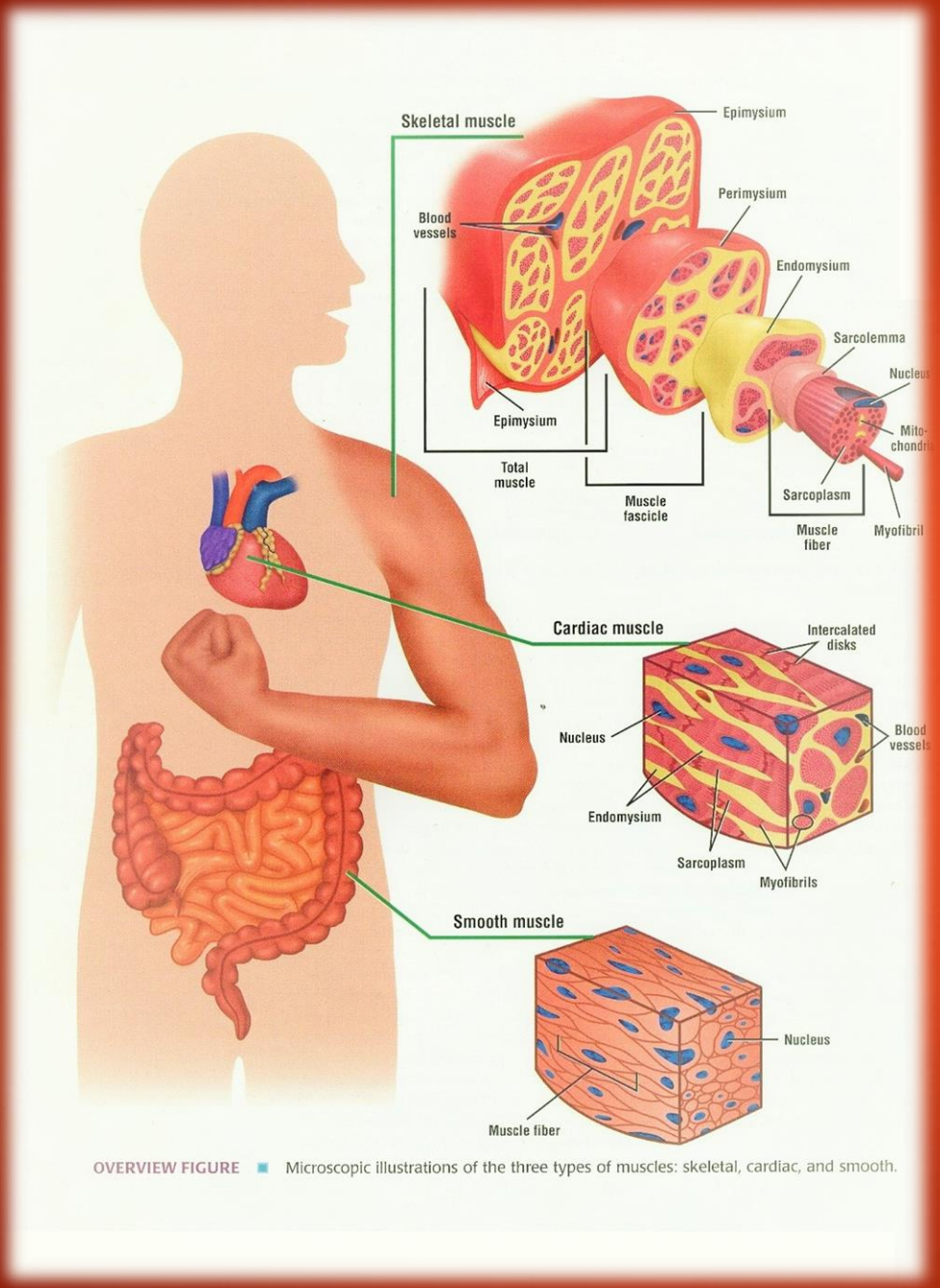
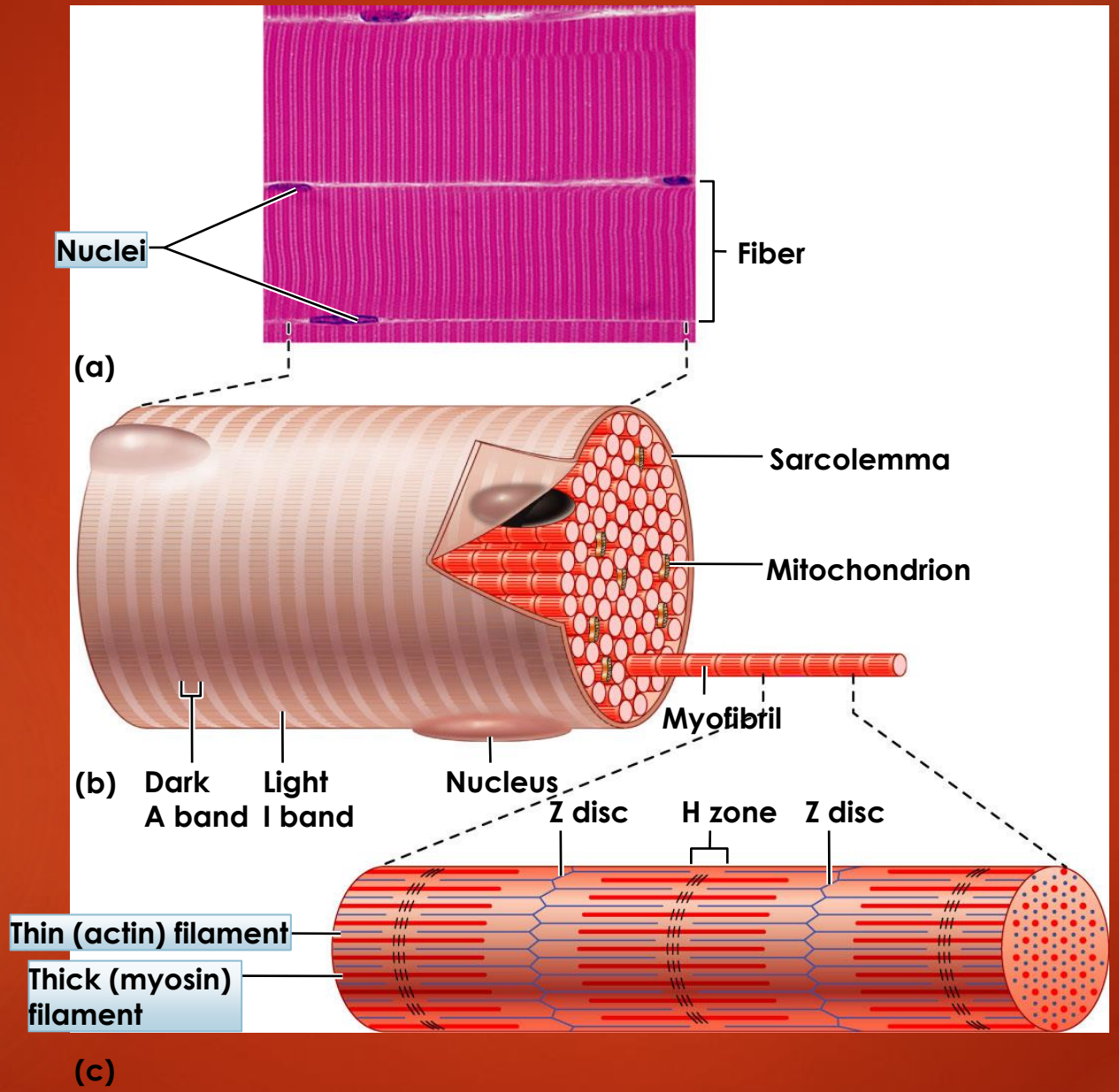
In The Name Of God



OVERVIEW FIGURE ■ Microscopic illustrations of the three types of muscles: skeletal, cardiac, and smooth.

MUSCULAR TISSUE

Microscopic anatomy of a skeletal muscle fiber



Muscle Terminology

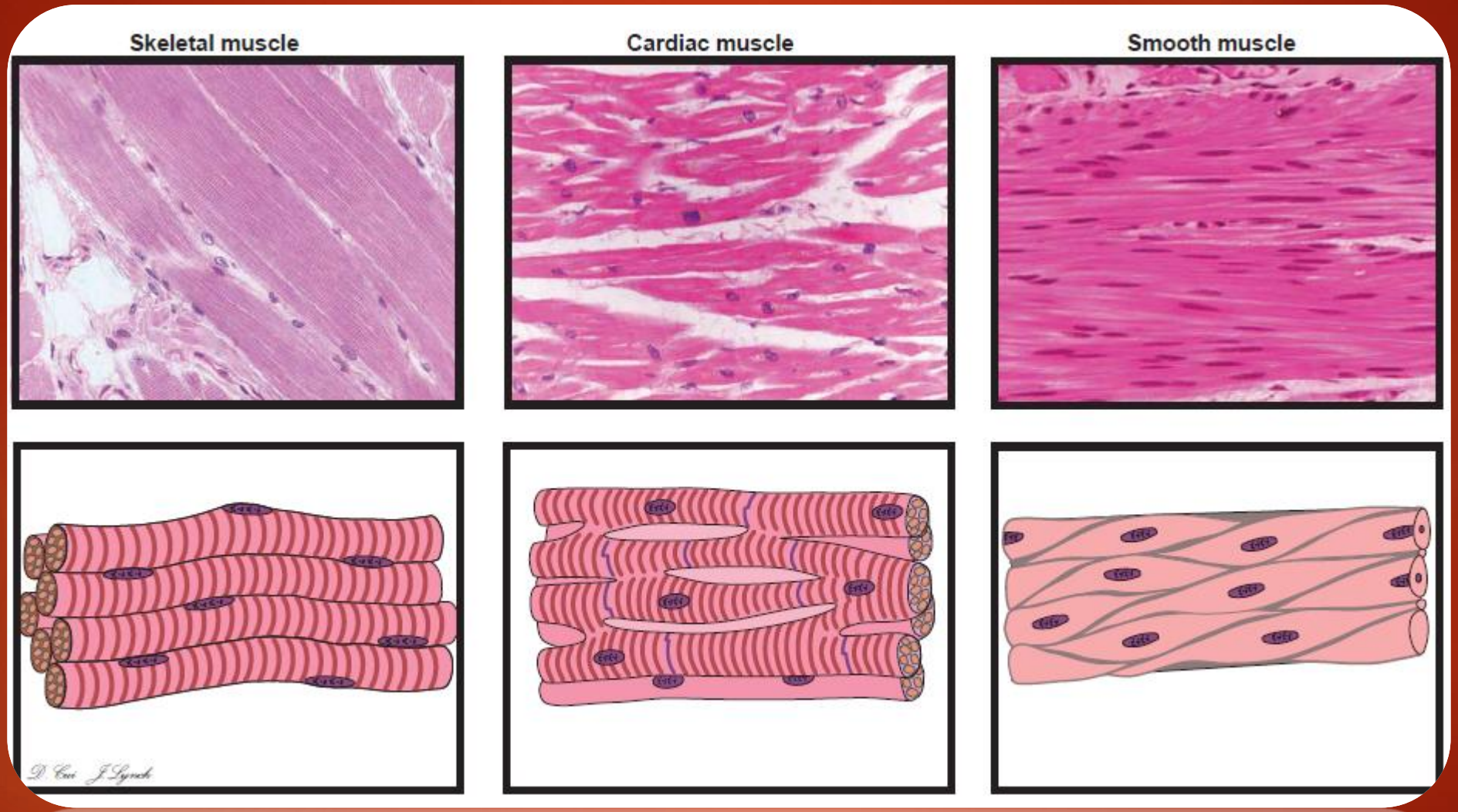
Myofiber Or Myocyte: a muscle cell

1. Sarcolemma: the plasma membrane of a muscle cell

2. Sarcoplasm: the cytoplasm of the muscle cell

3. Sarcoplasmic reticulum: the endoplasmic reticulum of a muscle cell

4. Sarcosome : the mitochondria of a muscle cell

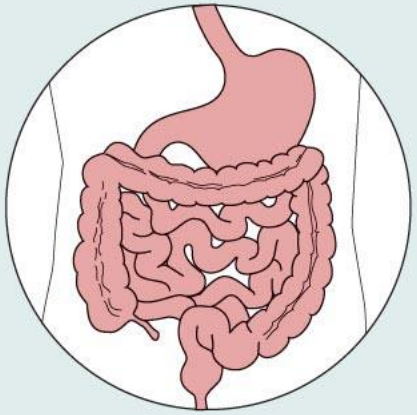

Skeletal muscle
Cardiac muscle
Smooth muscle

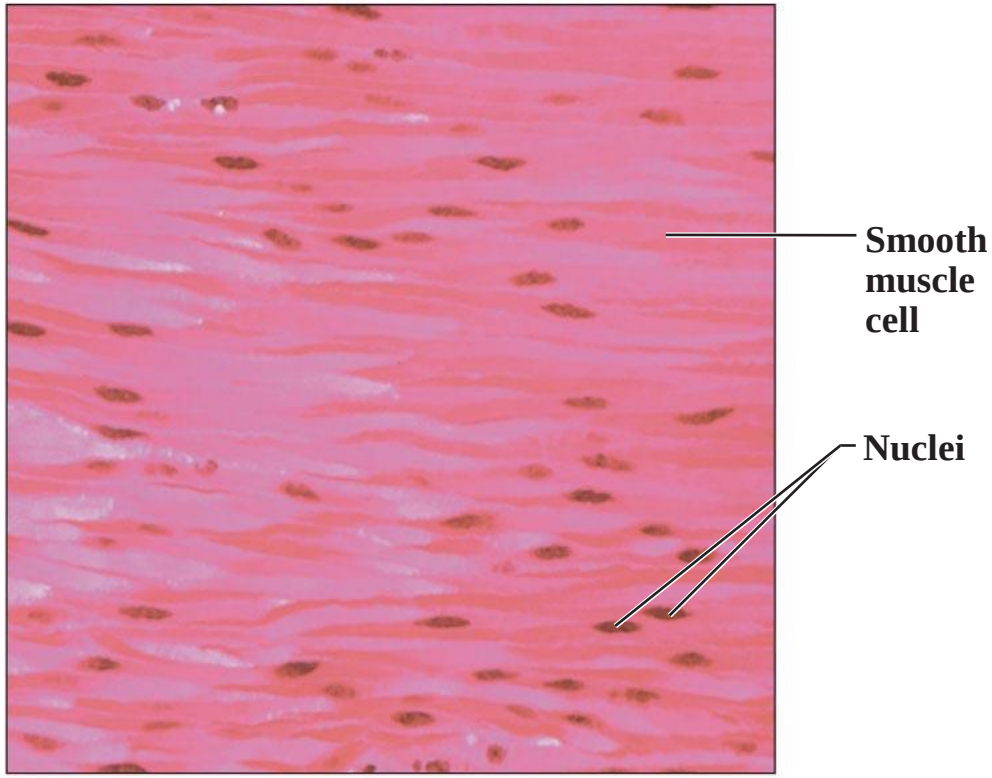
Smooth muscle

Description: Spindle-shaped cells with central nuclei; no striations; cells arranged closely to form sheets.

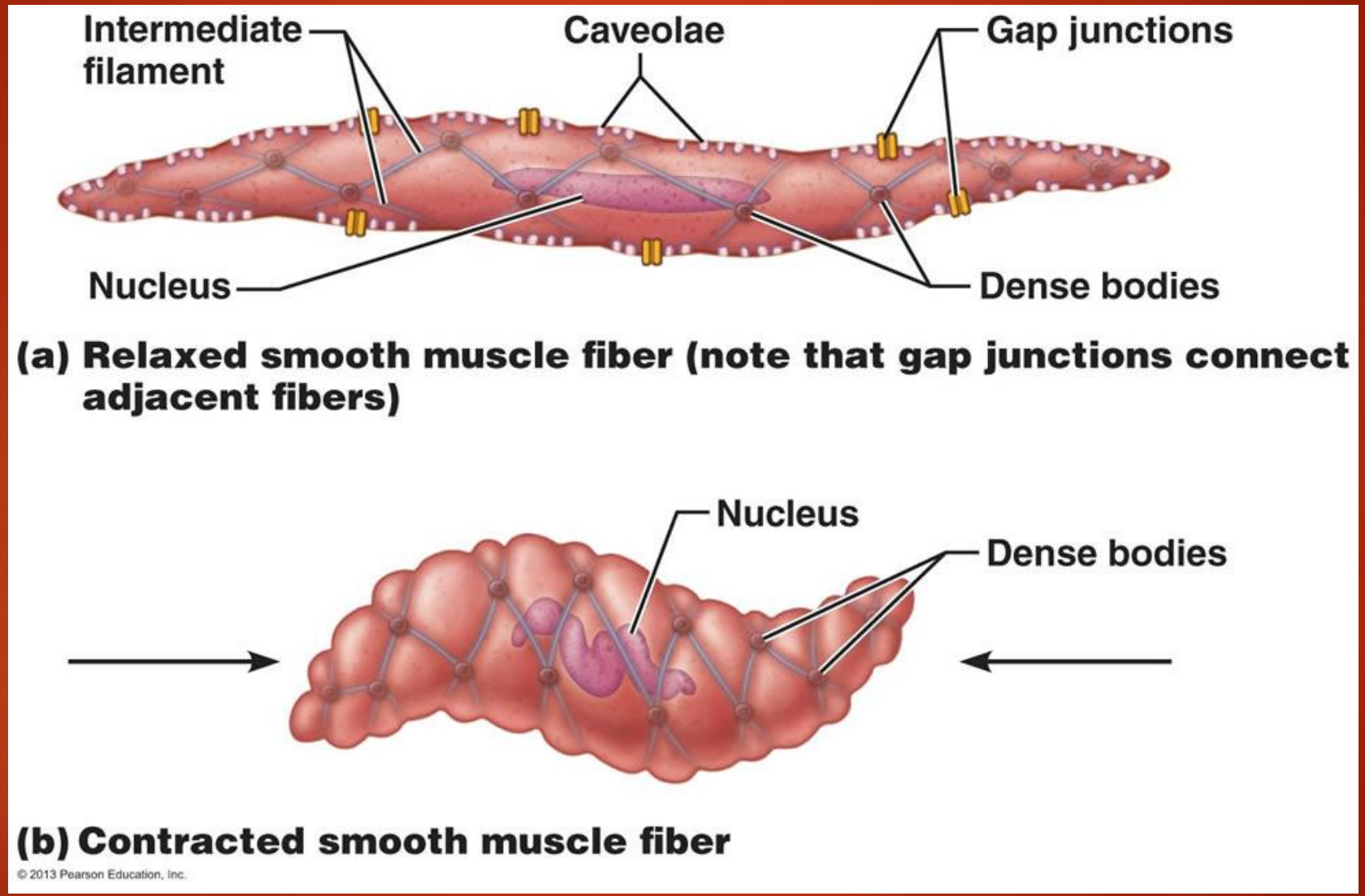
Function: Propels substances or objects (foodstuffs, urine, a baby) along internal passage-ways; involuntary control.

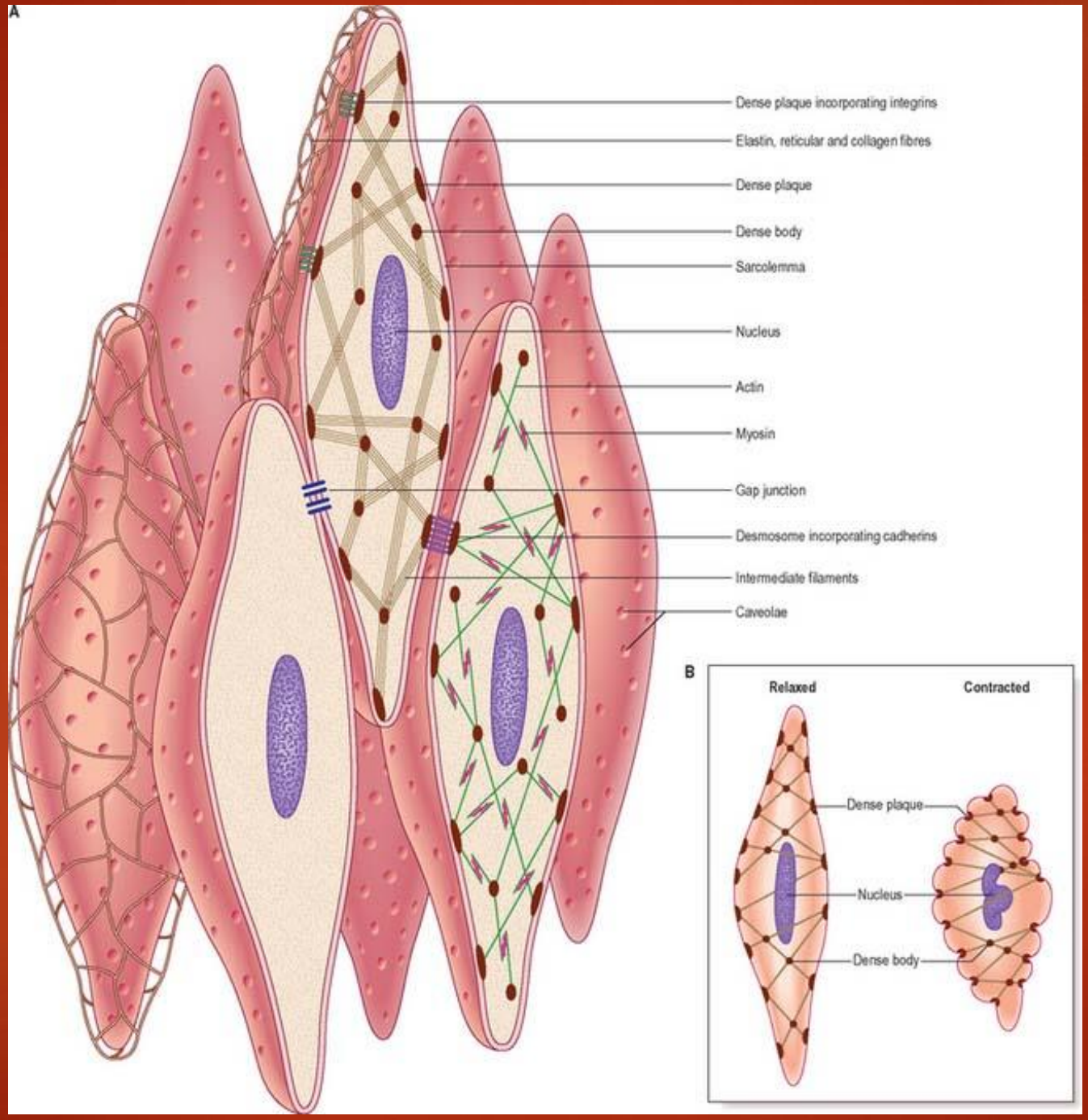
Location: Mostly in the walls of hollow organs.





Photomicrograph: Sheet of smooth muscle (200x).


Intermediate filament
Caveolae
Gap junctions
Nucleus
Dense bodies
(a) Relaxed smooth muscle fiber (note that gap junctions connect adjacent fibers)
Nucleus
Dense bodies
(b) Contracted smooth muscle fiber
© 2013 Pearson Education, Inc.


A
Dense plaque incorporating integrins
Elastin, reticular and collagen fibres
Dense plaque
Dense body
Sarcolemma
Nucleus
Actin
Myosin
Gap junction
Desmosome incorporating cadherins
Intermediate filaments
Caveolae
B
Relaxed
Contracted
Dense plaque
Nucleus
Dense body

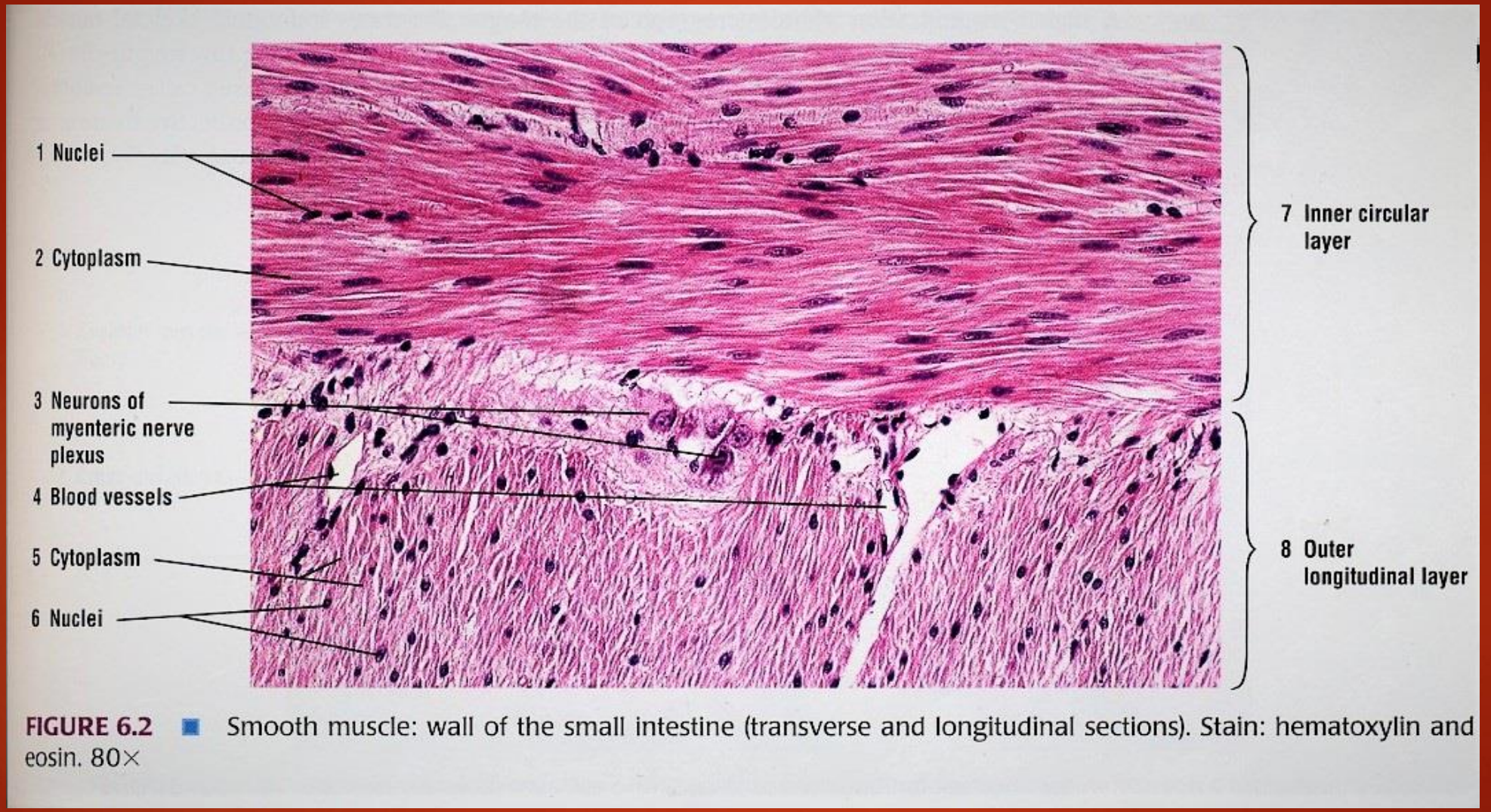


FIGURE 6.2 ■ Smooth muscle: wall of the small intestine (transverse and longitudinal sections). Stain: hematoxylin and eosin. 80×

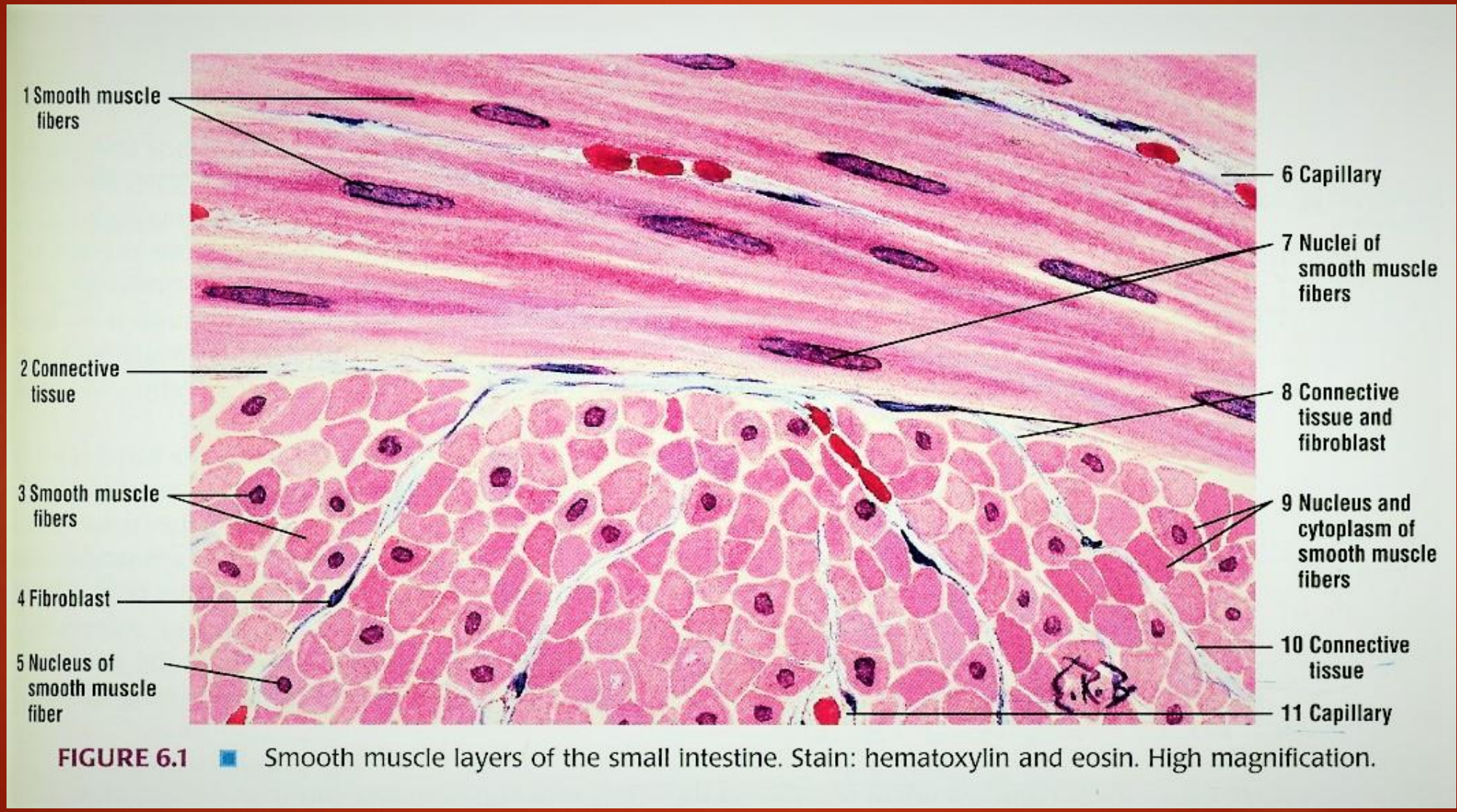


FIGURE 6.1 ■ Smooth muscle layers of the small intestine. Stain: hematoxylin and eosin. High magnification.

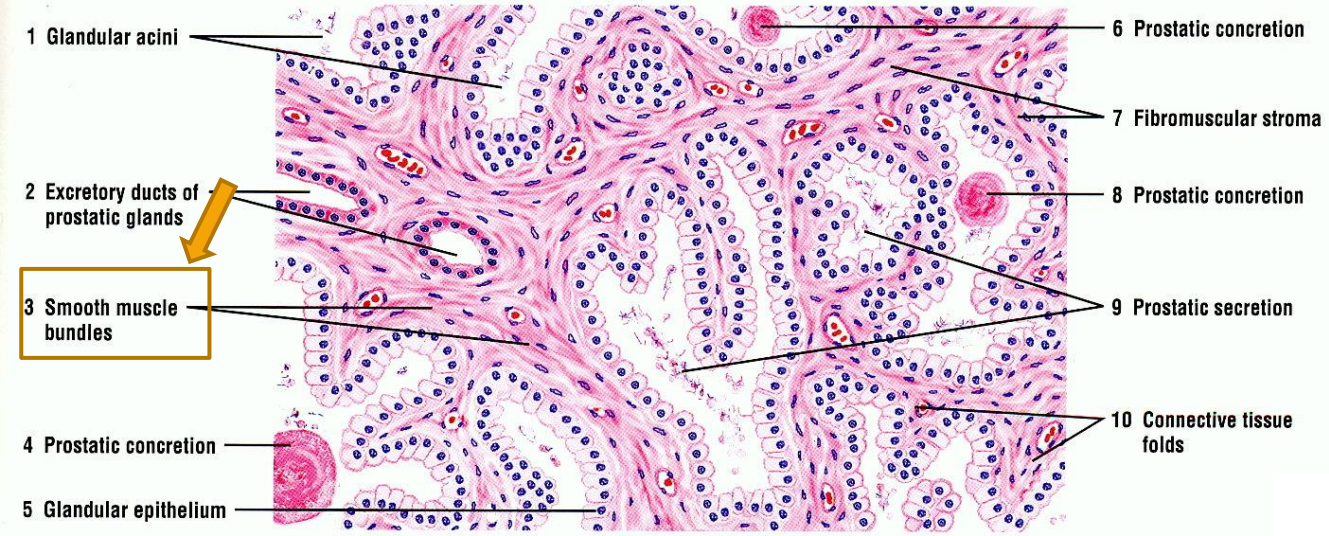
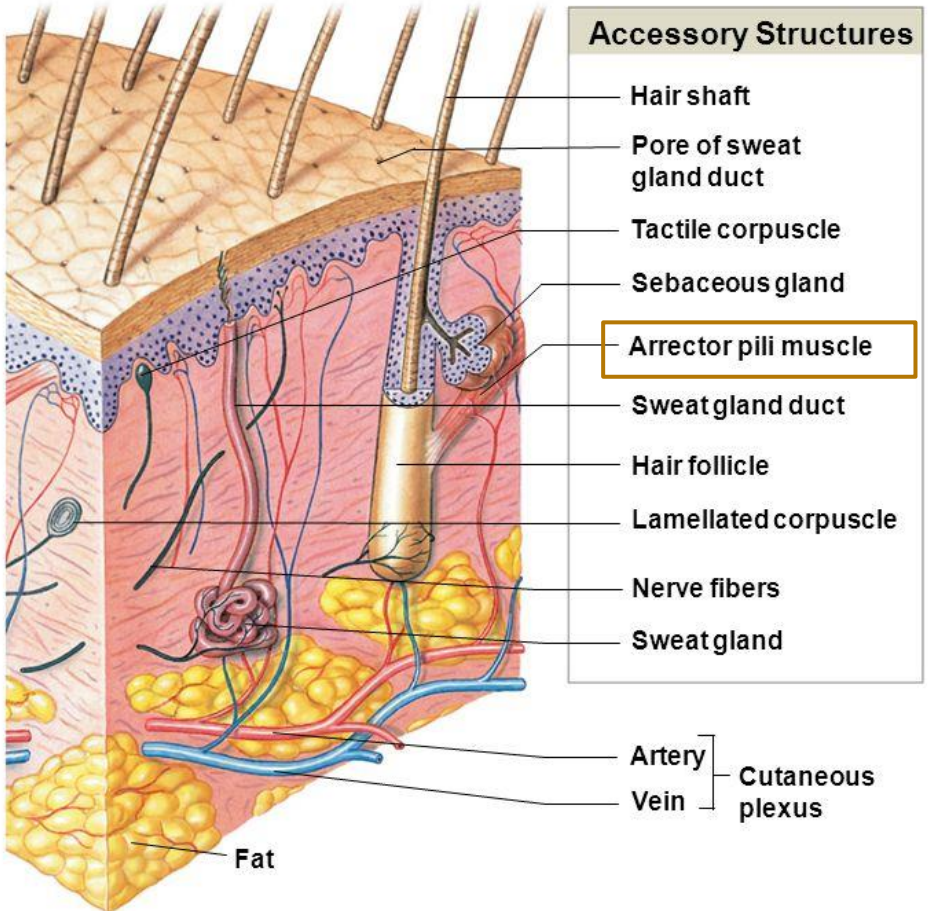


FIGURE 18.11 ■ Prostate gland: glandular acini and prostatic concretions. Stain: hematoxylin and eosin. Medium r
fication.

Figure 5-1 The Components of the Integumentary System

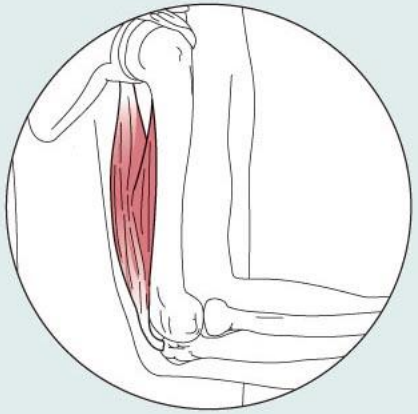


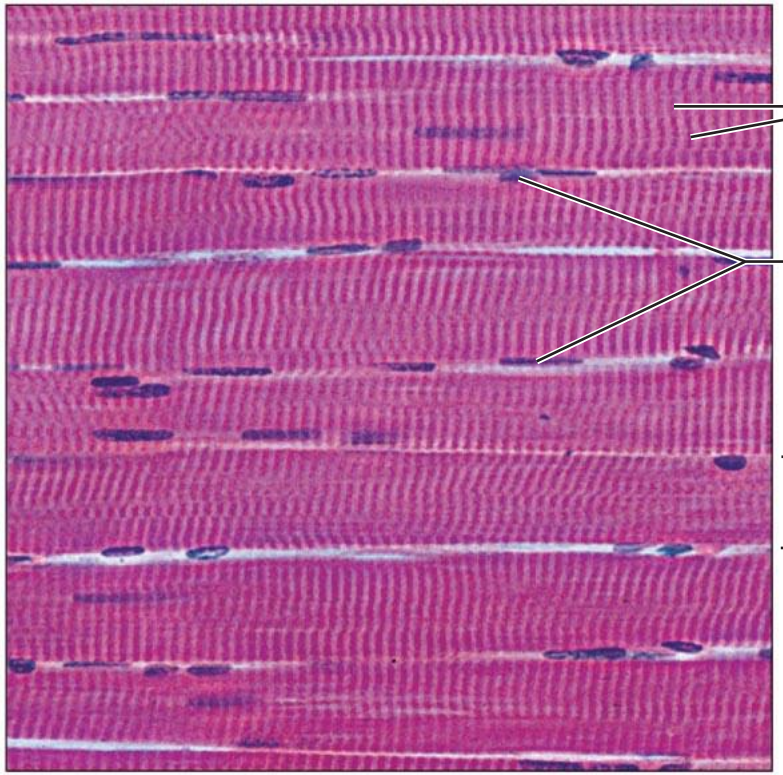
Skeletal muscle

Description: Long, cylindrical, multinucleate cells; obvious striations.

Function: Voluntary movement; locomotion; manipulation of the environment; facial expression; voluntary control.

Location: In skeletal muscles attached to bones or occasionally to skin.





Photomicrograph: Skeletal muscle (approx. 460x). Notice the obvious banding pattern and the fact that these large cells are multinucleate.

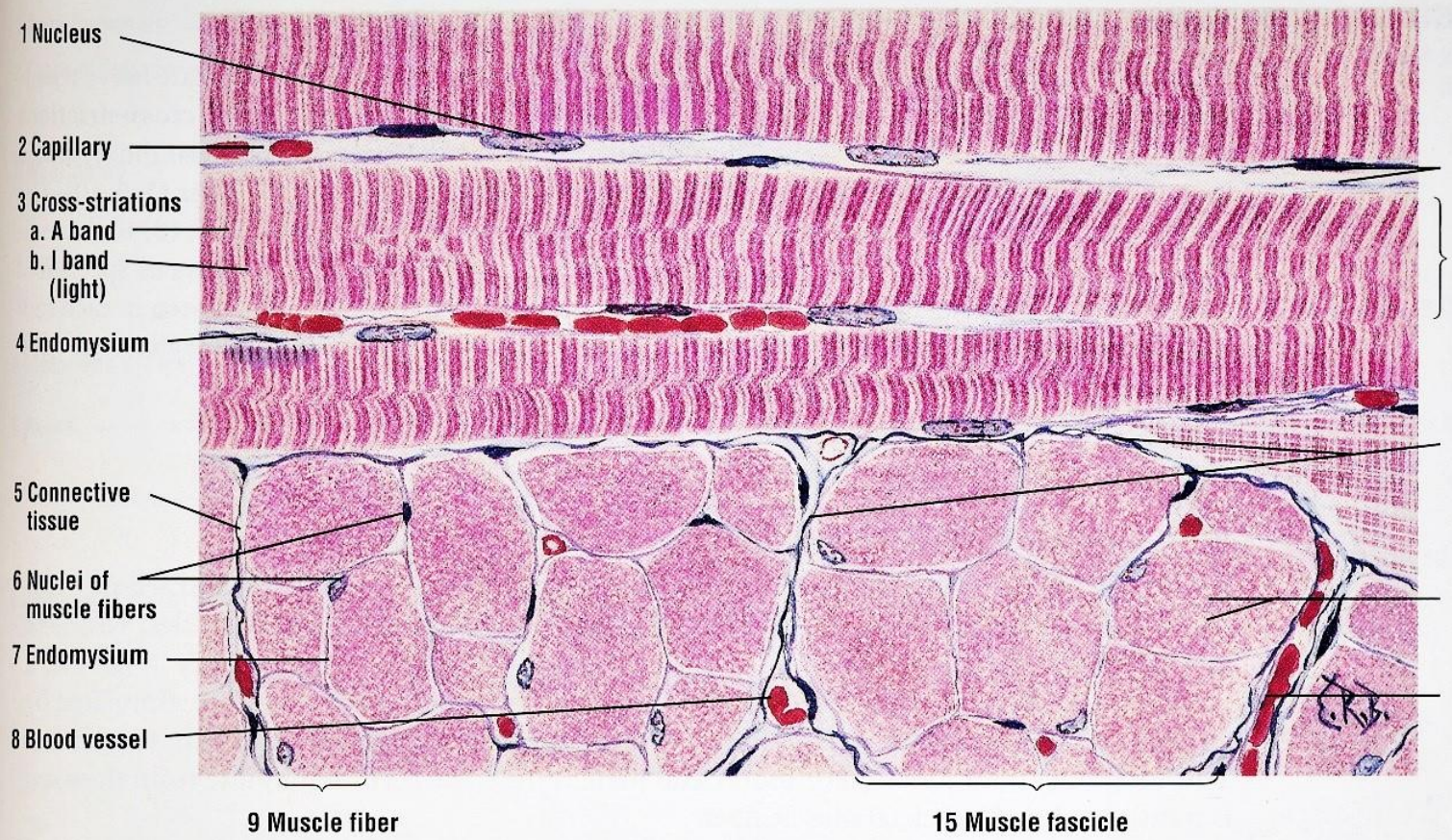
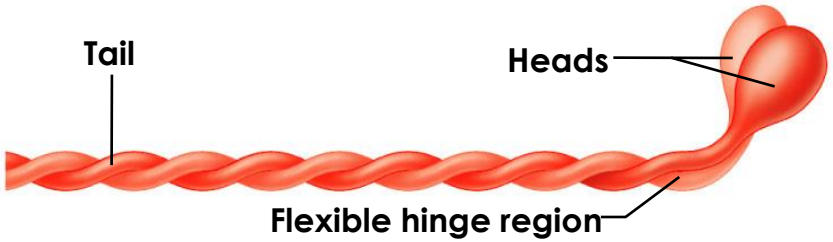


FIGURE 6.3 ■ Skeletal (striated) muscles of the tongue. Stain: hematoxylin and eosin. High magnification.

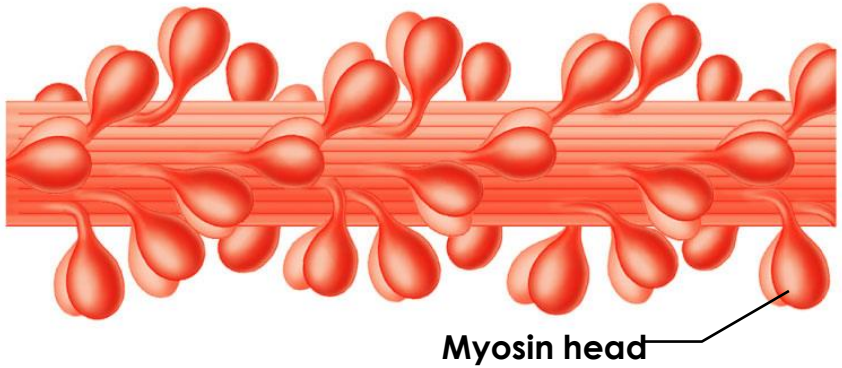
Koelliker Column

Chonheim Area

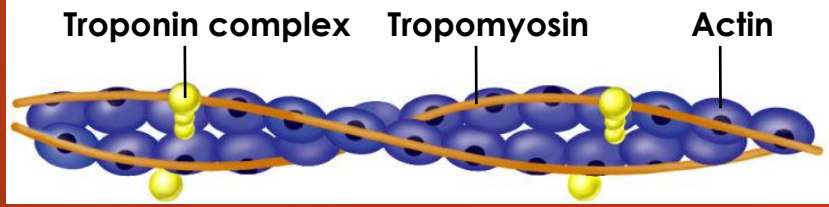
Composition of thick and thin filaments



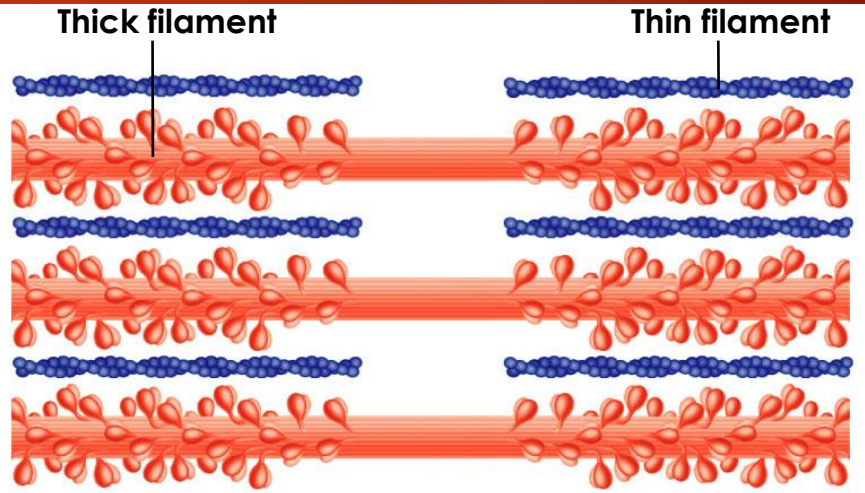
(a) Myosin molecule



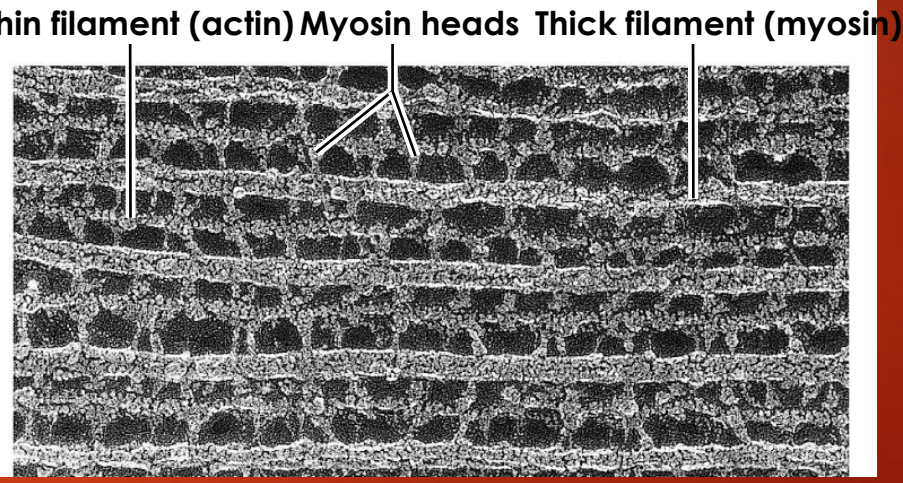
(b) Portion of a thick filament



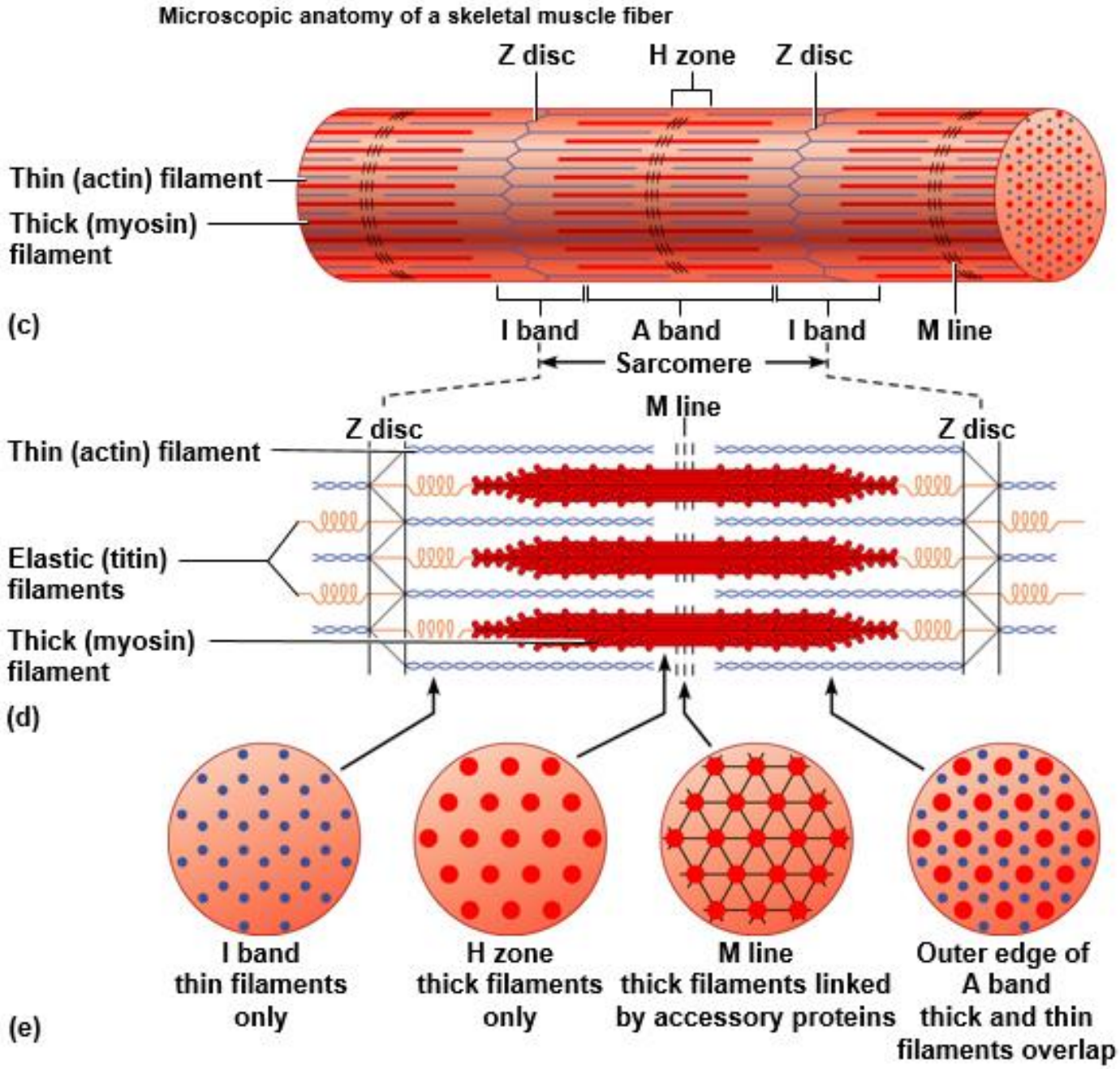
(c) Portion of a thin filament

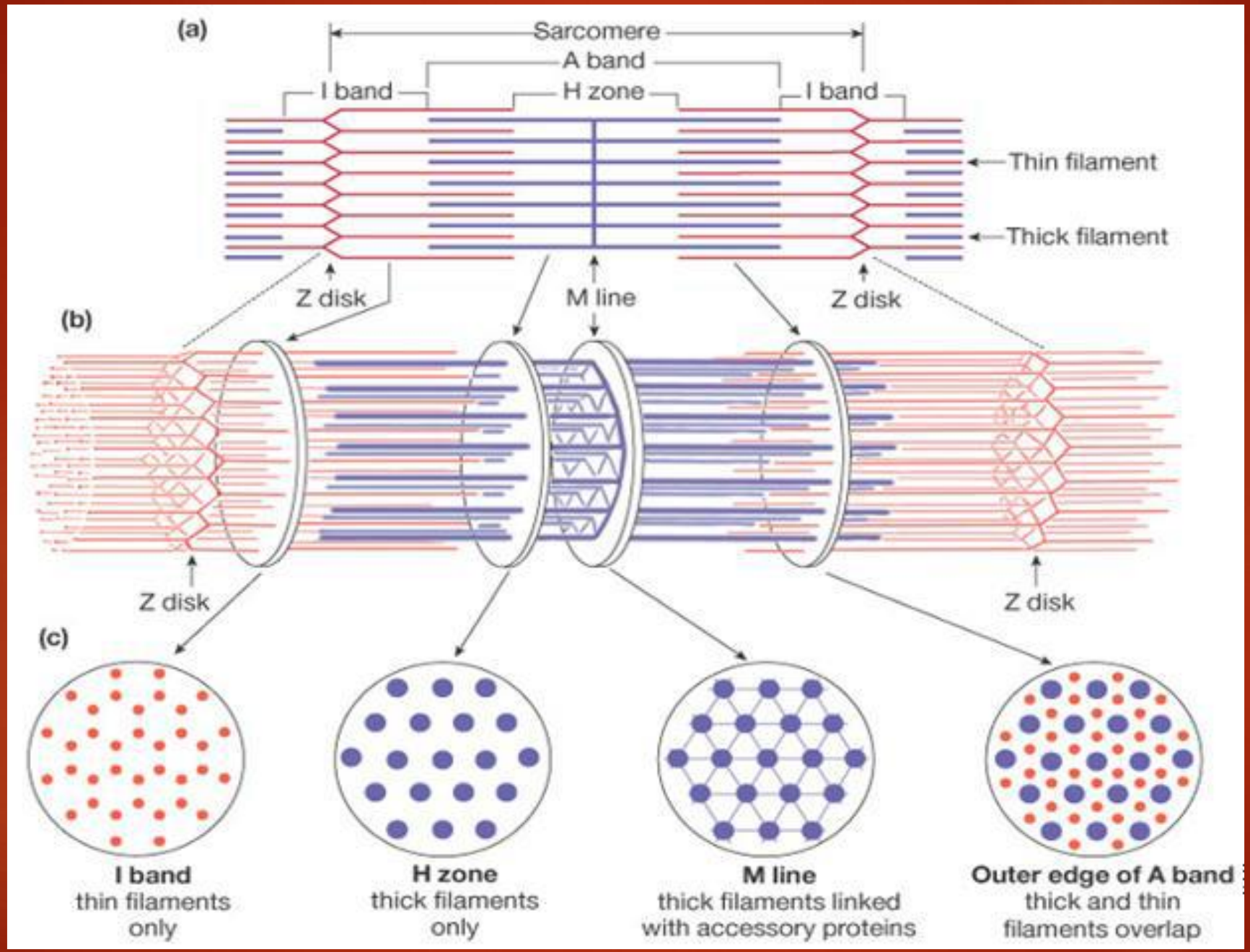


(d) Longitudinal section of filaments within one sarcomere of a myofibril

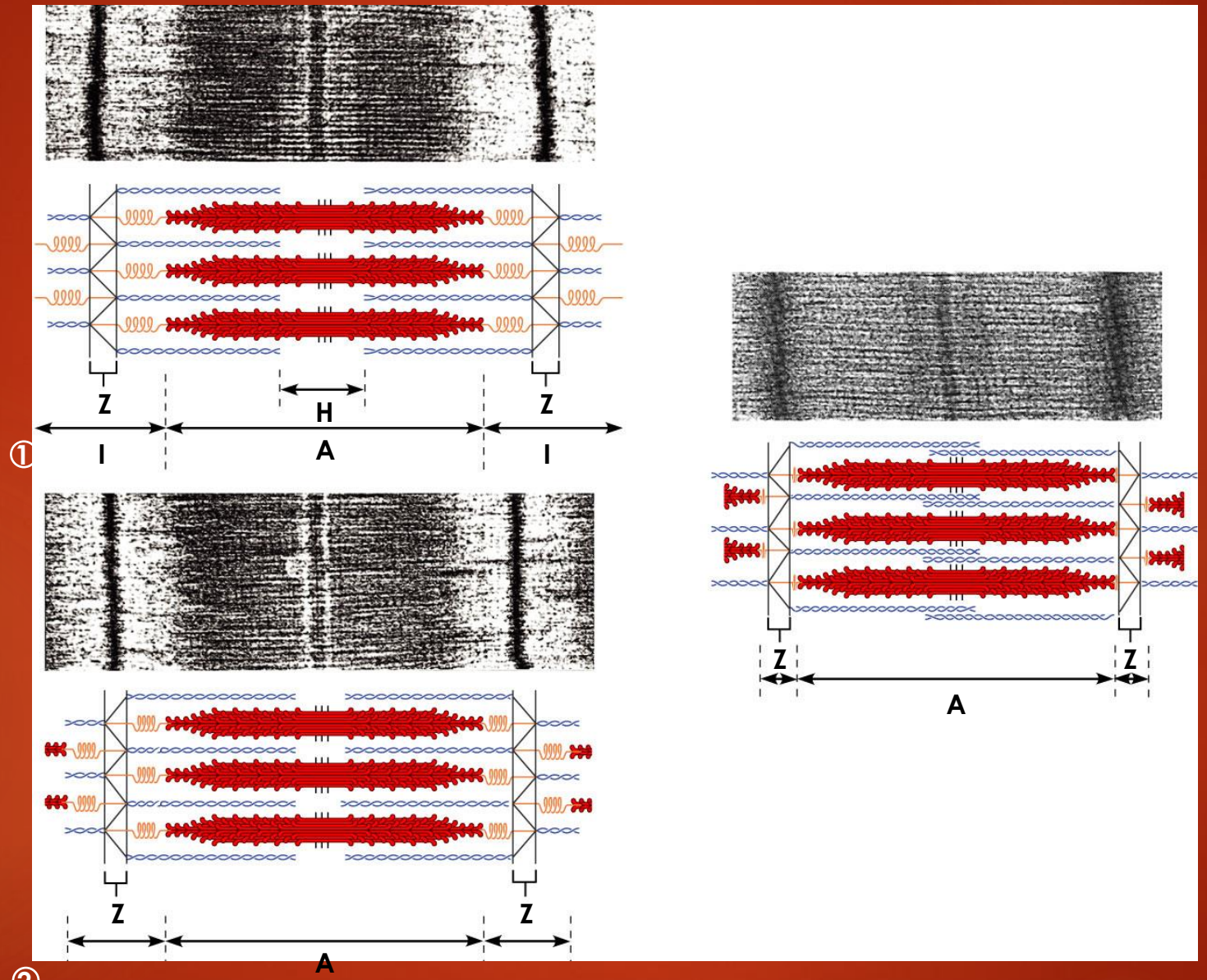


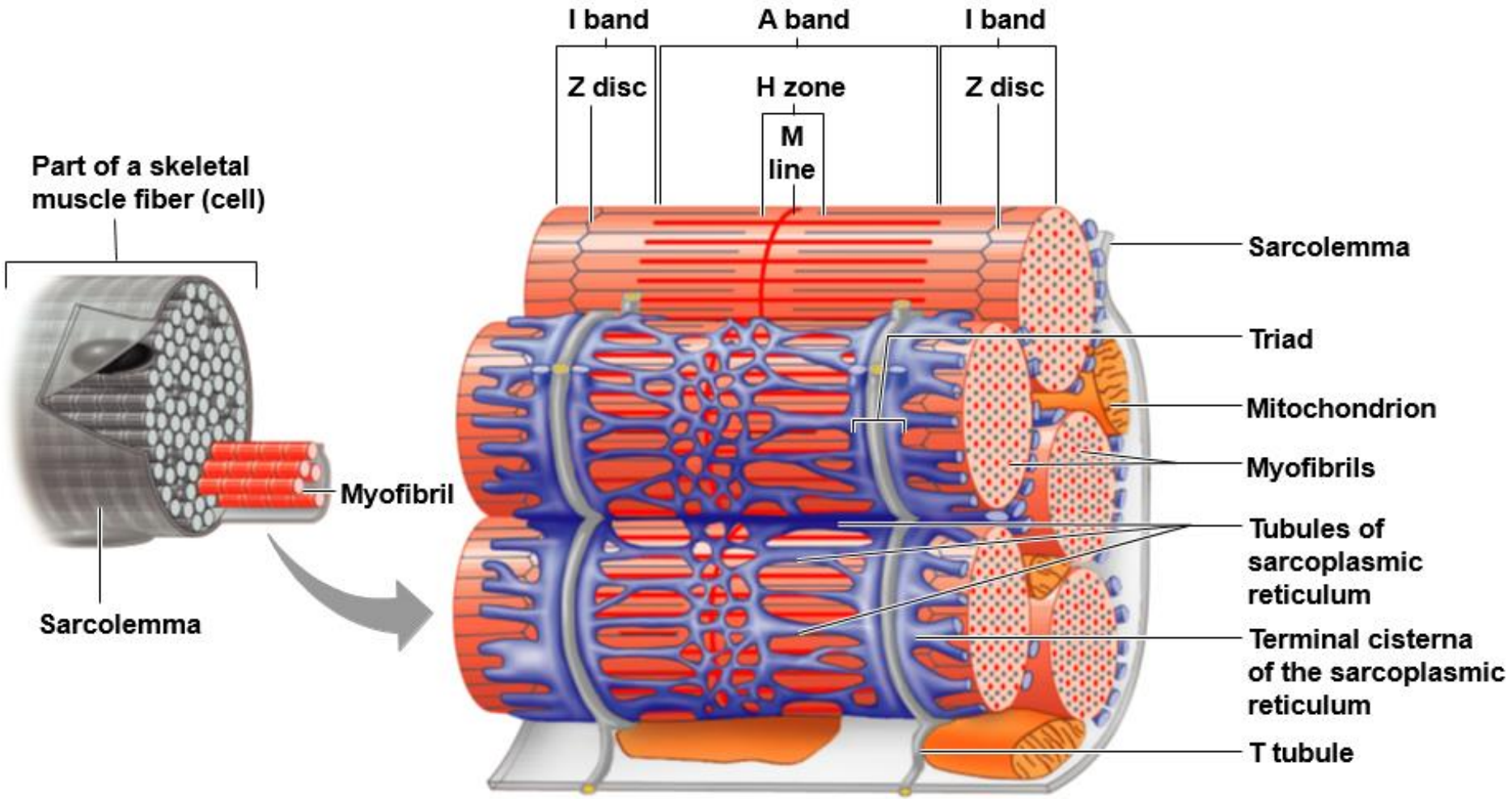
(e) Transmission electron micrograph of part of a sarcomere

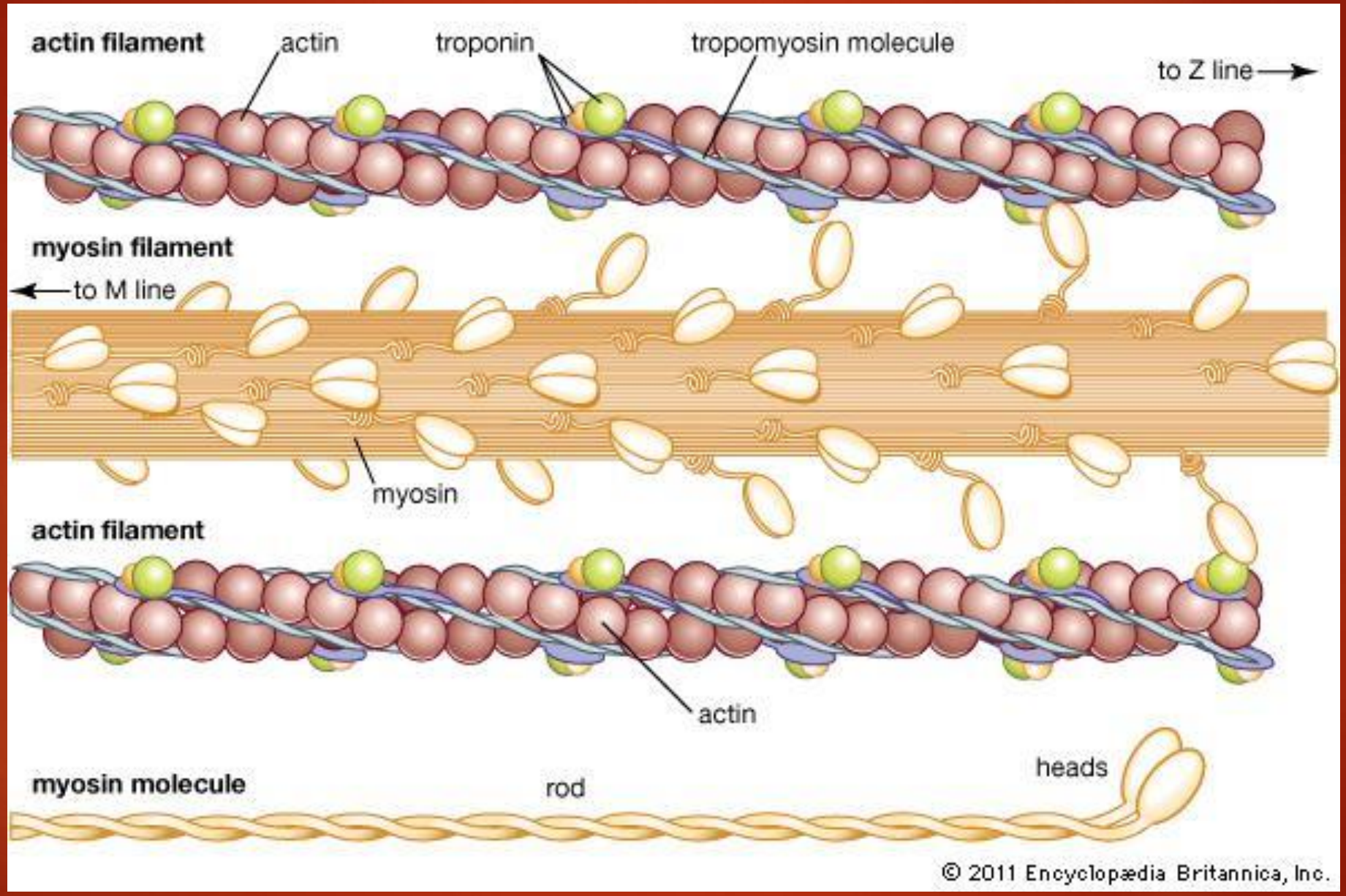

Microscopic anatomy of a skeletal muscle fiber
Z disc
H zone
Z disc
Thin (actin) filament
Thick (myosin) filament
(c)
I band
A band
I band
M line
Sarcomere
M line
Z disc
Z disc
Thin (actin) filament
Elastic (titin) filaments
Thick (myosin) filament
(d)
I band thin filaments only
H zone thick filaments only
M line thick filaments linked by accessory proteins
Outer edge of A band thick and thin filaments overlap
(e)


(a)
Sarcomere
A band
I band
H zone
I band
Thin filament
Thick filament
Z disk
M line
Z disk
(b)
Z disk
Z disk
(c)
I band
thin filaments only
H zone
thick filaments only
M line
thick filaments linked with accessory proteins
Outer edge of A band
thick and thin filaments overlap

Sliding filament model of contraction

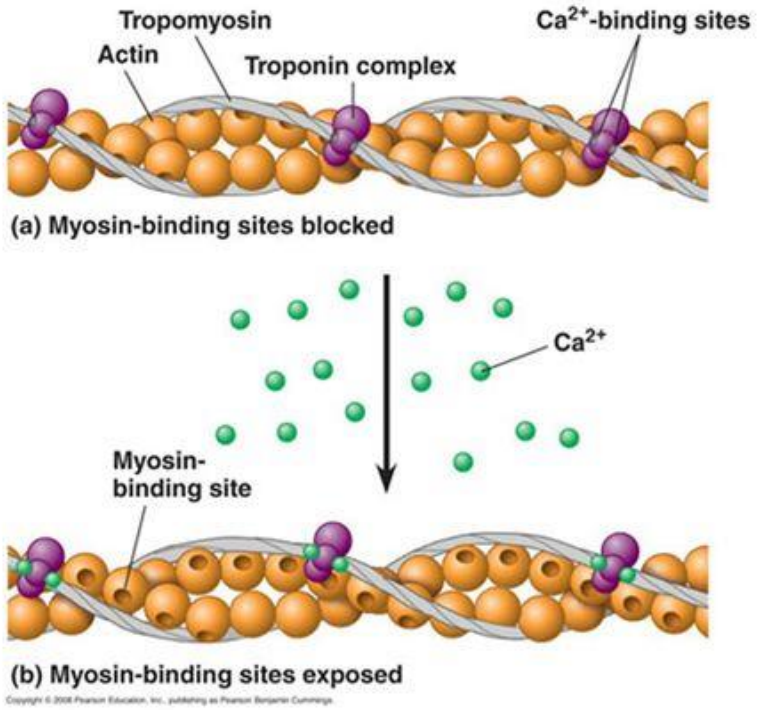


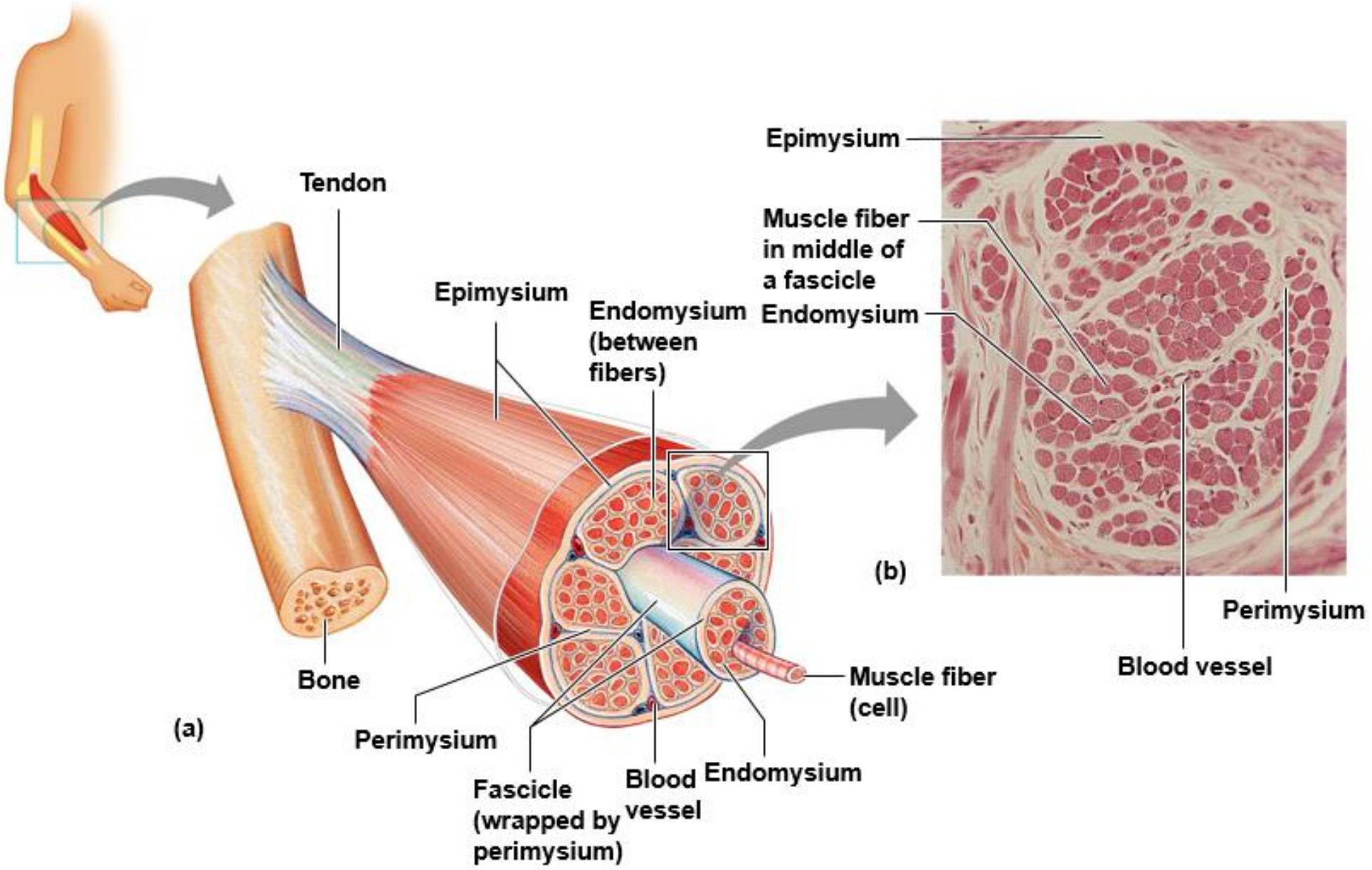

I band
A band
I band
Z disc
H zone
Z disc
M line
Part of a skeletal muscle fiber (cell)
Myofibril
Sarcolemma
Sarcolemma
Triad
Mitochondrion
Myofibrils
Tubules of sarcoplasmic reticulum
Terminal cisterna of the sarcoplasmic reticulum
T tubule

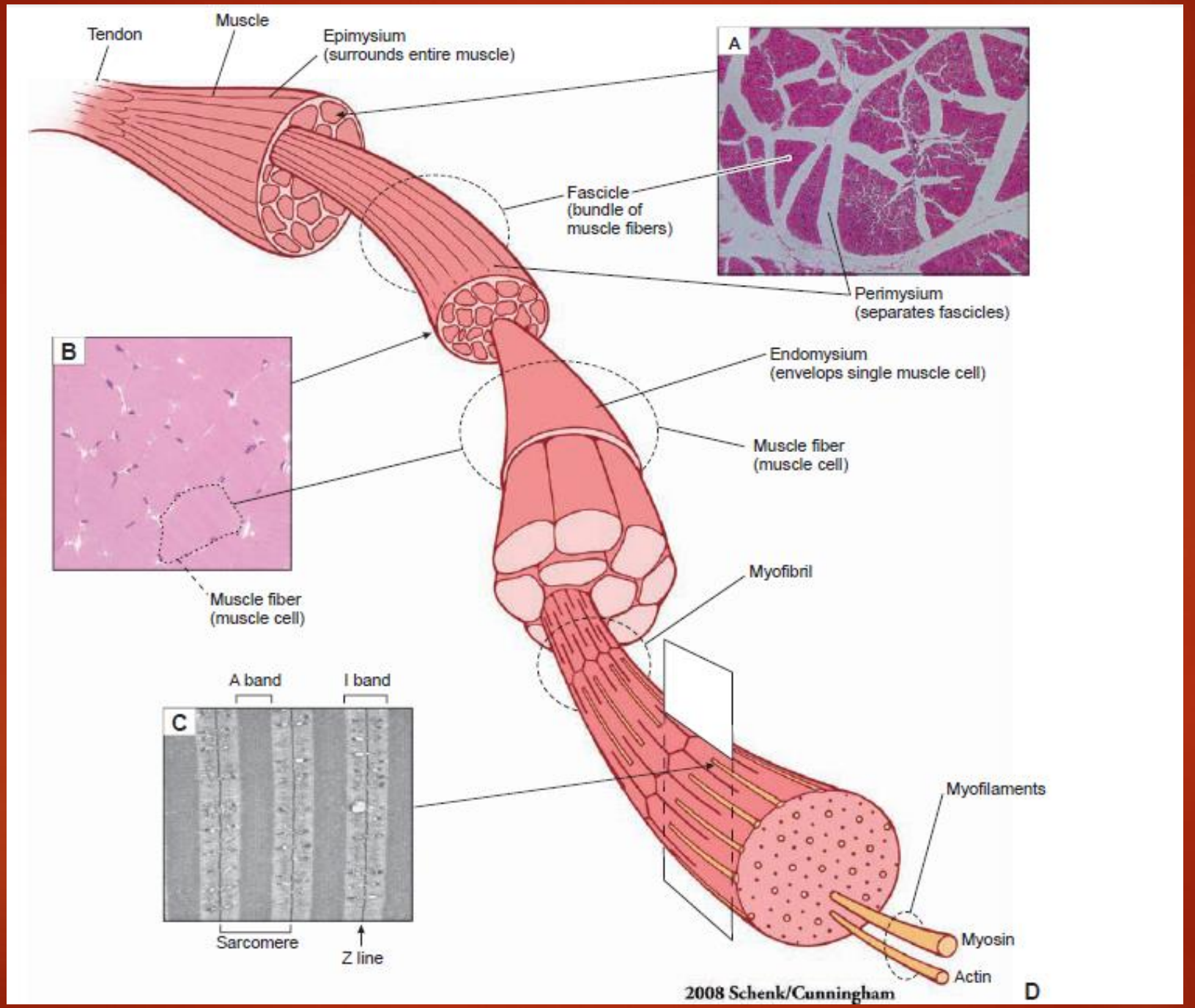

actin filament
actin
troponin
tropomyosin molecule
to Z line
myosin filament
to M line
myosin
actin filament
actin
myosin molecule
rod
heads
© 2011 Encyclopædia Britannica, Inc.

Role of Calcium (Ca^{2+}) in Contraction

- At low intracellular Ca^{2+} concentration:
  - Tropomyosin blocks the active sites on actin
  - Myosin heads cannot attach to actin
  - Muscle fiber relaxes




Tendon
Epimysium
Endomysium (between fibers)
Bone
(a)
Perimysium
Fascicle (wrapped by perimysium)
Blood vessel
Endomysium
Muscle fiber (cell)
Epimysium
Muscle fiber in middle of a fascicle
Endomysium
(b)
Perimysium
Blood vessel


Tendon
Muscle
Epimysium
(surrounds entire muscle)
A
Fascicle
(bundle of
muscle fibers)
Perimysium
(separates fascicles)
B
Endomysium
(envelops single muscle cell)
Muscle fiber
(muscle cell)
Myofibril
Muscle fiber
(muscle cell)
A band
I band
C
Myofilaments
Sarcomere
Z line
Myosin
Actin
2008 Schenk/Cunningham
D

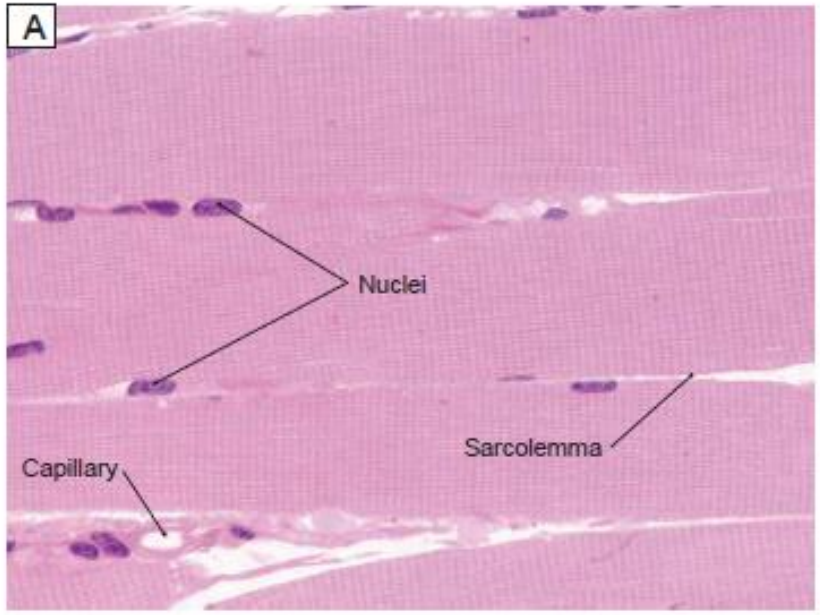


Figure 6-3A. Longitudinal section of striated muscle. H&E, ×400

The cellular units of skeletal muscle are called **muscle fibers**. Each fiber is a long, roughly cylindrical cell bounded by a plasma membrane, the **sarcolemma**. Muscle fibers range from 10 to 100 µm in diameter and may be many centimeters in length in mature muscles. This large size presents a problem for a single cell nucleus serving far distant cytoplasm and cell membrane. In skeletal muscle, this problem is solved by the formation of a **syncytium**, resulting from the fusion of several **myoblasts**, during development. A single muscle fiber will therefore have many nuclei. A distinctive feature of skeletal muscle, visible in this section, is a repeating pattern of dark and light bands oriented at right angles to the length of the fiber. These bands are designated **A bands** and **I bands** (see Fig. 6-4A). Capillaries and myelinated nerve fibers are often observed in sections of skeletal muscle tissue.

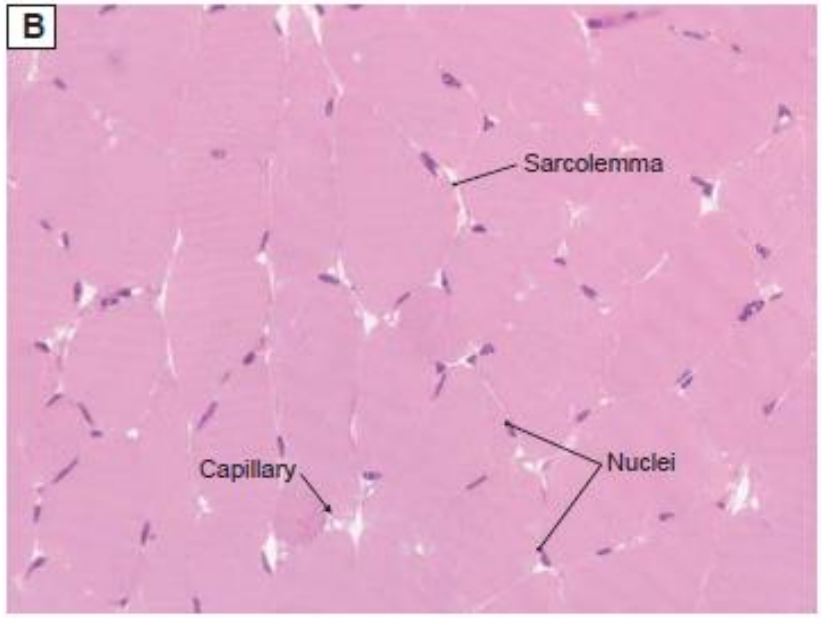
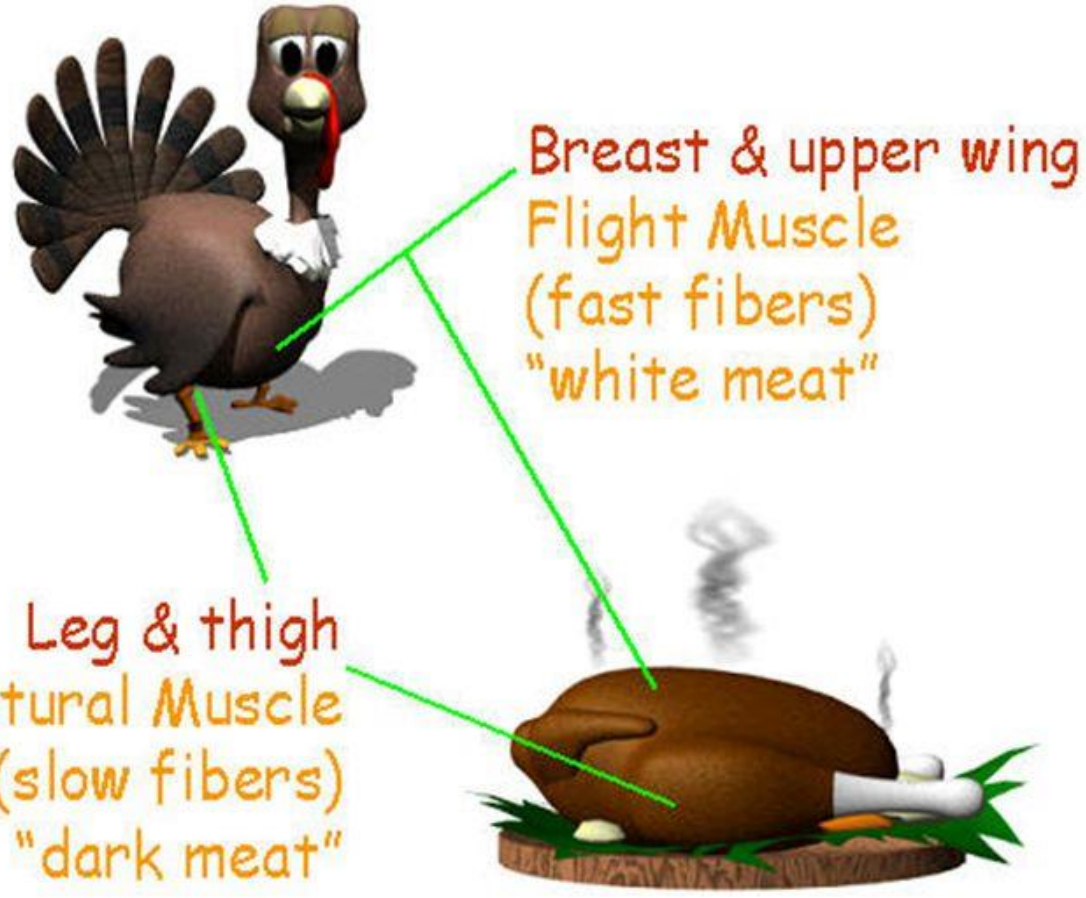


Figure 6-3B. Transverse section of skeletal muscle (tongue). H&E, ×272

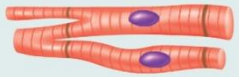
Muscle fibers in the tongue run in several different directions, so, although most fibers in this section are cut transversely (in cross section), some are cut diagonally. Skeletal muscle fibers are round or polygonal in cross section, and, in a normal muscle, the fiber diameter is relatively uniform. The nuclei are flattened and lie peripherally in each fiber, just beneath the **sarcolemma**.

White versus Red Muscle Fibers



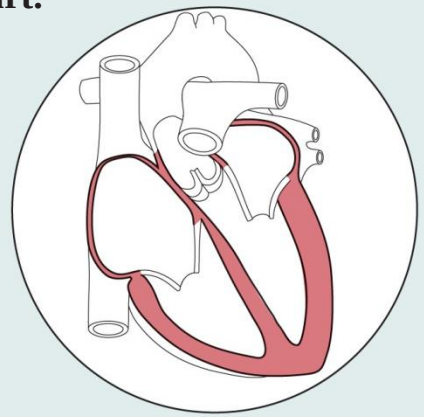
Cardiac muscle

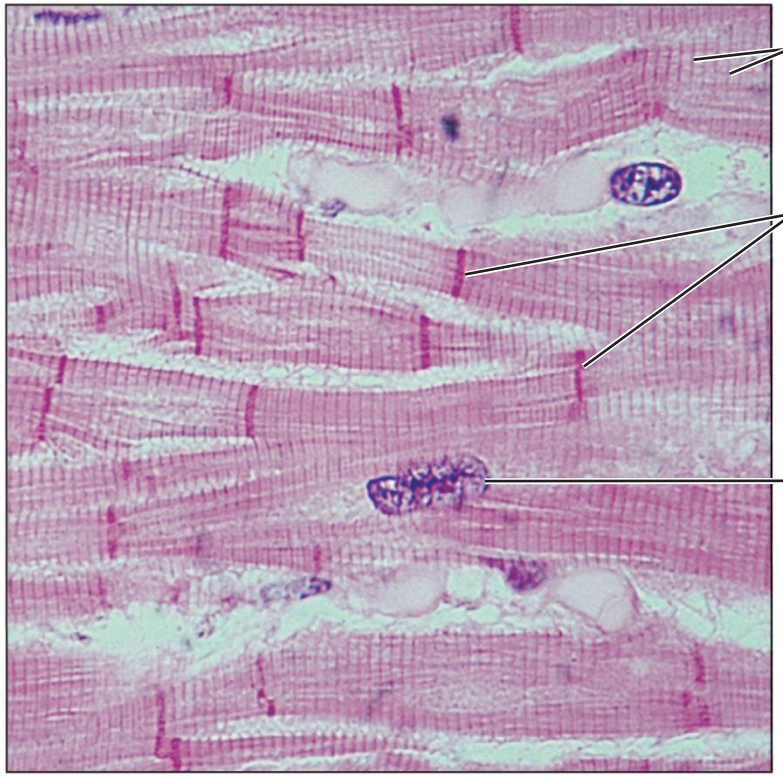
Description: Branching, striated, generally uninucleate cells that interdigitate at specialized junctions (intercalated discs).



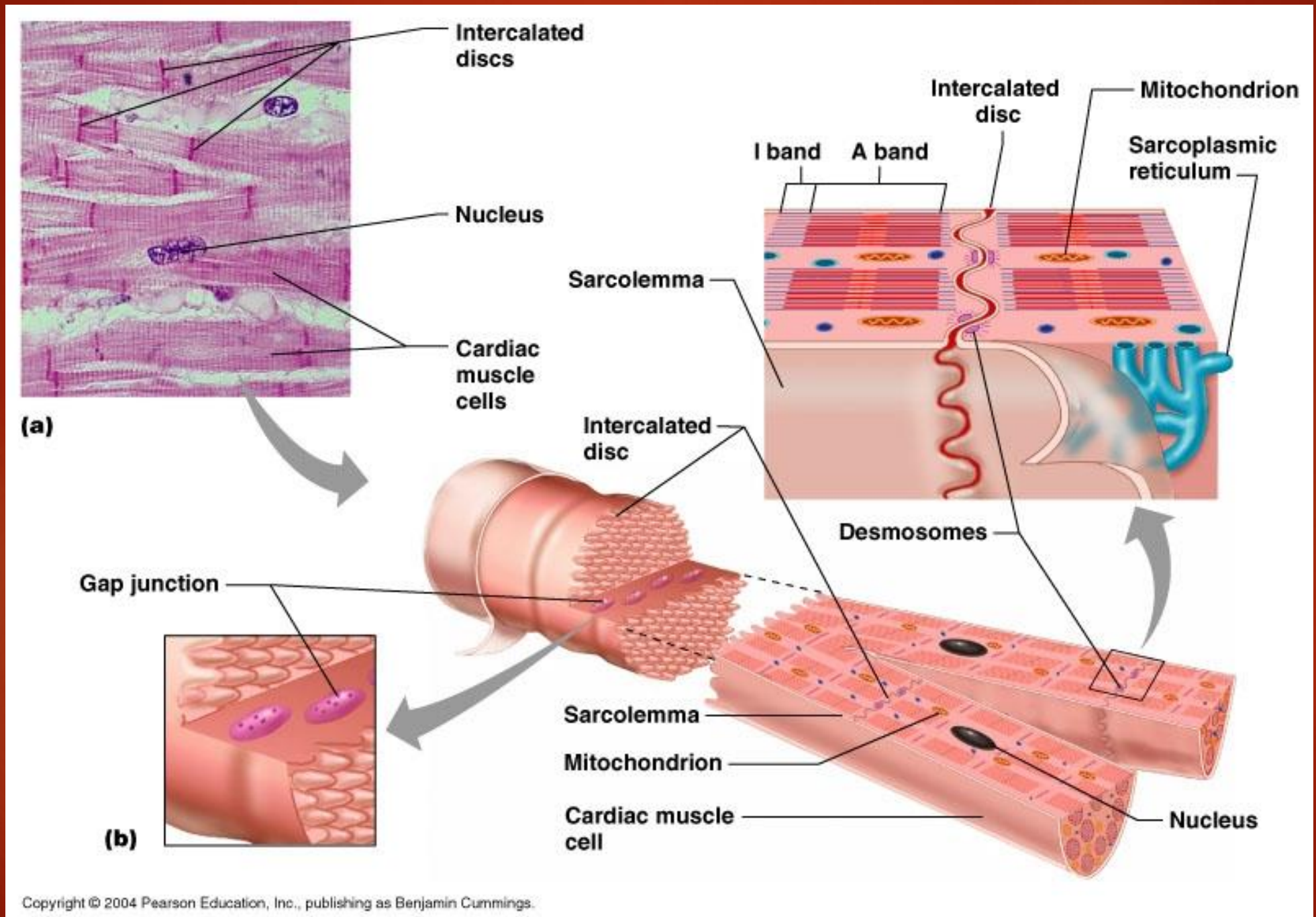
Function: As it contracts, it propels blood into the circulation; involuntary control.

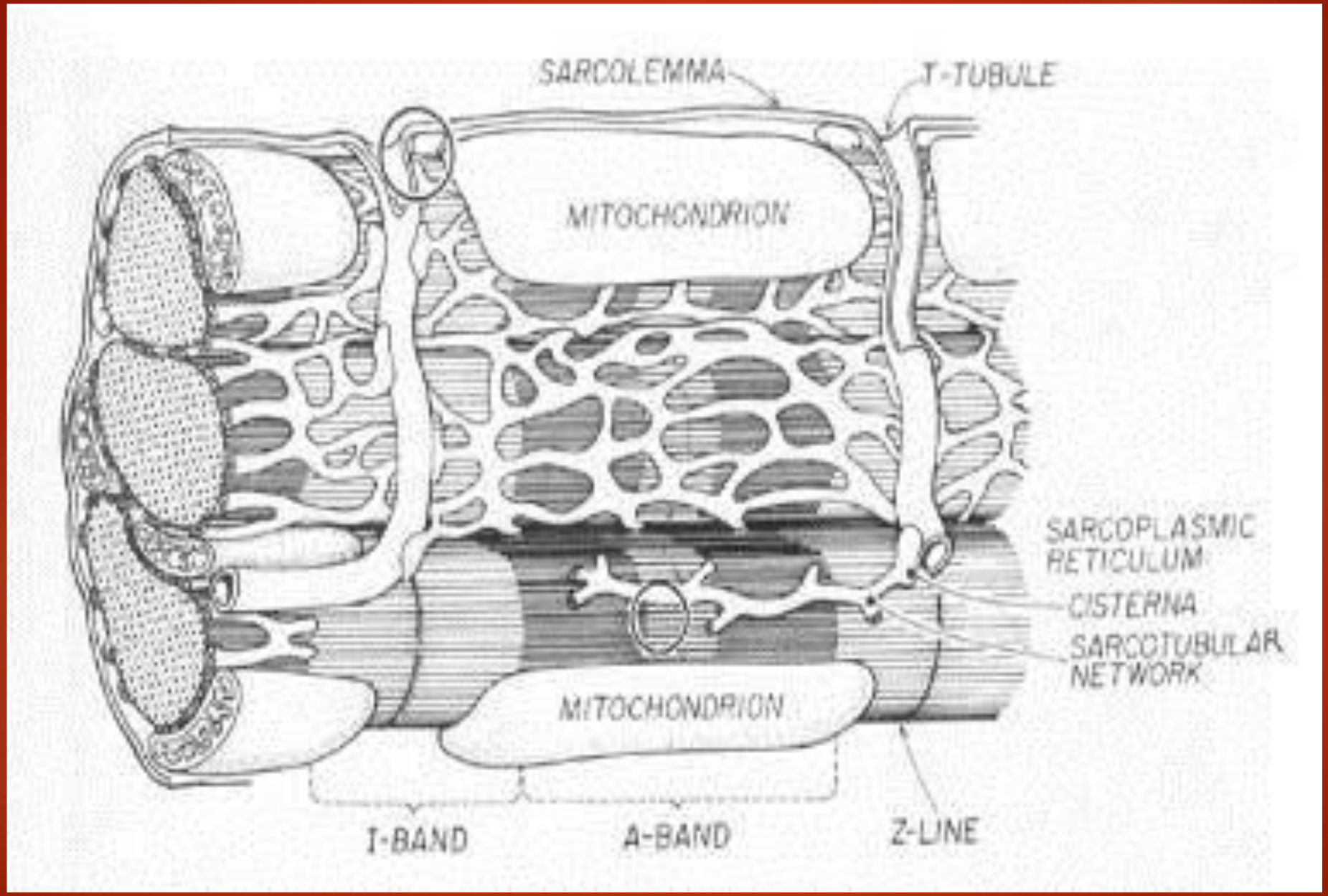
Location: The walls of the heart.





Photomicrograph: Cardiac muscle (500X); notice the striations, branching of cells, and the intercalated discs.




SARCOLEMMA
T-TUBULE
MITOCHONDRION
SARCOPLASMIC RETICULUM
CISTERNA
SARCOTUBULAR NETWORK
MITOCHONDRION
I-BAND
A-BAND
Z-LINE

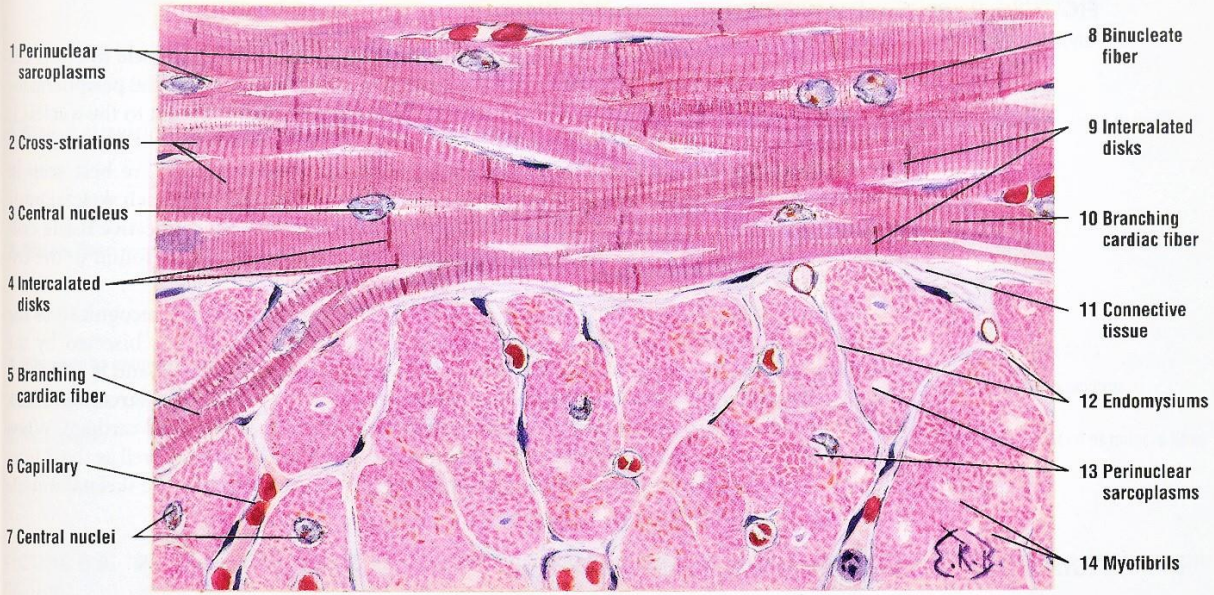


FIGURE 6.7 ■ Cardiac muscle (longitudinal and transverse sections). Stain: hematoxylin and eosin. High magnification.

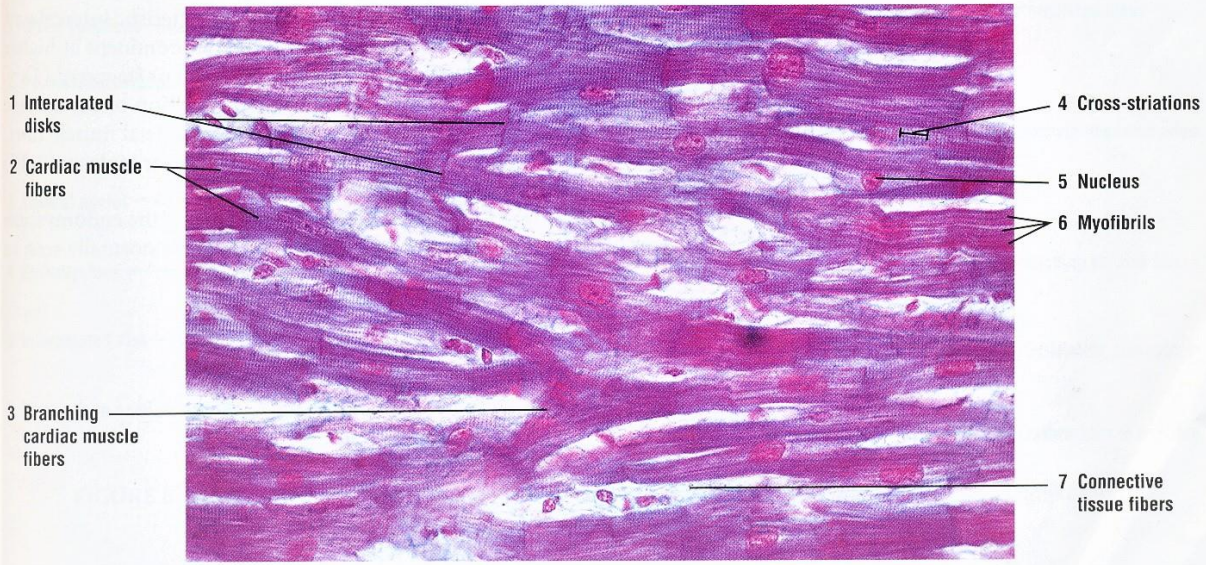


FIGURE 6.8 ■ Cardiac muscle (longitudinal section). Stain: Masson's trichrome. 130×

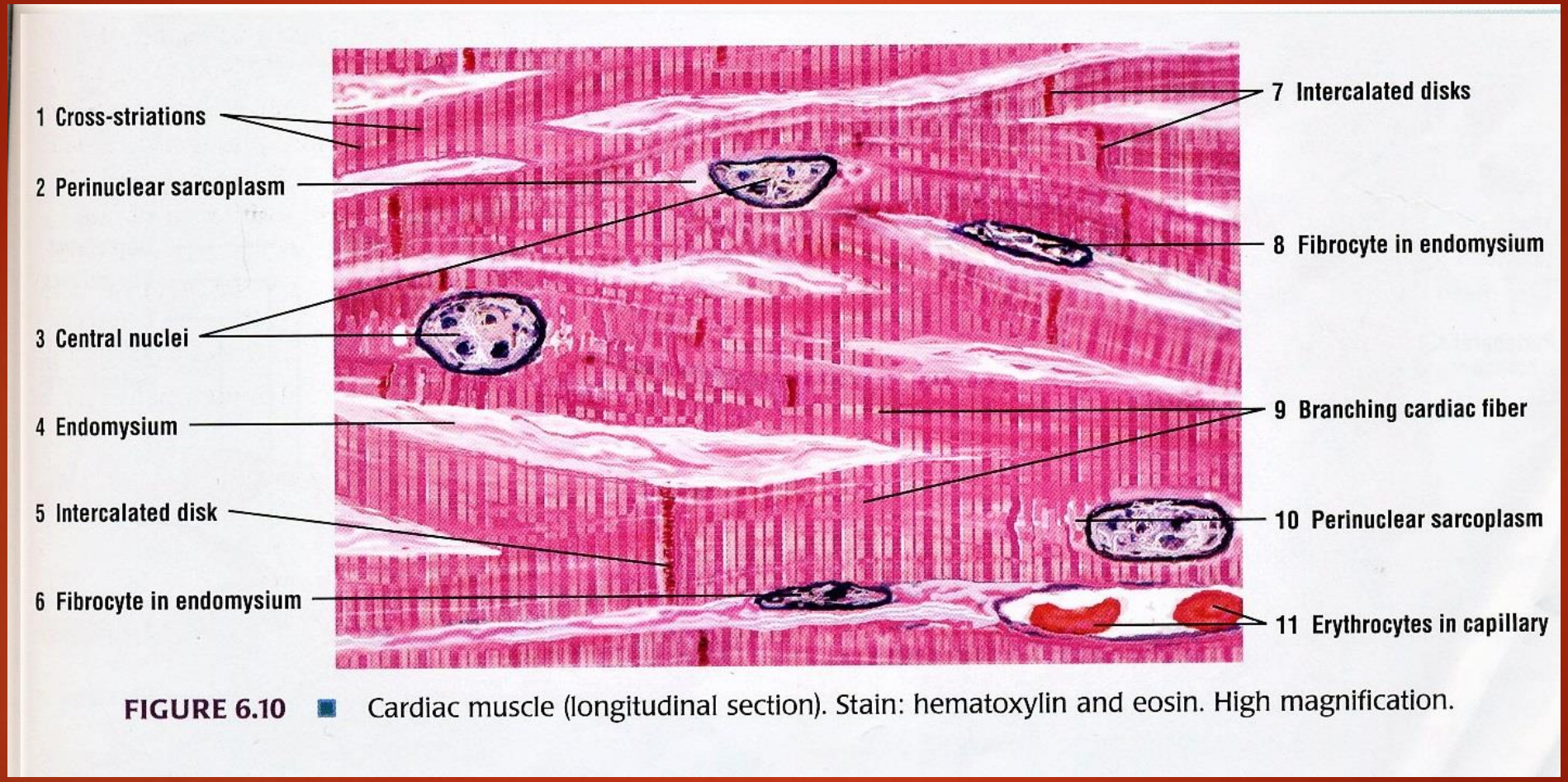


FIGURE 6.10 ■ Cardiac muscle (longitudinal section). Stain: hematoxylin and eosin. High magnification.

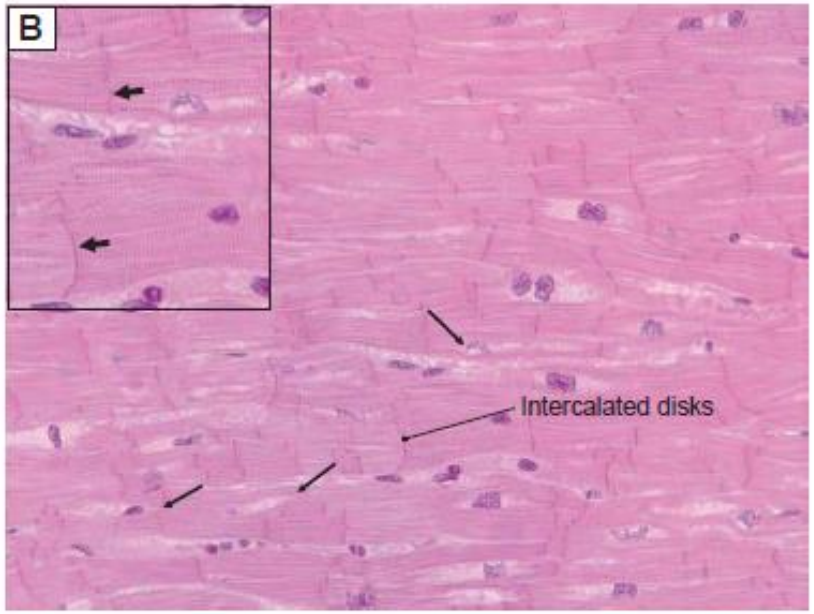


Figure 6-8B. Cardiac muscle, longitudinal section. H&E, ×272; inset ×418

Cardiac muscle is like skeletal muscle in that it is **striated**. Actin and myosin filaments are arranged into sarcomeres, with A bands, I bands, H bands, and Z lines (see Fig. 6-9). However, cardiac muscle is different in several respects. Actin and myosin filaments are not arranged in discrete myofibrils. **Cardiac muscle fibers** are much shorter than skeletal muscle fibers and typically split into two or more branches (*thin arrows*). The branches are joined, end to end, by **intercalated disks** (*thick arrows in inset*) and form a meshwork of muscle fibers. Each fiber has a single, centrally located nucleus. Cardiac muscle tissue is highly vascularized and contains many more mitochondria than other muscle types, owing to its constant activity and resulting high metabolic requirements.

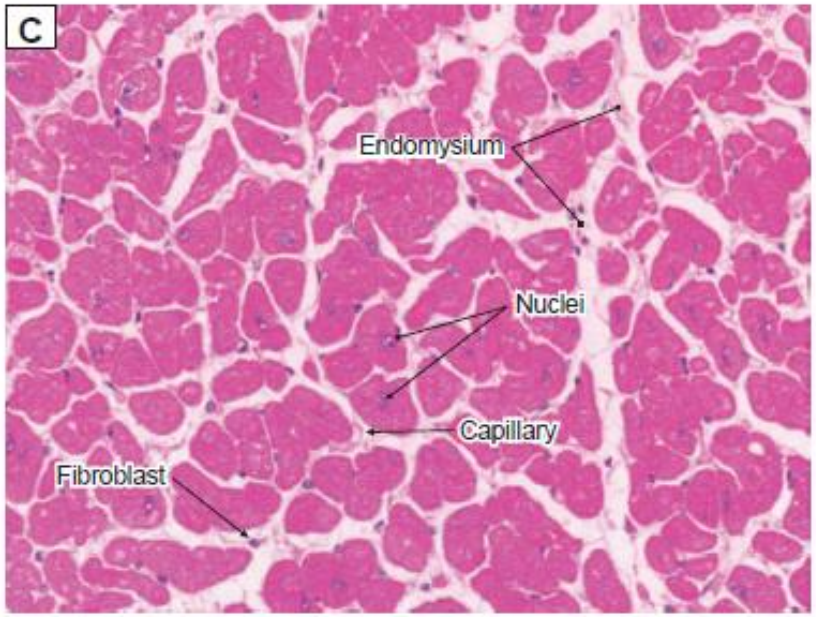
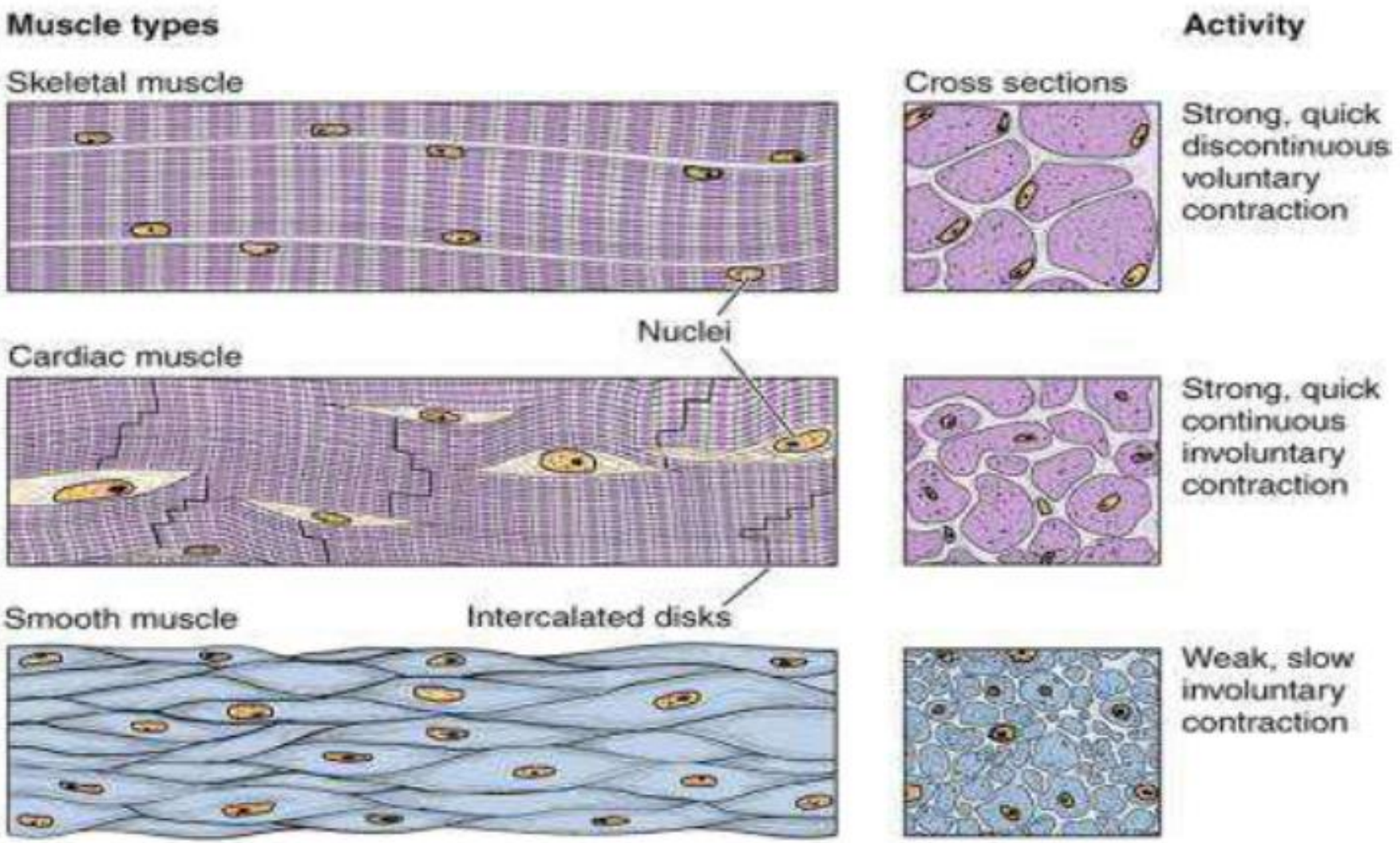


Figure 6-8C. Cardiac muscle, transverse section. H&E, ×272; inset ×418

Cardiac muscle fibers (**myocytes**) are elliptical or lobulated in transverse section. Each fiber has a single nucleus, which is irregular in shape and centrally located in the fiber. Many **capillaries** traverse the tissue, and the **endomysium** is typically more prominent than in skeletal muscle. The *inset* shows nuclei of myocytes and **fibroblasts** at higher power, with a capillary in the lower right quadrant (*arrow*).

TABLE 6-1 Muscle Characteristics

Features	Skeletal Muscle	Cardiac Muscle	Smooth Muscle
Striations	Yes	Yes	No
Fibers	Long, cylindrical, unbranched	Short, branched, anastomosing	Short, spindle shaped
Nuclei	Multiple, peripheral in cell	Single, central in cell	Single, central in cell
Cell junctions	No	Intercalated disks	Gap (nexus) junctions
T tubules	Well developed	Well developed	No
Sarcoplasmic reticulum	Highly developed; has terminal cisterns	Less well developed; small cisterns	Present, but poorly developed
Regeneration	Yes, satellite cells	No	Yes, mitosis
Contraction	Initiated by nerve action potential	Spontaneous; pacemaker system; modulated by nervous system and hormones	Spontaneous; modulated by nervous system and hormones
Main function	Voluntary movement of limbs, digits, face, tongue, and other muscles	Involuntary rhythmic contractions; pumps blood to muscles and organs; modulated by physiological and emotional factors	Involuntary control of blood vessel diameter, gut peristalsis, uterine contractions during childbirth, airway diameter, and others


Muscle types
Activity
Skeletal muscle
Cross sections
Strong, quick discontinuous voluntary contraction
Nuclei
Cardiac muscle
Strong, quick continuous involuntary contraction
Intercalated disks
Smooth muscle
Weak, slow involuntary contraction


THANKS FOR YOUR NICE ATTENTION