

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

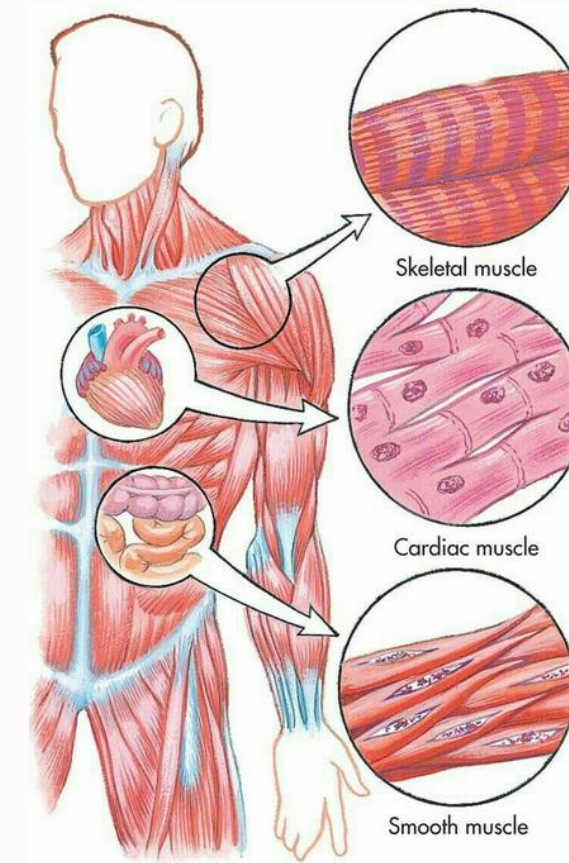


جنت

Histology | Final 9

Muscle Tissue (pt.1)

Written by : Heba Salah
Jannat Nasri

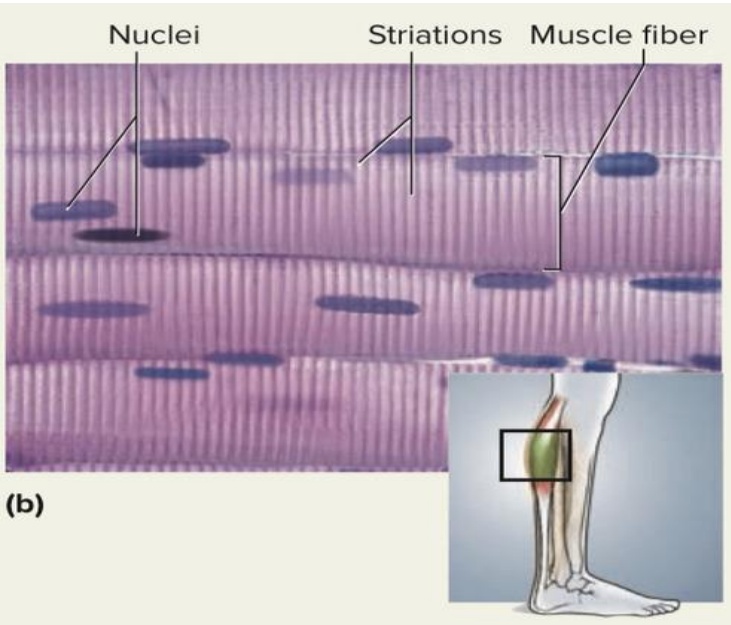


Muscle tissue

Histology

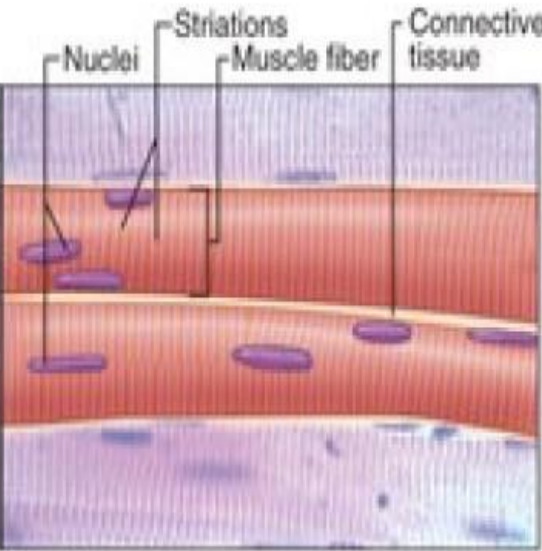
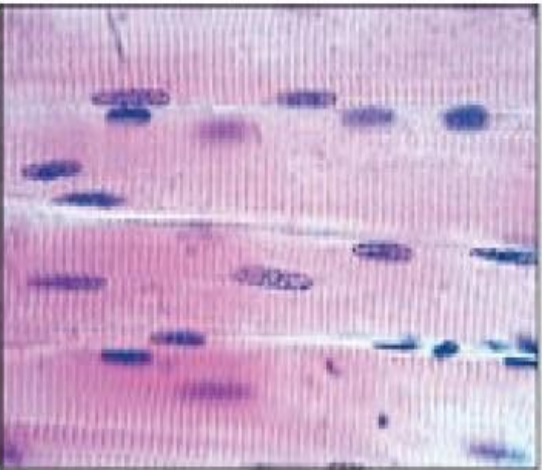
The similarity between the three types of muscle tissue is the concept of thin actin filaments overlapping with the thick ones, which are myosin. They slide past each other — this is the concept of contraction. In other words, the muscle shortens from a length of 1x to about half x, which means shortening and approximating the two attachments. This shortening results from the collective contraction of individual muscle fibers. This mechanism occurs in all three muscle types.

Type Of Muscles Tissue:

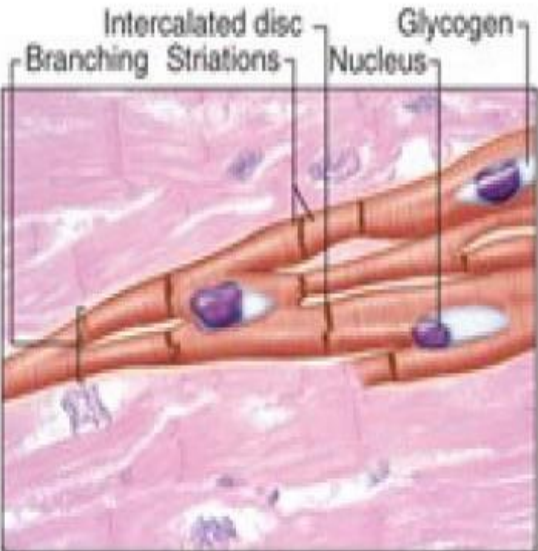


-Skeletal muscle exhibits cross-striations, not longitudinal striations. Its fibers are multinucleated, and the nuclei are not centrally located—they are positioned at the periphery, just beneath the sarcolemma.

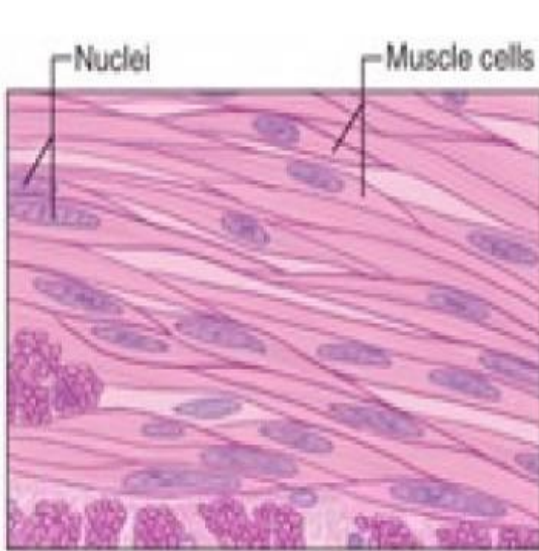
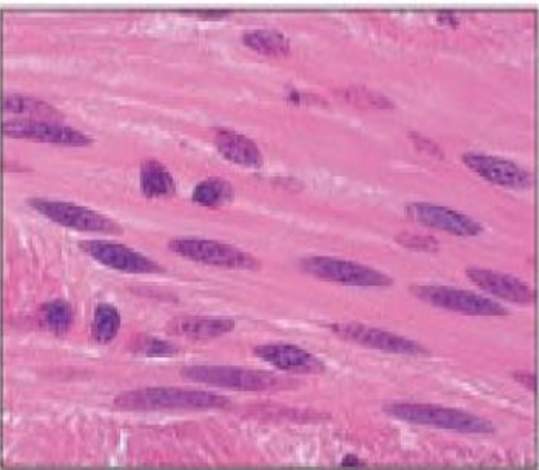
Skeletal muscle Cardiac muscles Smooth muscles.



(a) Skeletal muscle



(b) Cardiac muscle



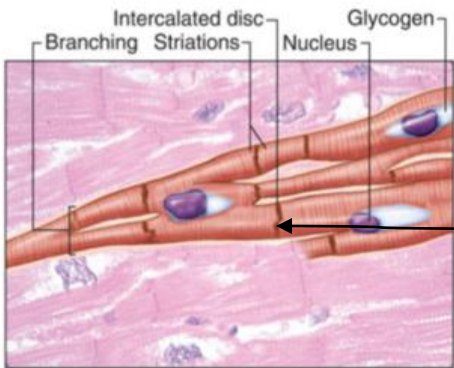
(c) Smooth muscle

-Cardiac muscles are branched. A cell does not remain isolated; it extends and connects to other cells. The structural arrangement of cardiac muscle is essential for heart function. The striations are not the same as those seen in skeletal muscle. Intercalated discs are very important for adhesion between different cardiac fibers and for communication between them. Both the intercalated discs and the type of striation are unique to cardiac muscle.

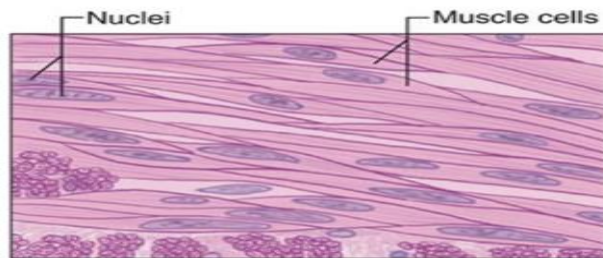
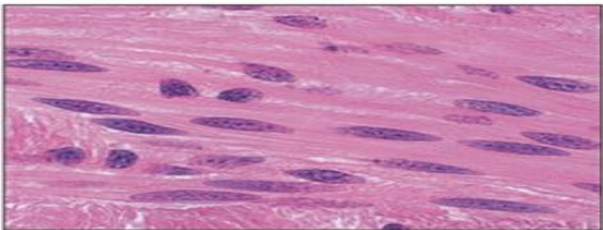
Intercalated discs are the junctions between two different cardiac muscle fibers.

- When we observe an area that is darker than the surrounding tissue, it usually means this area has more concentrated components, leading to more intense staining.

-In smooth muscles, there is no striation. They consist of many cells, usually smaller than the other two types of muscles: cardiac and skeletal. However, in the uterus during pregnancy, these cells can stretch and grow up to 500 micrometers in length. As you see, cells in smooth muscle are spindle-shaped. The nucleus occupies a large part of the cell and is located centrally (not peripherally). The nucleus also takes a shape similar to that of the cell.



These junctional complexes between the cells act like glue, helping the cells stay attached during contraction. At the same time, the cells can communicate through gap junctions, which are very important for spreading the action potential. This feature does not exist in skeletal muscle, which makes cardiac muscle different



Types

- **Skeletal muscle:** bundles of very long, multinucleated cells with cross-striations. Their contraction is quick, forceful, and usually under voluntary control.
- **Cardiac muscle:** cross-striated and is composed of elongated (often branched) cells bound to one another at structures called intercalated discs (unique). Contraction is involuntary, vigorous, and rhythmic.
- **Smooth muscle:** consist of collection of fusiform cells that lack striations and have slow, involuntary contractions.

The three types of muscle tissue differ in their innervation:

- Skeletal muscle is innervated by somatic motor nerves.
- Cardiac muscle is innervated by the autonomic nervous system, including both sympathetic and parasympathetic fibers.
- Smooth muscle is also innervated by the autonomic nervous system, with sympathetic and parasympathetic input depending on the organ and function.

We added another unique feature to cardiac muscle. These muscle fibers can contract on their own, without the aid of the Autonomic Nervous System (ANS). However, we need the ANS to increase or decrease the heart rate—in other words, to increase or decrease the frequency of contraction. Not all of the muscle fibers contract at the same time. There is what we call the SA node, which initiates contraction by undergoing spontaneous depolarization and repolarization, then transmits the action potential to other cells through gap junctions. This generates the normal heart rate, but it is not left entirely on its own, as the ANS regulates it.

Skeletal Muscle development

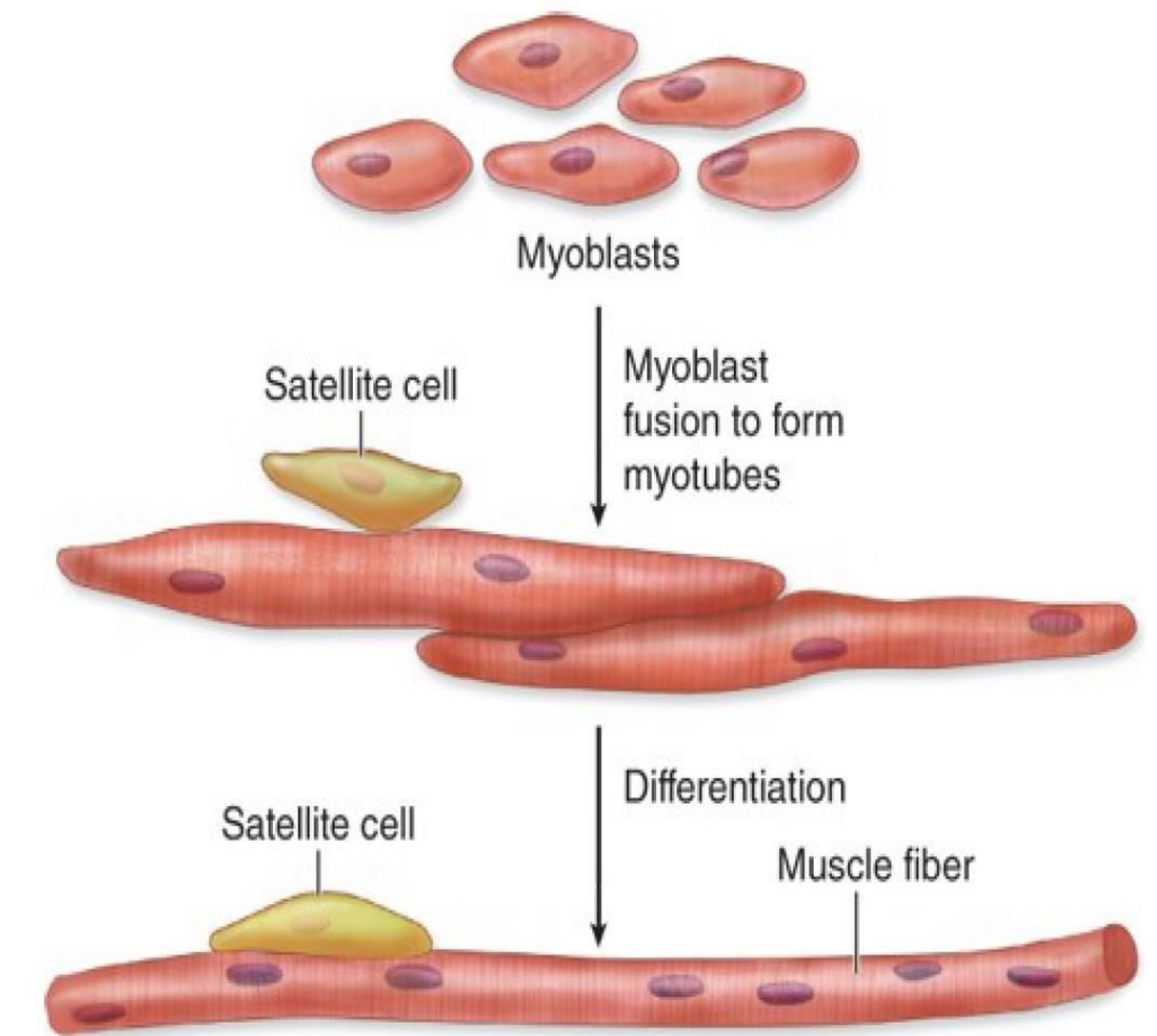
Skeletal (or striated) muscle:

- Long, cylindrical multinucleated cells (10-100 μm diameter).
- Mesenchymal myoblasts--fuse--myotube--differentiate--striated muscle fibers.

The term 'muscle fiber' is more accurate than 'muscle cell' when referring to skeletal muscle, because it results from the fusion of many myoblasts during development. This fusion leads to the formation of a long, multinucleated fiber.

- Satellite cells: A small population of reserve progenitor cells of muscle tissue.

Satellite cells are very important for regeneration and repair. As you see in the adjacent pictures, they show just one of them, and this makes sense, as their number isn't large. There is a much higher number of satellite cells in children. In middle-aged individuals, the number is approximately 50–50. In elderly people, the number is much lower. This means fewer of them are present as age advances. If there is minor damage, it might be corrected by the presence of these satellite cells. But in massive damage, unfortunately, this will not do. In other words, after a severe accident, if the person's muscles are damaged, these muscles won't divide and compensate. So this is corrected by fibrous tissue, or what is called scar tissue, as fibroblasts are ready to synthesize, proliferate easily, release collagen, and fill in the gaps. Unfortunately, there will be a significant loss of muscle function.



Source: Anthony L. Mescher: Junqueira's Basic Histology: Text and Atlas, 15th Edition. Copyright © McGraw-Hill Education. All rights reserved.

Fibroblasts, chondroblasts, osteoblasts, and myoblasts all have the same genetic material. The idea is which genes are upregulated and turned on, producing mRNA copies that go to the cytoplasm and give different products. Externally, we see them the same, but internally they are different. Structurally and genetically they are the same, but functionally they are not.

Organization of skeletal muscle

Connective tissue is very important in covering and supporting muscle. It works as a platform for muscle fibers, as it covers and organizes them. Also, the connection between muscle and bone — the tendon — is made of connective tissue.

Muscle tissue are organized by connective tissue:

- **Epimysium**

External sheath of dense irregular connective tissue. Carries vessels, nerves, and lymphatics

- **Perimysium**

Thin connective tissue layer that immediately surrounds each bundle of muscle fibers (fascicle)

- **Endomysium**

Very thin and delicate layer of reticular fibers/scattered fibroblasts. fibers, capillaries form a rich network

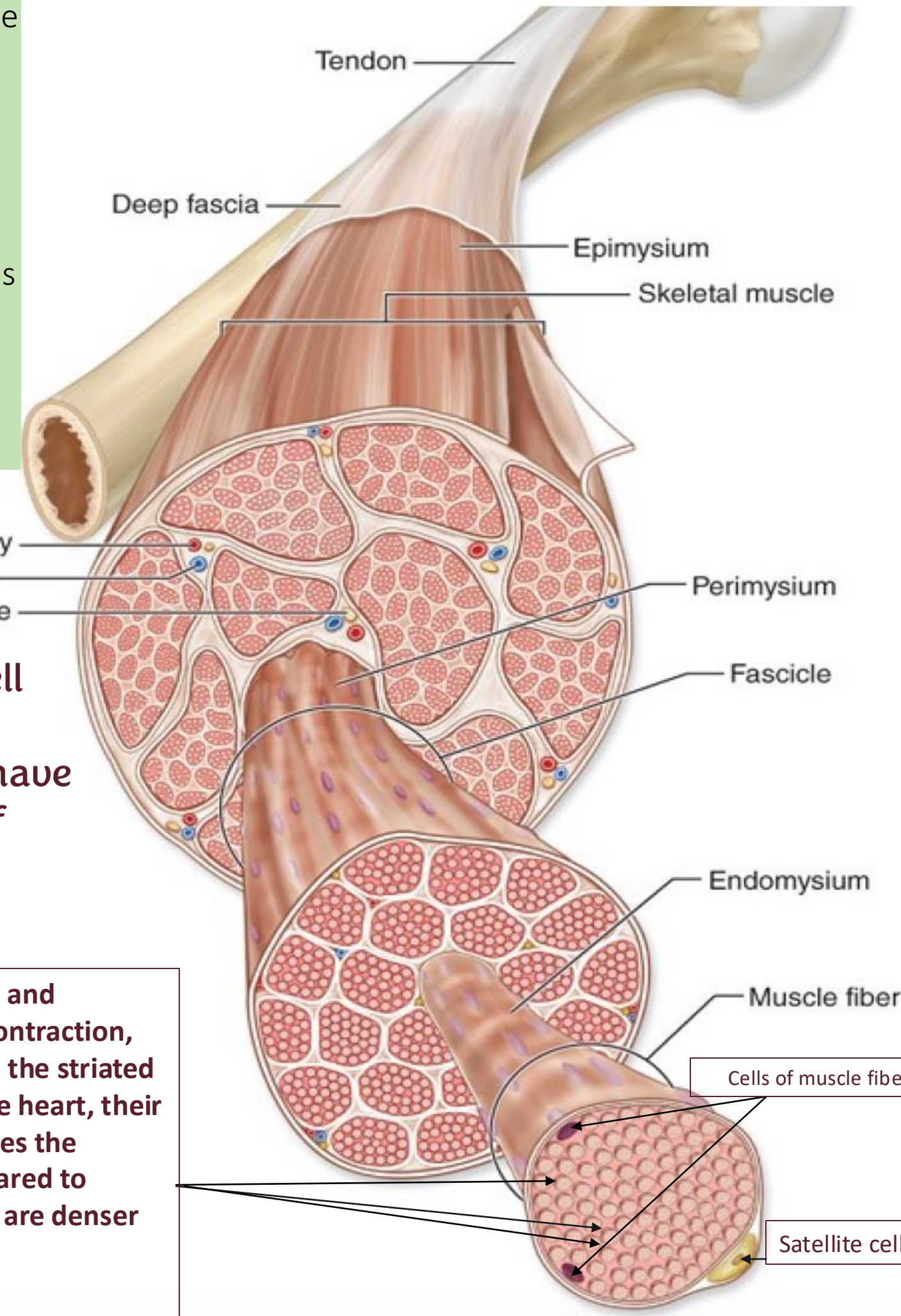
-Within the same fascicle, muscle fibers are surrounded and supported by the endomysium, which separates and organizes them.

- All three layers, plus the deep fascia (overlies the epimysium) are continuous with the connective tissue of a tendon at myotendinous junctions (join the muscle to bone, skin, or another

muscle).

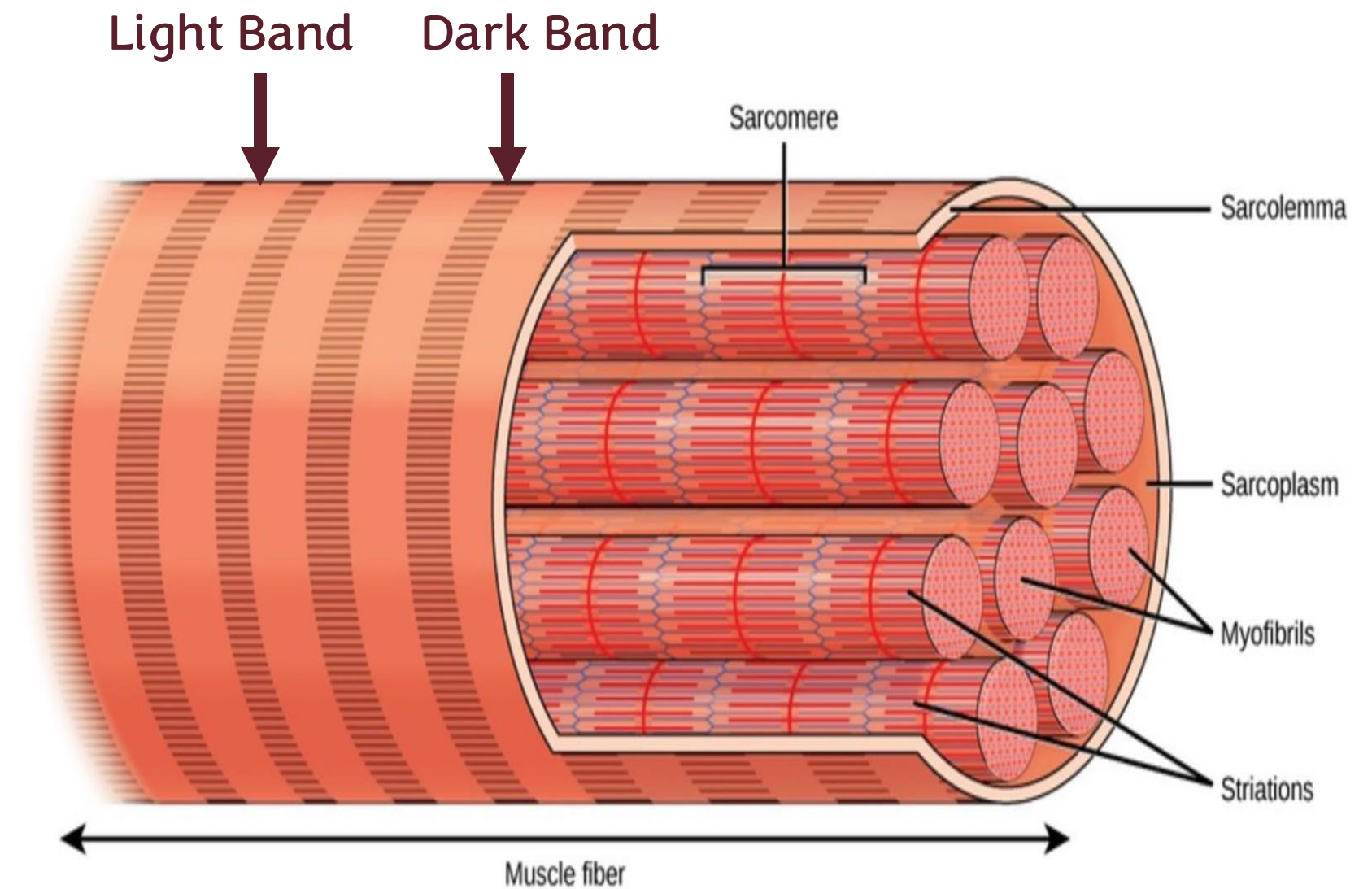
Muscles are well vascularized, meaning they have a rich supply of blood vessels.

Myofibrils are the structural and functional basis of muscle contraction, and they are responsible for the striated appearance of muscle. In the heart, their amount is lower, which makes the striations less distinct compared to skeletal muscle, where they are denser and more organized.



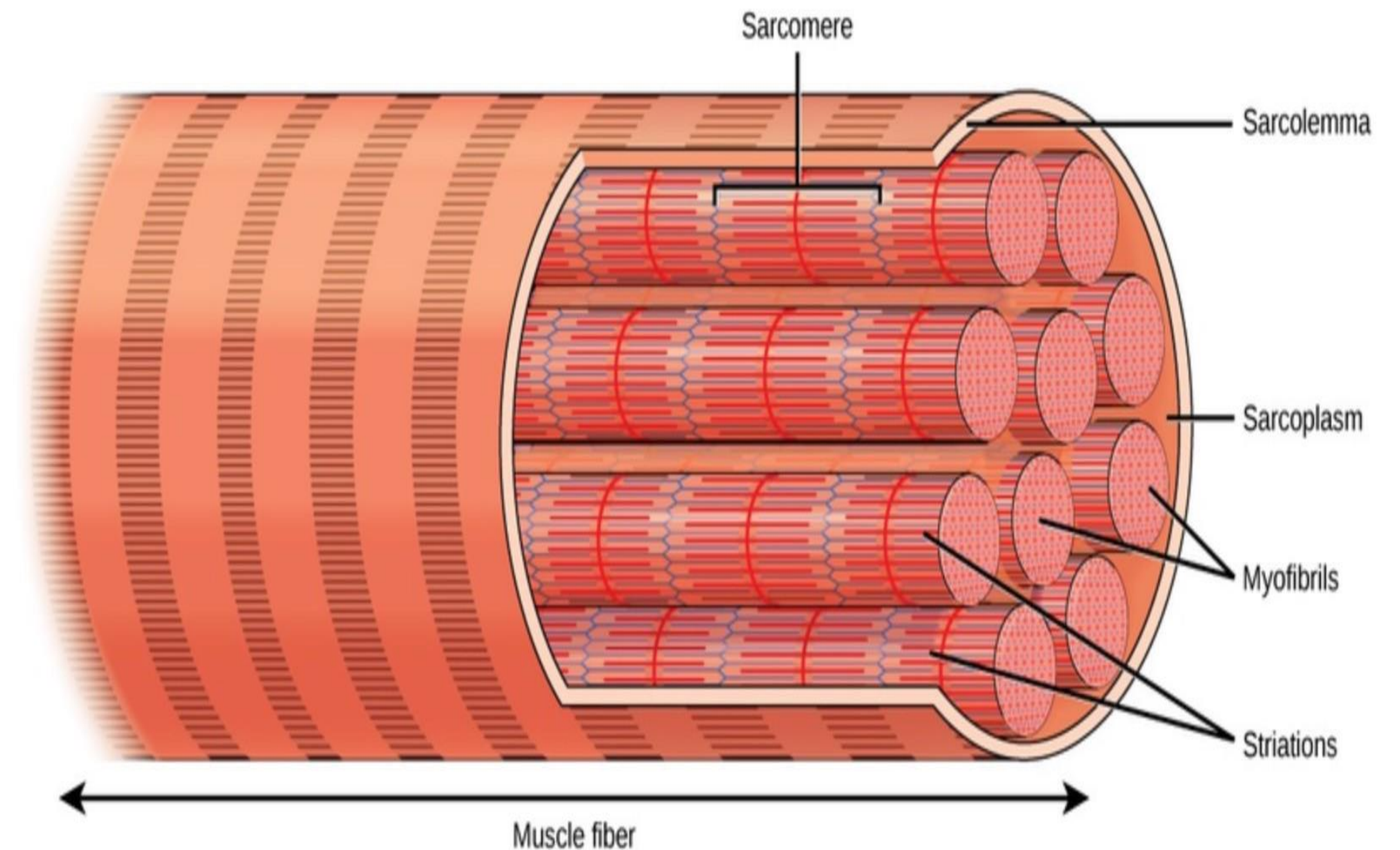
Organization Within Muscle Fibers

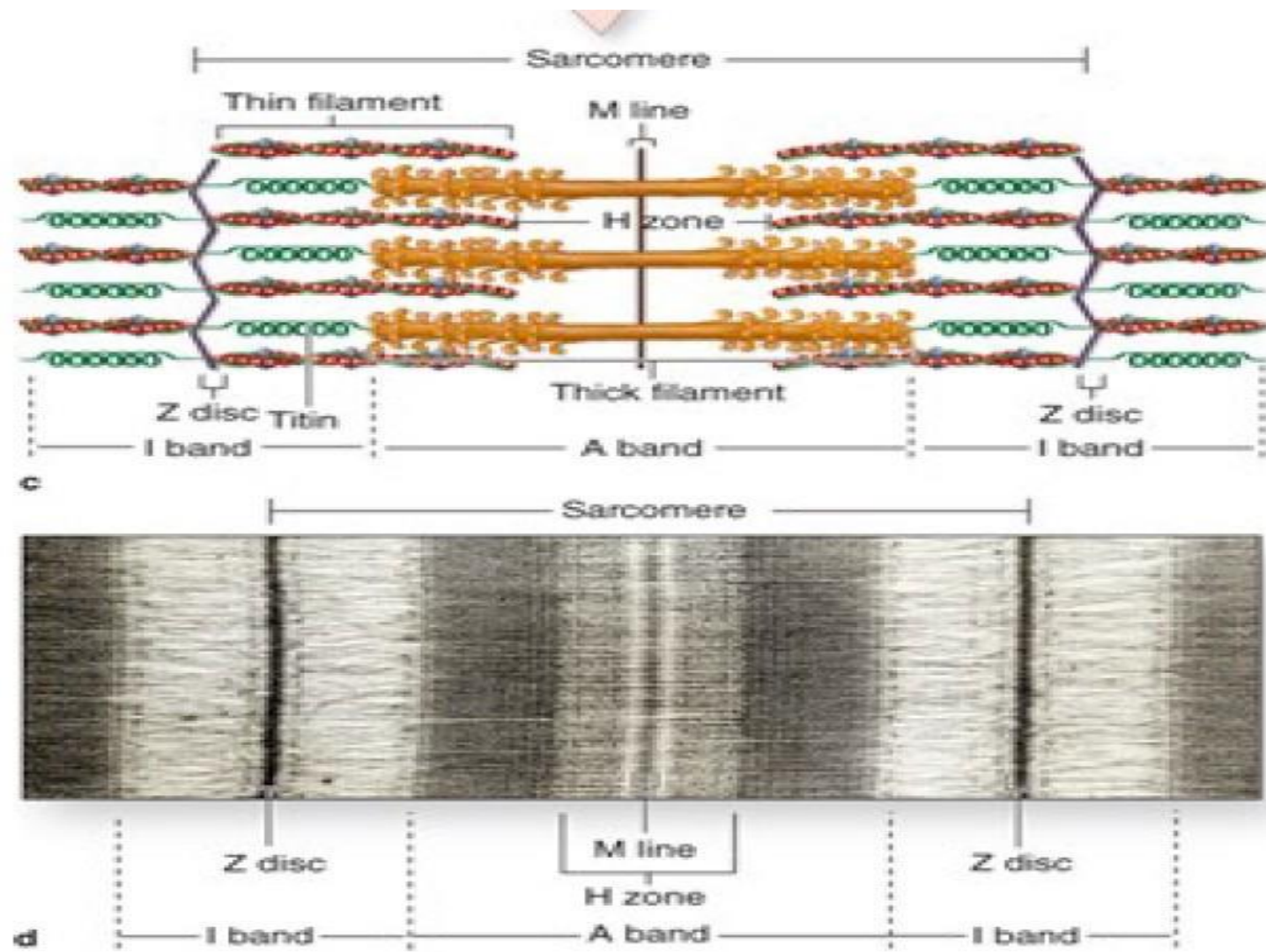
- Longitudinally, skeletal muscle fibers show striations of alternating light and dark bands
- Contains cylindrical filament bundles called myofibrils that run parallel to the long axis of the fiber
- Dark bands are called A bands ; the light bands are called I bands.
- The I band is bisected by a dark transverse line (Z disc).
- Sarcomere is the repetitive functional subunit of the contractile apparatus (extends between 2, Z discs), 2.5 μm in resting muscle.



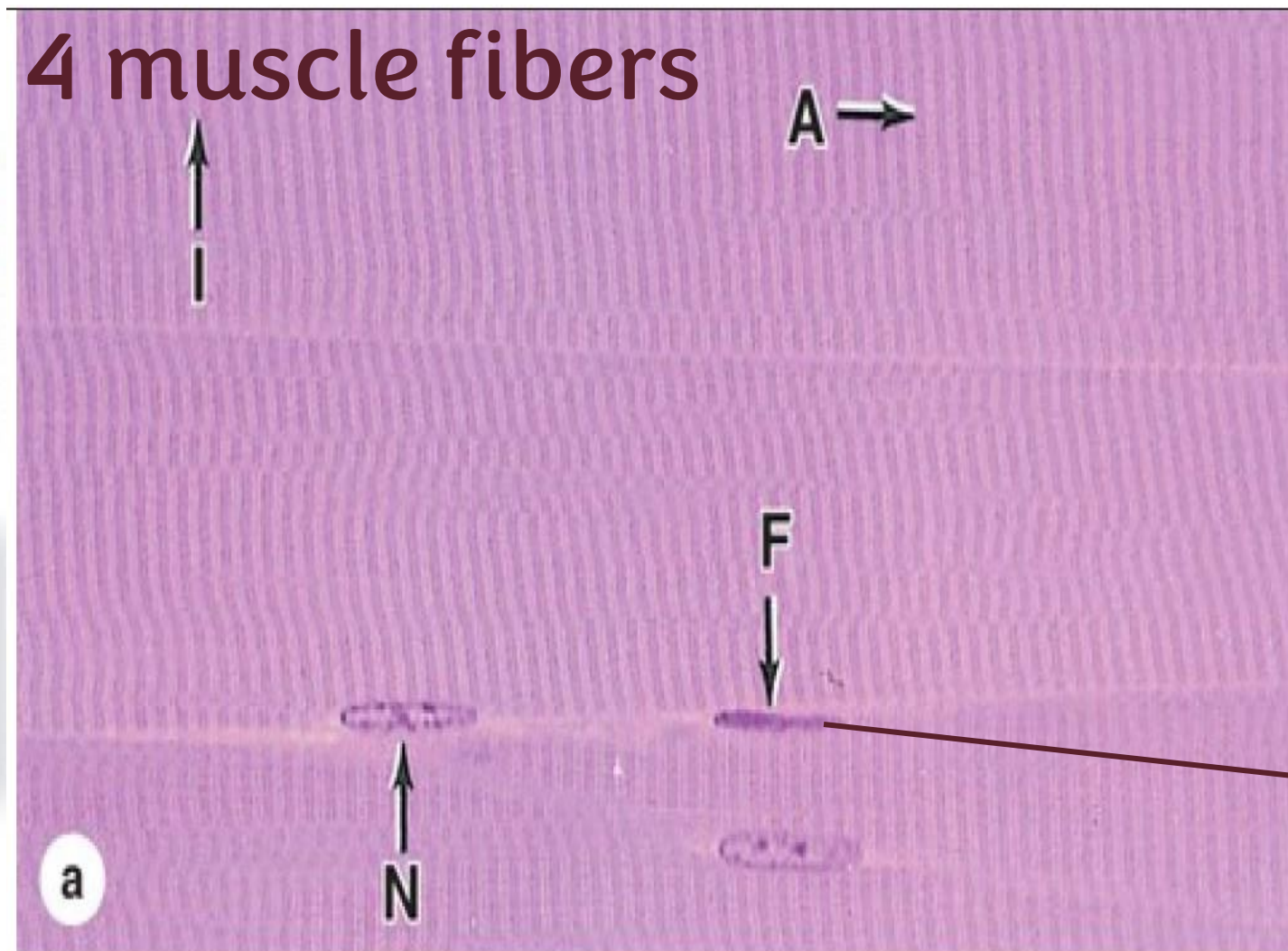
Skeletal Muscle Fiber

- Sarcomere the structure between two Z discs (each myofibril consists of a long series of sarcomeres)
- Sarcoplasm--- cytoplasm
- Sarcolemma---plasma membrane





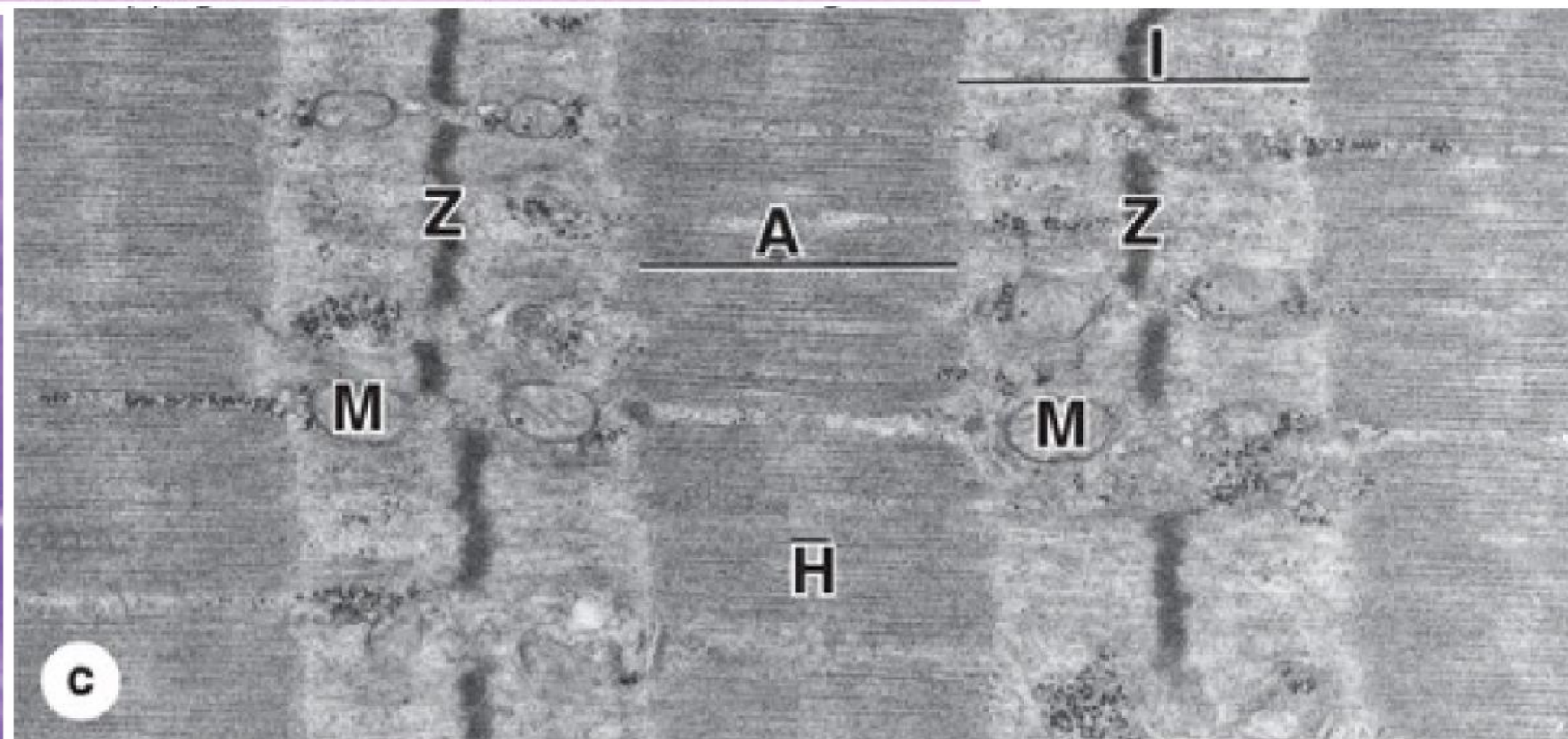
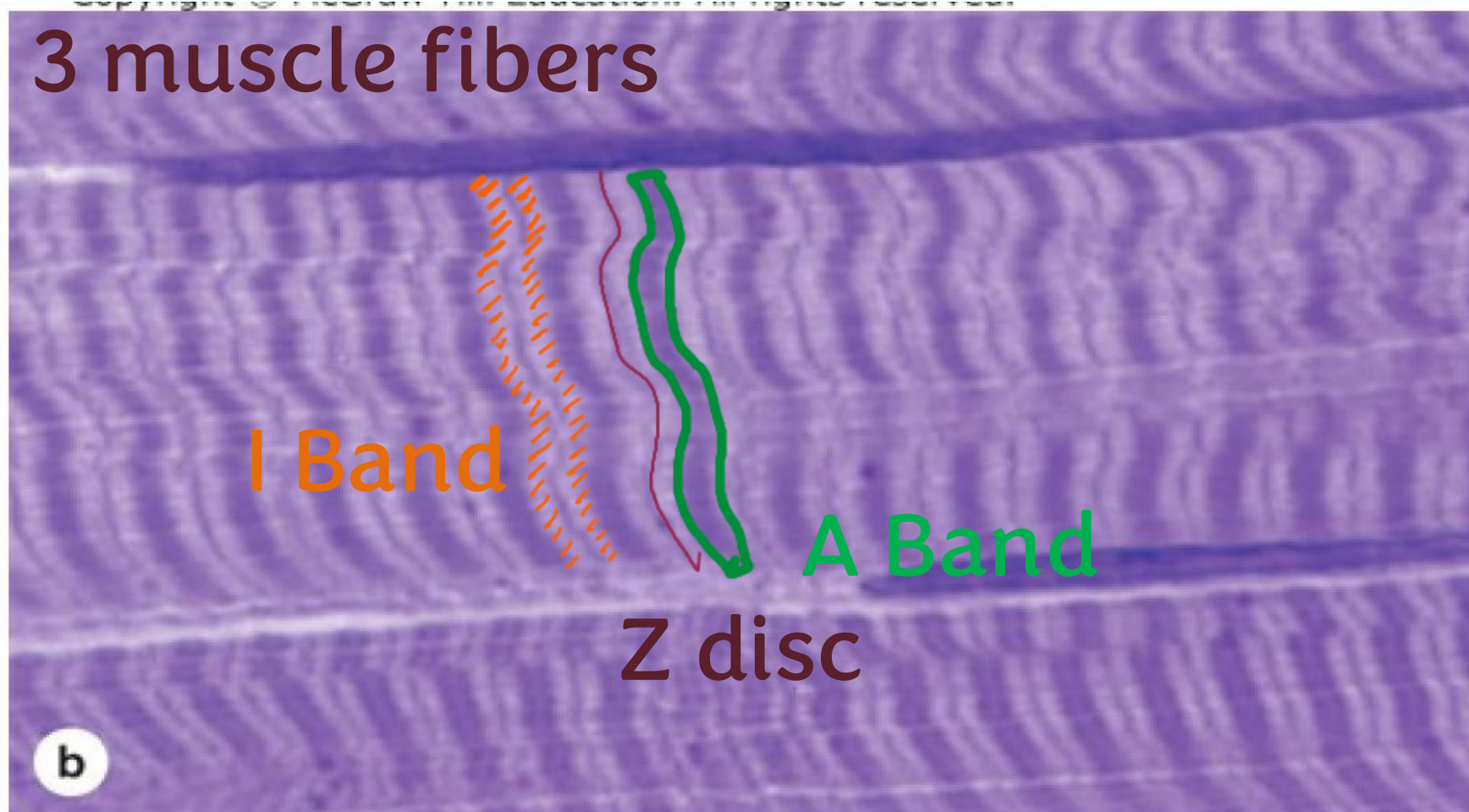
4 muscle fibers



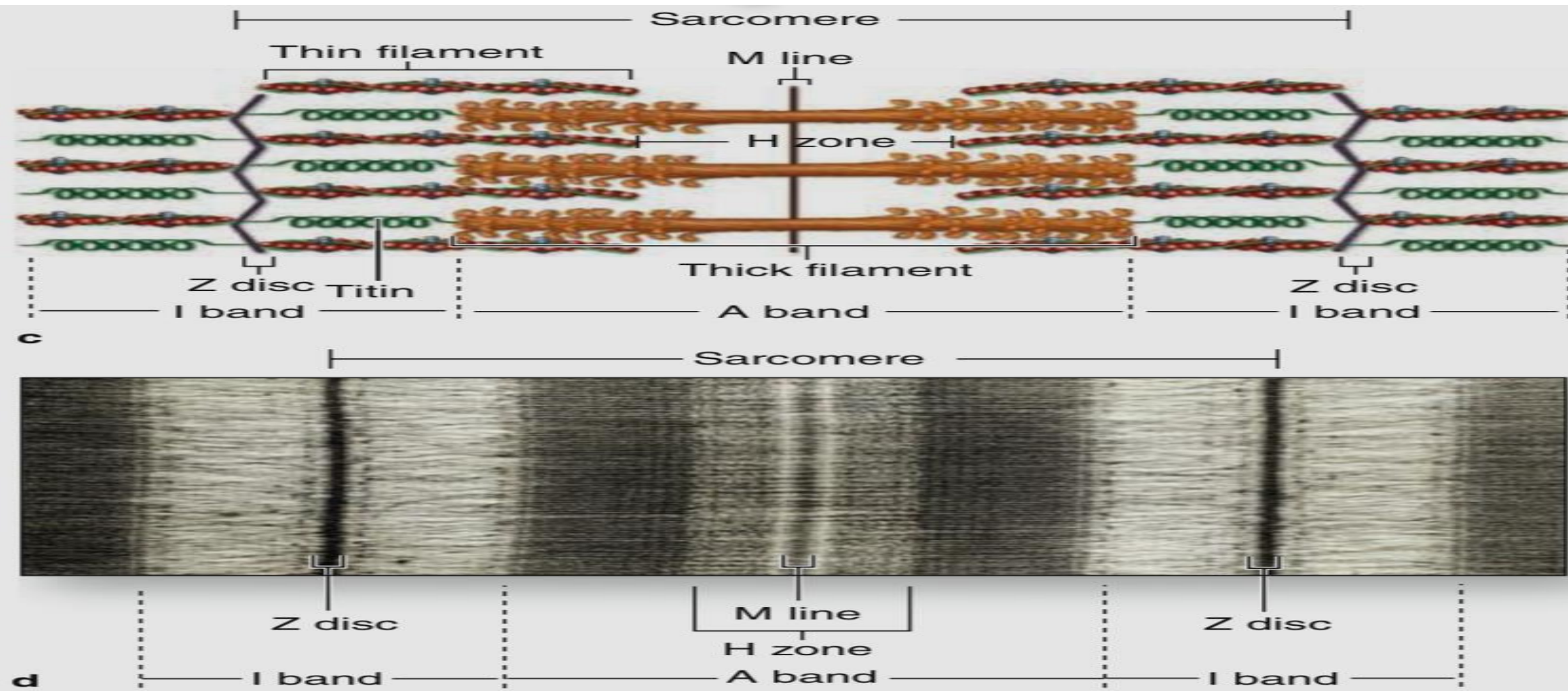
A: A Band
I: I Band
N: Nucleus of muscle fiber.
F: Nucleus of fibroblast
Z: Z disc
H: H zone
M: Mitochondria.

Fibroblasts are present to produce the endomysium.

3 muscle fibers



TEM



Thick filaments are attached indirectly to Z disc

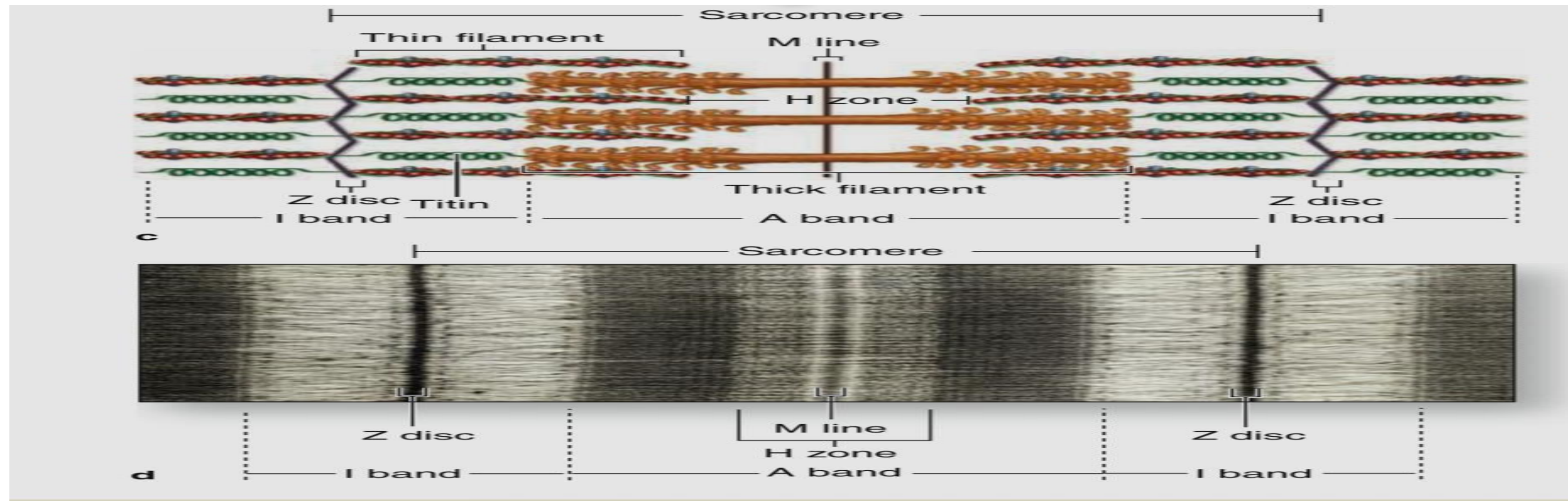
Relaxed muscle

A band: entire length of thick filaments+ overlapping thin filaments.

H zone :only thick filaments.

Sarcomere: one full A band + 2 halves of I band in both sides.

The I band is shared between two sarcomeres, with half of it located in one sarcomere and the other half in the adjacent one.



During Contraction:

The I band will shorten

The A band will remain the same

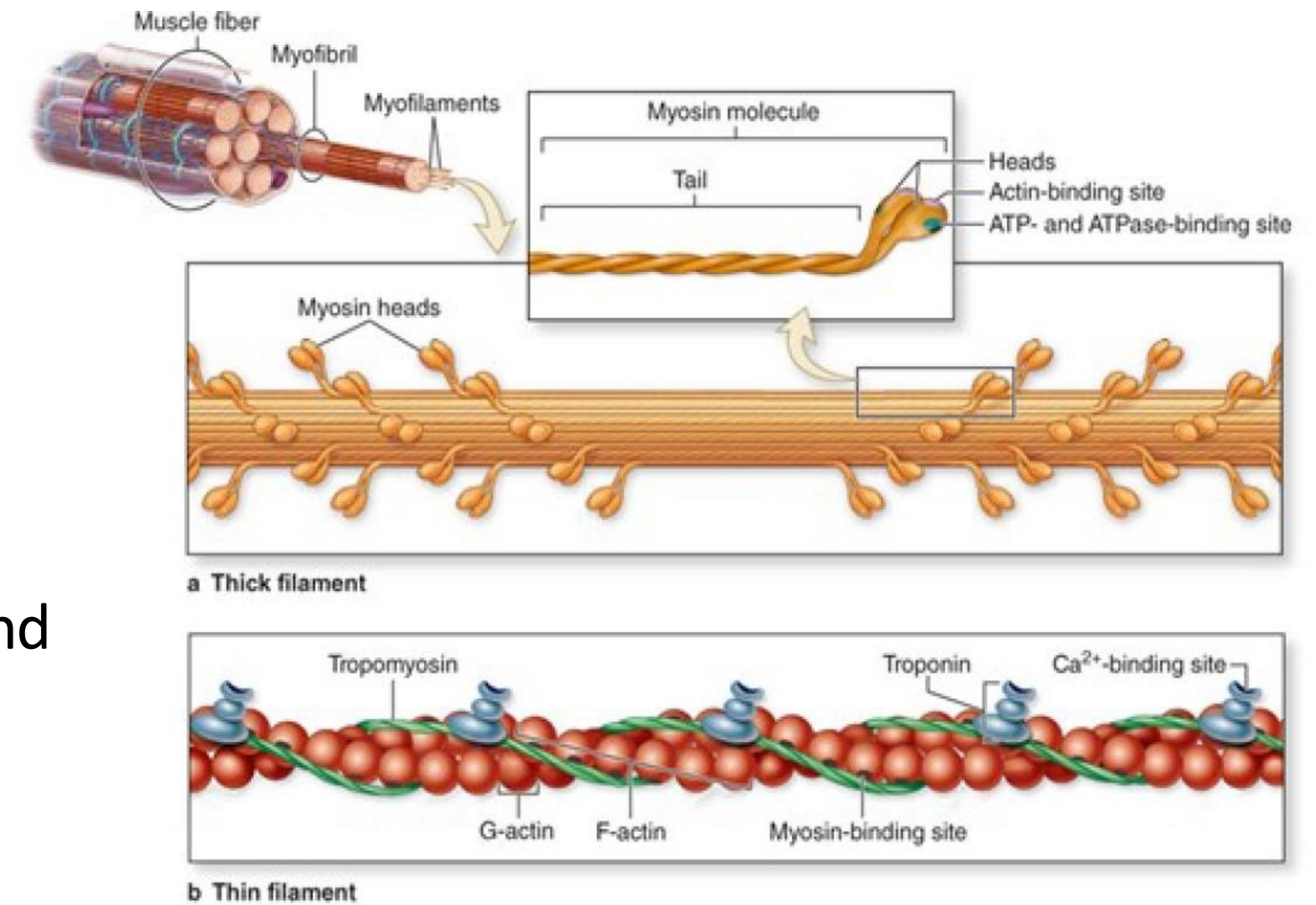
Because it represents the length of the thick filaments

The H zone will shorten

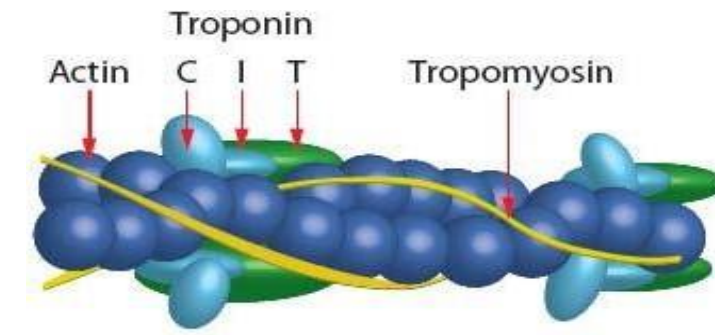
The two Z discs will become closer together

Myofilaments

- Composed of thick and thin filaments
- Thick: 200-500 myosins.
- Myosin is a large complex with two identical heavy chains and two pairs of light chains.
- Globular projections containing the four myosin light chains form a head at one end of each heavy chain.
- The myosin heads bind both actin, forming transient crossbridge between the thick and thin filaments, and ATP, catalyzing energy release (actomyosin ATPase activity).
- Several hundred myosin molecules are arranged within each thick filament with overlapping rodlike portions and the globular heads directed toward either end.



Myofilaments



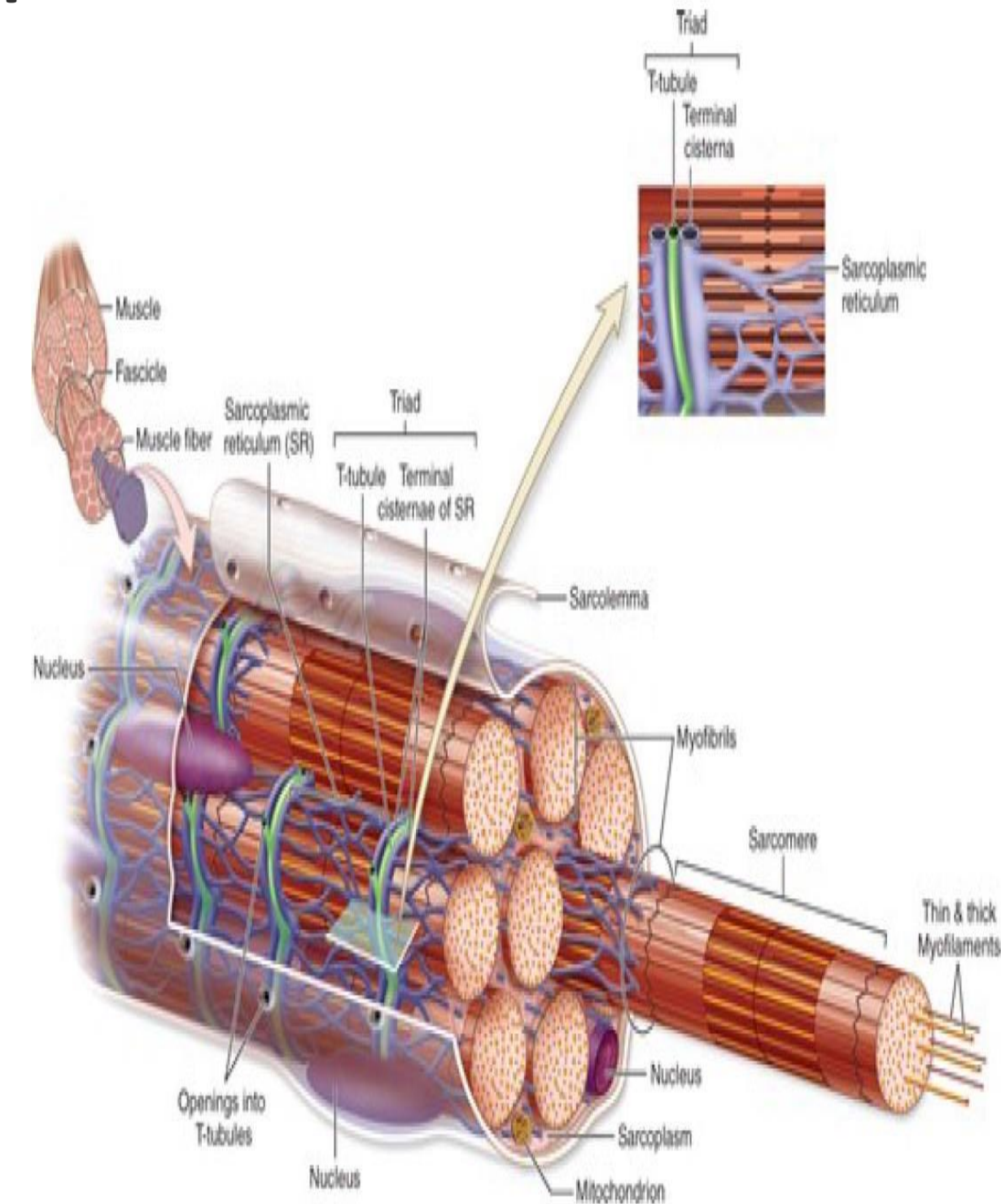
Thin filaments are actually composed of three types of proteins: actin, tropomyosin, and troponin.

F-actin is the component of the thin filament that directly interacts with myosin.

- Thin filaments: contains F-actin, tropomyosin, and troponin.
- The thin, helical actin filaments are each 1.0- μm long and 8-nm wide and run between the thick filaments.
- Each G-actin monomer contains a binding site for myosin
- Tropomyosin: long coil of two polypeptide chains located in the groove between the two twisted actin strands.
- Troponin: three subunits: TnT, which attaches to tropomyosin; TnC, which binds Ca^{2+} ; and TnI, which regulates the actin-myosin interaction.

Sarcoplasmic Reticulum & Transverse Tubule System

- The sarcoplasmic reticulum, contains pumps and other proteins for Ca^{2+} sequestration and surrounds the myofibrils.
- Calcium release from cisternae of the sarcoplasmic reticulum through voltage-gated Ca^{2+} channels is triggered by membrane depolarization produced by a motor nerve.
- The sarcolemma has deep invaginations called **T-tubules** that encircles each myofibril near I-A bands junction.
- Each of T-tubule becomes associated with two **terminal cisternae** of the sarcoplasmic reticulum...**TRIAD**



For any feedback, scan the code or click on it.



Corrections from previous versions:

Versions	Slide # and Place of Error	Before Correction	After Correction
$V_0 \rightarrow V_1$	13	-	Image added from the updated slides
$V_1 \rightarrow V_2$	7	-	Light band and dark band are reversed.

رسالة من الفريق العلمي:

< Back



23 May 2025 at 8:01PM

♥ "فَاسْتَبِقُوا الْخَيْرَاتِ"

☐ نوم مبكرًا zZ

☐ قيام الليل + الوتر 1

☐ استغفار قبل الفجر + سحور 🌿

☐ الجلوس في المصلى بعد الفجر حتى الشروق
(أجر حجة وعمرة تامة) 🙏

☐ صلاة الأوابين (الضحى) ☀️

☐ أذكار الصباح والمساء 🌅🌆

☐ الفروض والسنن 🕌

☐ التكبير والتهليل 🌻

☐ الدعاء الدعاء الدعاء 🙏

☐ صدقة 💰

☐ (استغفار + تسبيح + صلاة على النبي) x1000 🙏

☐ قراءة جزء من القرآن 🕌

﴿ ذَلِكُمْ وَمَنْ يُعْظَمْ شَعَائِرَ اللَّهِ فَإِنَّهَا مِنْ تَقْوَى الْقُلُوبِ ﴾



روى مسلم وغيره أن النبي صلى الله عليه وسلم قال: "صيام يوم عرفة أحتسب على الله أن يكفّر السنة التي قبله والسنة التي بعده".

وفي الحديث قال صلى الله عليه وسلم: "ما من أيام العمل الصالح فيها أحب إلى الله من هذه الأيام، يعني أيام العشر قالوا: يا رسول الله ولا الجهاد في سبيل الله؟ قال: ولا الجهاد في سبيل الله إلا رجل خرج بنفسه وماله، فلم يرجع من ذلك بشيء".

في يوم عرفة الله سبحانه وتعالى ينزل إلى الأرض فطوبى لمن يغتنم هذا اليوم