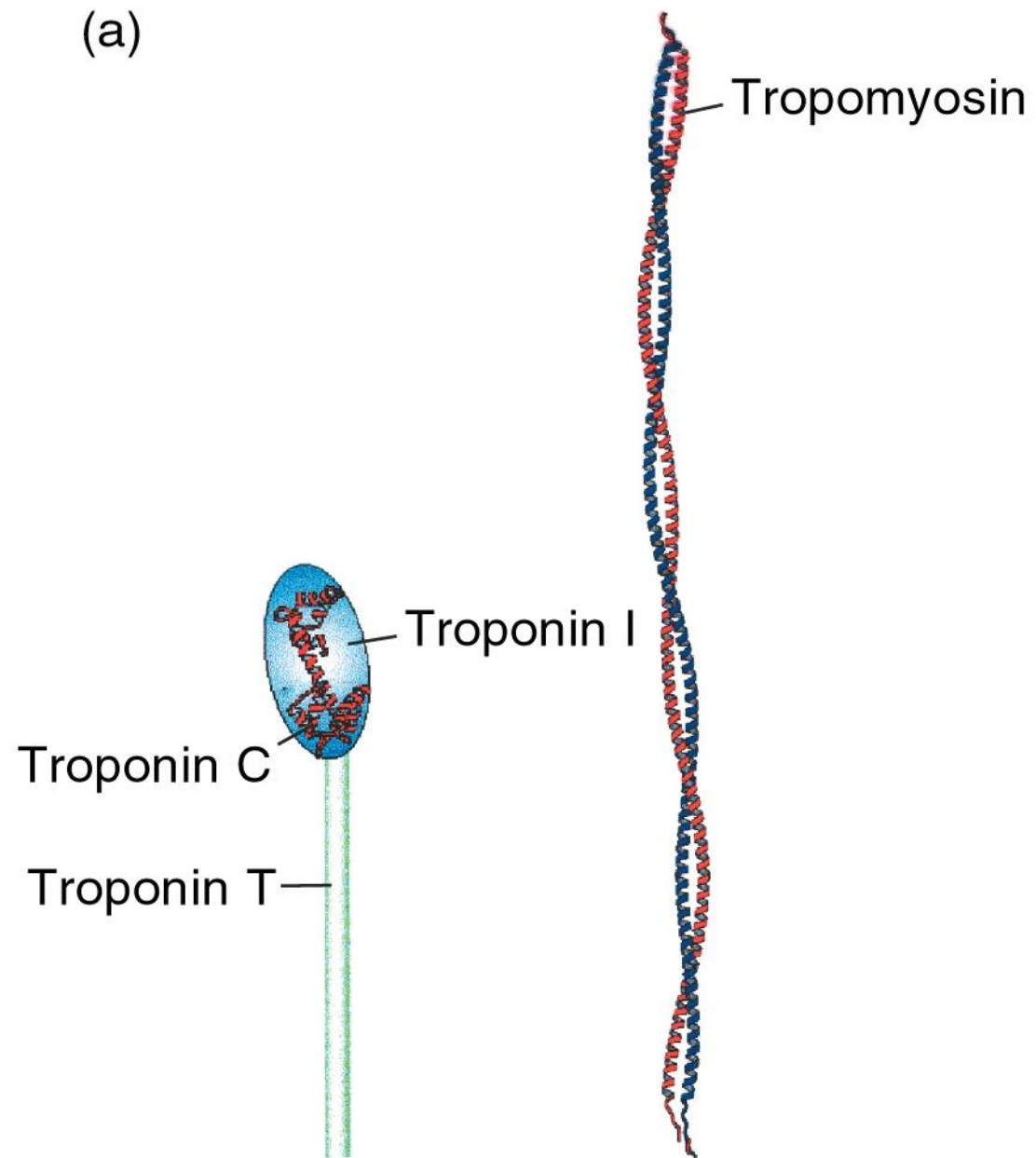
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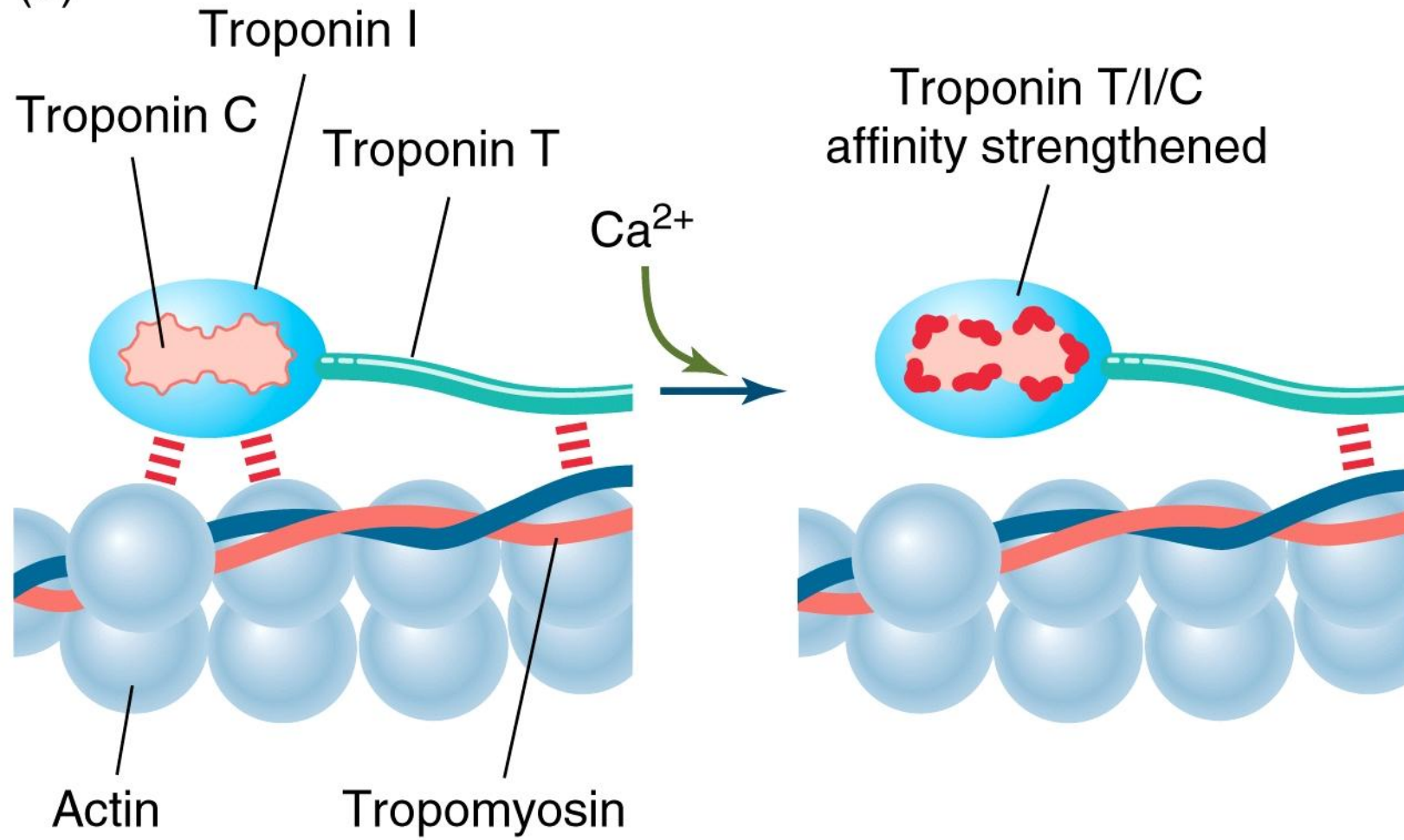
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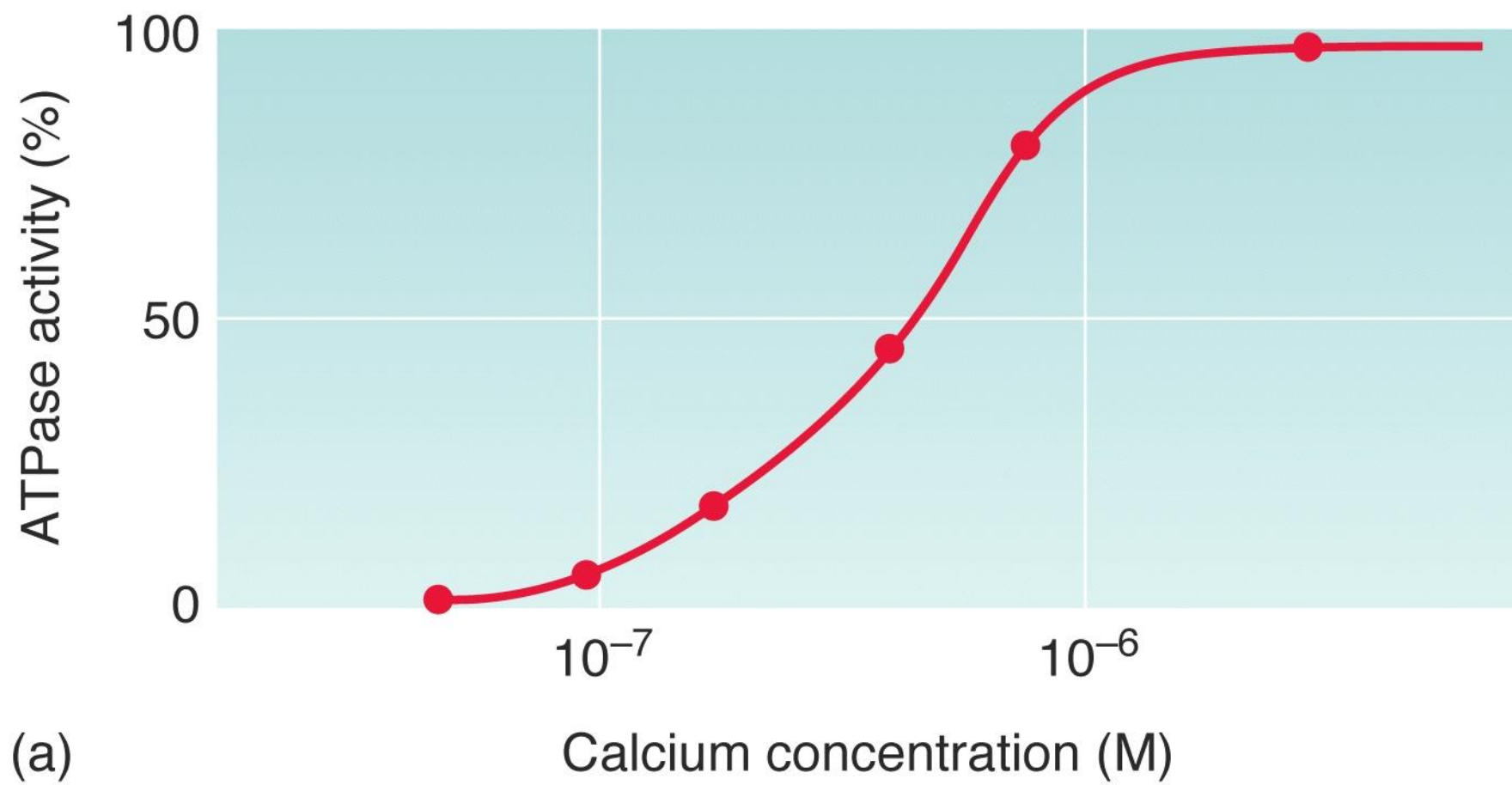


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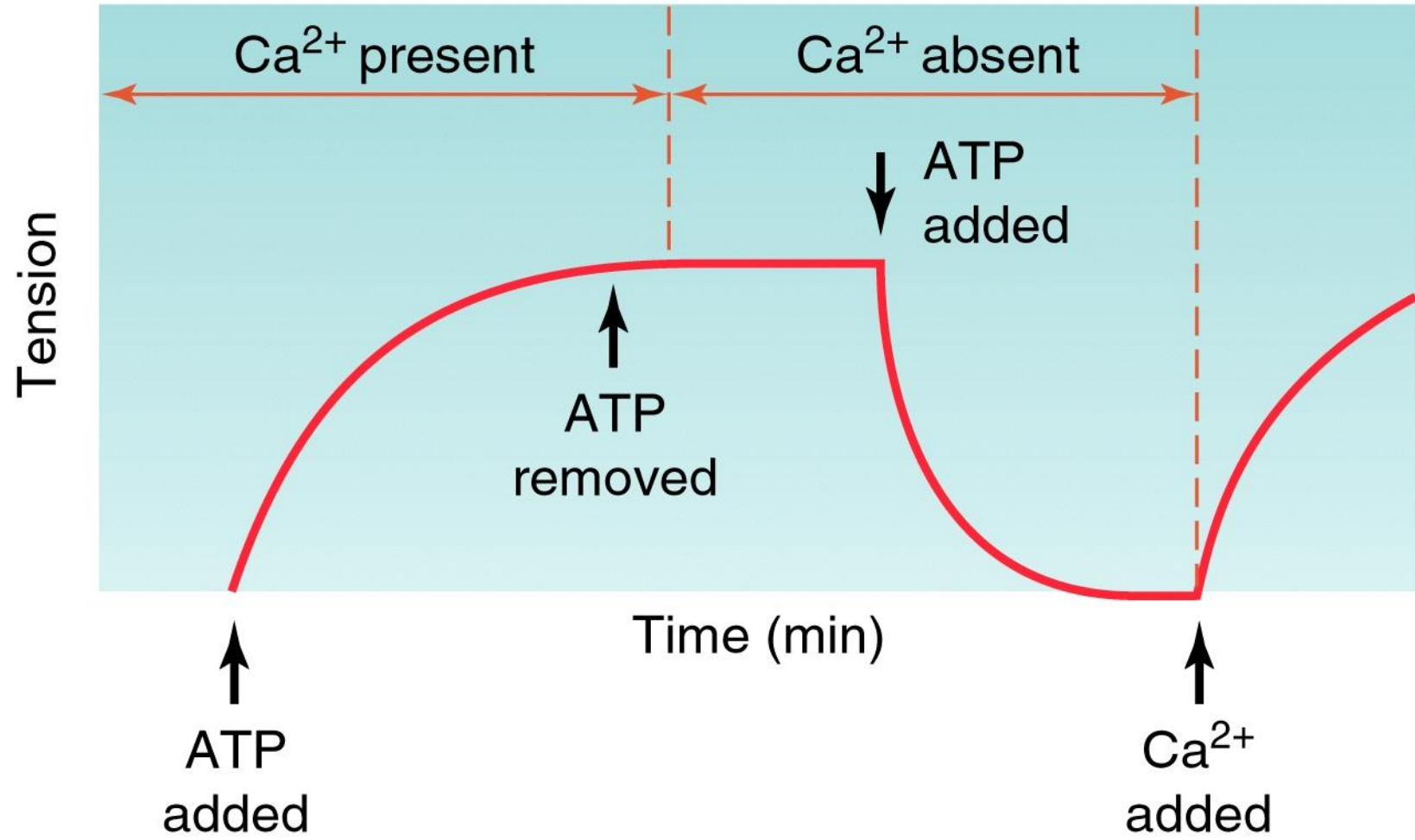


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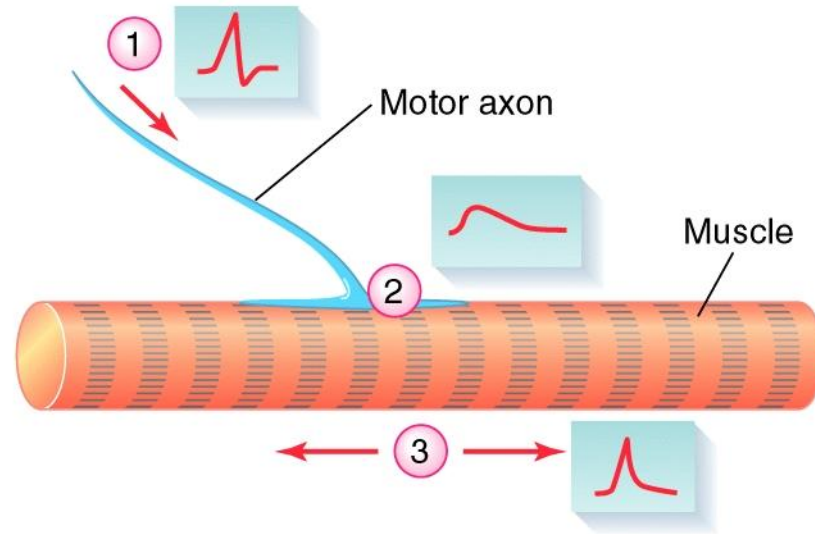




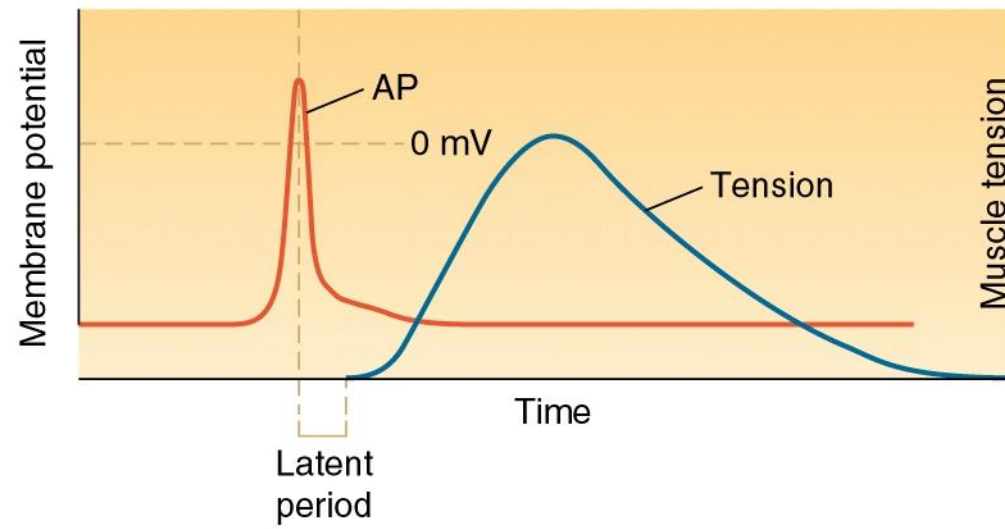
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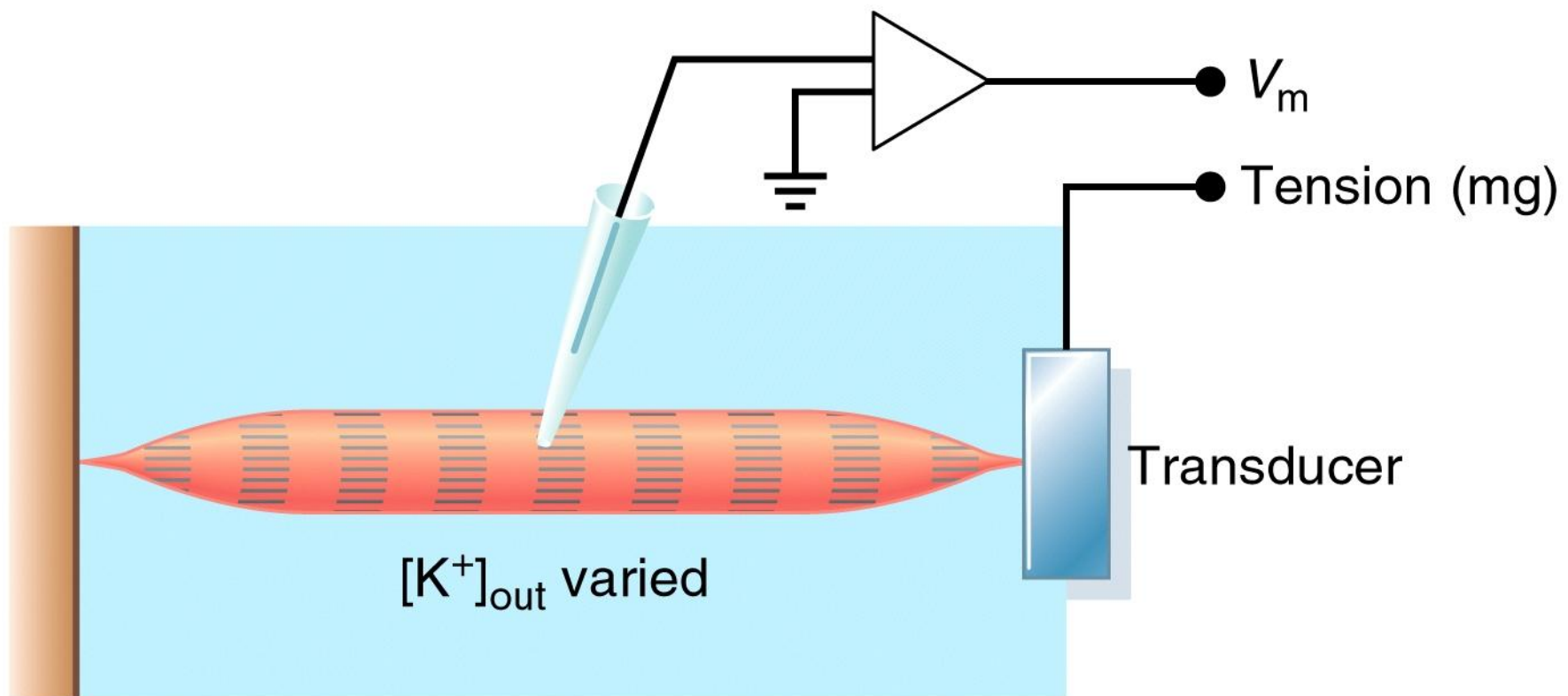
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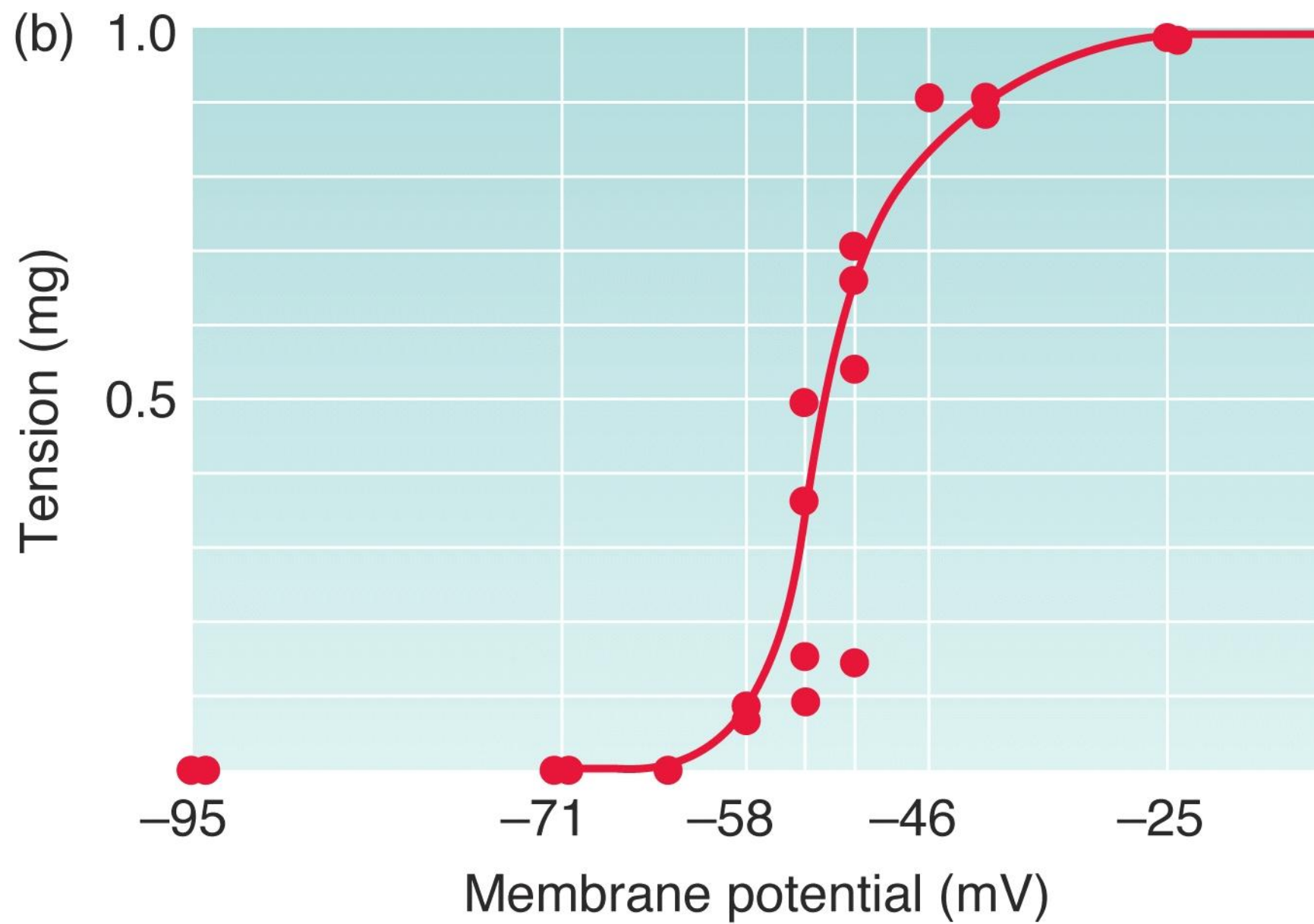


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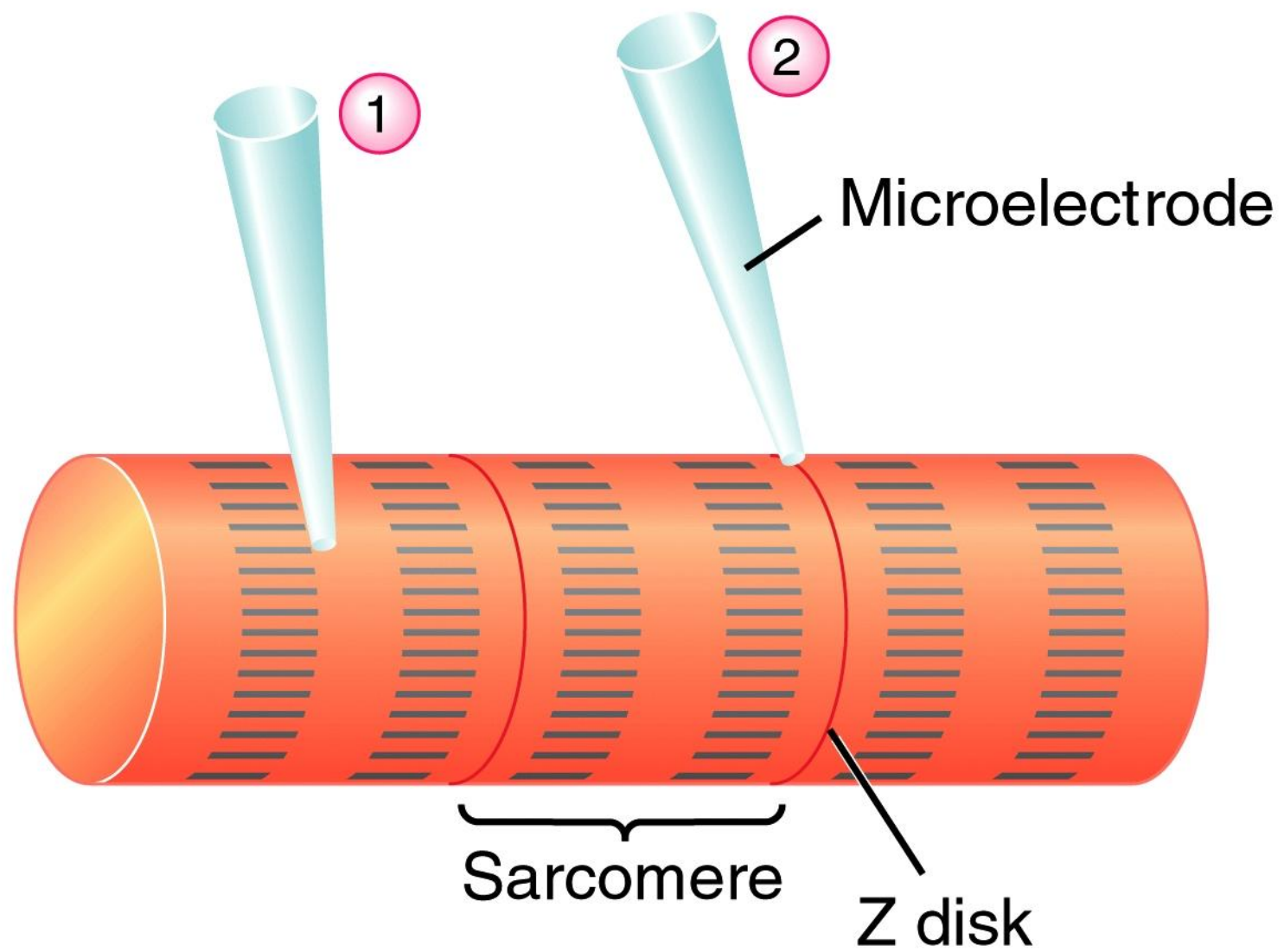


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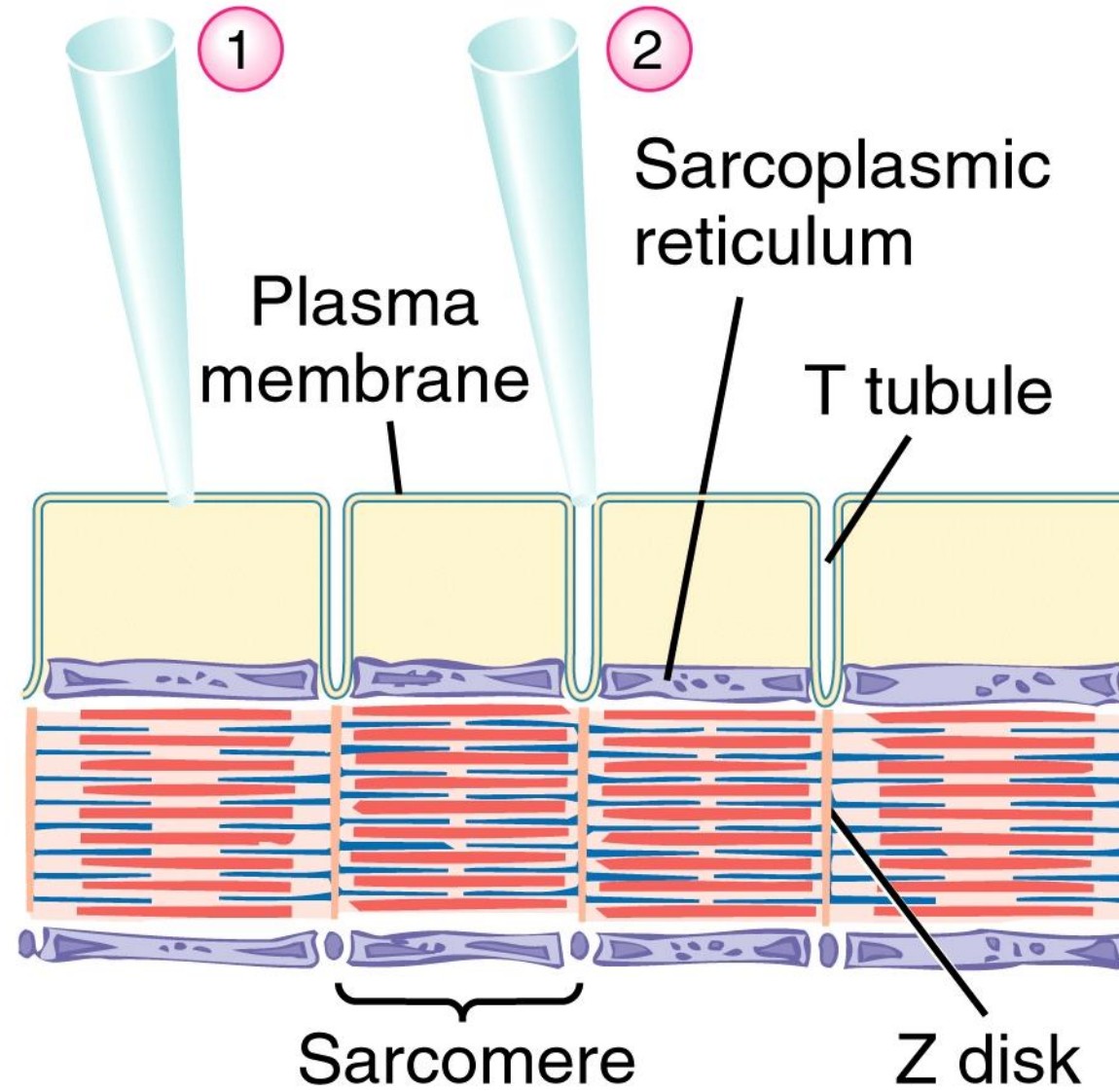


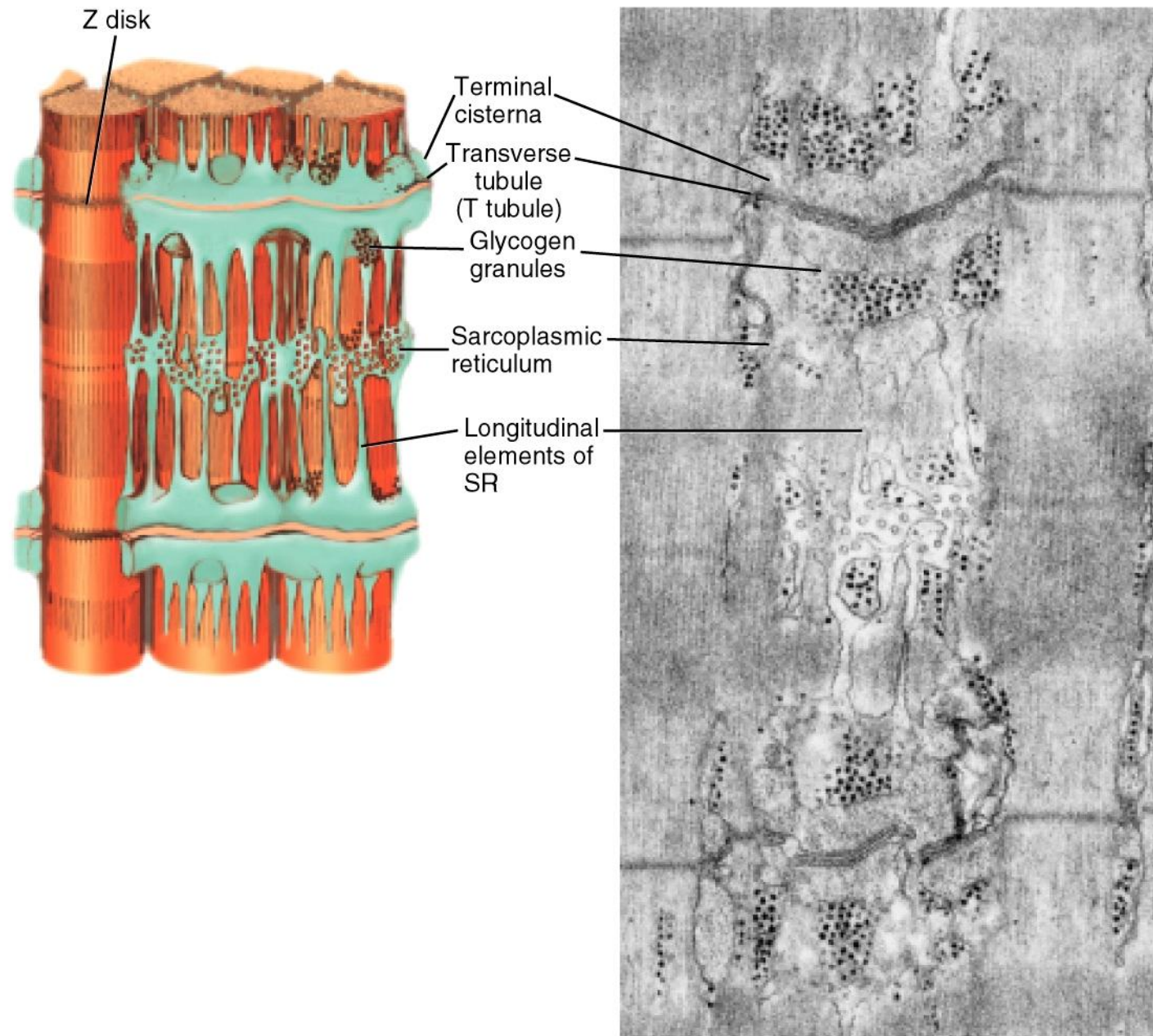


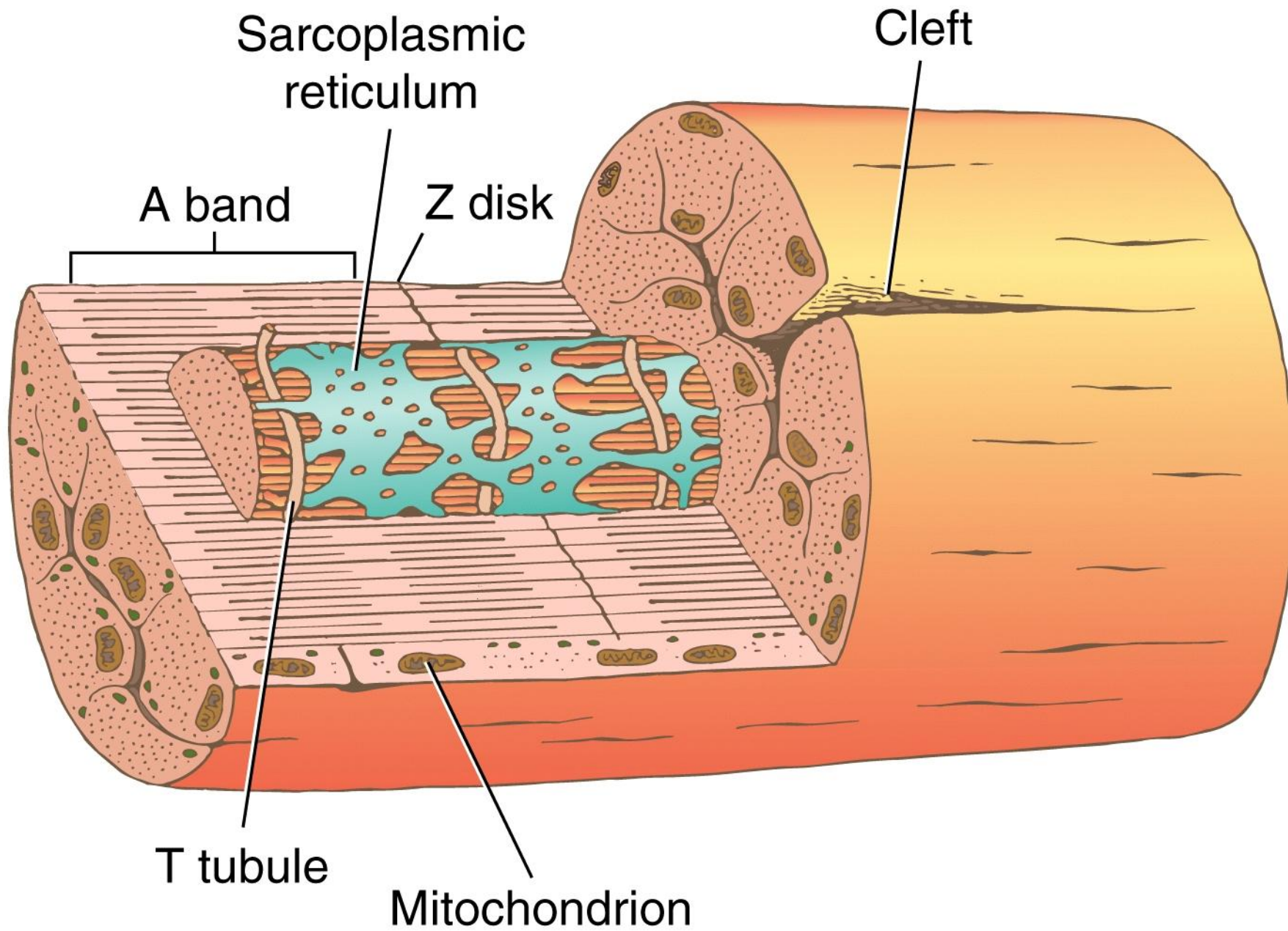
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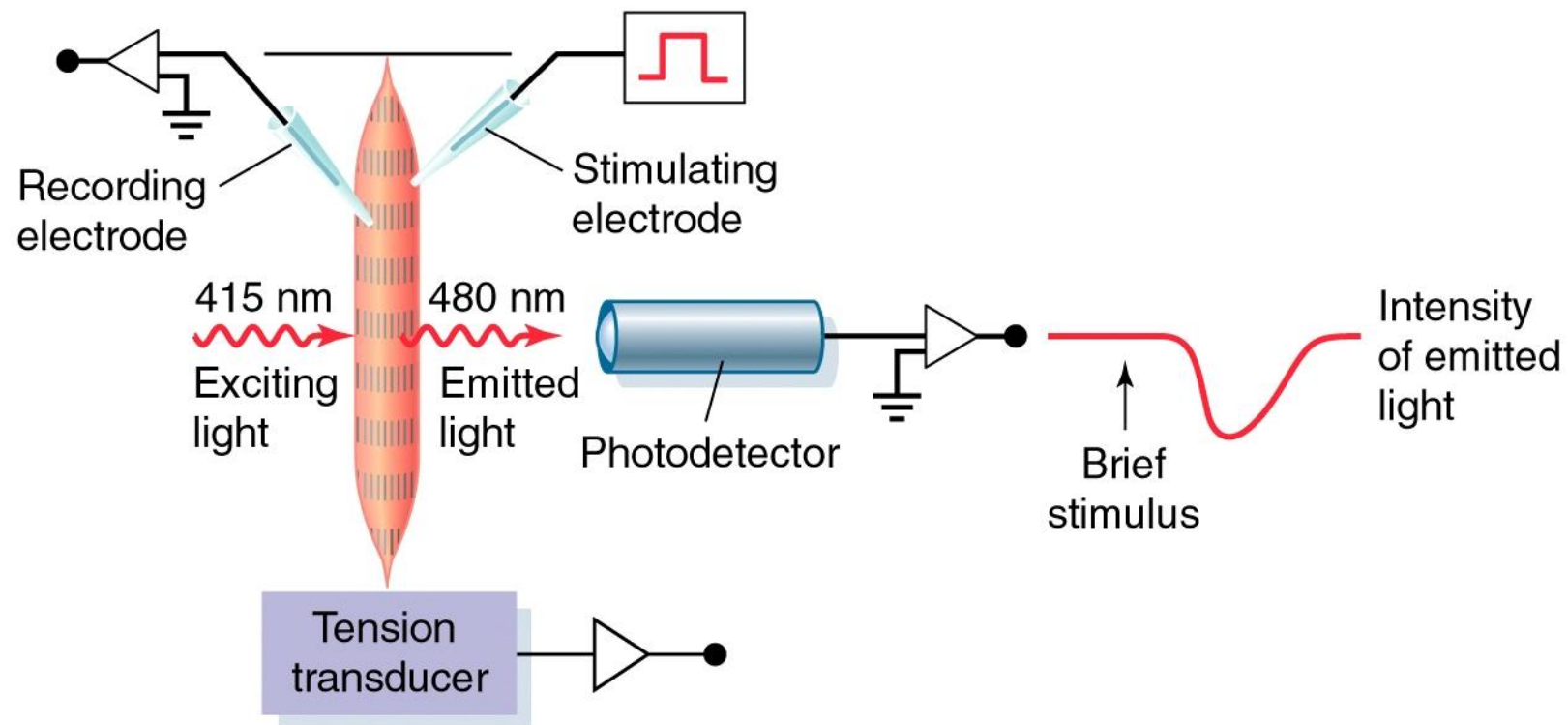
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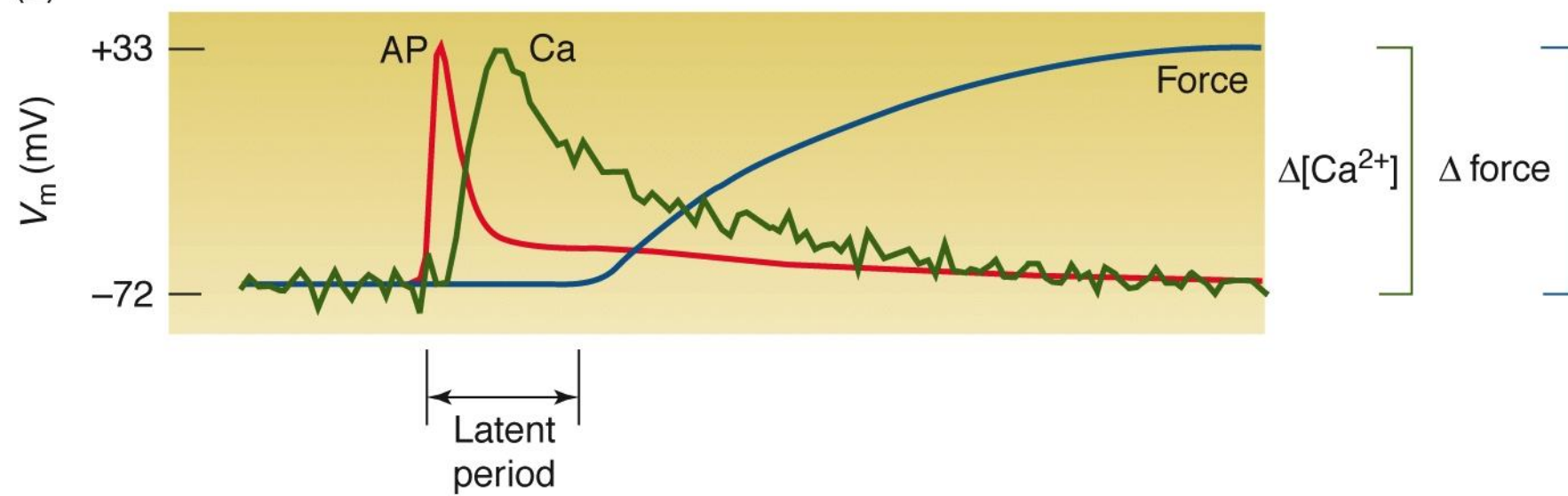




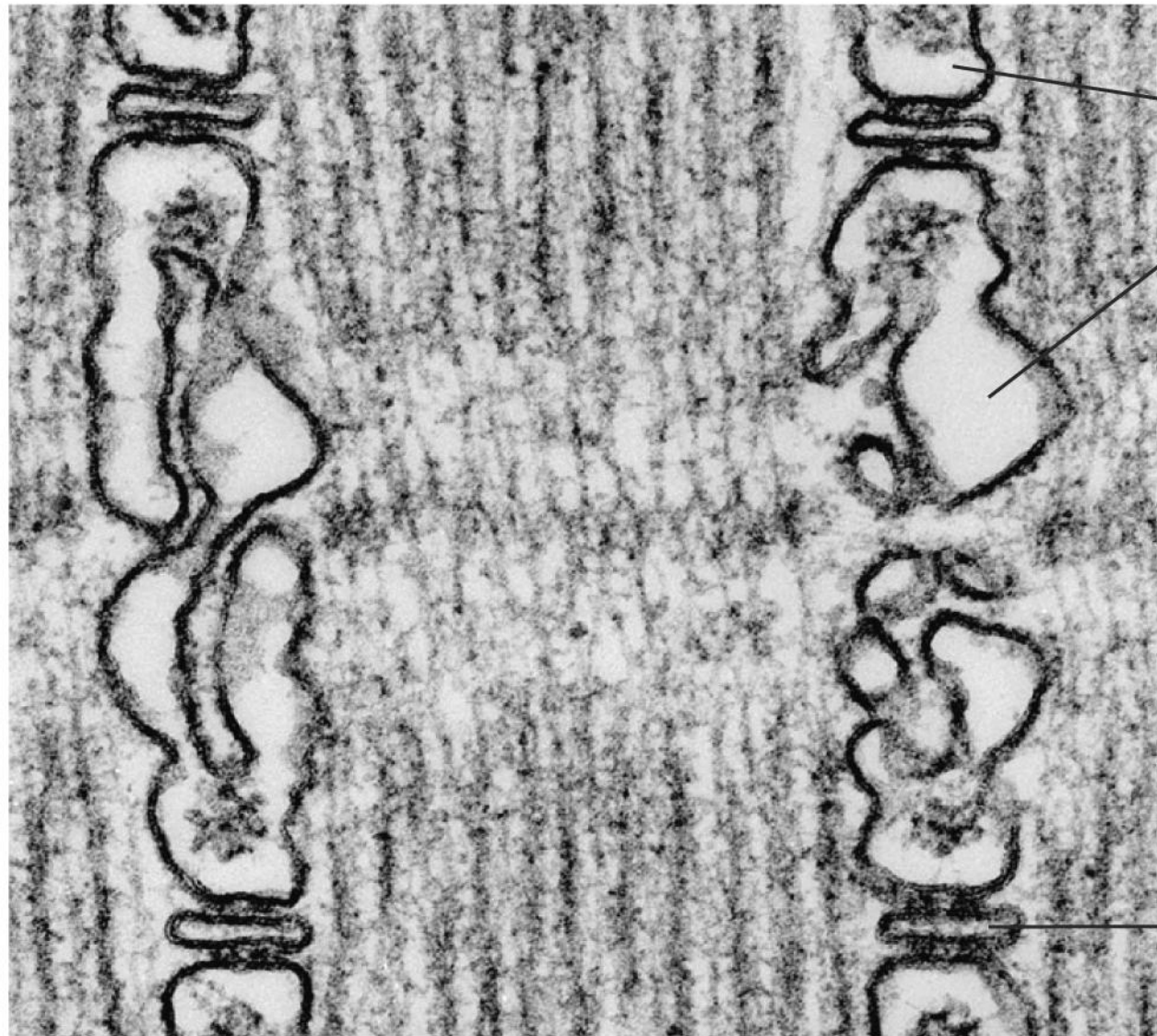
(a)



(b)



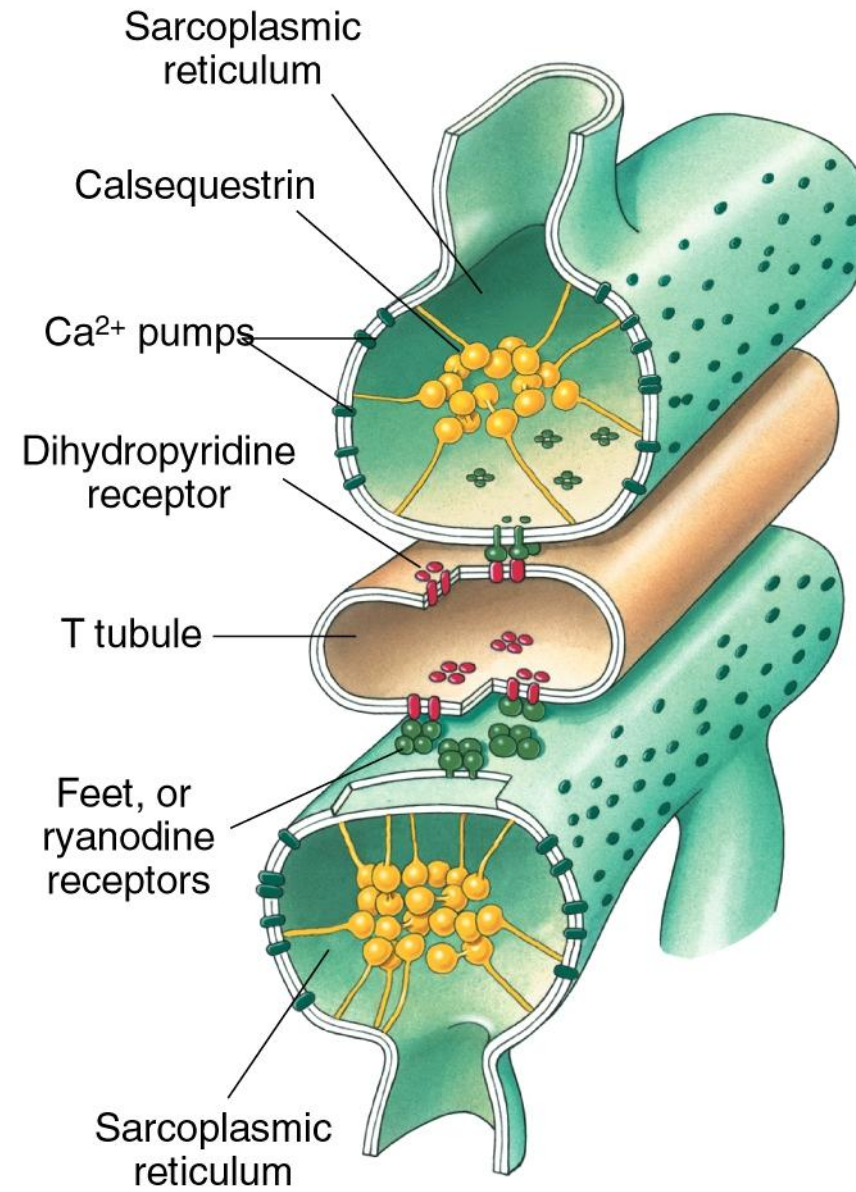
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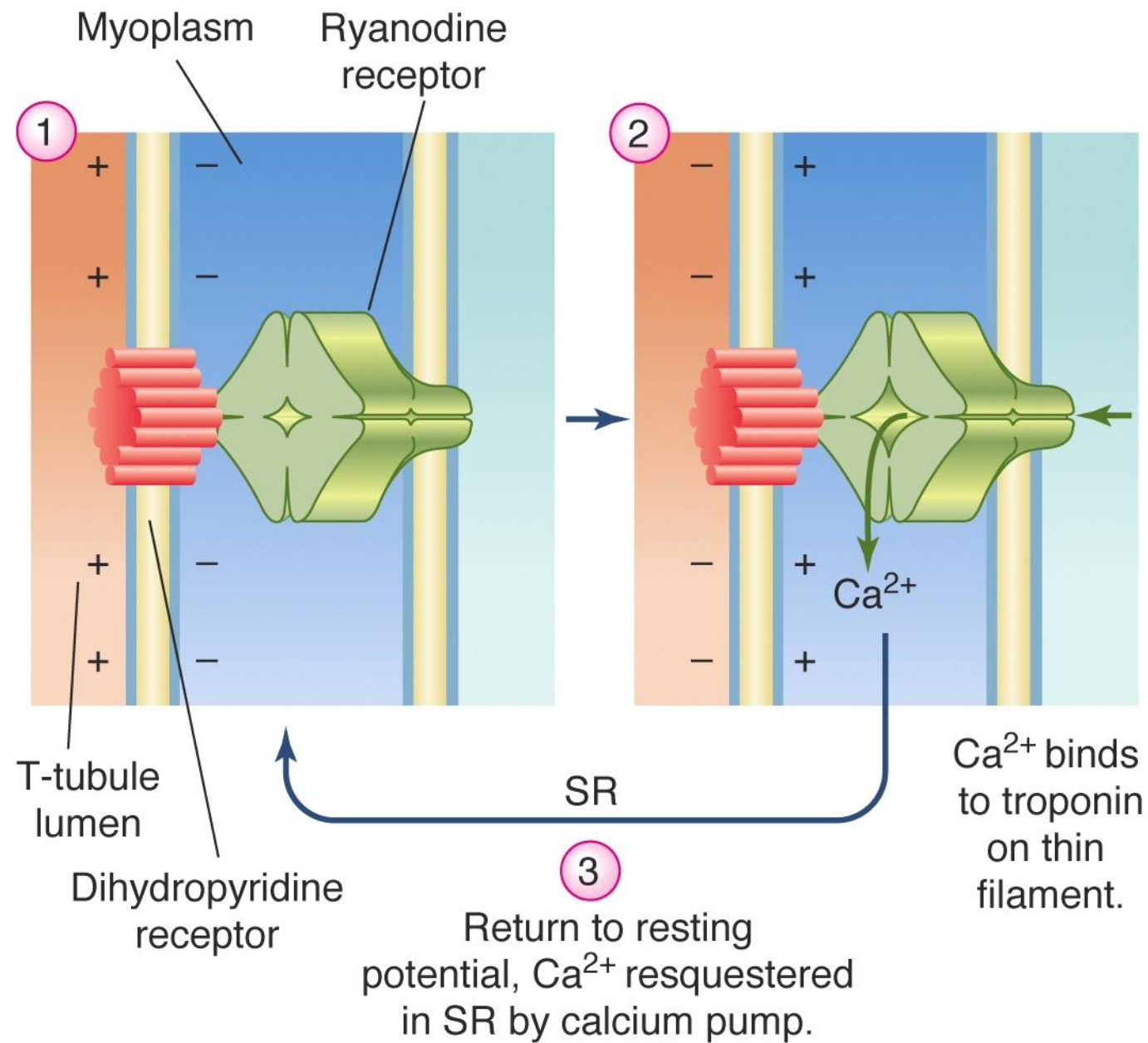


Terminal
cisternae

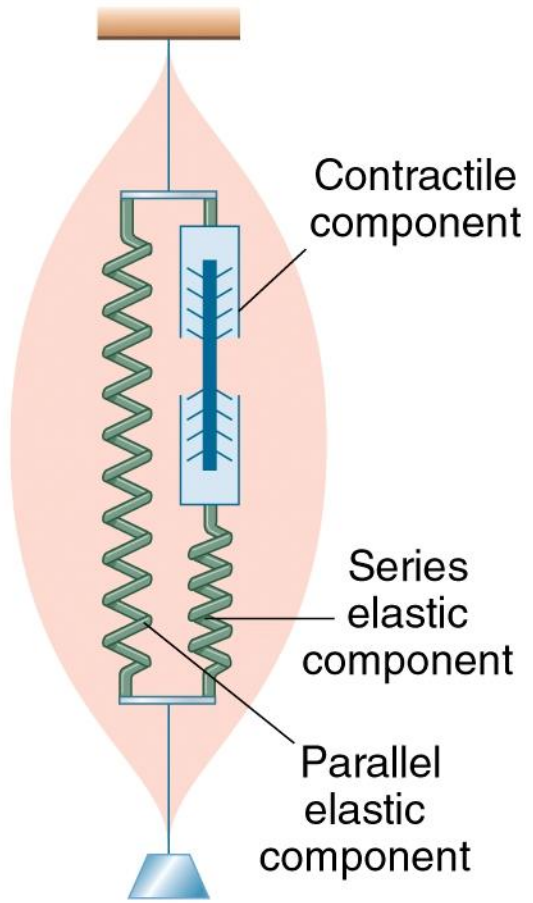
T tubule

(d)

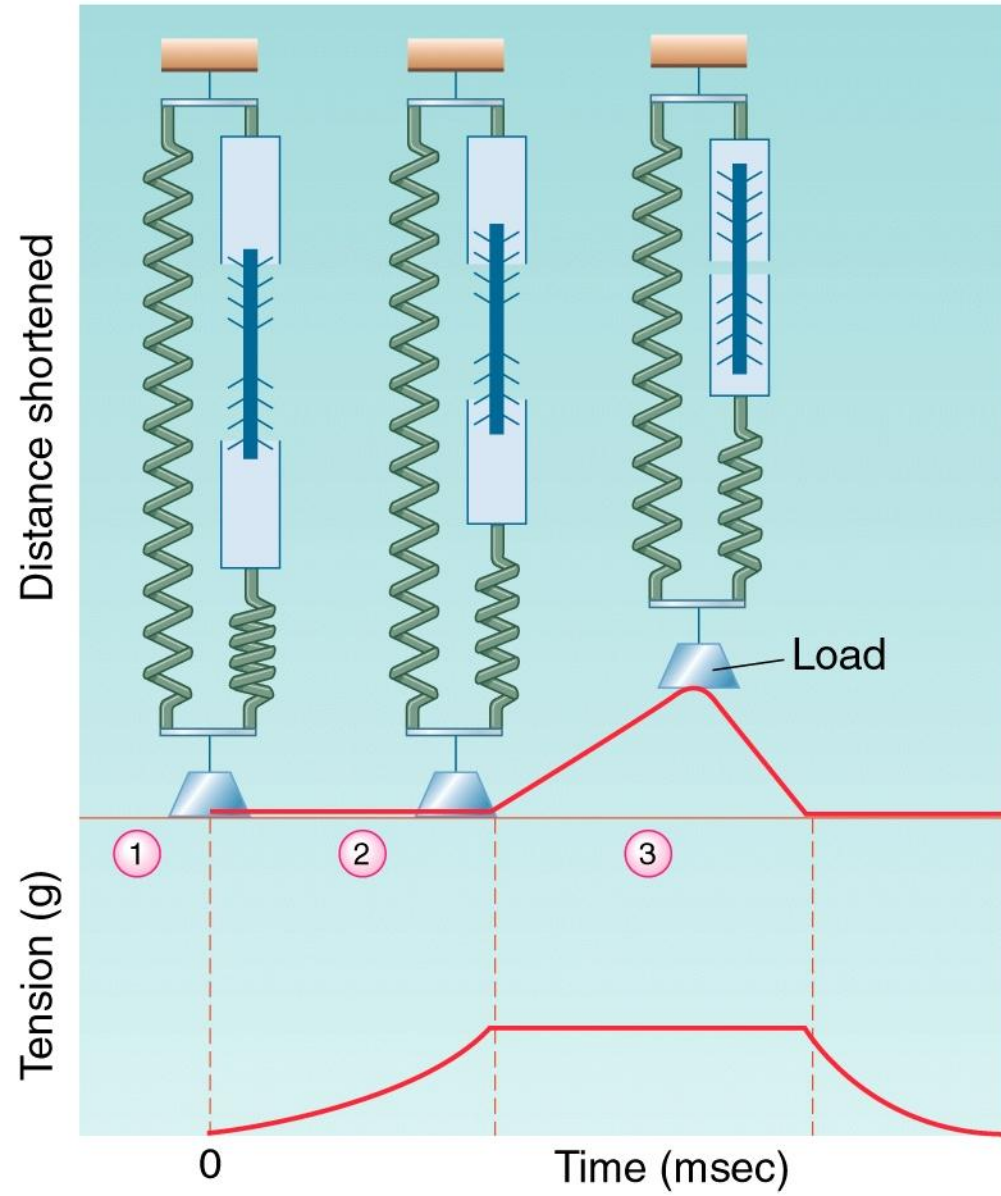


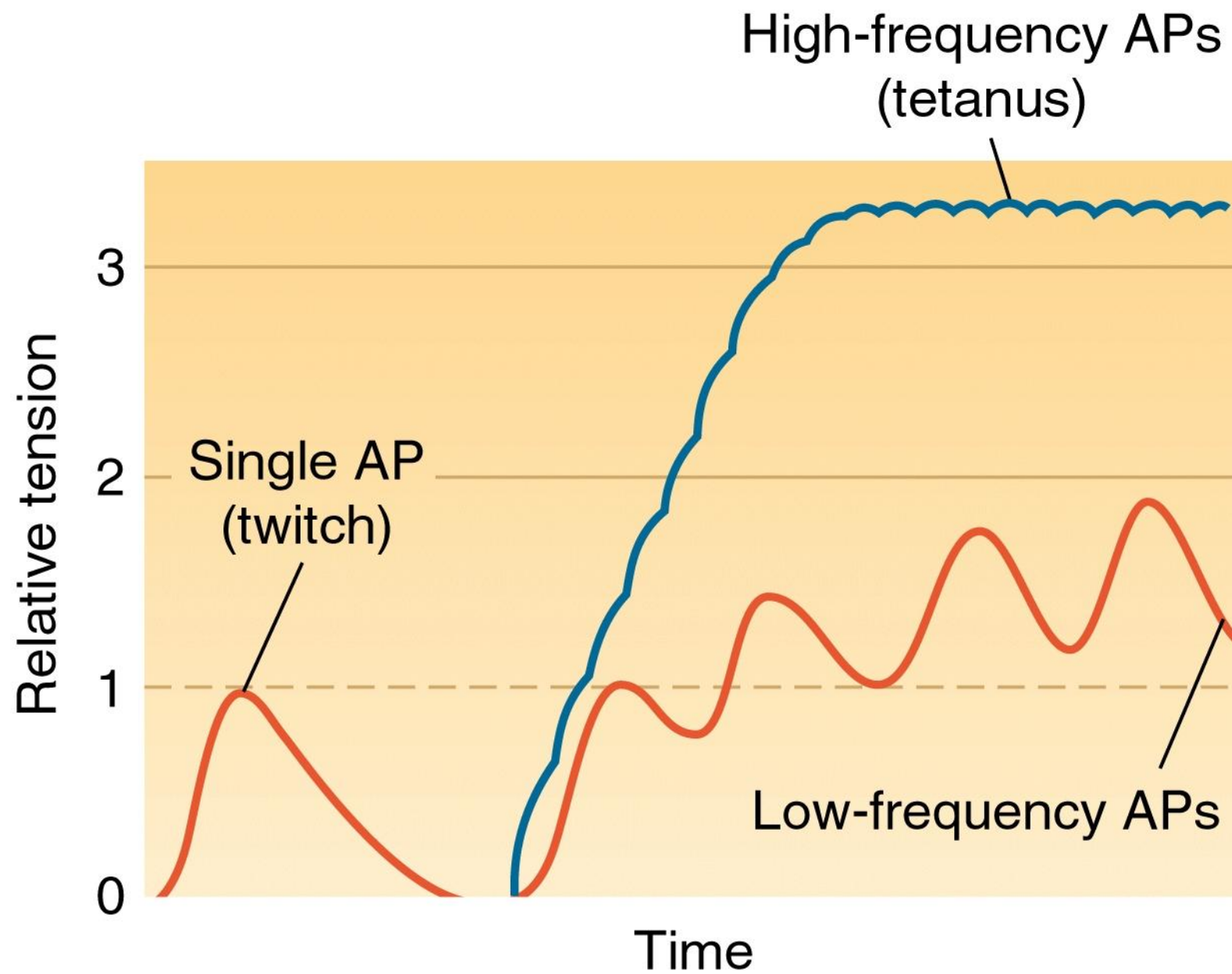


(a)



(b)





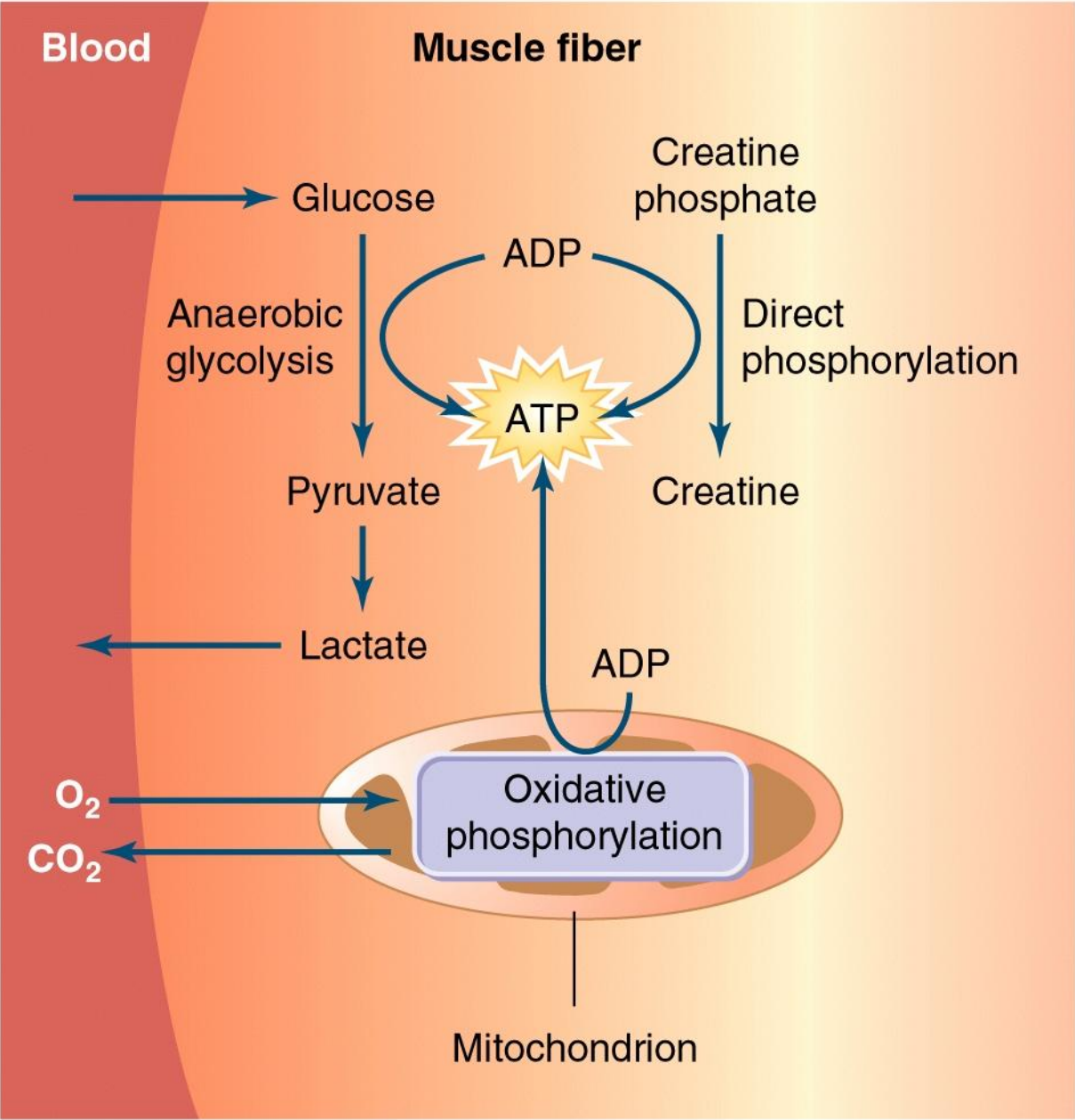
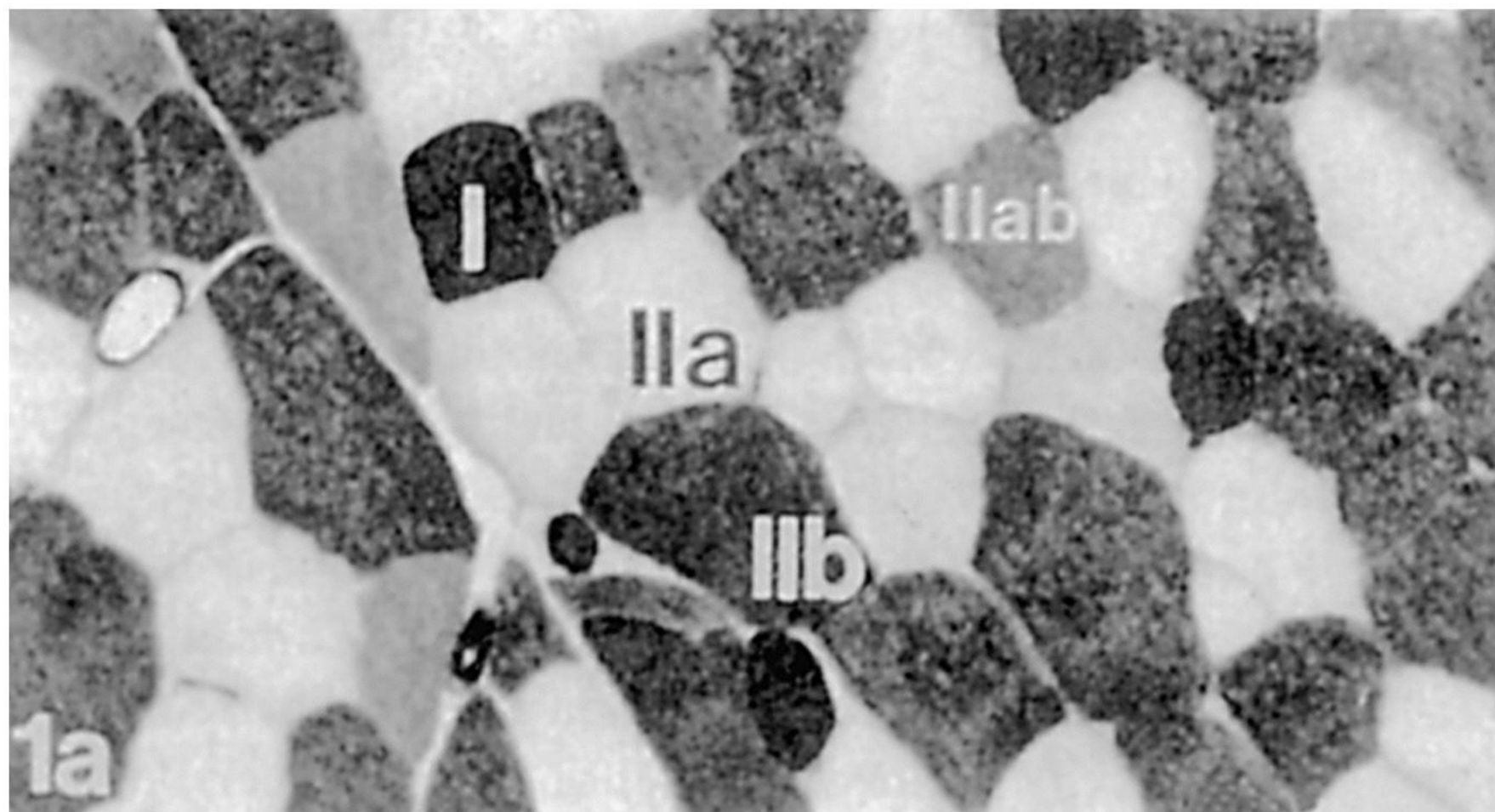


Table 10-1 Properties of twitch (phasic) fibers in mammalian skeletal muscles

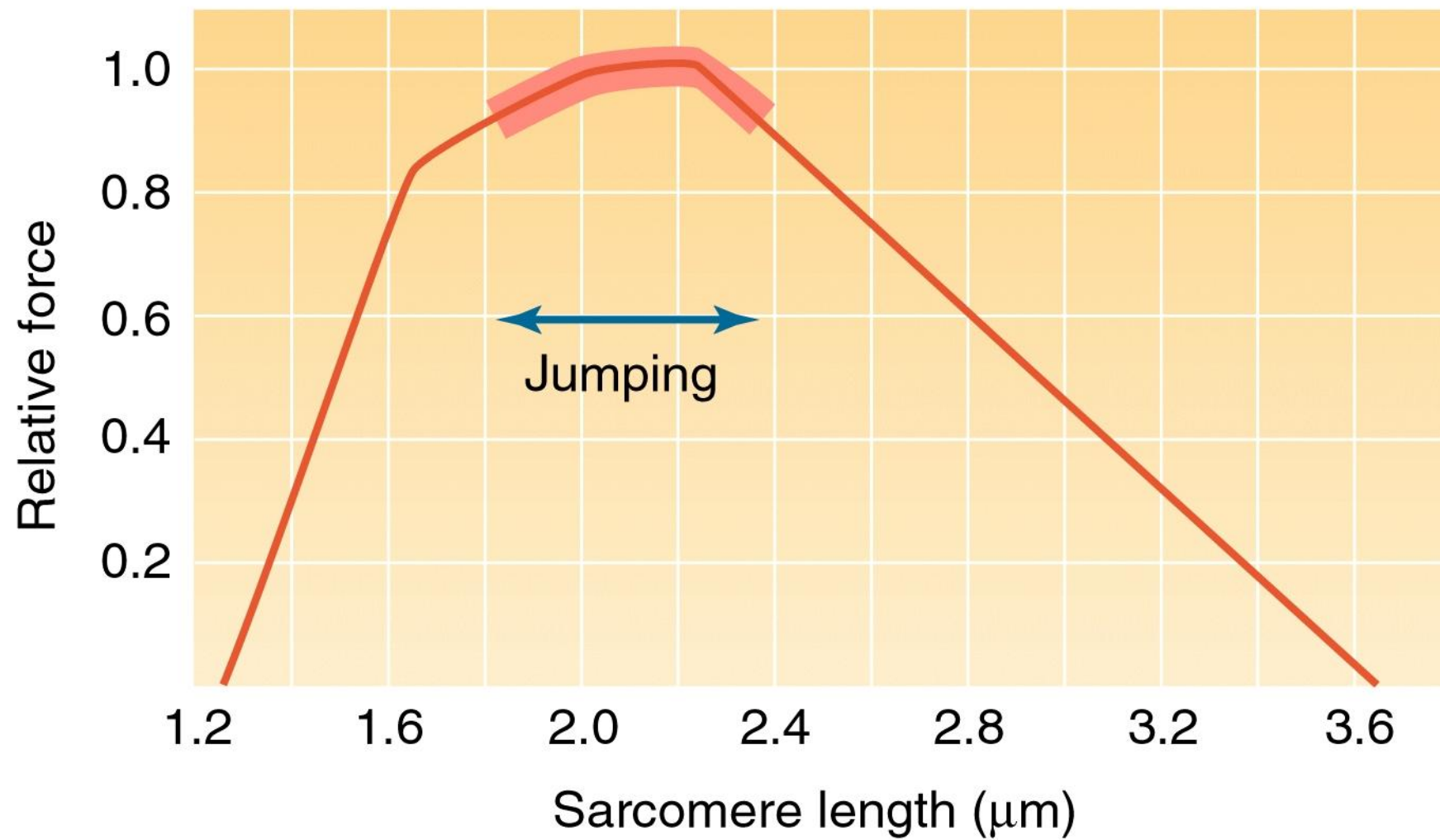
Property	Slow oxidative (type I)	Fast oxidative (type IIa)	Fast glycolytic (type IIb)
Fiber diameter	↓	↔	↑
Force per cross-sectional area	↓	↔	↑
Rate of contraction ($V_{\max}$)	↓	↑	↑
Myosin ATPase activity	↓	↑	↑
Resistance to fatigue	↑	↔	↓
Number of mitochondria	↑	↑	↓
Capacity for oxidative phosphorylation	↑	↑	↓
Enzymes for anaerobic glycolysis	↓	↔	↑
<i>Source:</i> Adapted from Sherwood, 2001. Key = ↓ Low ↔ Intermediate ↑ High			



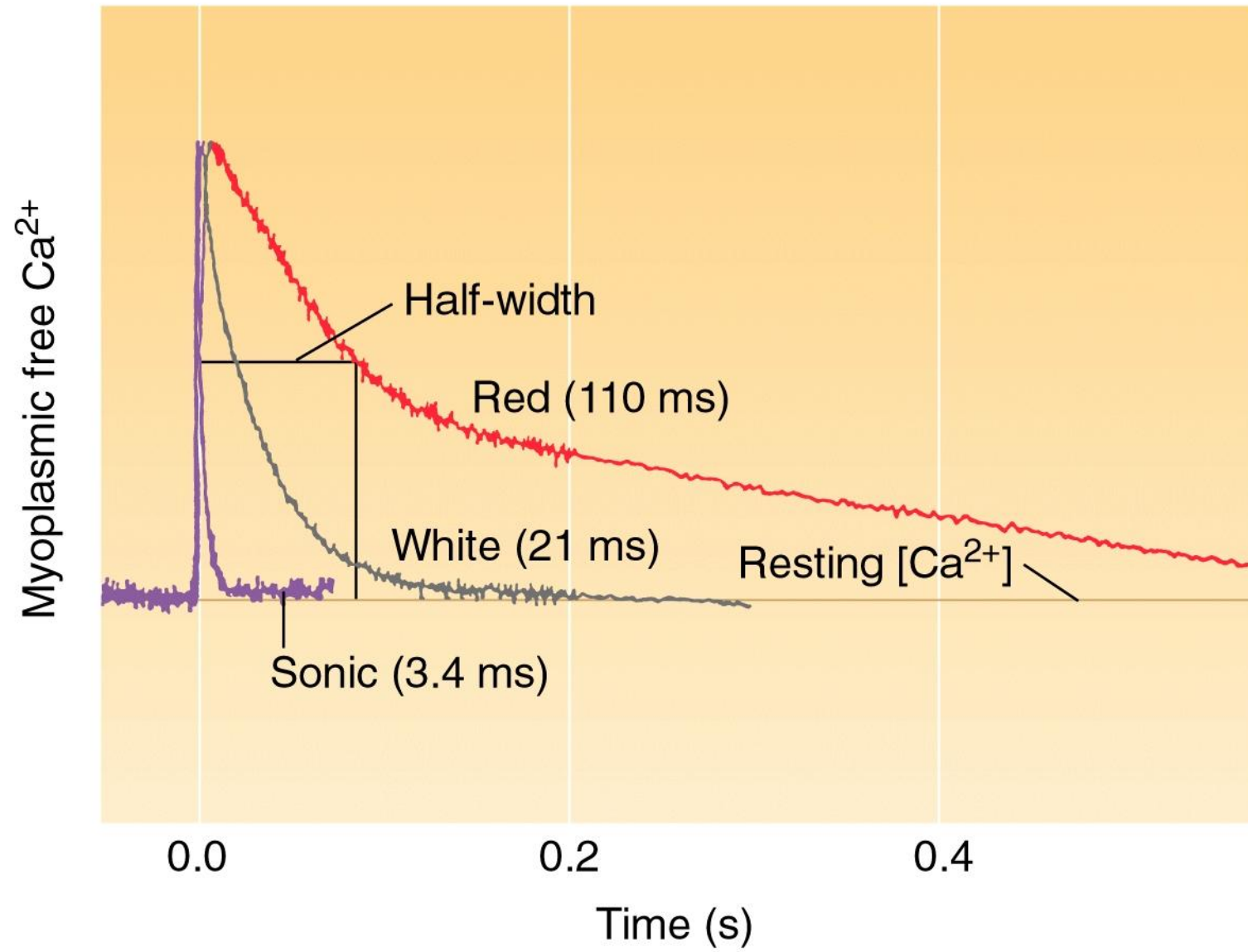
(a)



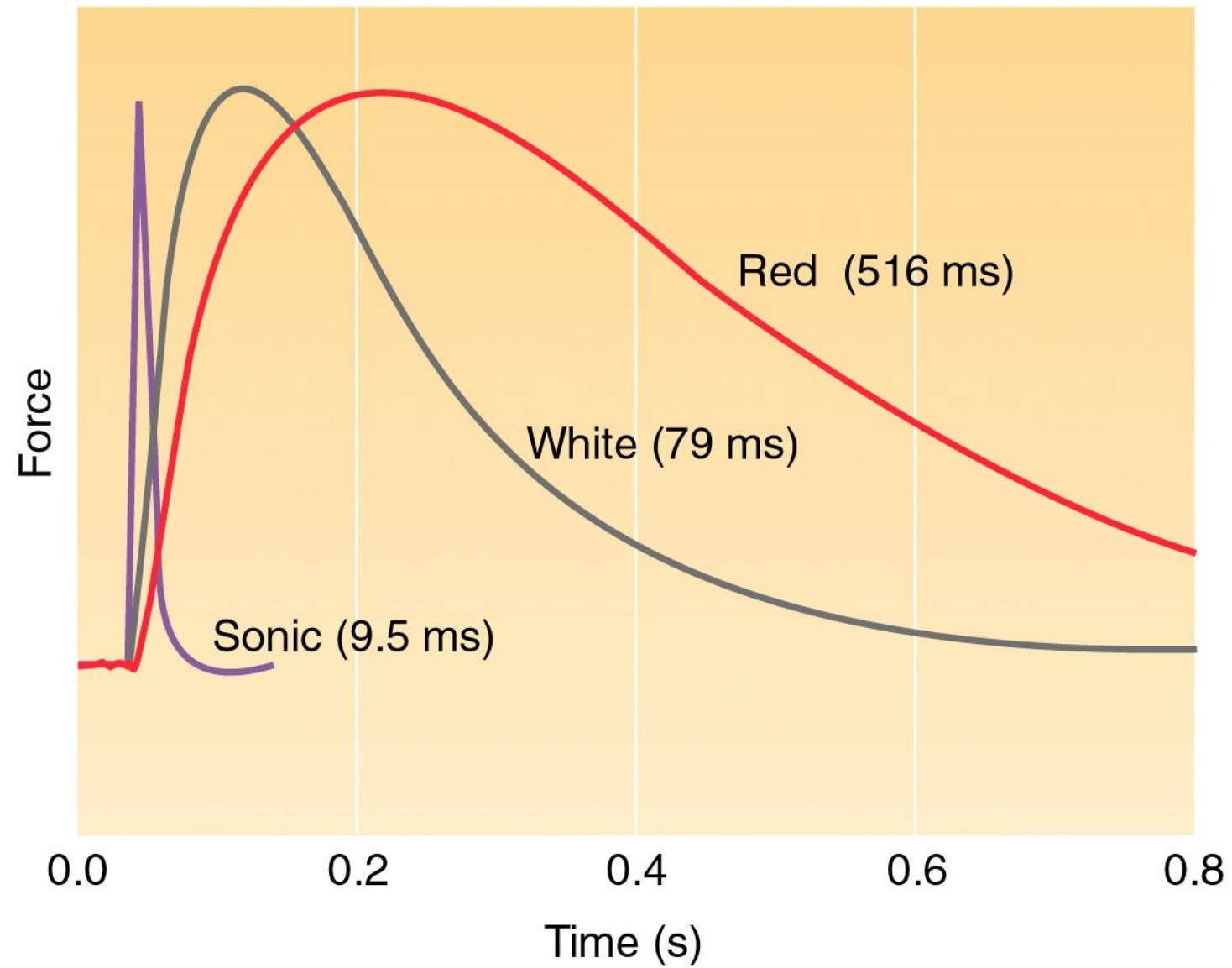
(a)

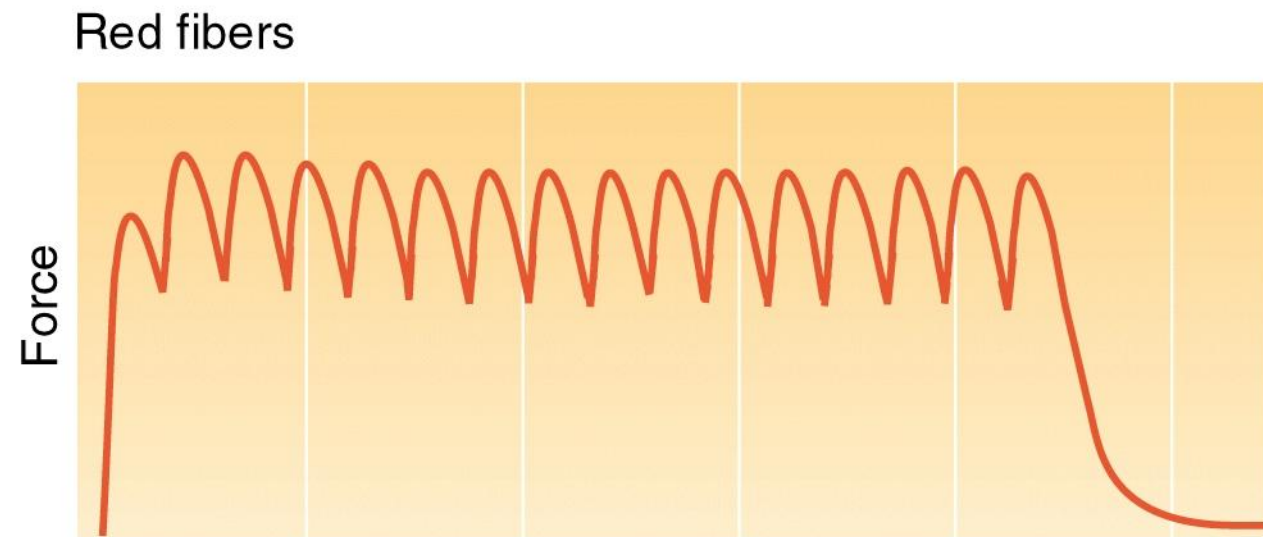
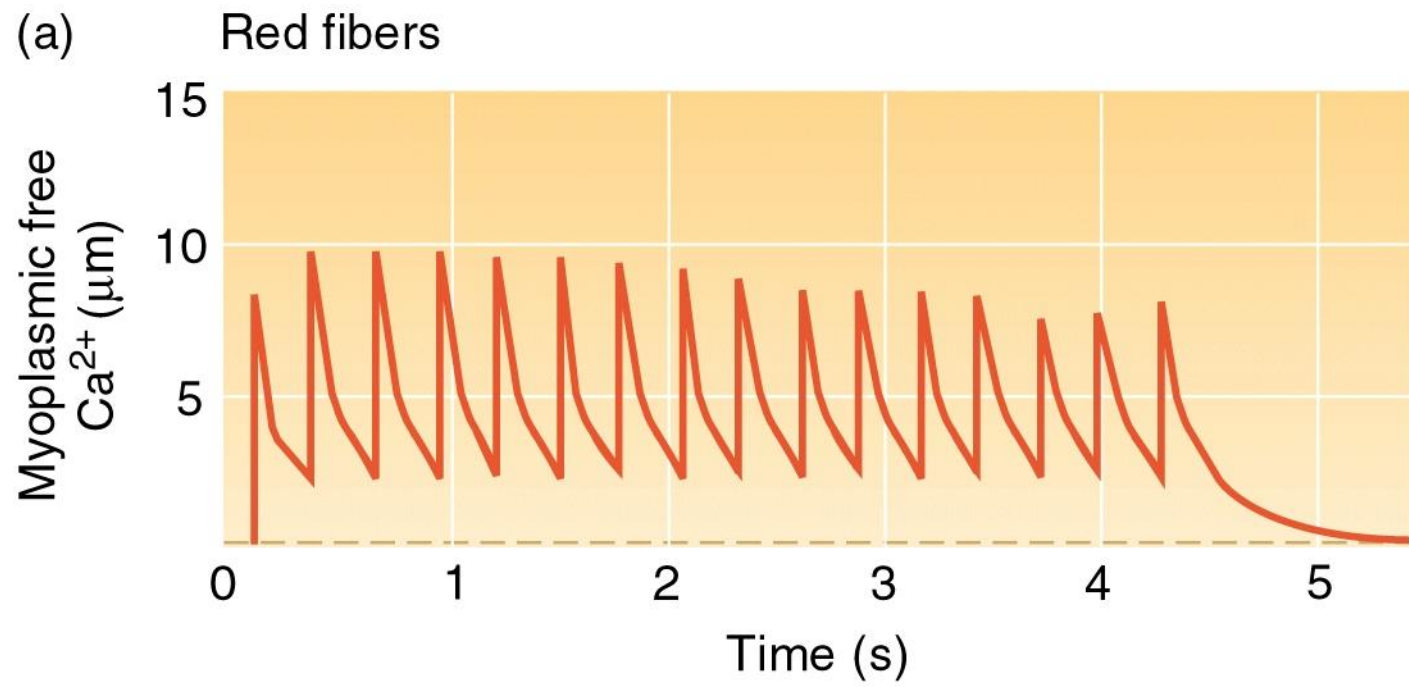


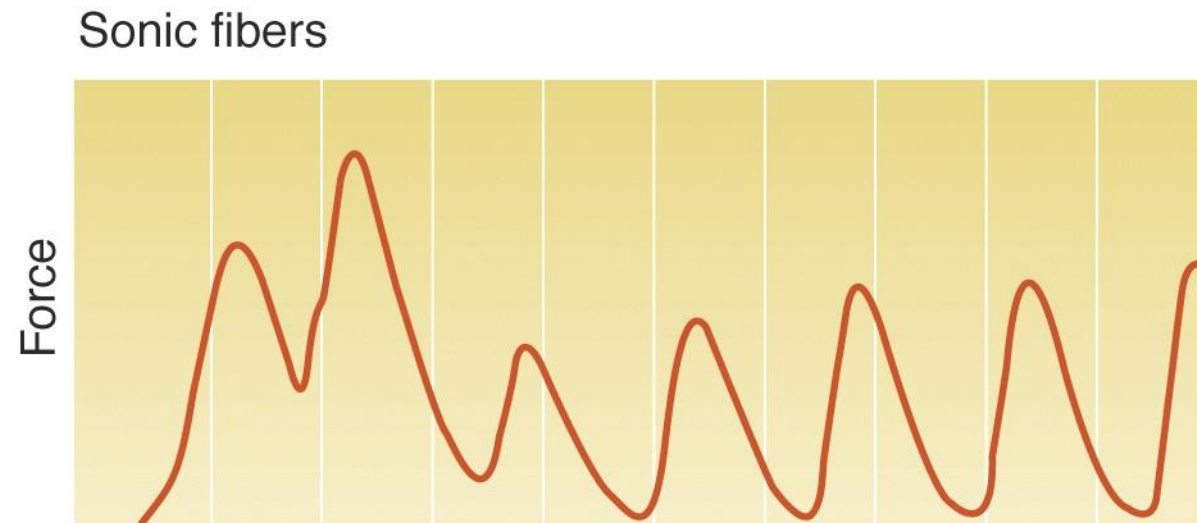
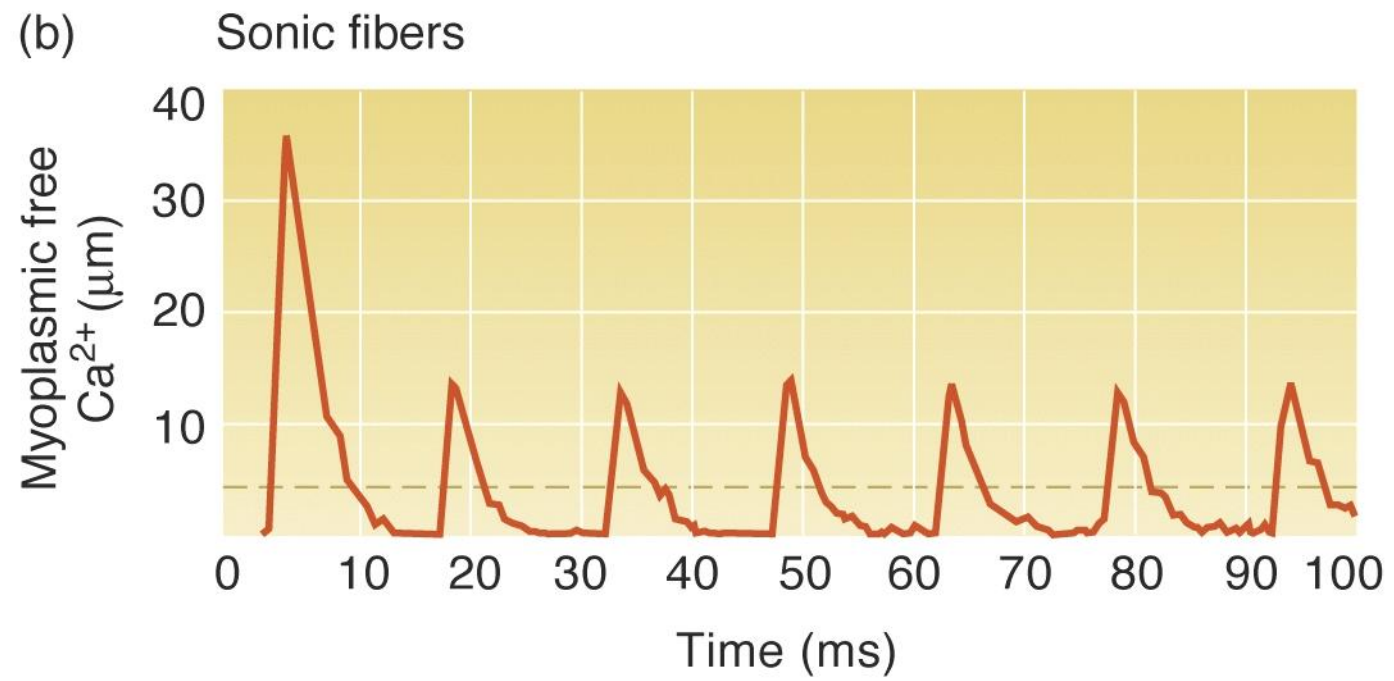
(a) Ca^{2+} concentration over time

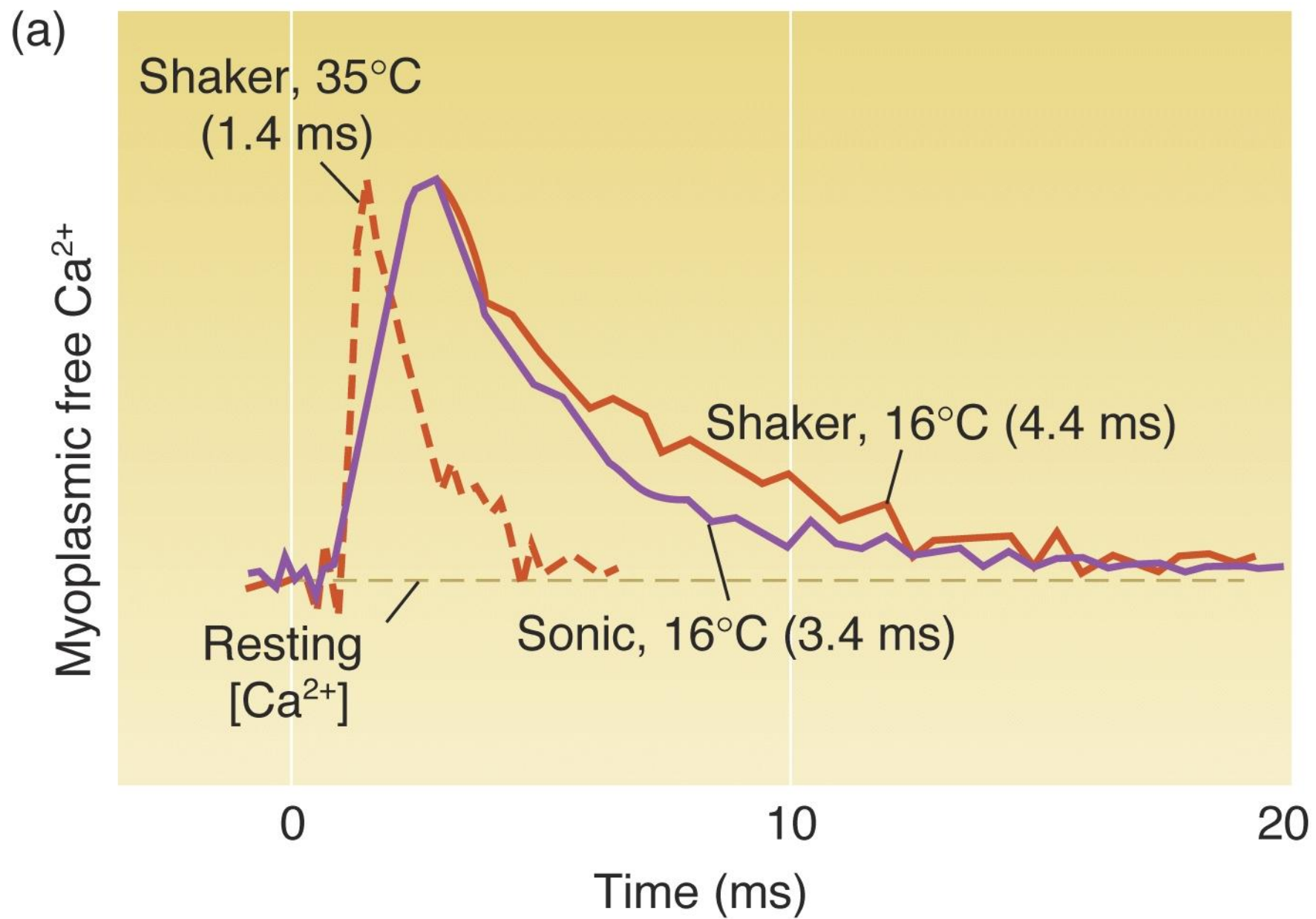


(b) Twitch tension over time

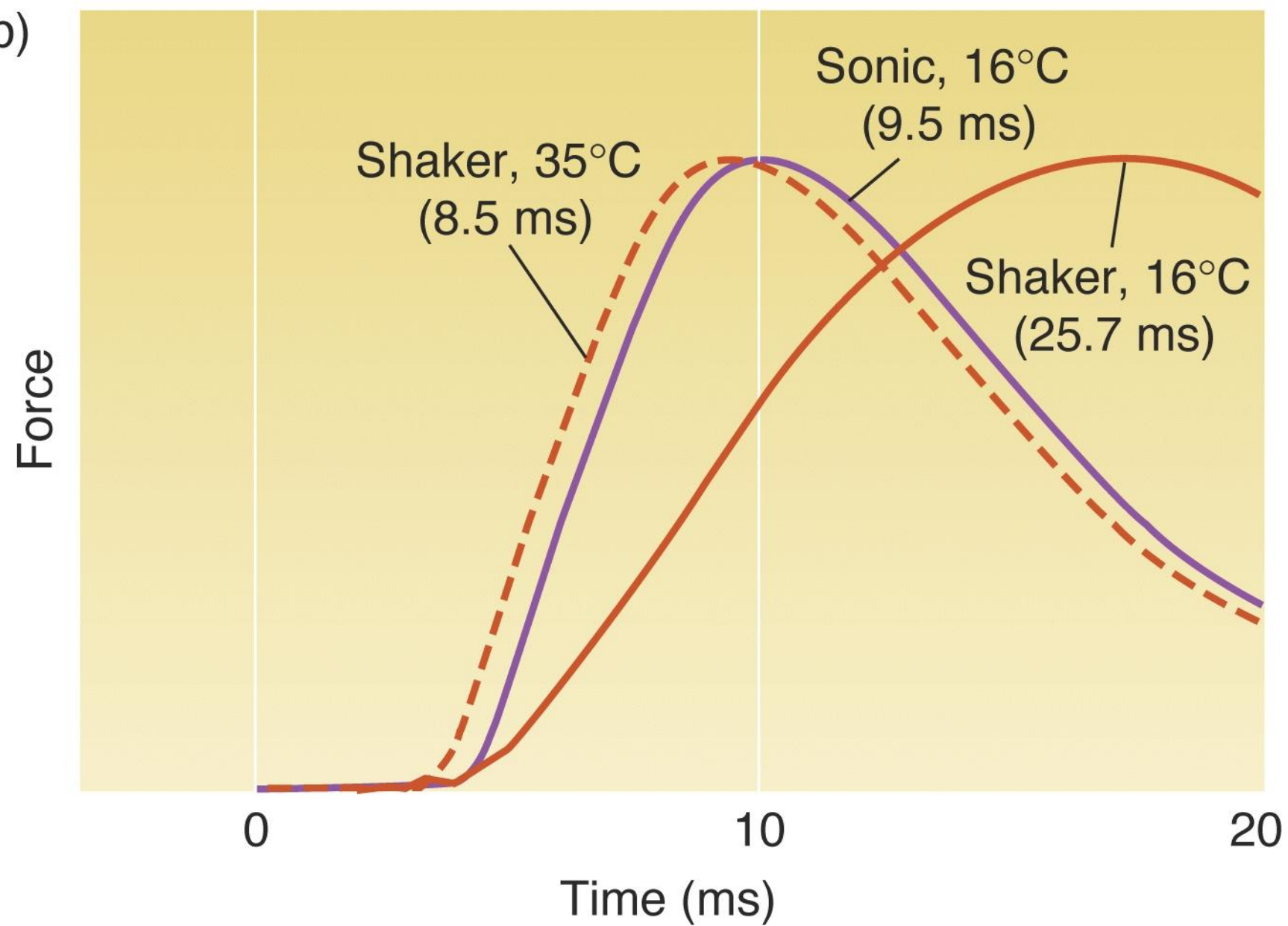




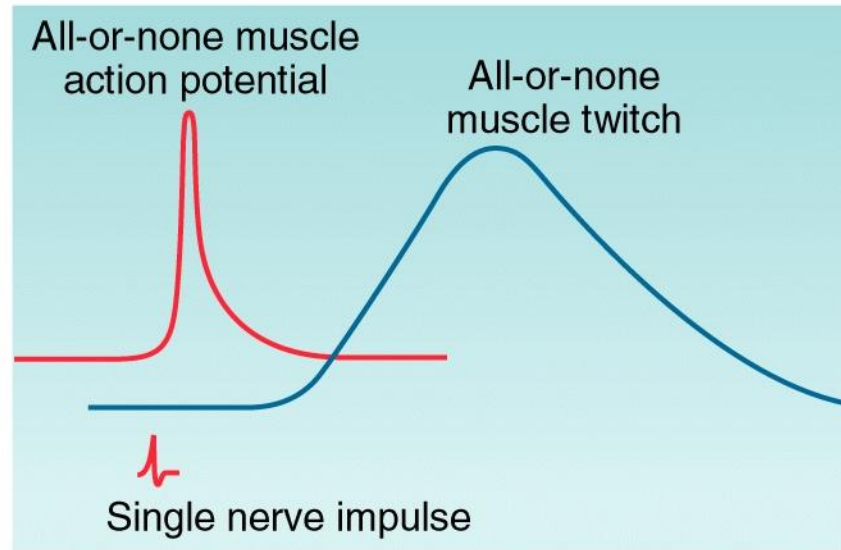
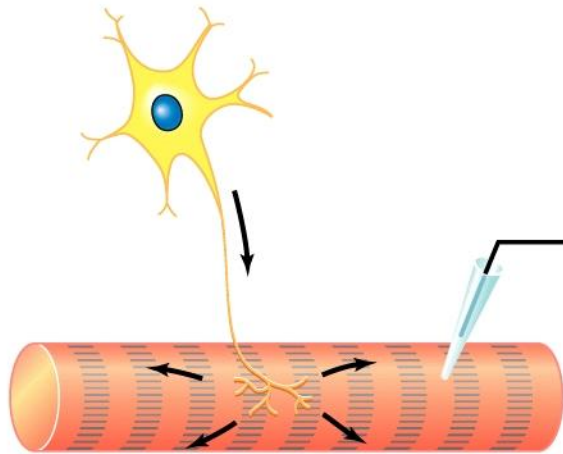




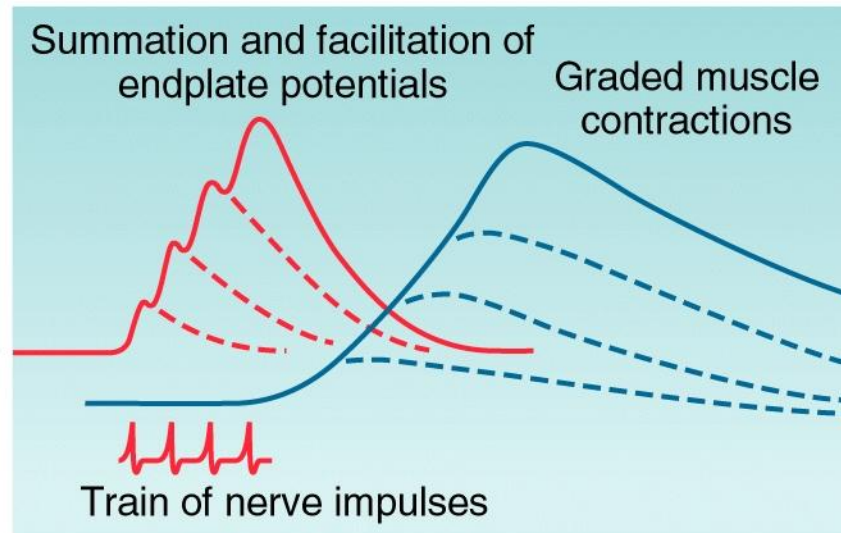
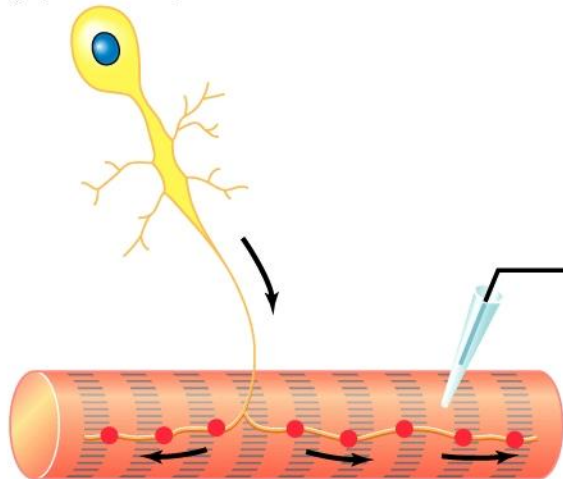
(b)



(a) Vertebrate



(b) Arthropod



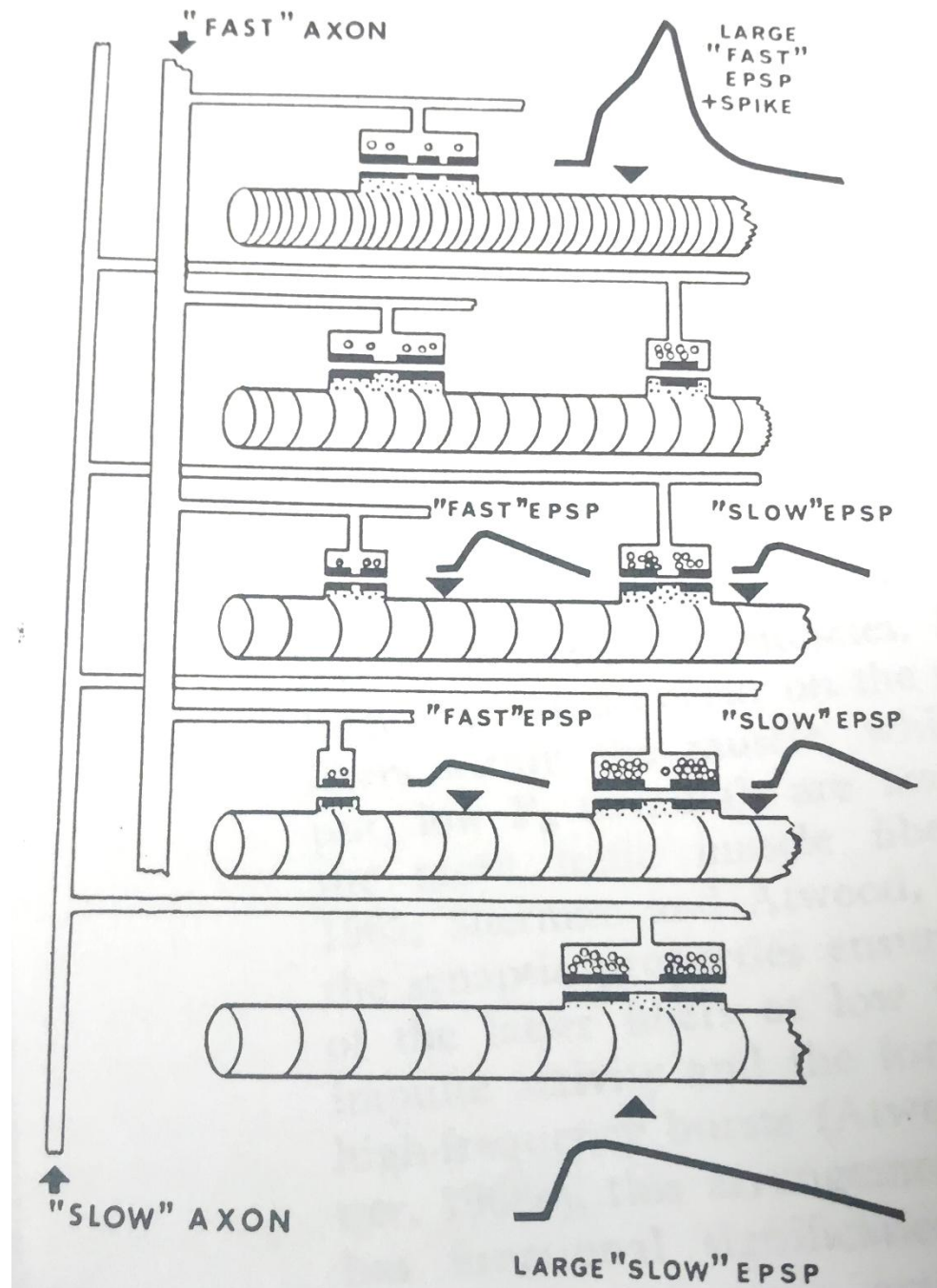


TABLE 8. Hypothesis to account for muscle fiber differentiation in terms of the time of innervation during development.

Early events in development or regeneration	Timing of innervation during muscle fiber maturation			Final differentiation of the muscle fiber
	Early	Intermediate	Late	
(A) Genetic factors	(1) Phasic axon			Phasic muscle fiber
(B) Influence of nearby tissues	(2) Tonic axon			Tonic muscle fiber
(C) Early neural stimulus to development	(3)	Tonic axon		Tonic or intermediate muscle fiber
(D) Muscle fibers reach pre-innervation stage (short sarcomeres)	(4)		Tonic axon	Intermediate or phasic muscle fiber
	(5) Phasic axon Tonic axon			Tonic muscle fiber
	(6) Phasic axon	Tonic axon		Intermediate or phasic muscle fiber

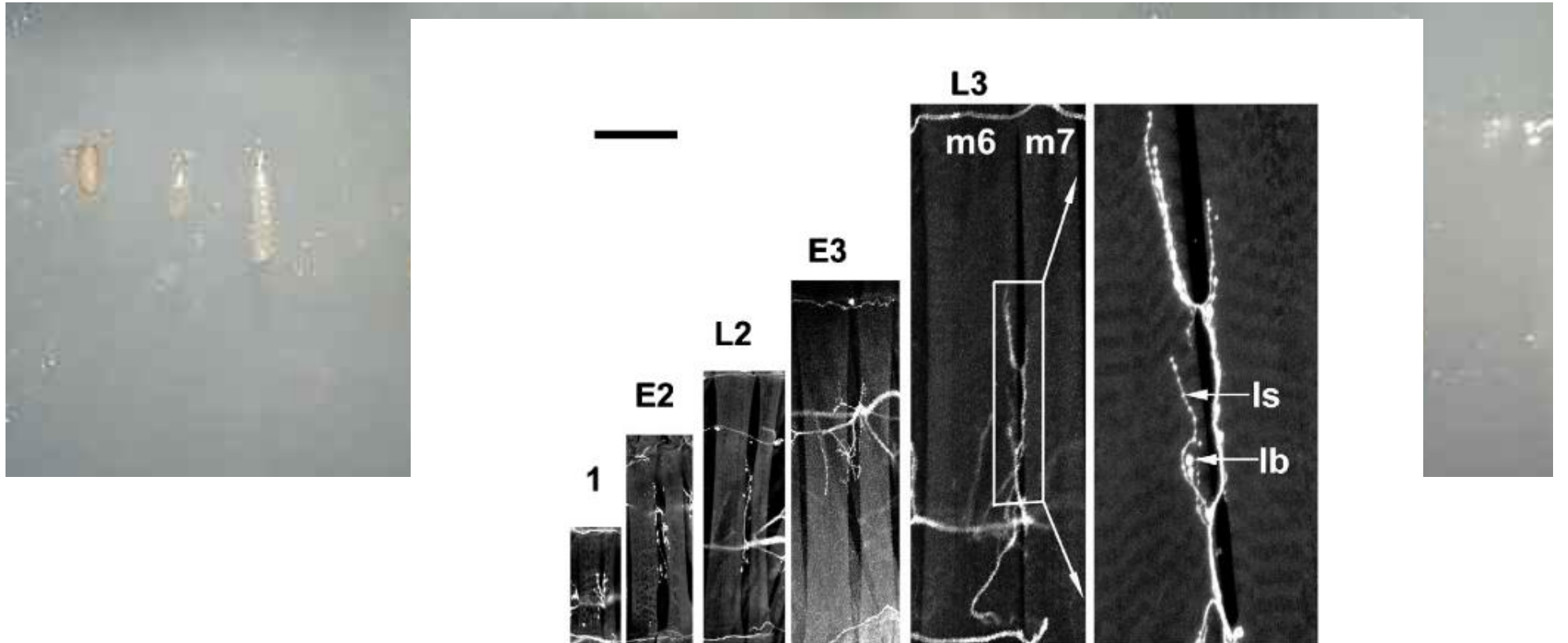
TABLE 7. *Sarcomeres of Grapsus limb buds (stretcher muscle).*

Limb bud length, cm	R value	Mean sarcomere length, μ
0.4	8	3.2
0.6	10.7	4.5
1.1	24.5	4.9
Adult		7.5 (high F_e) ; 10.7 (low F_e).

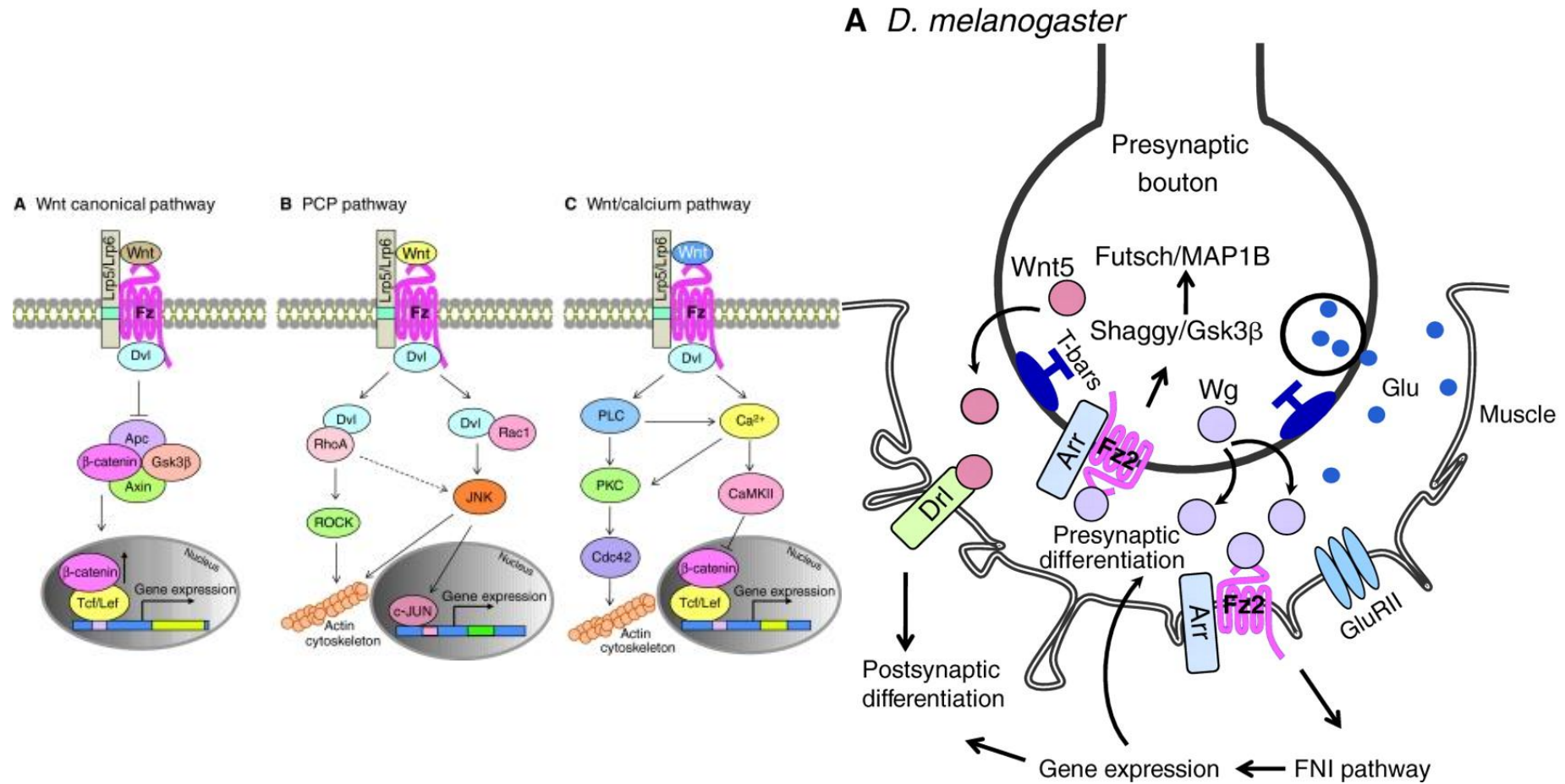
(R value; after Bliss, 1960.)

Questions

- How does the NMJ regulate the extent of growth and amount of transmission (quantal content) ?
- How is the transmission maintained as the muscle grows ?

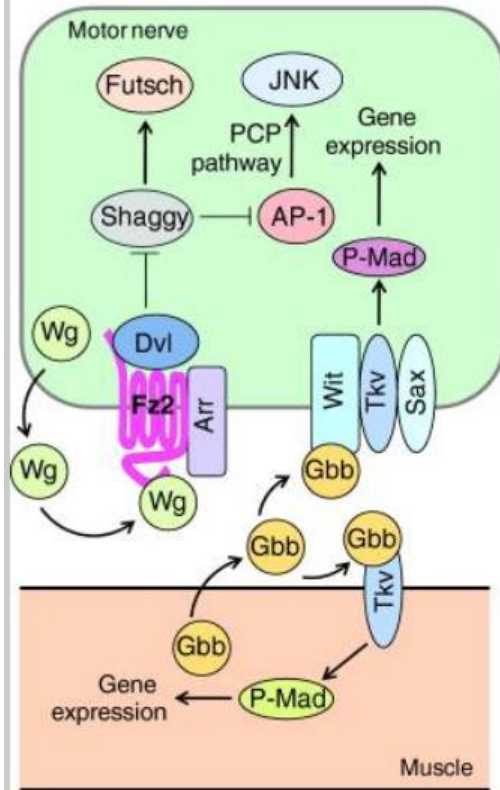


Li, H. , Peng, X., and Cooper, R.L. (2002) *Neuroscience* 115:505-513

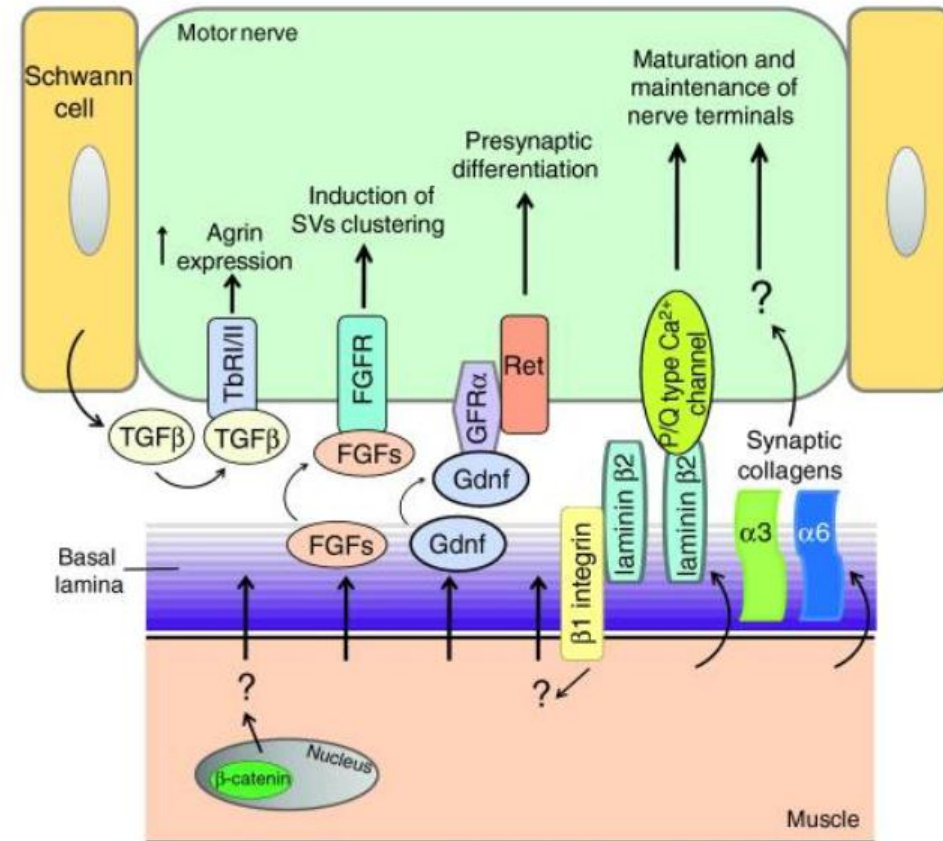


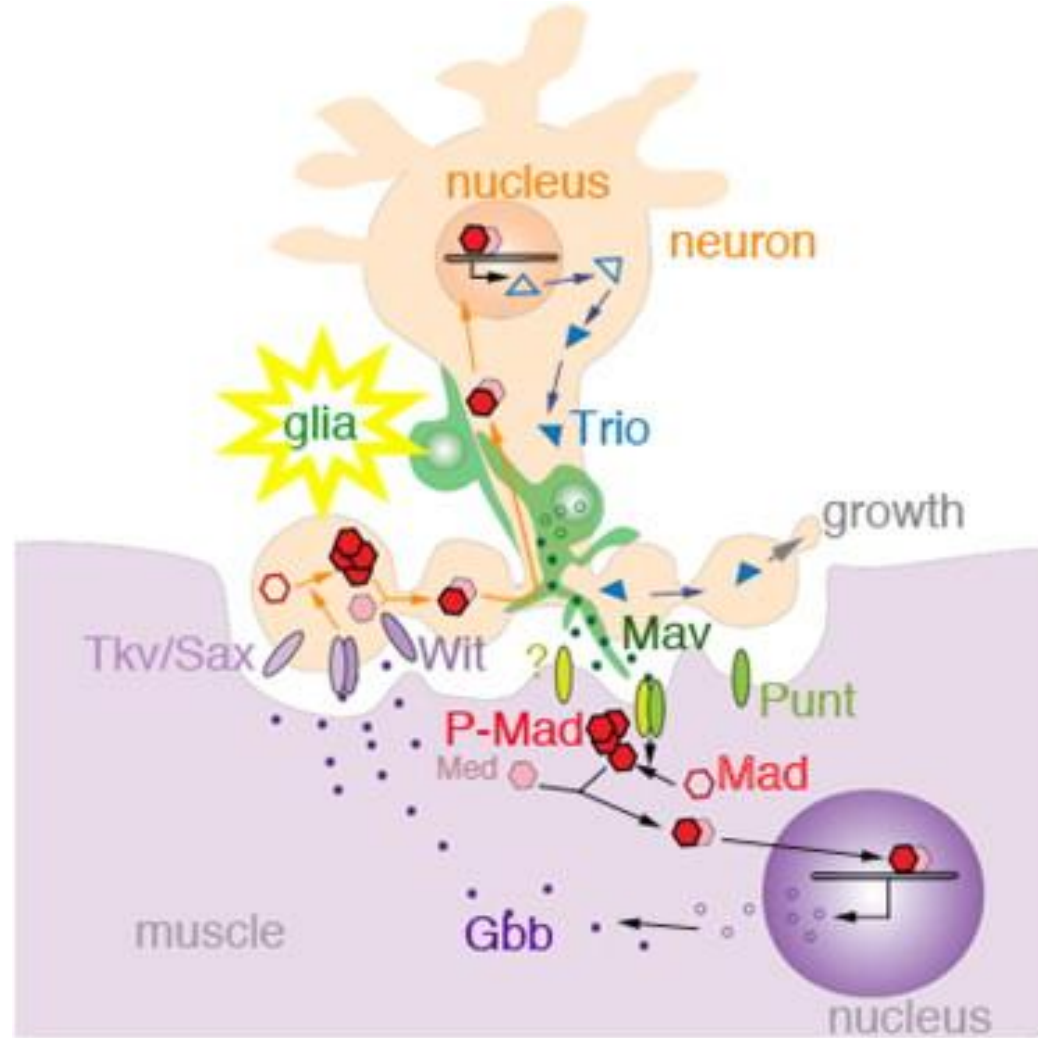
Wu, Xiong, Mei, Development. 2010

A *D. melanogaster*



B Mouse





Yuly Fuentes-Medel et al., 2012 Current Biology

How does muscle relax ?



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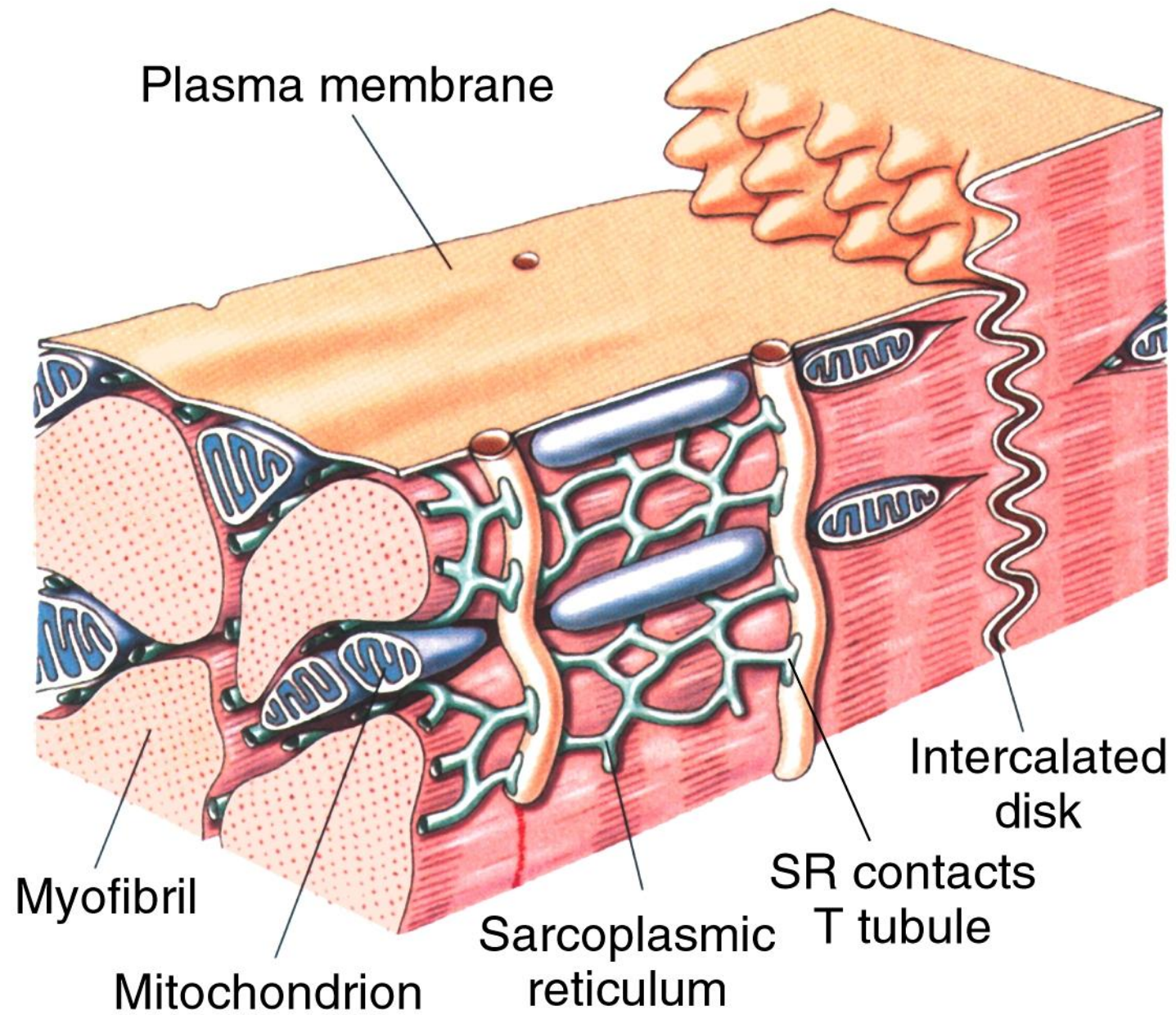


Table 10-2 Characteristics of the major types of muscle fibers in vertebrates

Property/component	Striated muscle	
	Skeletal	Cardiac
Visible banding pattern	Yes	Yes
Myosin thick filaments and actin thin filaments	Yes	Yes
Tropomyosin and troponin	Yes	Yes
Transverse tubules	Yes	Yes
Sarcoplasmic reticulum	Well developed	Well developed
Mechanism of contraction	Sliding of thick and thin filaments past each other	Sliding of thick and thin filam past each othe
Innervation	Somatic nerves	Autonomic nerve
Initiation of contraction*	Neurogenic	Myogenic
Source of Ca^{2+} for activation†	SR	ECF and SR
Gap junctions between fibers?	No	Yes
Speed of contraction	Fast or slow depending on fiber type	Slow
Clear-cut relationship between length and tension	Yes	Yes

*Neurogenic muscles contract only when stimulated by synaptic input from a neuron. Myogenic muscles endogenously produce depolarizing membrane potentials, allowing them to contract independently of any neuronal input.

†SR, sarcoplasmic reticulum; ECF, extracellular fluid.

Source: Adapted from Sherwood, 2001.

Table 10-2 Characteristics of the major types of muscle fibers in vertebrates

Property/component	Striated muscle		Smooth (nonstriated) muscle	
	Skeletal	Cardiac	Multi-unit	Single-unit
Visible banding pattern	Yes	Yes	No	No
Myosin thick filaments and actin thin filaments	Yes	Yes	Yes	Yes
Tropomyosin and troponin	Yes	Yes	No	No
Transverse tubules	Yes	Yes	No	No
Sarcoplasmic reticulum	Well developed	Well developed	Very little	Very little
Mechanism of contraction	Sliding of thick and thin filaments past each other	Sliding of thick and thin filaments past each other	Sliding of thick and thin filaments past each other	Sliding of thick and thin filaments past each other
Innervation	Somatic nerves	Autonomic nerves	Autonomic nerves	Autonomic nerves
Initiation of contraction*	Neurogenic	Myogenic	Neurogenic	Myogenic
Source of Ca^{2+} for activation†	SR	ECF and SR	ECF and SR	ECF and SR
Gap junctions between fibers?	No	Yes	No	Yes
Speed of contraction	Fast or slow depending on fiber type	Slow	Very slow	Very slow
Clear-cut relationship between length and tension	Yes	Yes	No	No

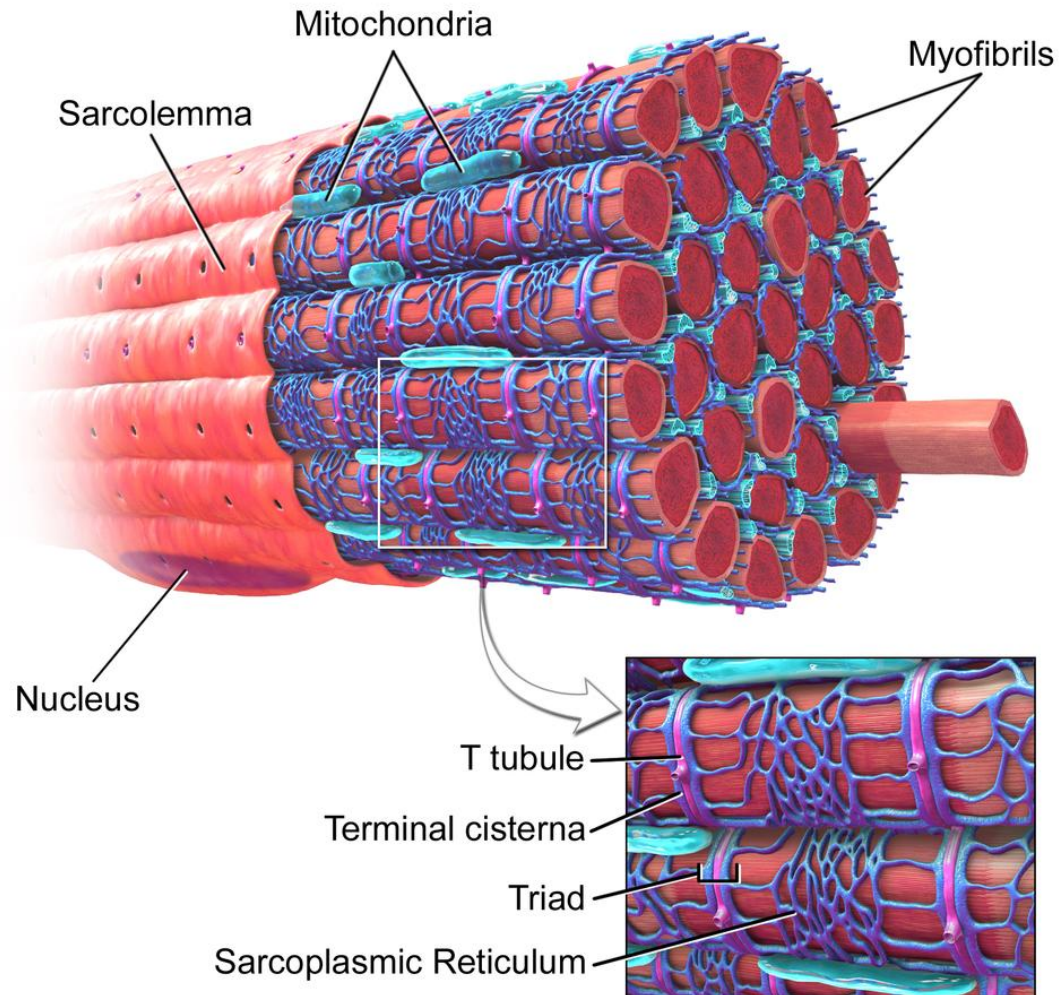
*Neurogenic muscles contract only when stimulated by synaptic input from a neuron. Myogenic muscles endogenously produce depolarizing membrane potentials, allowing them to contract independently of any neuronal input.

†SR, sarcoplasmic reticulum; ECF, extracellular fluid.

Source: Adapted from Sherwood, 2001.

The **sarcolemma** (*sarco* (from *sarx*) from Greek; flesh, and *lemma* from Greek; sheath.) also called the **myolemma**, is the cell membrane of a striated muscle fiber cell. (wikipedia)

Skeletal Muscle Fiber



<https://en.wikipedia.org/wiki/Sarcolemma>