

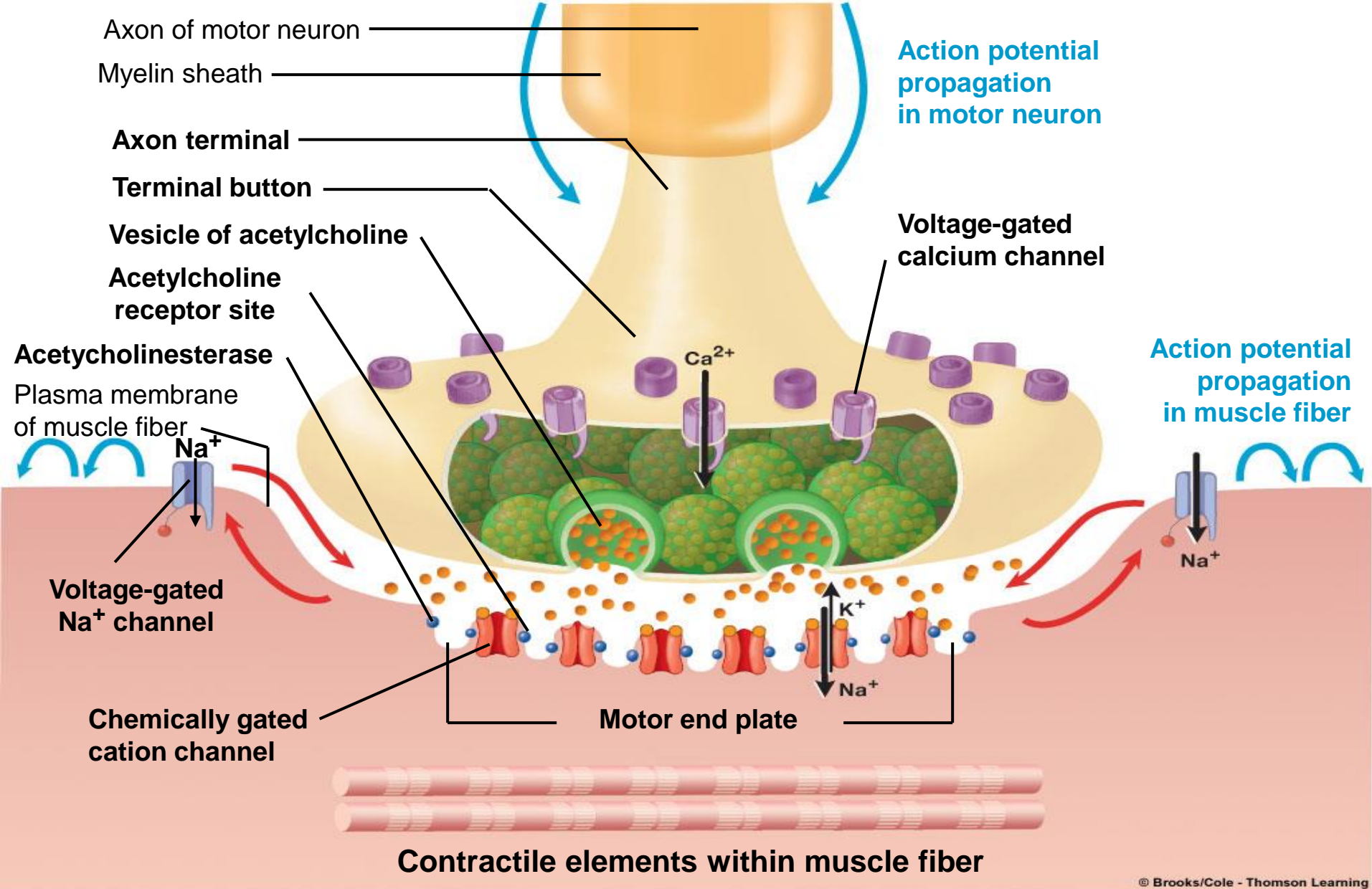
Nerve and Muscle

Neuromuacular transmission & Mechanics of muscle contraction

Lecture 3

Course: M 132

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Fig. 7-6, p. 196

Steps of transmission across neuromuscular junction. (Acetylcholine Ach)

- 1- An action potential opens voltage-gated calcium channels in the terminal button. Calcium ions diffuse into the terminal button**
- 2. Calcium, causes Ach release by exocytosis from vesicles into the junctional cleft.**
- 3. Acetylcholine diffuses in the cleft towards the membrane of muscle**
- 4. Ach binds to receptor sites on the motor end plate of the muscle cell membrane.**
- 5. This binding opens channels for sodium influx into the ICF of the muscle cell.**
- 6. This produces a local current flow that opens adjacent sodium channels in the motor end plate.**
- 7. An action potential is initiated through the muscle fiber.**



Summary of chemical agents and drugs that affect the neuromuscular junction

Mechanism that Alters Release of Acetylcholine

- * Causes explosive release of acetylcholine
- * Blocks release of acetylcholine

Chemicals or Disease

- * Black widow spider venom
- * Clostridium botulinum toxin

Block acetylcholine Receptor

- * Bind reversibly

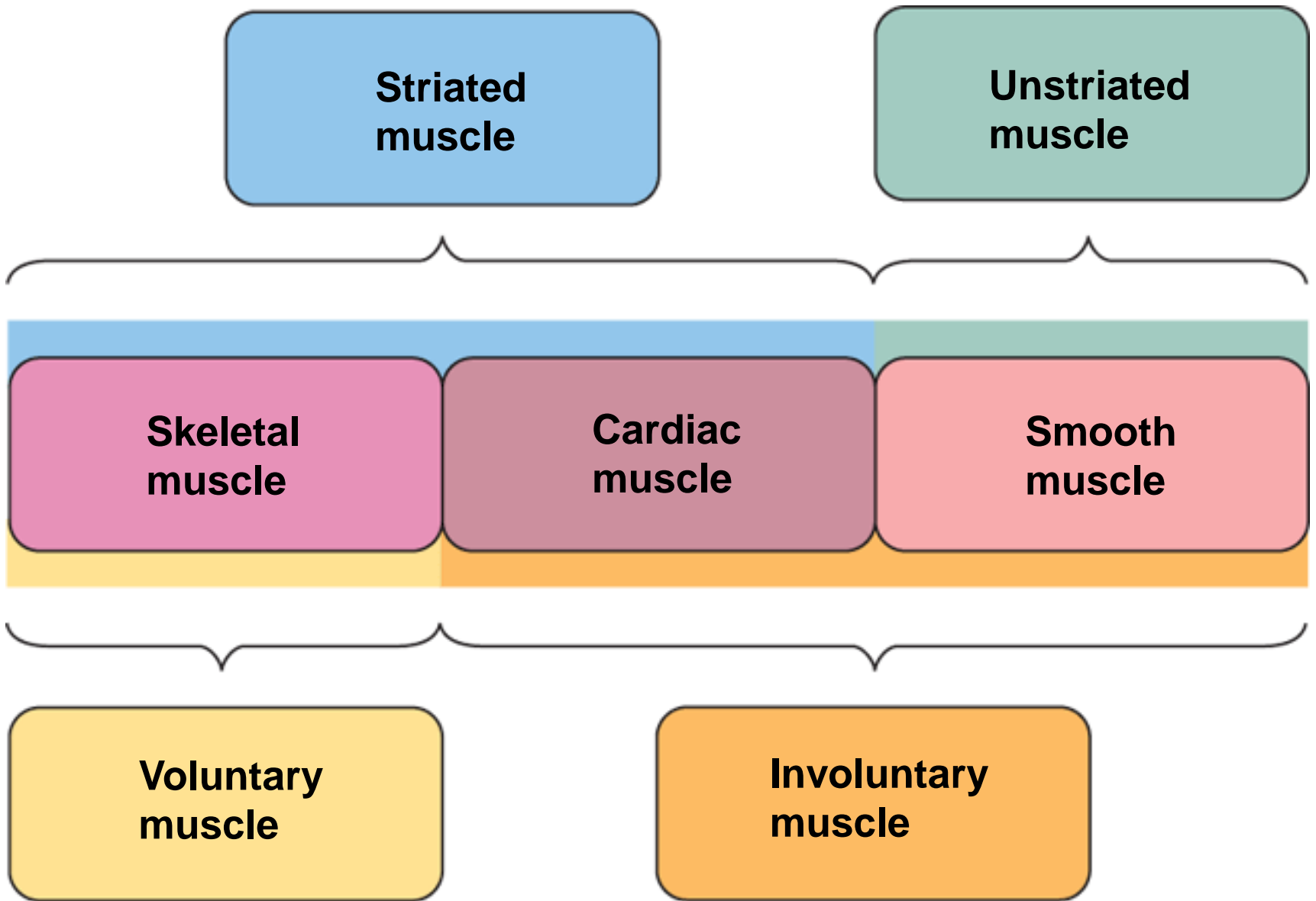
- * Curare

Prevents inactivation of acetylcholine

- * Irreversibly inhibits acetylcholinesterase

- * Organophosphates





Muscle

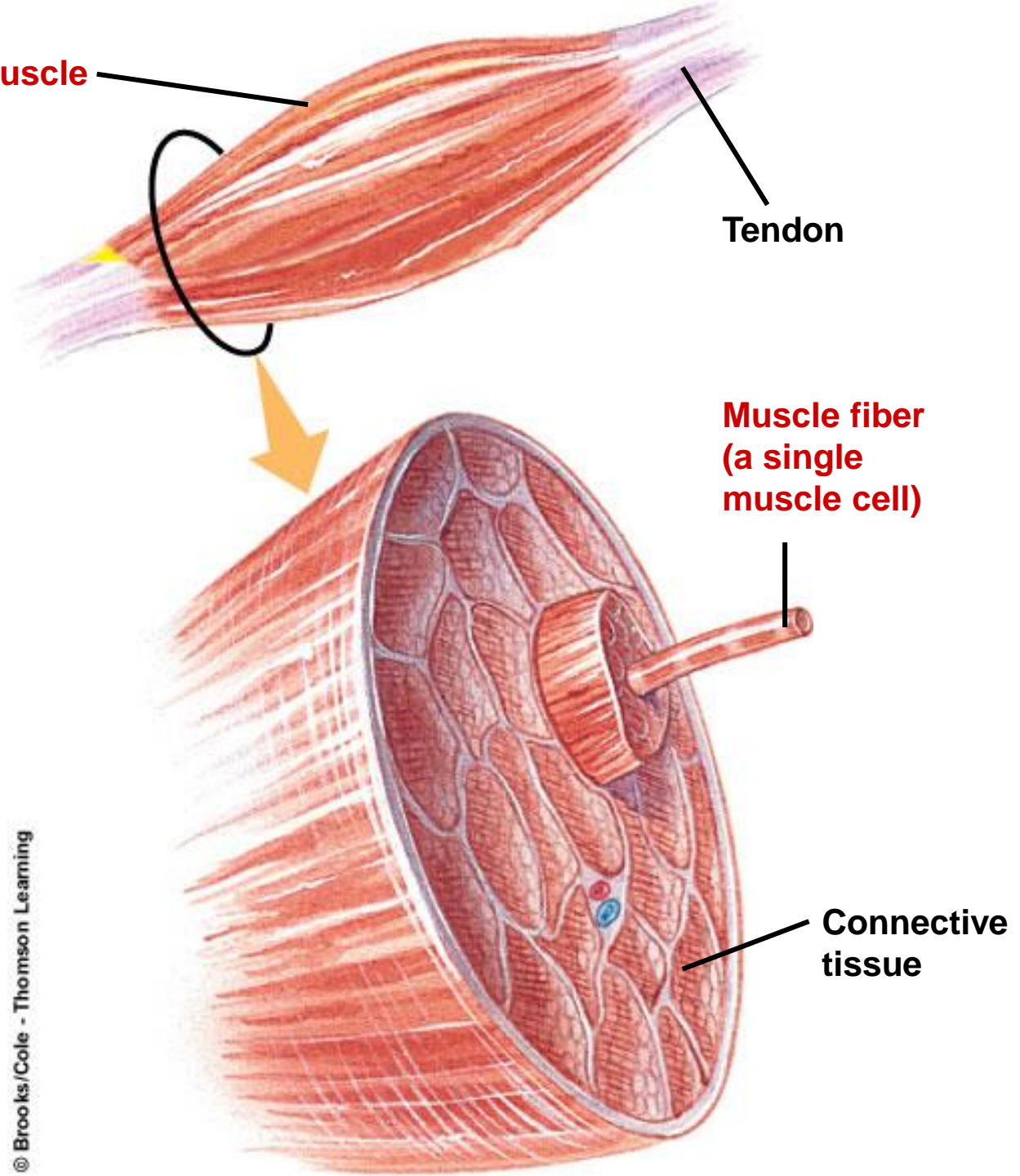
Tendon

**Muscle fiber
(a single
muscle cell)**

**Connective
tissue**

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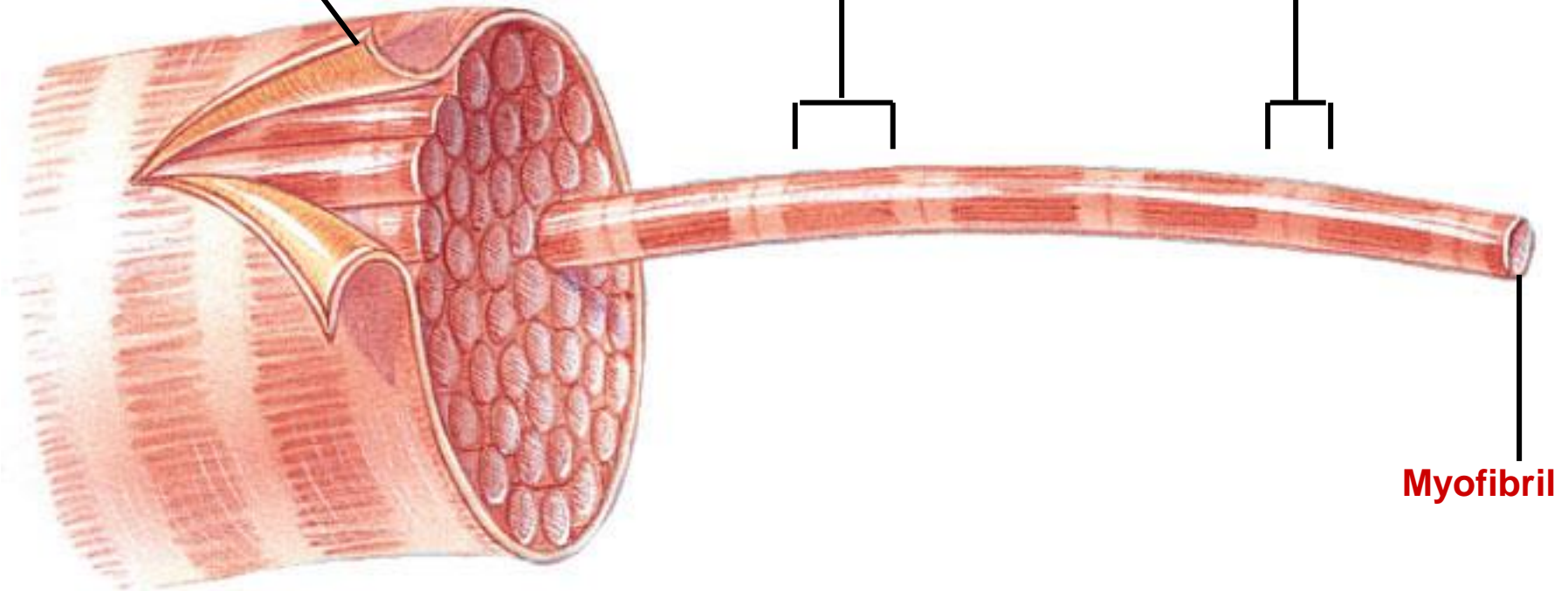
Slide 3



Muscle fiber

Dark A band

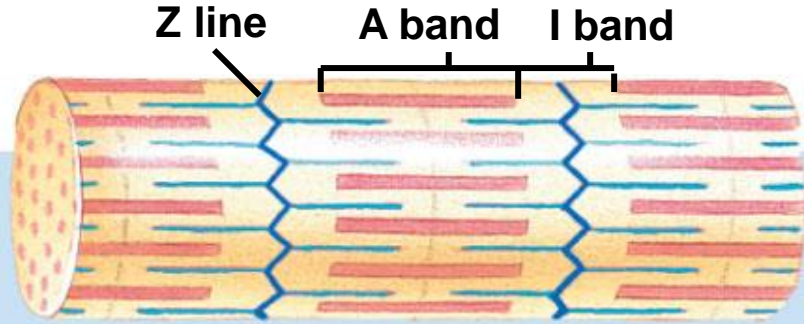
Light I band



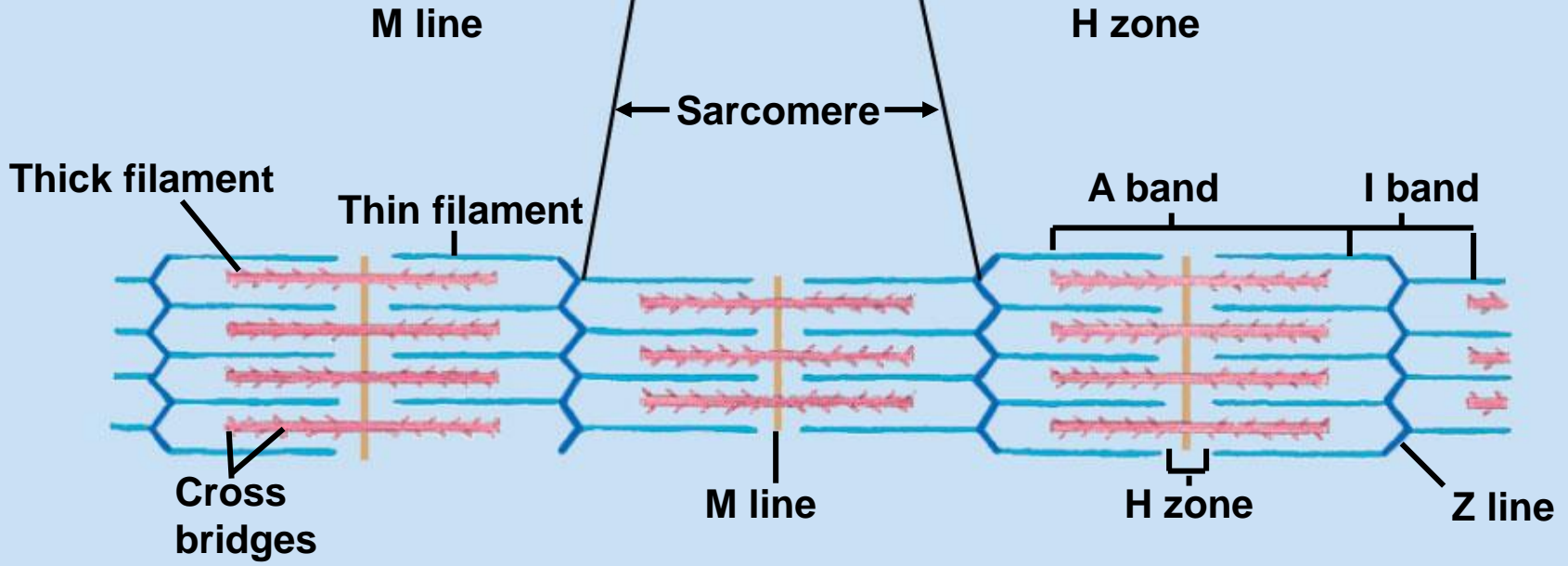
Myofibril

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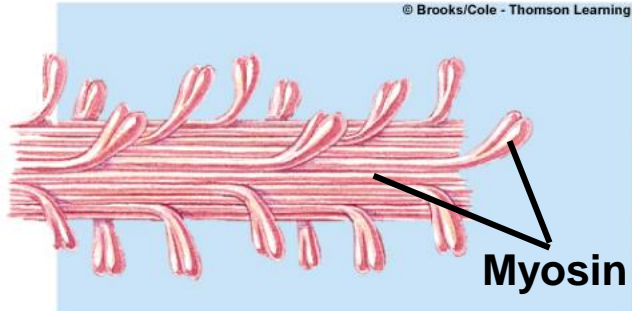
Portion of myofibril



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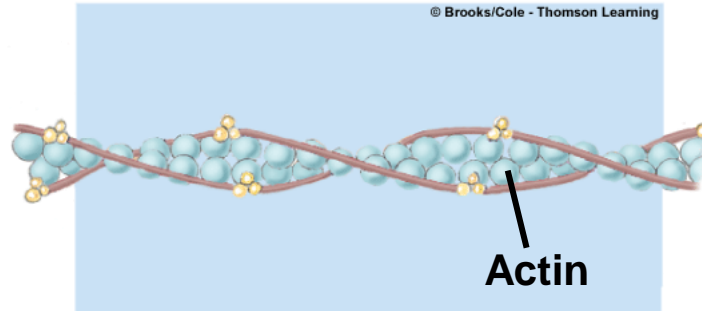


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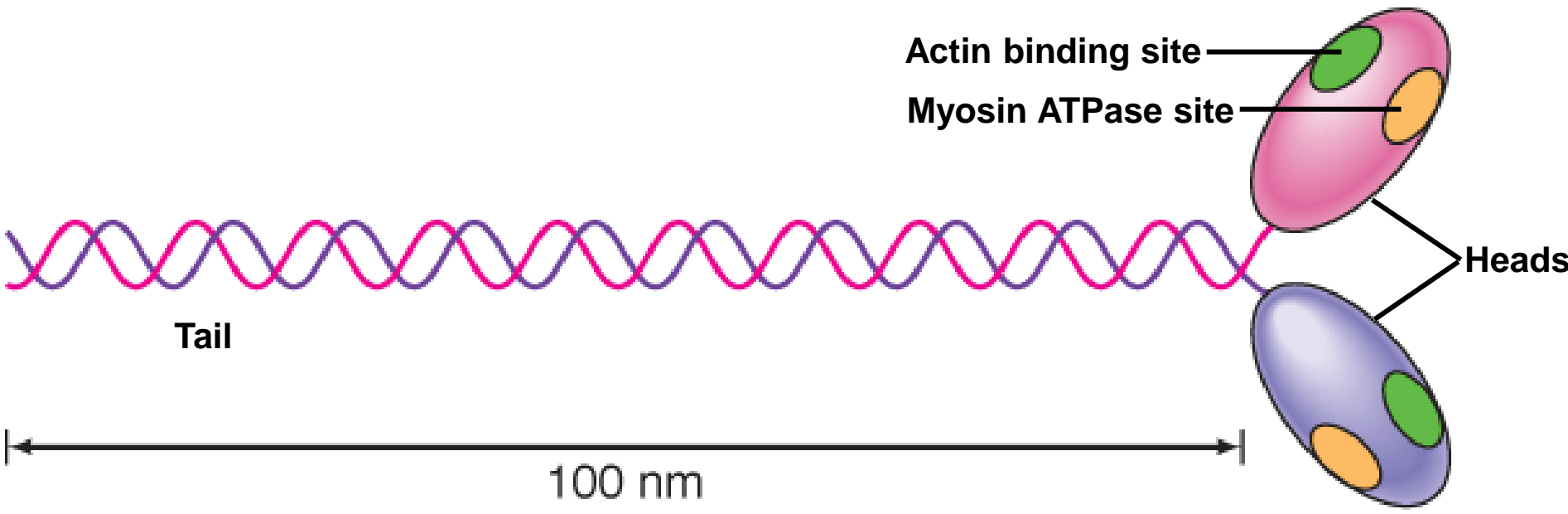
Thick filament

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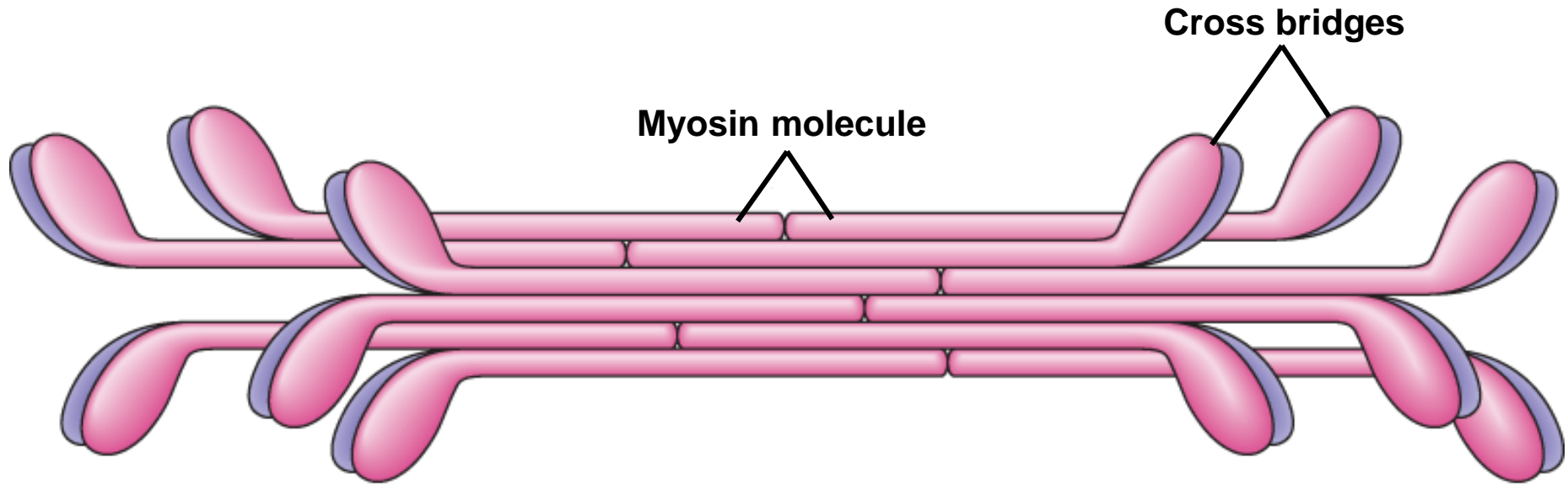
Thin filament

Myosin molecule

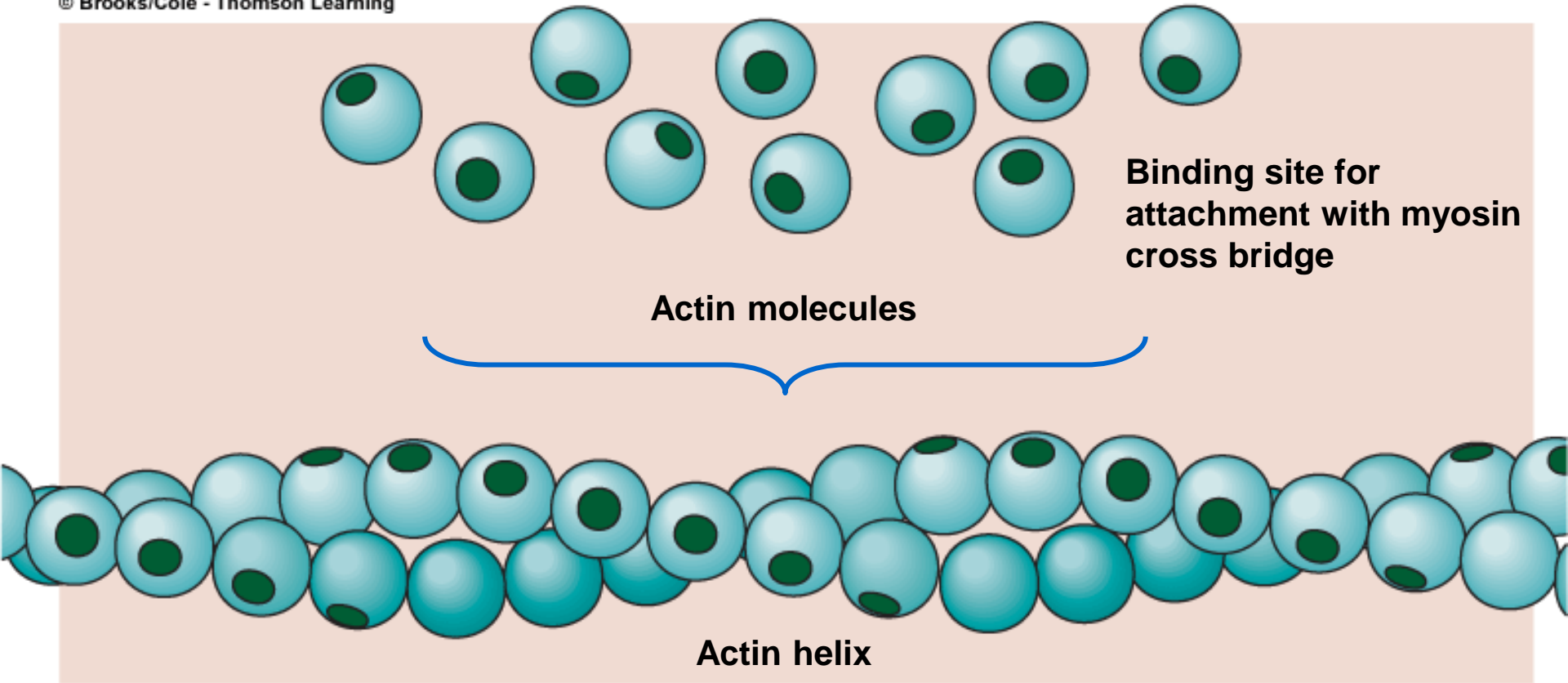


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Thick filament

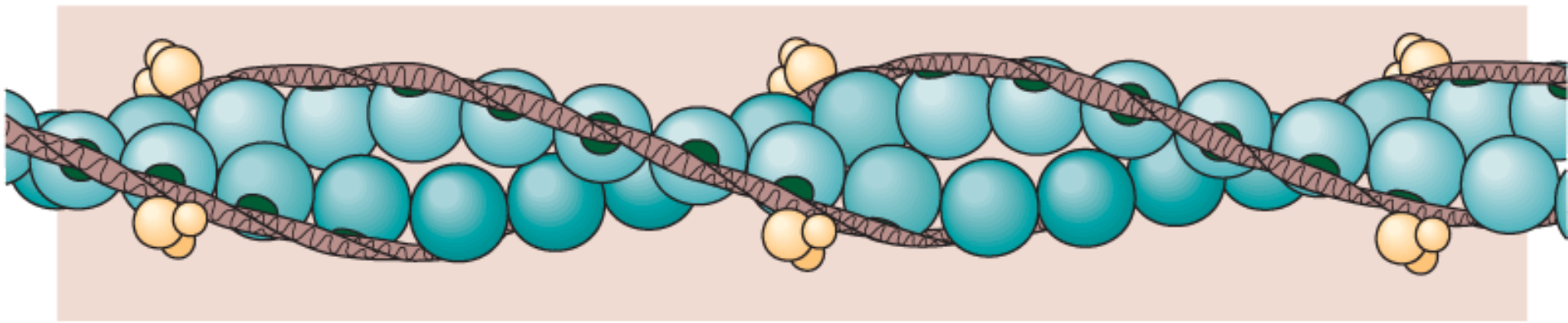
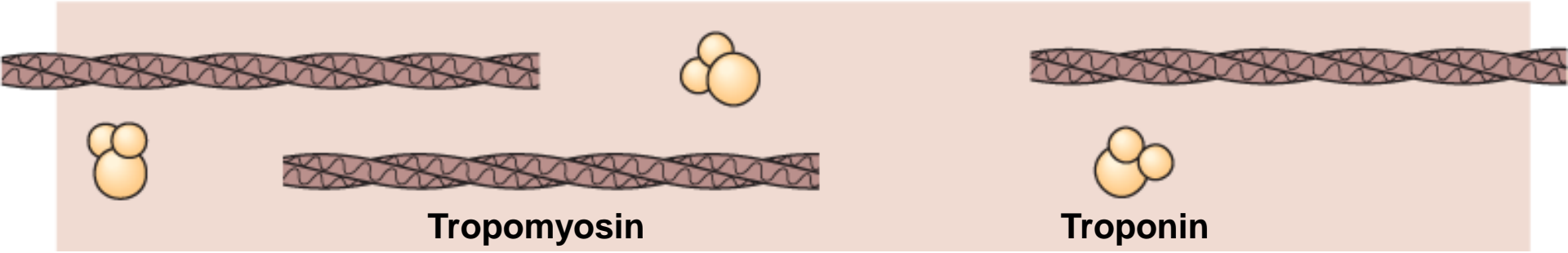


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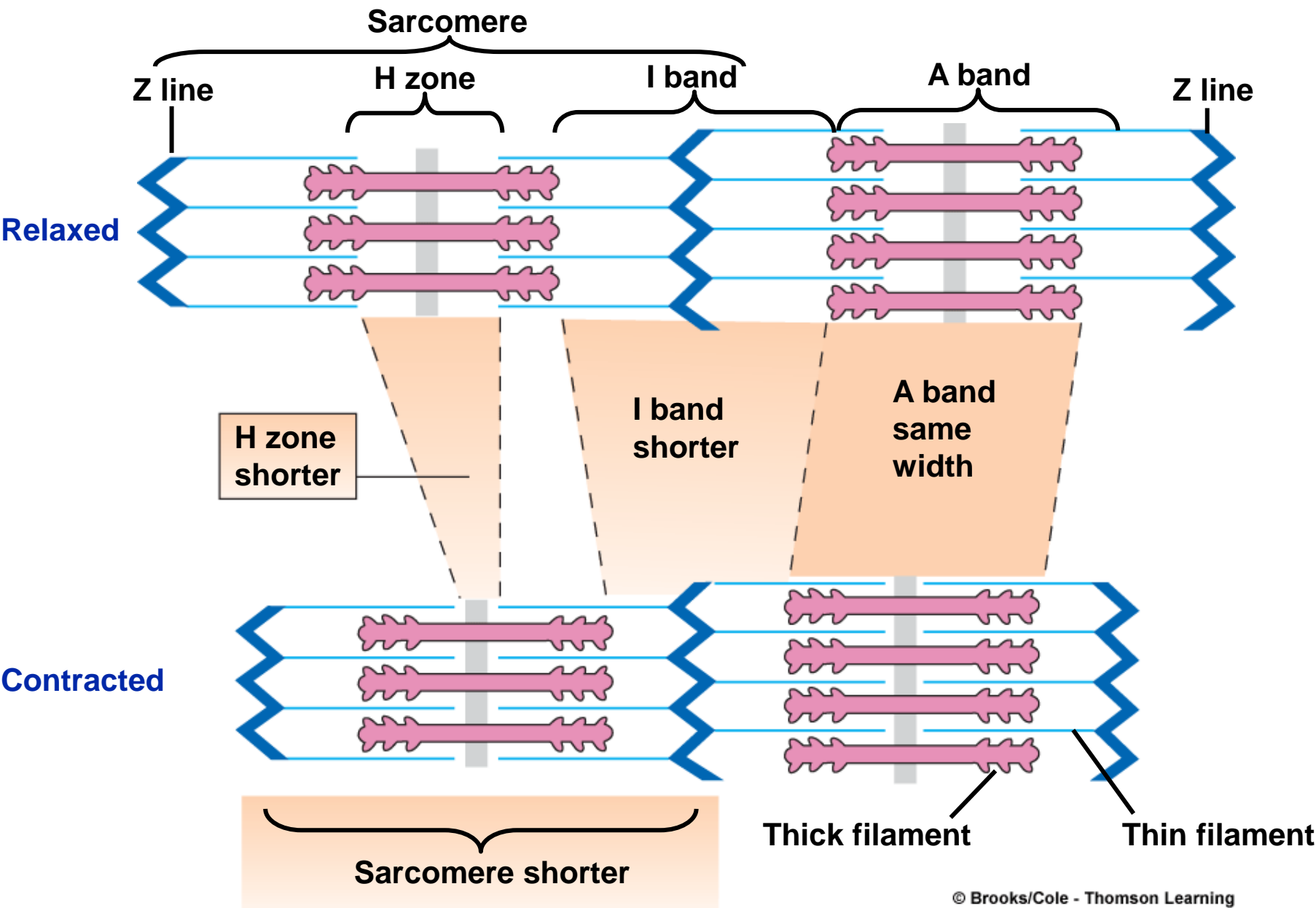


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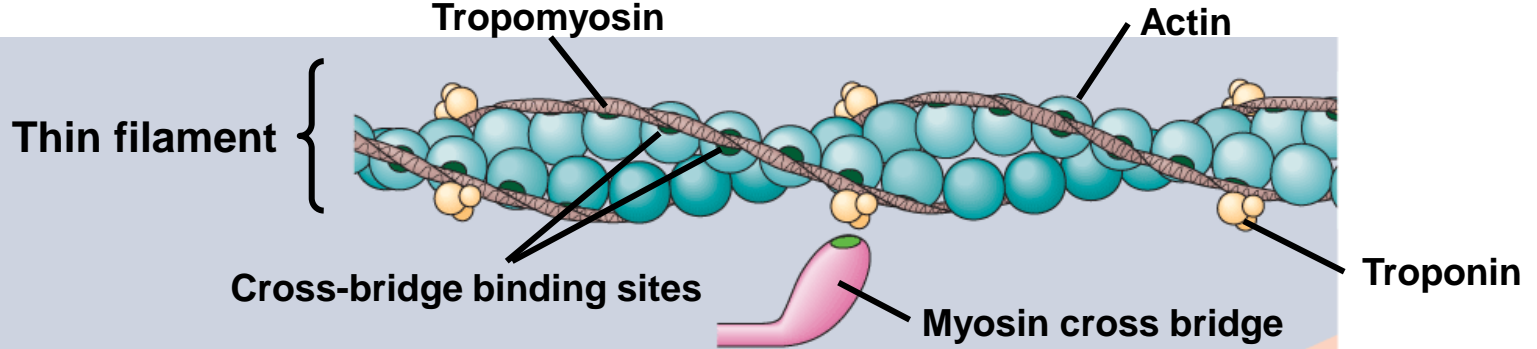
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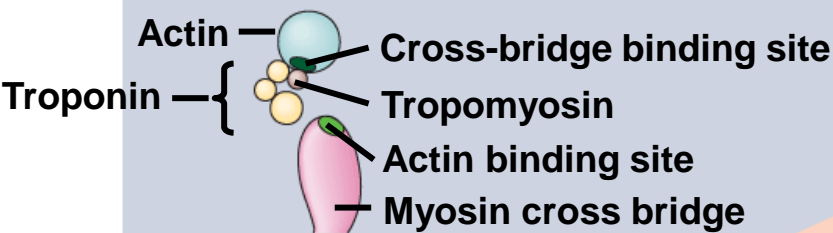
Thin filament



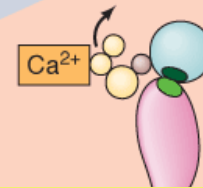
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Cross-sectional view



Relaxed

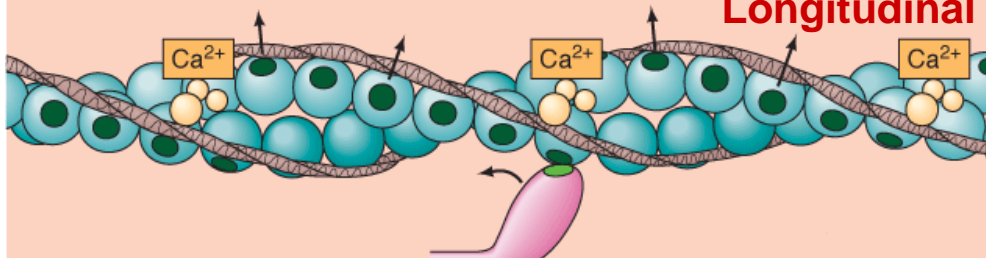


Excited

Muscle fiber excited; released Ca^{2+} binds with troponin, pulling troponin-tropomyosin complex aside to expose cross-bridge binding site; cross-bridge binding occurs

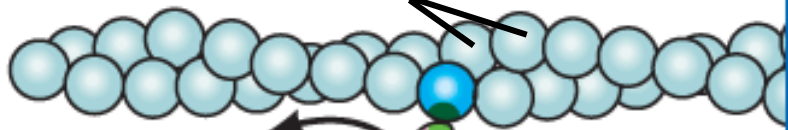
Muscle fiber relaxed; no cross-bridge binding because the cross-bridge binding site on actin is physically covered by the troponin-tropomyosin complex

Longitudinal view



Binding of actin and myosin cross bridge triggers power stroke that pulls thin filament inward during contraction

Actin molecules in thin myofilament

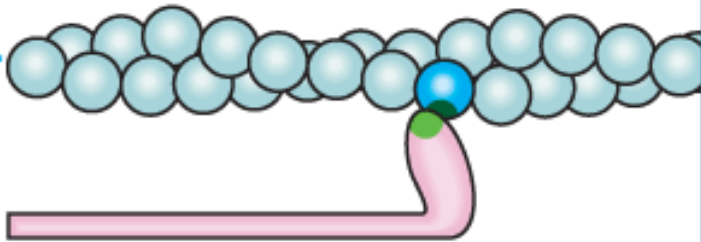


BINDING Myosin cross bridge binds to actin molecule.

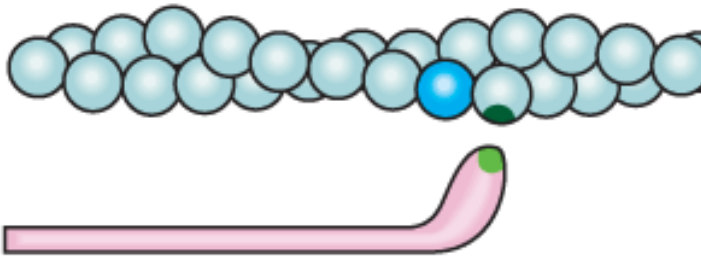
Myosin cross bridge

Z line

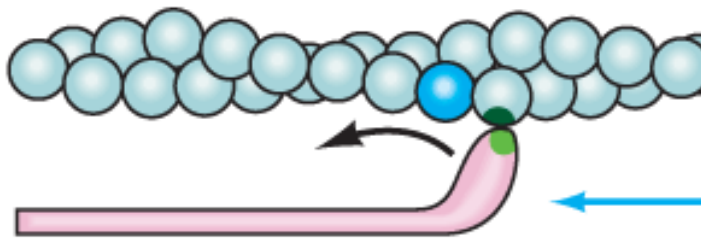
POWER STROKE Cross bridge bends, pulling thin myofilament inward.

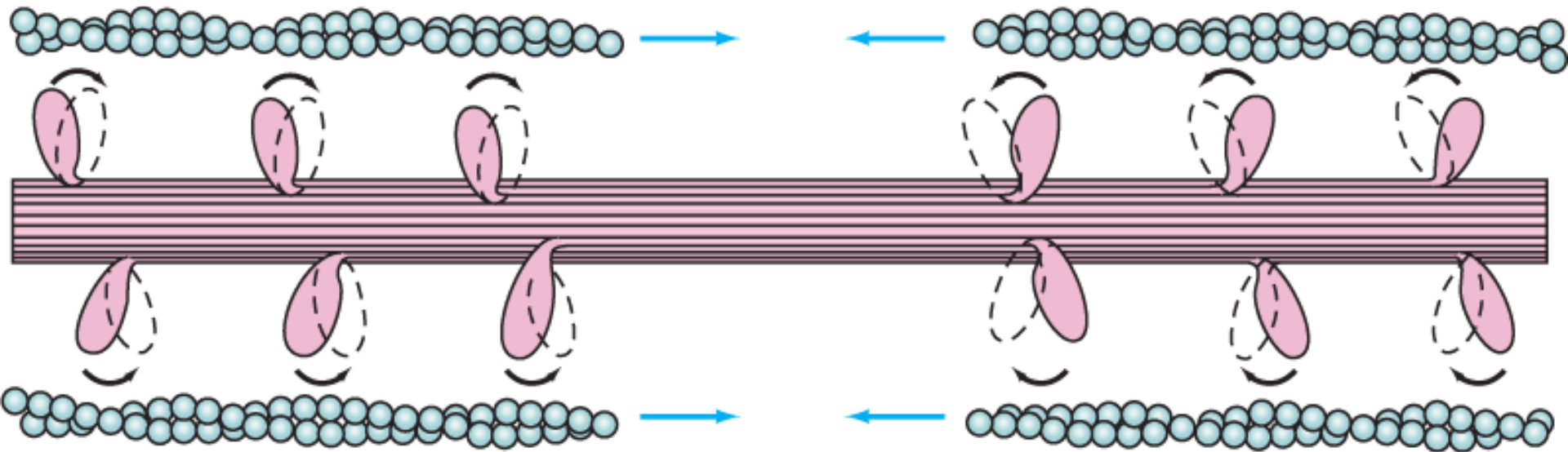


DETACHMENT Cross bridge detaches at end of power stroke and returns to original conformation.

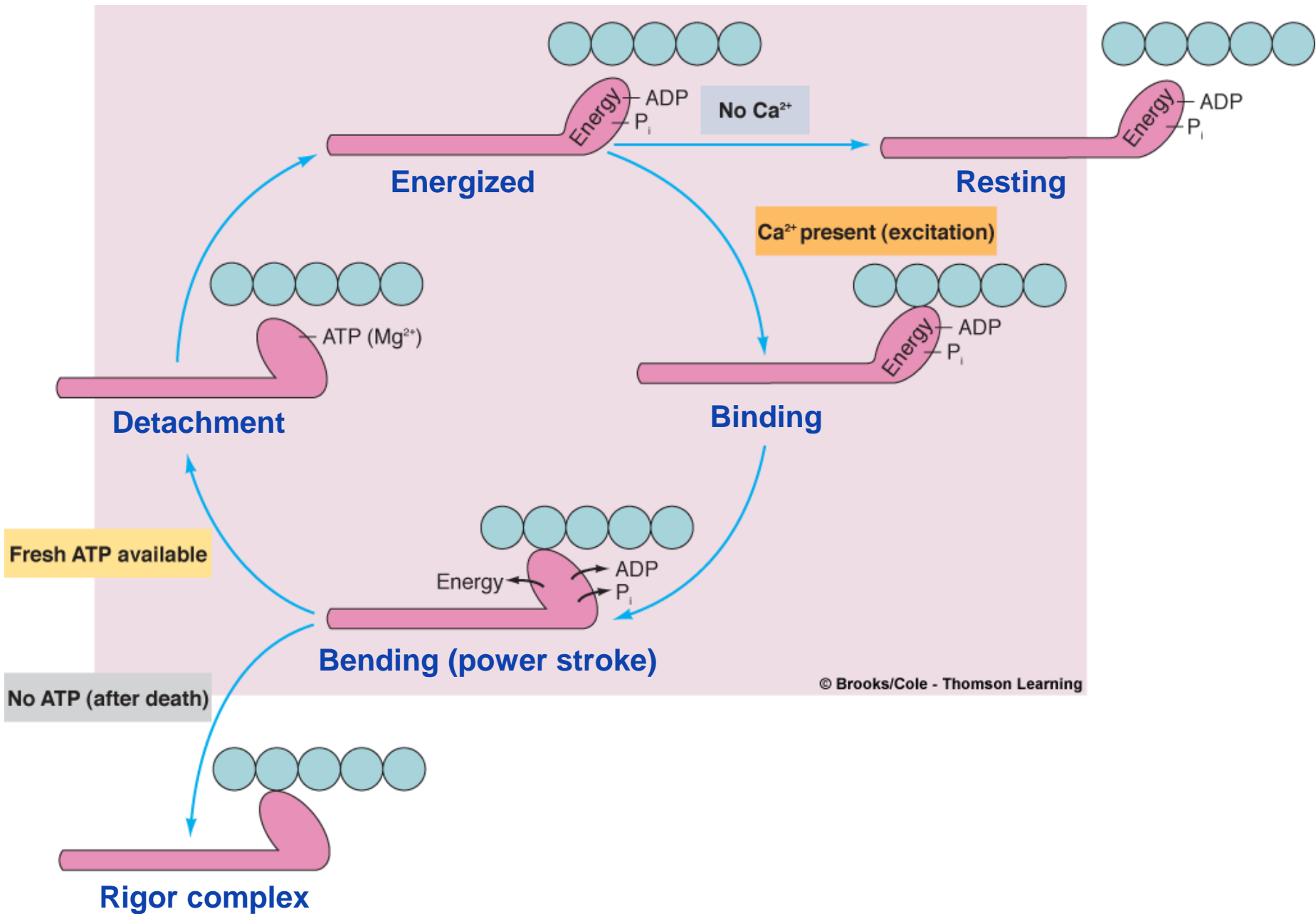


BINDING Cross bridge binds to more distal actin molecule; cycle repeated.

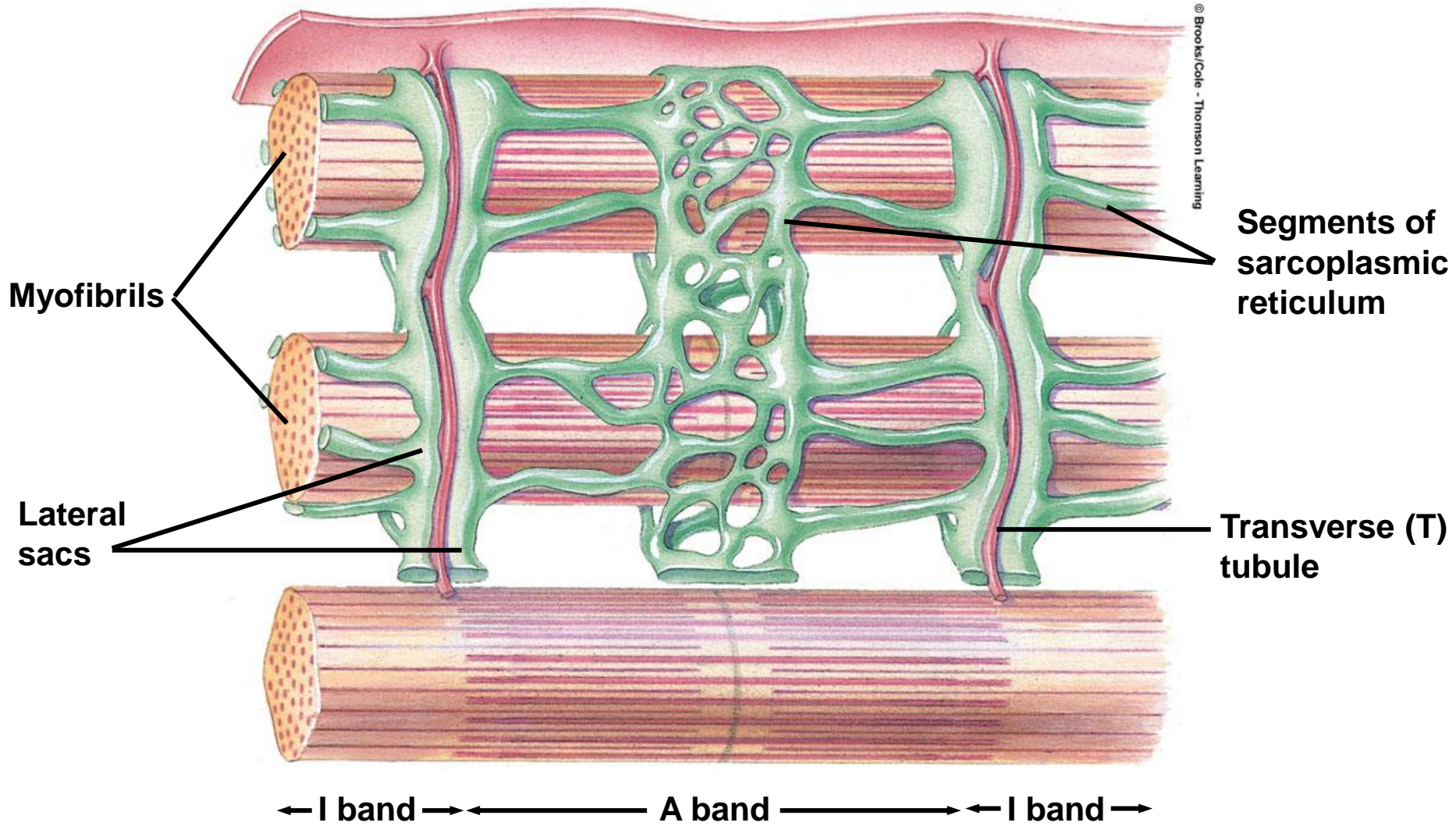


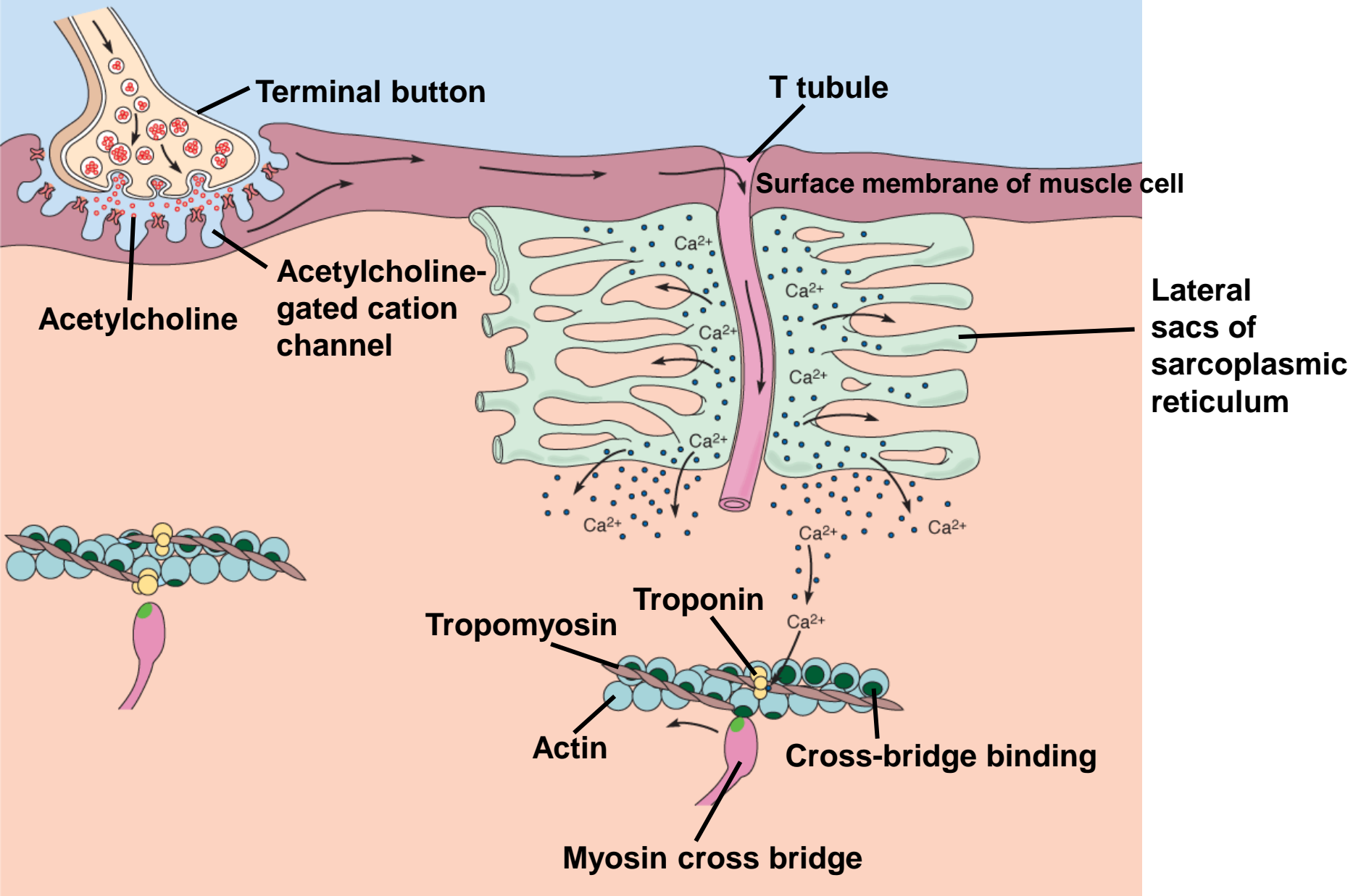


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Surface membrane of muscle fiber



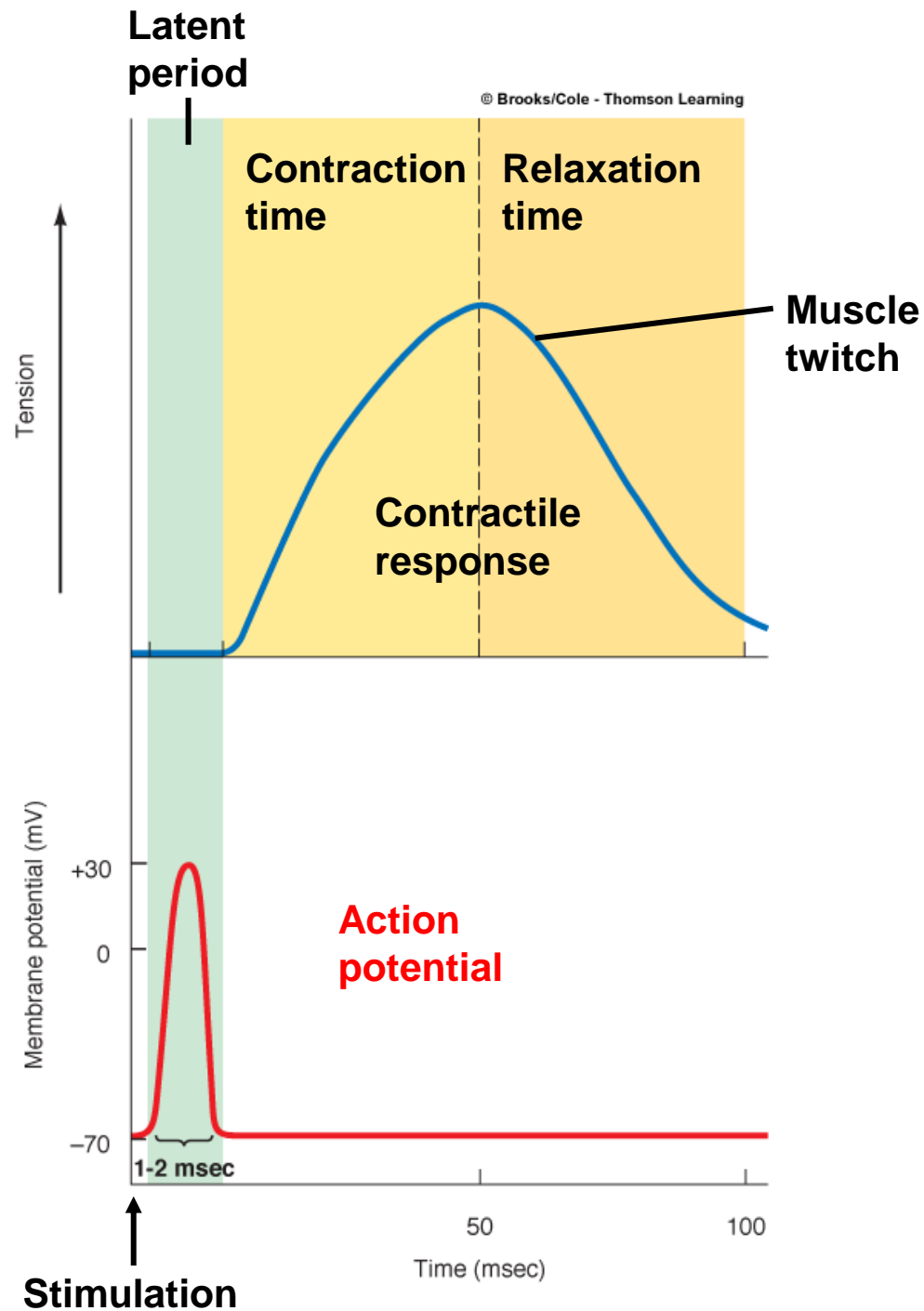


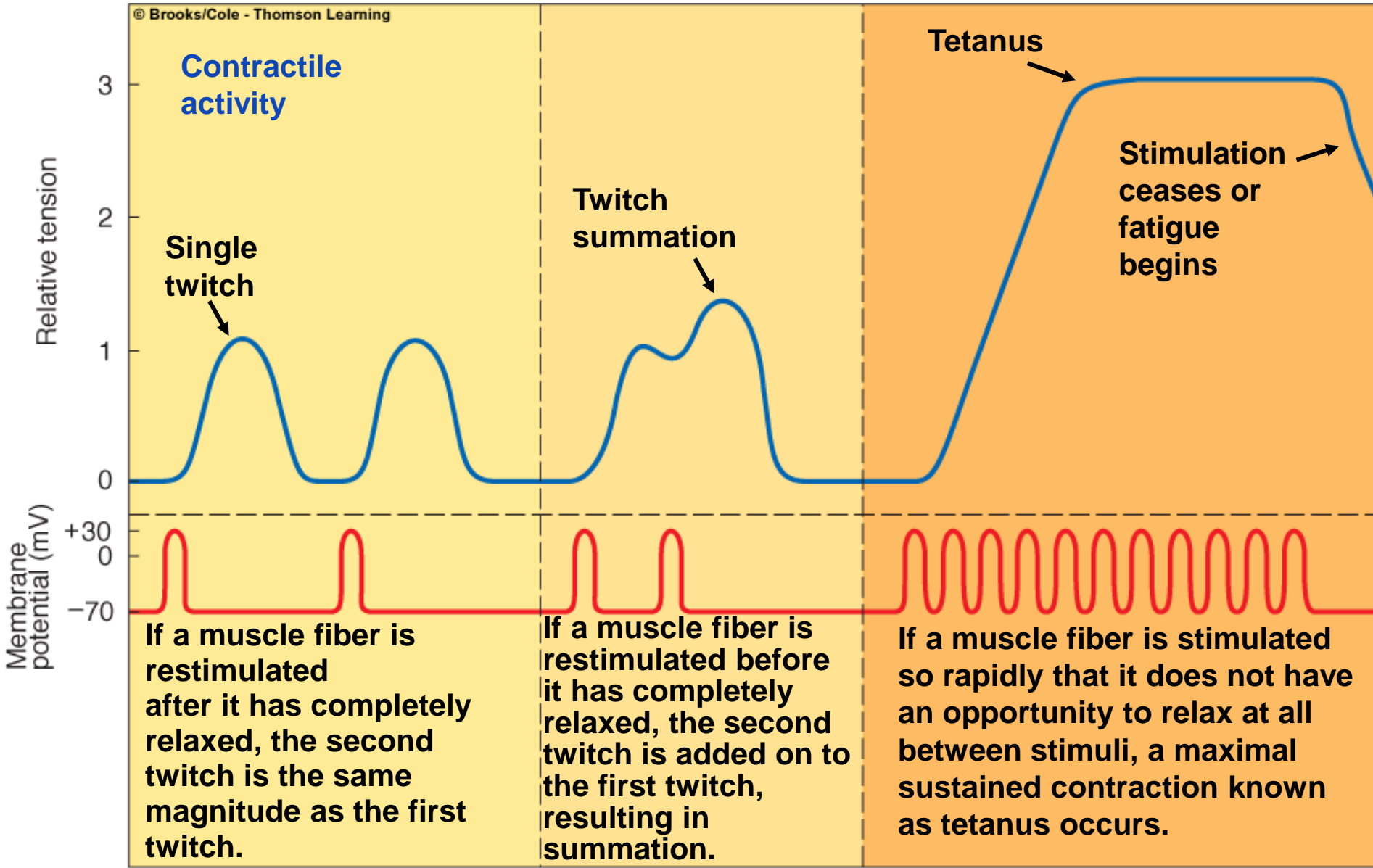
Twitch, Summation, & Tetanus

If muscle is stimulated by an increasing frequency of electrical shocks, its tension will increase to a near maximum “ **summation** “ (i.e incomplete tetanus)

If frequency is so fast no relaxation occurs, a smooth sustained contraction results called **complete tetanus**

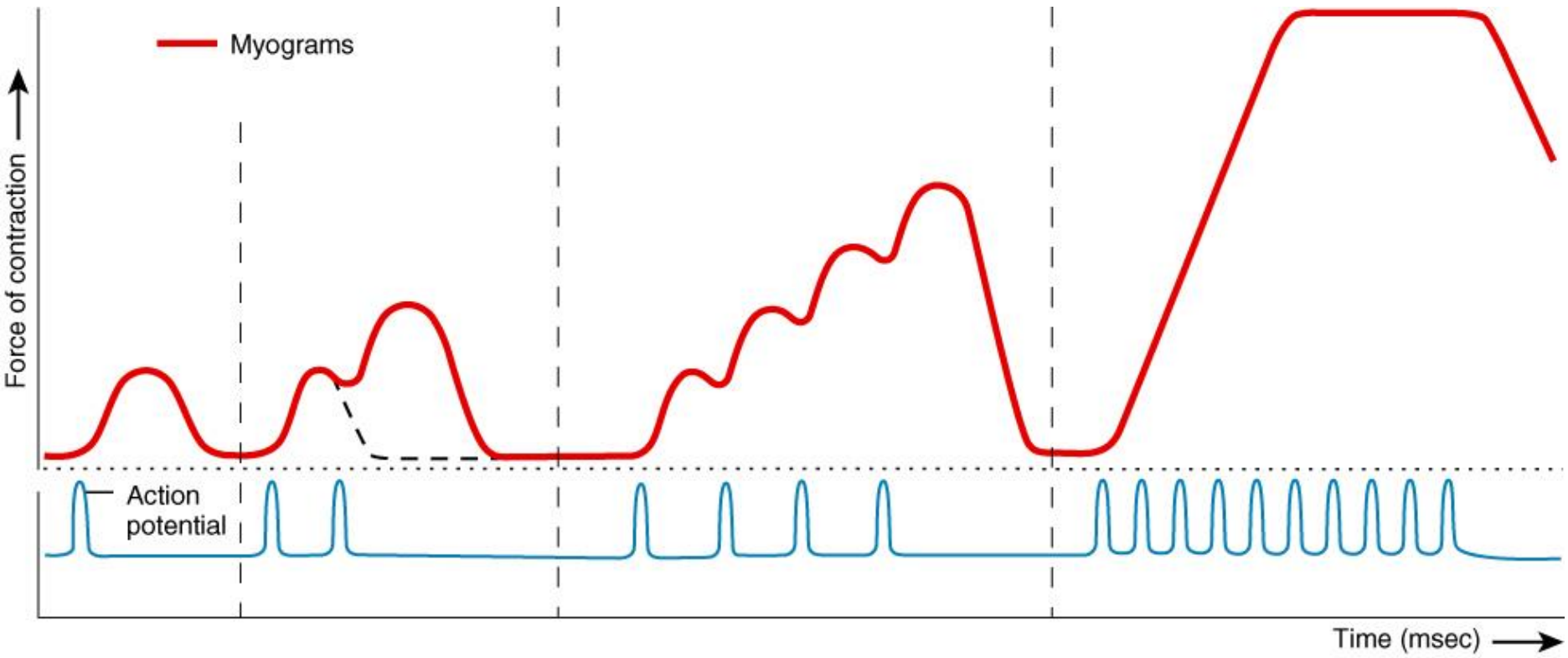
The duration of the action potential is not drawn to scale but is exaggerated.





Time

Action potentials



(a) Single twitch

(b) Wave summation

(c) Unfused tetanus

(d) Fused tetanus

10.16

