

VEIN BATCH 2027



Sub: Histology المادة:

Lecture: 6 المحاضرة:

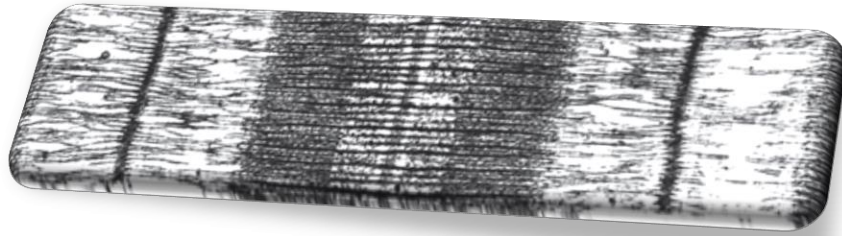
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Edited: تعديل:



Muscular Tissue

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(2022)



تفريغ : محمد العمري

Muscular tissue is the type of tissue whose cells are differentiated to optimally use the contractile ability of the cells.

This ability is due to the interaction between Actin and Myosin microfilaments where they slide upon each other.

بعض الخلايا بالجسم بتحتوي على structures معينة (actin and myosin) هي اللي بتعطيها القدرة على الإنقباض مثل ال myoepithelial cells/ myofibroblasts/pericytes , بالإضافة لبعض الخلايا اللي بتنتج pseudopodia (اللي بتساعد على الحركة برضه لأنها بتحتوي على actin and myosin) مثل ال WBCs بالإضافة لكل الخلايا اللي بتعمل phagocytosis , بس ال tissue الوحيد اللي بقدر يستفيد من هاي ال structures عشان يعمل bodily movement هو النسيج العضلي

Cell membrane = Sarcolemma

Cytoplasm = Sarcoplasm

Smooth endoplasmic reticulum = Sarcoplasmic reticulum

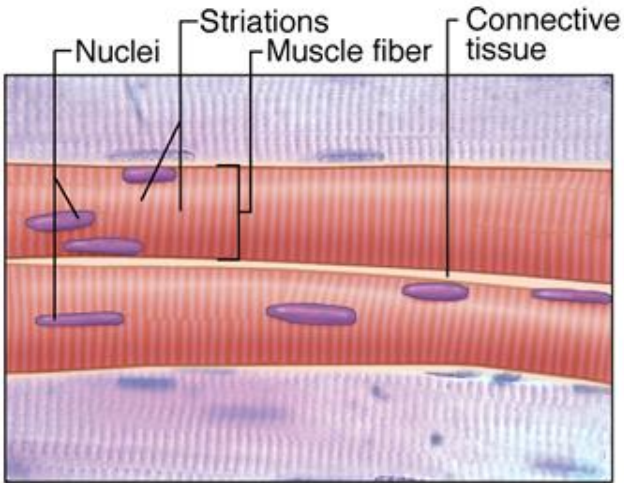
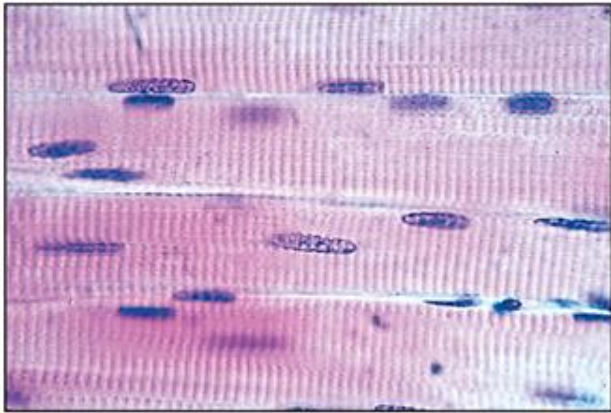
وينعطي اهتمام خاص لل smooth endoplasmic reticulum لأنه مهم جدا في ال muscle cells

Sarco- = related to muscle (sarco- = flesh)

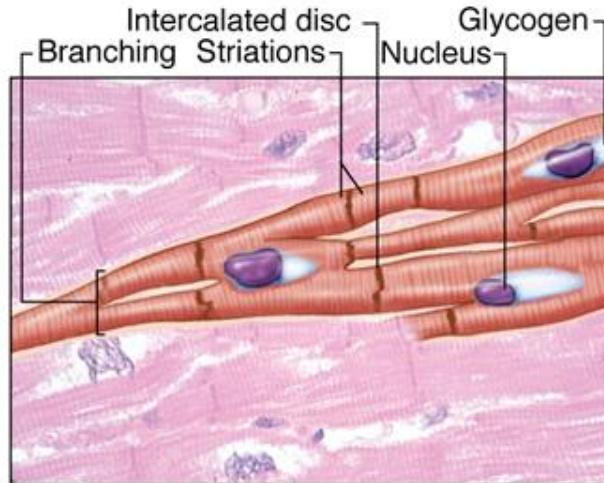
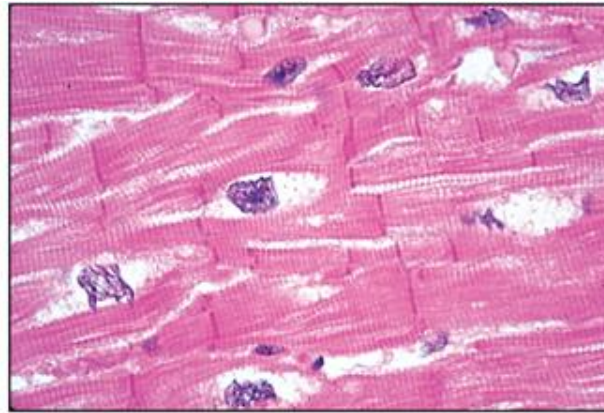
*myofilaments = actin/myosin 2

Types of Muscular tissue

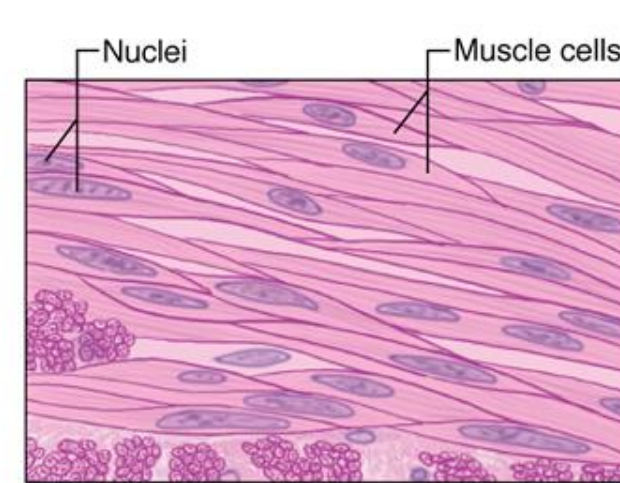
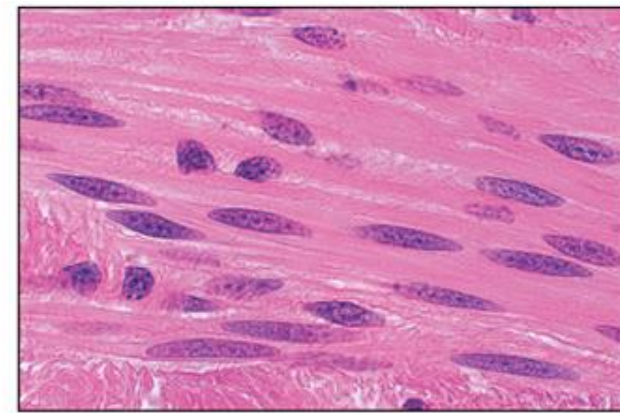
Skeletal Muscles



Cardiac Muscles



Smooth Muscles



Skeletal Muscles

Muscles
attached to
the skeleton



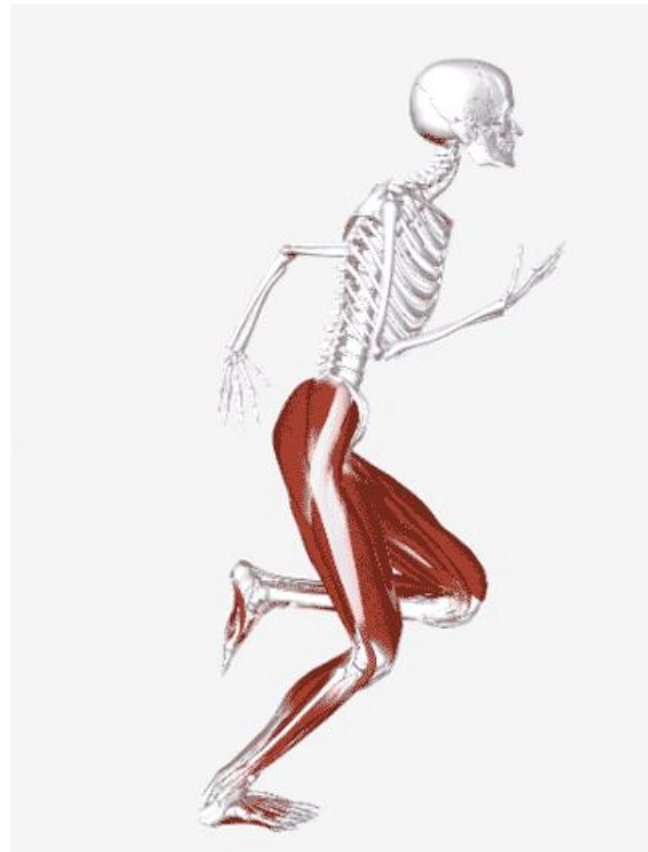
- This type of muscles is voluntary and the cells are:
 - 1) Elongated → therefore, they're called **muscle fibers**.
 - 2) Cylindrical. الcells هون بسميها fibers والسبب انها long and cylindrical
 - 3) Multinucleated. Nuclei on the periphery of the cell. (زي ما كنا نقول عن الaxon انه nerve fiber) nuclei كلها طرفية ما بنلاقيها في وسط الcytoplasm
 - 4) With cross-striation (**seen in longitudinal sections**).
 - 5) (**Have**) Mitochondria and abundant smooth endoplasmic reticulum. بنحتاج الmitochondria لأنها مصدر الطاقة للإنقباض.. والsmooth endoplasmic reticulum مفيدة لأنها مكان تخزين الCa
- The multinucleation is due to the fusion of several muscle-cell precursors called **myoblasts**.

في الحياة الجنينية (embryonic life) يتم تكوين الskeletal muscle عن طريق تجمع الmyoblast اللي كل واحد منها يحتوي على nuclei وبالتالي صار multinucleated

Functions of Skeletal muscles:

1. Production of bodily movement.
2. Maintaining posture.
3. Stabilization of joints.
4. Production of heat.

الطاقة التي بالجسم بنحصل عليها من المواد الغذائية بحيث
بنتحول لـATP, بس مش كل الطاقة بنتحول لـATP جزء
منها بتحول لحرارة.. عشان هيك لما الواحد يلعب رياضة أو
يبذل جهد بشعر بالسخونة.. وبرضه لما الجسم يبترد بصير
يرجف, والرجفة هاي بتعمل انقباضات عديدة للعضلات هدفها
توليد الحرارة للجسم.. (صار عنا نسيجين بنتجوا الحرارة
السkeletal muscles والbrown adipose tissue)

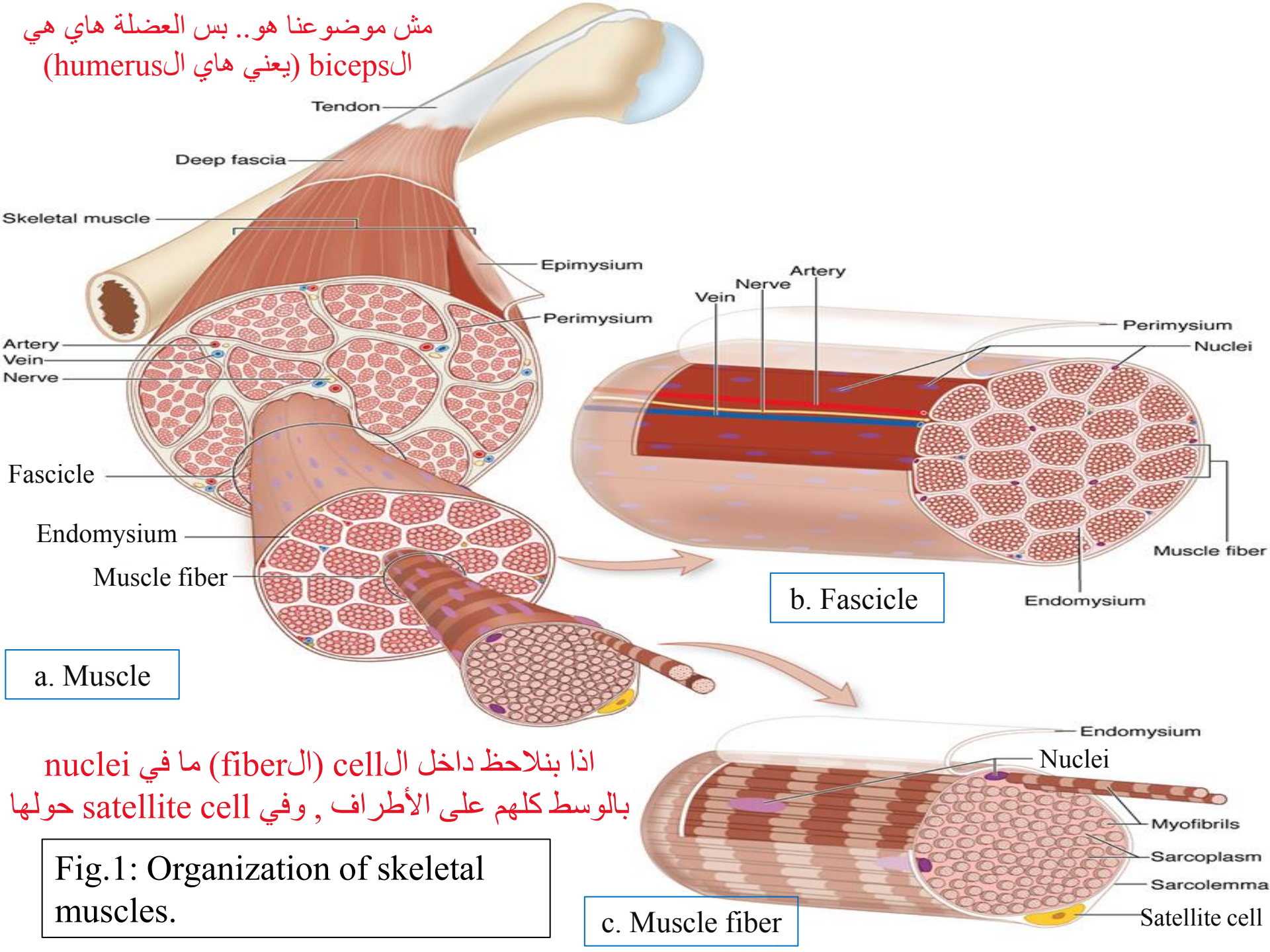


Organization of Skeletal muscles:

- Skeletal muscles are formed of several bundles of muscle fibers. يعني لو أتطلع على عضلة زي ال biceps مثلا رح الاحظ انها بتتكون من مجموعة من ال bundles اللي بتتكون من مجموعة muscle fibers
- Each fiber is surrounded by **Endomysium**: a loose areolar CT layer that merges with the **basal lamina** produced by the muscle fibers.
- (Fascicle)
- Each bundle is surrounded by **CT Perimysium**.
- The whole muscle is surrounded by **Epimysium**: a dense collagenous CT layer.

الطبقات هاي كلها عبارة عن CT layers وما الها علاقة بأي اشي داخل العضلة نفسها.. بتحتوي على fibroblasts وهي اللي بتكوّنلي ال ECM لهاض ال tissue , بس برضه العضلة نفسها بتشارك بتكوين ال ECM بنسبة قليلة جدا

مش موضوعنا هو.. بس العضلة هاي هي ال biceps (يعني هاي ال humerus)



a. Muscle

b. Fascicle

c. Muscle fiber

اذا بنلاحظ داخل ال cell (ال fiber) ما في nuclei بالوسط كلهم على الأطراف , وفي satellite cell حولها

Fig.1: Organization of skeletal muscles.

بنلاحظ بالصورة عدة أمور.. أولاً
النوى nuclei على طرف كل fiber ،
بالإضافة للخط الرفيع بين
الfibers والتي هو
الendomysium ، بعدين بنلاحظ
خطوط أعرض شوي محيطة
بمجموعة fibers (bundle) وهو
الperimysium ، وآخر اشي
والمحيط بالmuscle كاملة
الepimysium

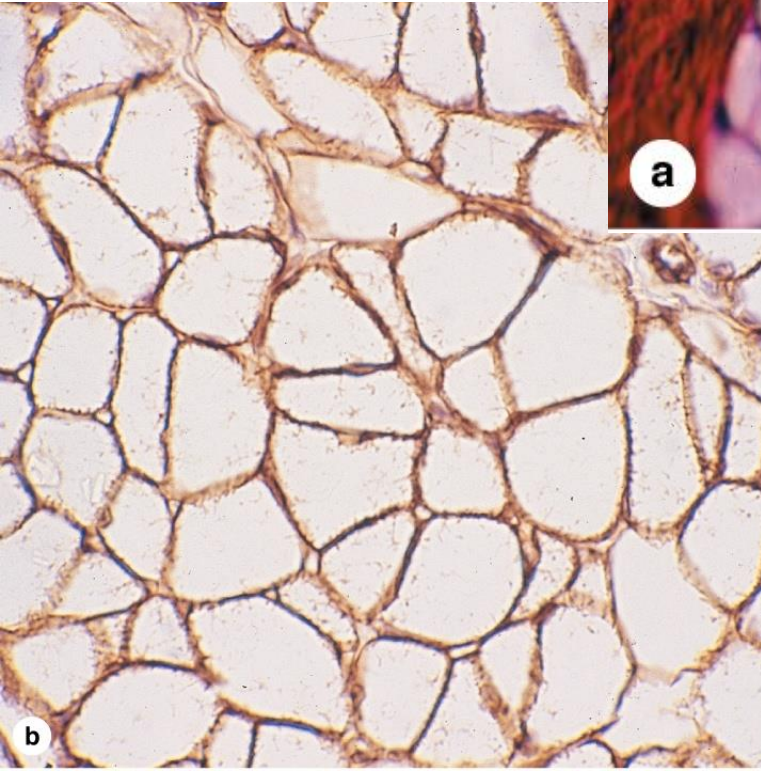
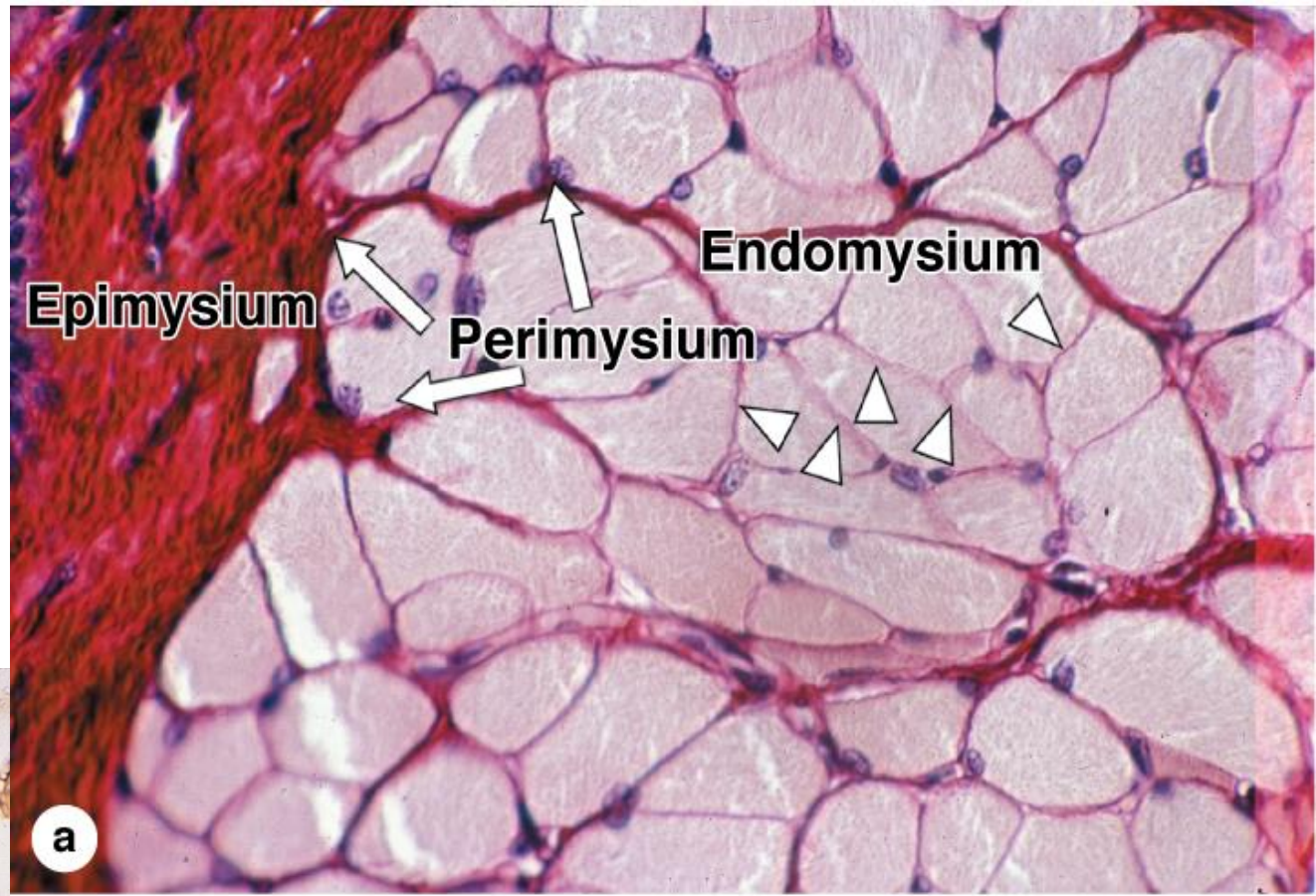


Fig.2: Cross section through skeletal muscle.
In (a), note the peripheral location of the nuclei.
Arrow heads indicate the endomysium. Arrows
indicate the perimysium.
In (b), an immunohistochemical method was
used to stain laminin.

استخدمنا صبغة خاصة لل laminin عشان يظهر.. وظهوره
يعني انه في basal lamina محيطة بال cells هي اللي كونتها

Skeletal muscle fiber:

- ✓ Skeletal muscle fibers, under the LM, appear to have alternating dark and light areas. These are called the A and I bands, respectively. The banding is due to the regular arrangement of the thin myofilament Actin and the thick myofilament Myosin.

بسبب الترتيب المنتظم للactin والmyosin بتظهر العضلة بهاض الشكل



- ✓ Under the EM, this arrangement proves to be more complex.

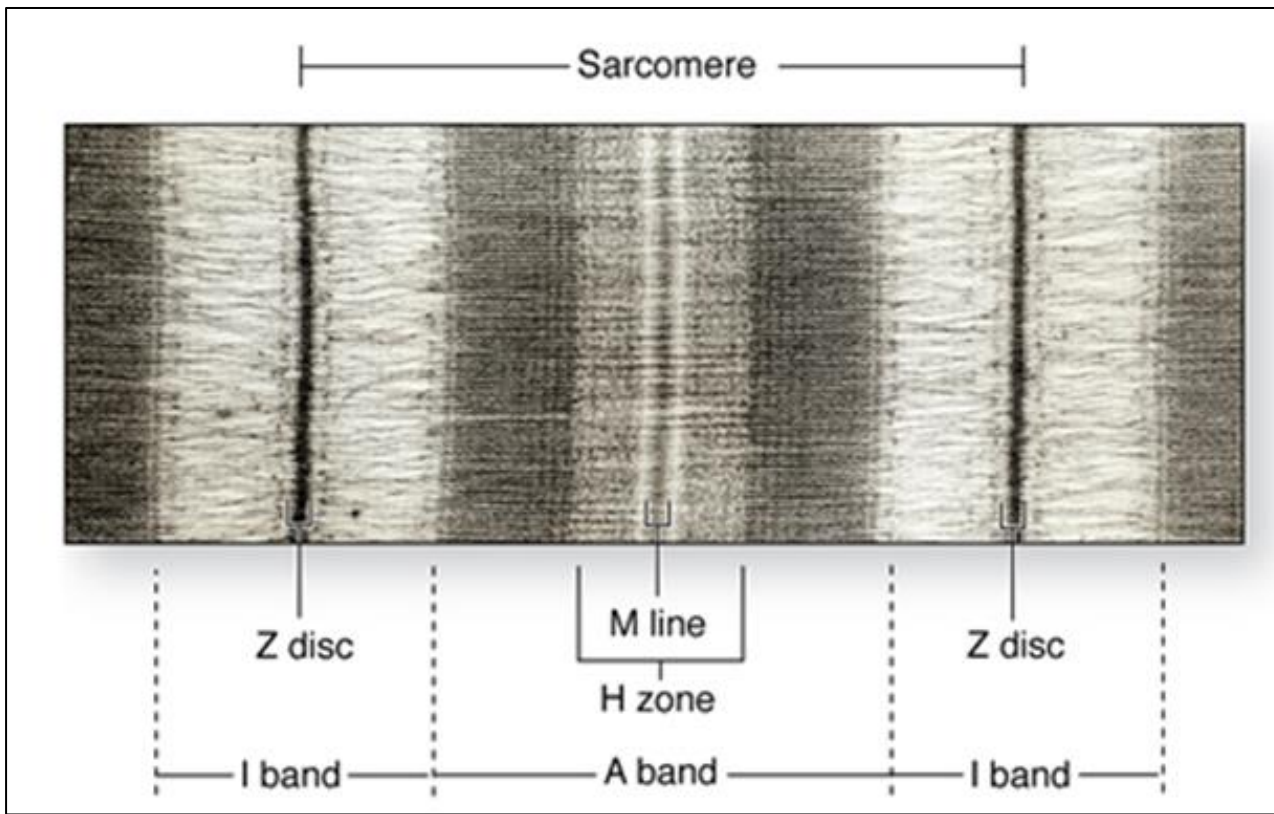


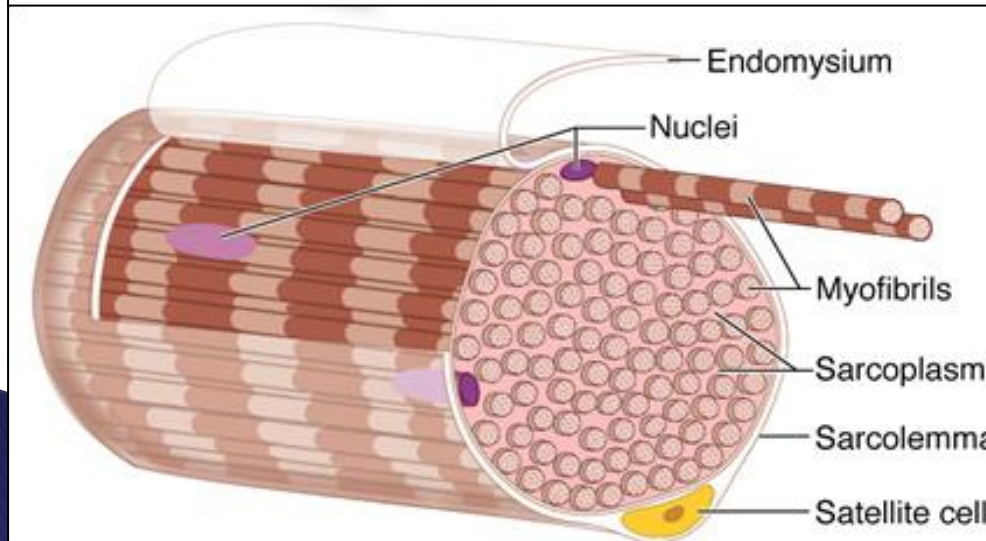
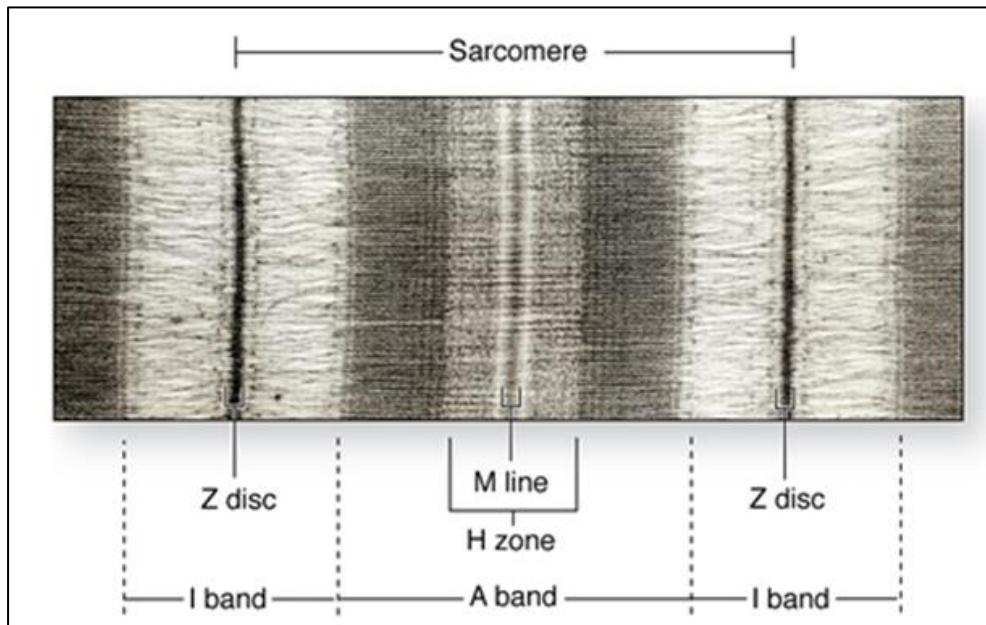
Fig.3: The A and I bands under EM.

↪ But still darker than the I band

- ✓ **H Zone**: a lighter colored area within the A band.
- ✓ **M Line**: darker colored line in the middle of the H zone.
- ✓ **Z Disc (Line)**: a dark line in the middle of the light I band.

The minimum structure that is required for contraction is the sarcomere..

يعني ما بصير عندي انقباض بجزء منه لازم يكون كامل



c Muscle fiber

✓ ***The Sarcomere***: is the repetitive functional subunit of the contraction apparatus. It extends from one Z-line to the next Z-line.

✓ Several sarcomeres arranged end-to-end form a myofibril. These are elongated, cylindrical structures. Each muscle fiber contains numerous myofibrils.

الان مجموعة ال sarcomeres بتكوّن ال myofibrils.. وهي موجودة بكثرة فال cytoplasm, وهاض سبب وجود ال nuclei على الطرف

The Sarcomere:

❖ The sarcomere is formed of several types of proteins, all important for the contraction process.

❖ These are:

1. Actin.
2. Tropomyosin.
3. Troponin.
4. Myosin.
5. Titin.

ال thin بتكون بشكل أساسي من
actin وبتحوي أيضا على
troponin و tropomyosin

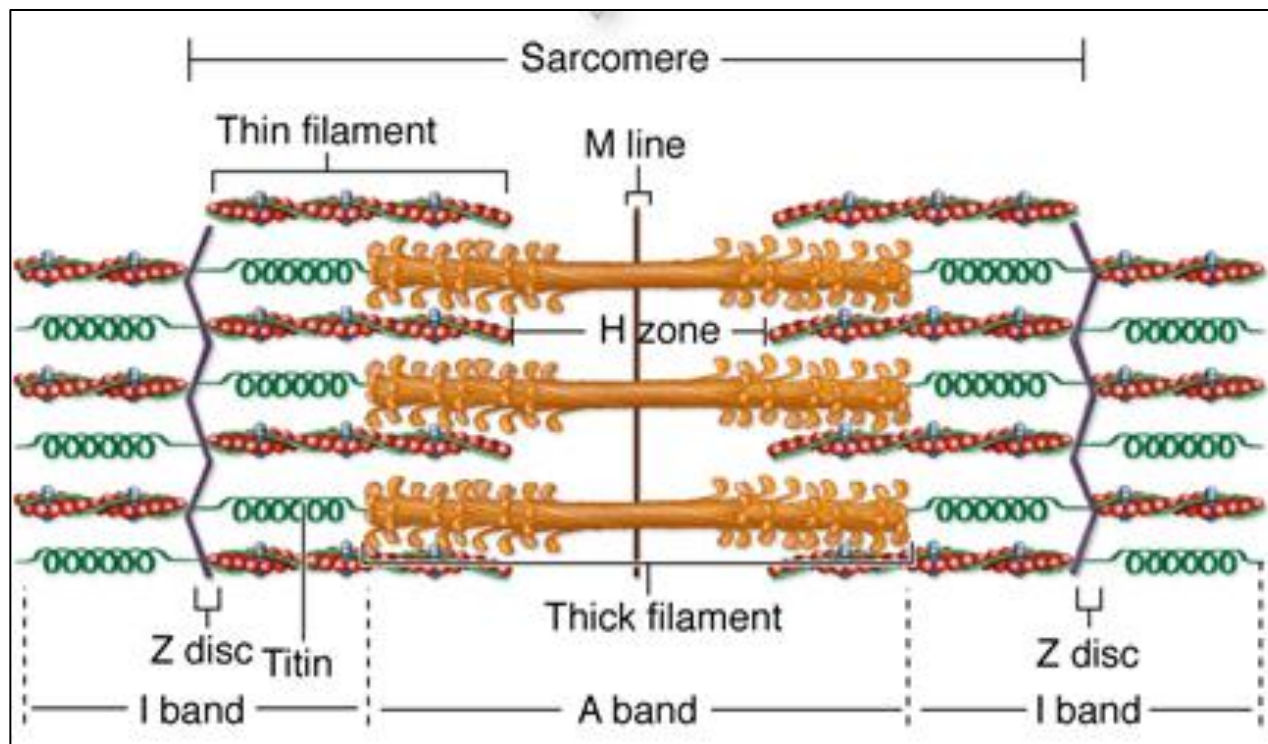


Fig.4: The sarcomere and the proteins that form it.

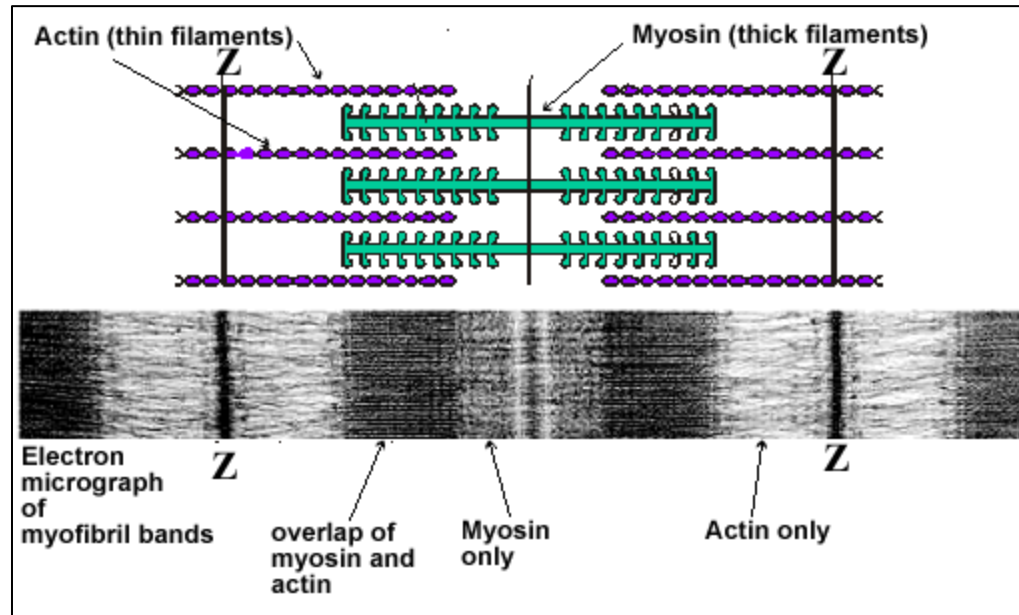
The M line and the Z disc are disc shaped structure

- ❖ **A band:** is the area that extends the entire length of the thick filaments including the area of overlap between the thin and thick myofilaments.

- ❖ **H zone:** is the area in the middle of the A band where there's **only thick myofilaments.**

وهاض السبب اللي بخليه أفتح من بقية الـ A band وأغمق من الـ I band

- ❖ **I band:** is the area where there's **only thin myofilaments.**



The Sarcoplasmic Reticulum and T-Tubules:

- **Contraction** of muscle fibers **depends on** the availability of **Ca²⁺**.
- Nerve impulse reaches the surface of the muscle cell at certain points (neuromuscular junctions). This impulse stimulates the sarcoplasmic reticulum to release Ca²⁺.
- The impulse starts at the surface and then travels along invaginations of the sarcolemma called Transverse (T) tubules that form a network within the muscle fiber that surrounds individual myofibrils near the A-I junction.

القنوات هاي امتداد لل cell membrane بتدخل ال cell وتعمل network وبتحيط بكل ال myofibrils في نقطة التقاء ال A band مع ال I band فقط, وبسميها T tubules

المنطقة اللي بالمستطيل بتمثل الTriad, وهي عبارة عن T tubule بالوسط وفوقها وتحتها الterminal cisterna

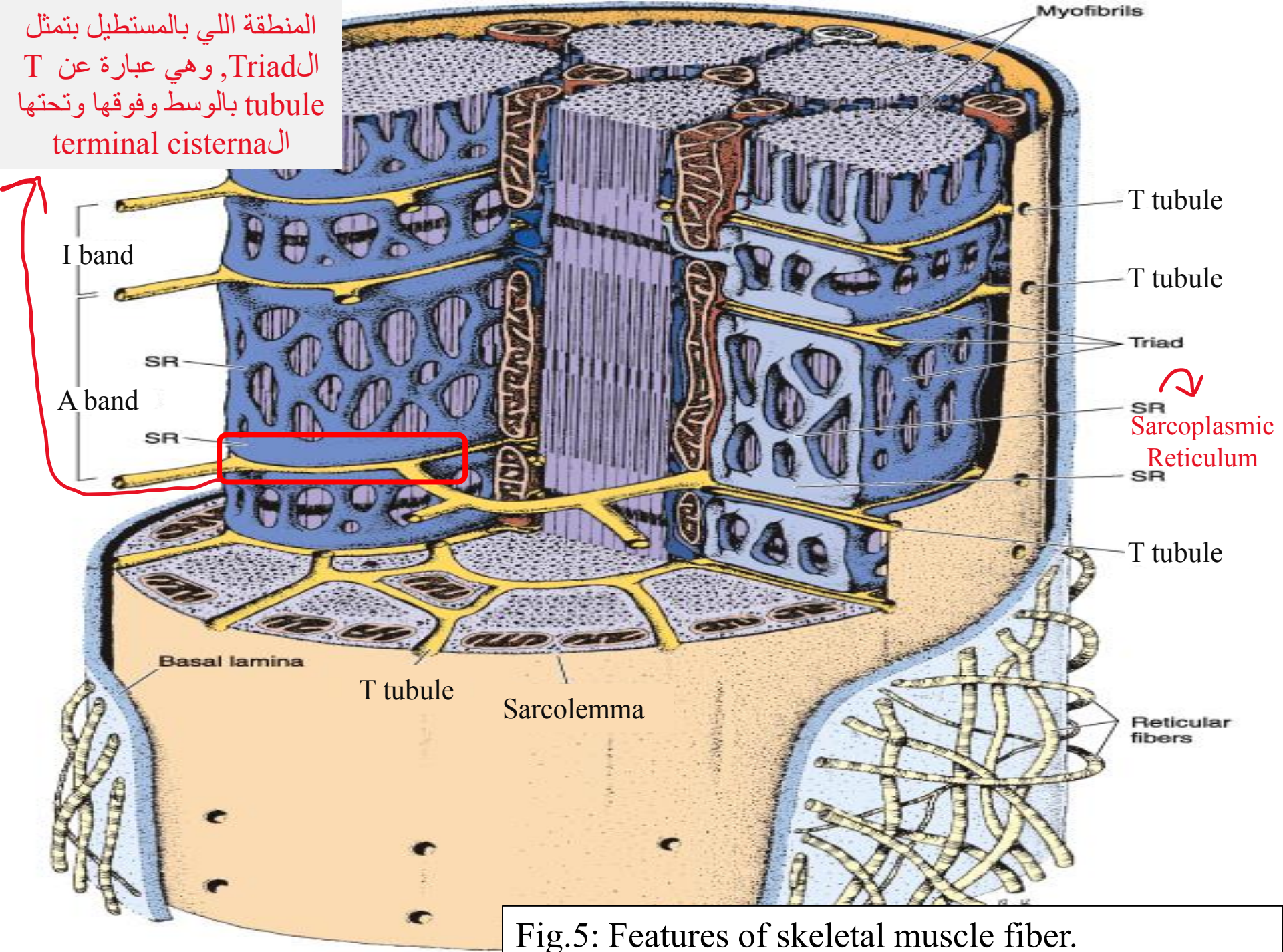
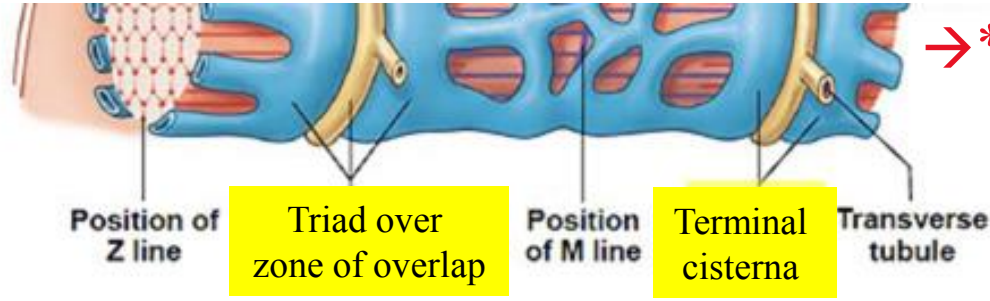


Fig.5: Features of skeletal muscle fiber.

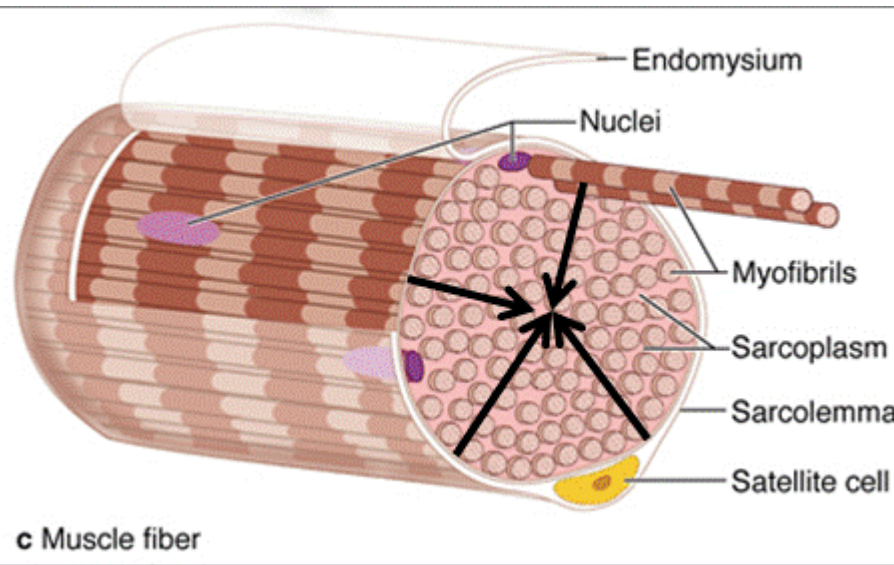


صورة من النت بتوضح موقع ال triad

*انتقال ال impulse عبرها اسرع من انتقاله عبر ال cytoplasm

(المكان اللي يتم تخزين ال Ca فيه)

- Each **T-tubule** has an expanded **terminal cisterna** of the sarcoplasmic reticulum on each side. This complex of a T-tubule and two terminal cisternae is called a **Triad**.



- This arrangement ensures that the impulse reaches all parts of the fiber at the same time making all the myofibrils contract together. If the T-tubules were not present, the contraction will start at the periphery and then spread (more slowly) to the deeper myofibrils.

Fig.6: The spread of contraction in a muscle cell if T-tubules were not present.

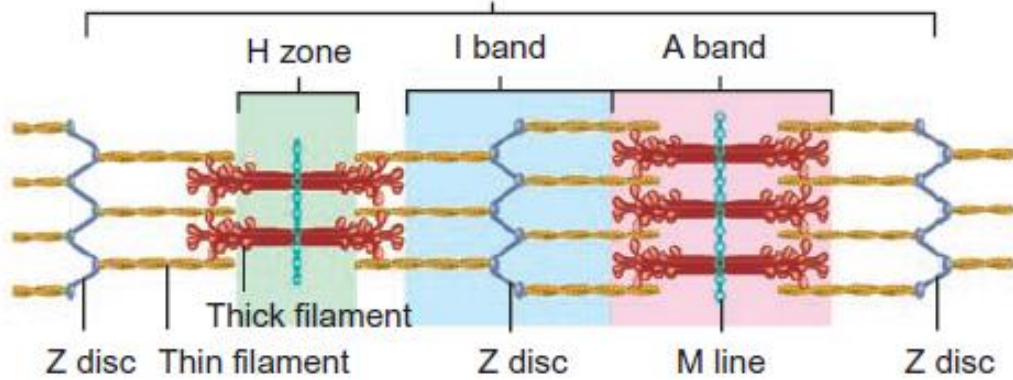
انقباض العضلة يبدأ من منطقة التقاء ال A/I bands عشان هيكل ال T tubules بتتواجد بهاي المنطقة بحيث أول ما

يوصل ال impulse للعضلة تحفز إفراز ال Ca مباشرة ويتم الإنقباض, بس لو ما كانت موجودة رح يصير في بطء بوصول ال impulse واجزاء الخلية رح تتقلص بأوقات مختلفة

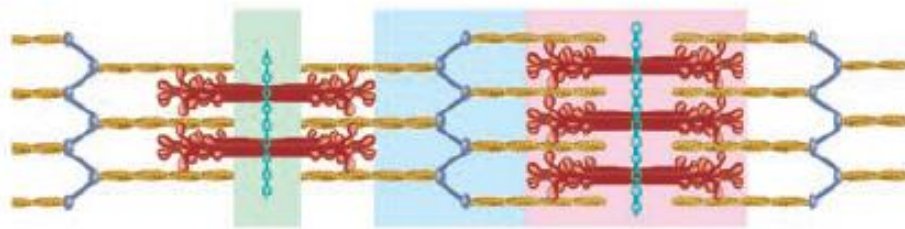
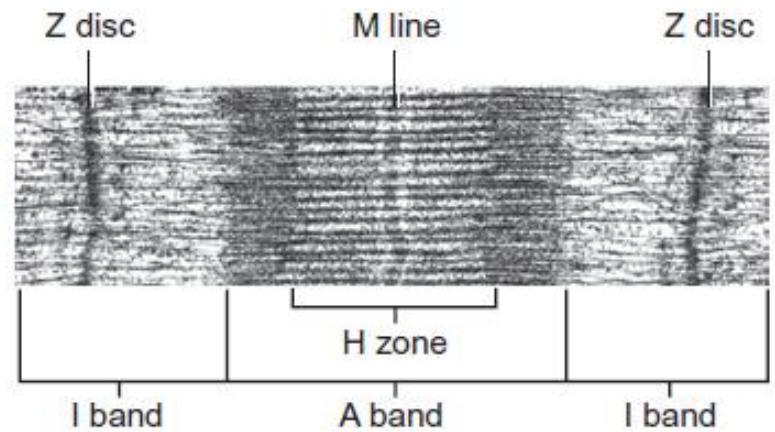
Changes in the Sarcomere during Contraction:

- ❑ Contraction depends on the availability of Ca^{2+} .
- ❑ When this ion is present, the degree of overlap of the thin and thick myofilaments increases pulling the Z-discs closer to each other.
- ❑ When the Z-discs come closer together, the sarcomere will shorten. The myofibrils and the whole muscle, as a result, will shorten → Contraction.

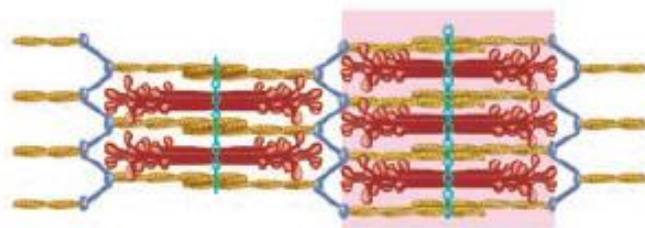
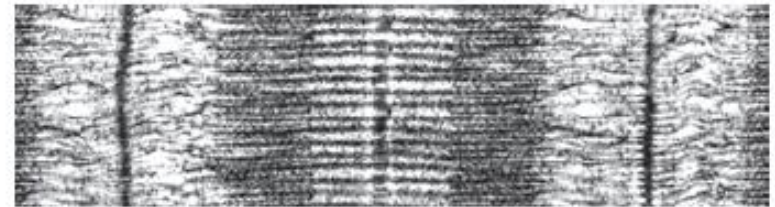
2 Sarcomeres



(a) Relaxed muscle



(b) Partially contracted muscle



(c) Maximally contracted muscle

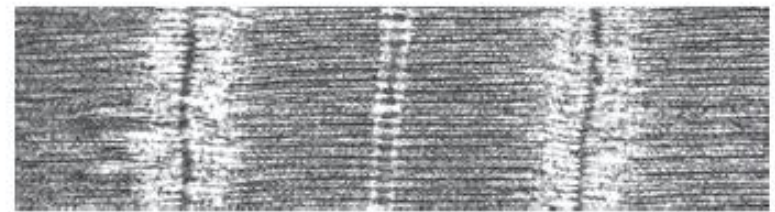
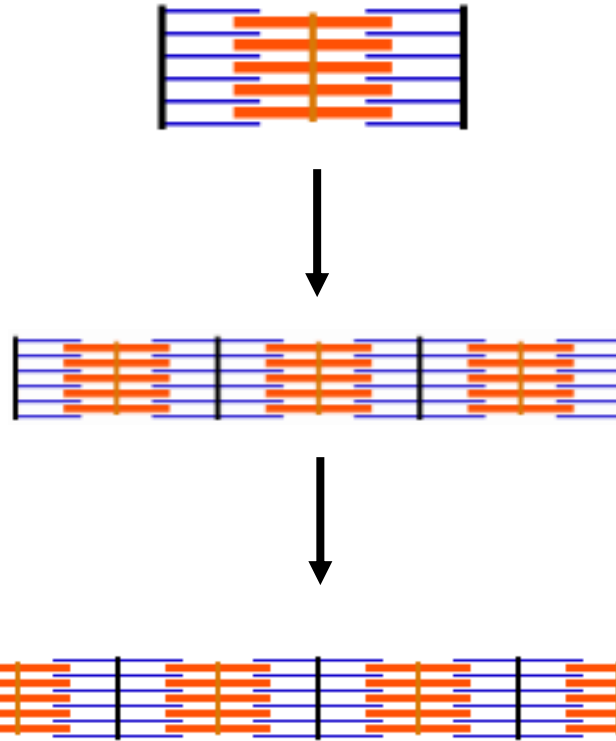


Fig.7: Changes during contraction. *Note how the Z-discs become closer. The H-zone and I-band become narrower.*

الان احنا بنعرف انه ال H zone عبارة عن thick myo وال I band عبارة عن thin فقط.. وبالتالي لما يصير ال contraction ويصير لهم overlapping فوق بعض المناطق هاي رح تصير أصغر (لإنهم صاروا فوق بعض بطلوا منفصالات), عشان هيك هضول المنطقتين بصيروا أصغر لما يصير الانقباض.. بينما ال A band بتضل بنفس الحجم ما بتغير طولها, والسبب انه ال A بتمثل طول ال thick myo كامل بغض النظر هو معه thin ولا لحاله.. يعني ال filaments طولها بضل زي ما هو ثابت بس لما يقربوا على بعض بتقصر العضلة..

ال structure هاض بكون ممتد من ال origin للعضلة للinsertion, الان اذا بنلاحظ فال sarcomeres بتتقلص باتجاه الوسط.. طيب ليش العضلة لما تنقبض ما بتروح للوسط؟ اللي بصير انه الانقباض بصير معه حركة للعظم.. ف كل العضلات بتتقلص بنفس الطريقة وللوسط بس الاختلاف بصير بسبب الحركة حول ال joint



(الشكل هون فيه animation لآلية الانقباض وال overlapping اذا بدكو تشوفوه محتاجين ترجعوا لل PowerPoint وتفتحوه من تطبيق ال PowerPoint نفسه)

Tendons:

- Skeletal muscles are attached to bones by tendons which are formed of dense collagenous regular connective tissue. *هنا ال layers اللي بتحيط بالعضلة عبارة عن CT وبداخلها collagen fibers, وهاي ال collagen fibers بتستمر إلى داخل ال tendon بعد ما تنتهي العضلة*
- Collagen fibers of the tendon are continuous with those in the CT layers that surround the muscle thus allowing the transfer of force of contraction from muscle to bone.

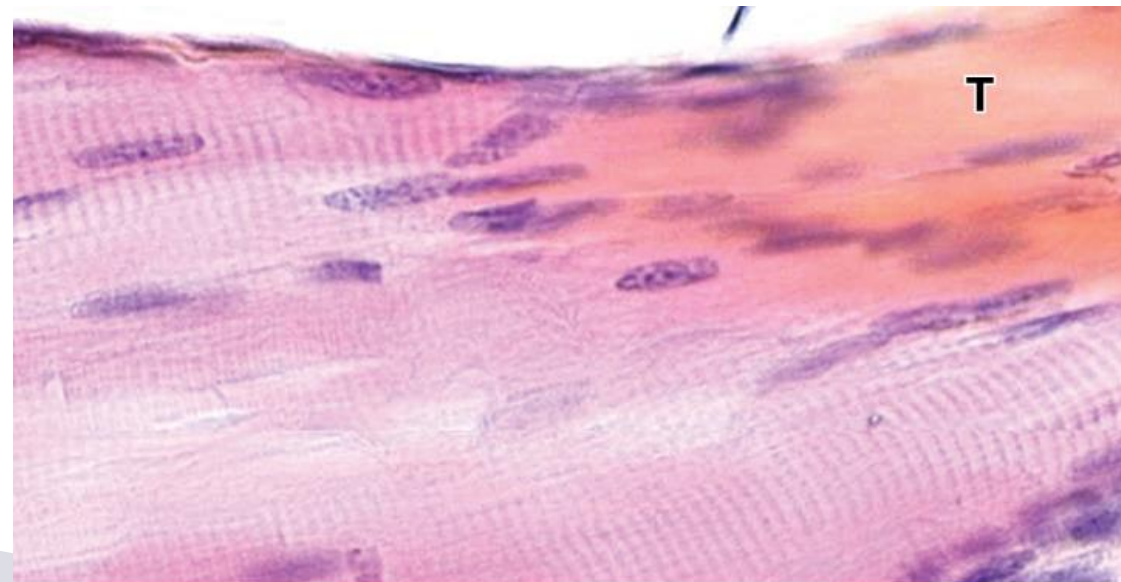
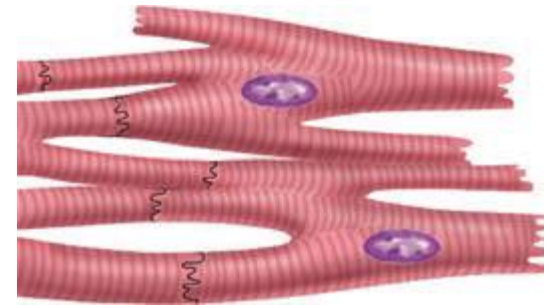


Fig.8: In this image, we can see how the tendon (T) is continuous with the muscle.

Cardiac Muscles

- ✓ These **involuntary** muscles are present ^(Only) in the heart. They form the middle layer of the heart wall → The myocardium.



- ✓ Characterized by:
 - 1) Cells have branches and surrounded by endomysium.
 - 2) One **(sometimes two)** centrally located nucleus.
 - 3) Show cross-striation (similar to skeletal muscles).
 - 4) Numerous mitochondria.

بتظهر مخططة لنفس السبب برضه
(ترتيب ال myofilaments)

Cardio- = related to heart.

5) Branches of cardiac muscles are connected with each at the ***Intercalated discs***. At these discs, we have desmosomes and gap junctions. Sarcomeres are ultimately attached to these discs.

Desmosomes to connect branches together, and gap junctions that insure the rapid transfer for Ca ions from one cell to another, and eventually all sarcomeres ends at the intercalated discs (على عكس الهيكلية اللي ممكن تمتد على طول العضلة)

6) The T-tubules are larger than those in skeletal muscles but the sarcoplasmic reticulum is less well developed.

ال SR أصغر هون والسبب انه هون عندي gap junctions تساعد نقل ال Ca بين الخلايا ف ما بحتاج اخزنه بشكل كبير لانه ينتقل بسرعة بين الخلايا

7) Cytoplasm contains fatty droplets, glycogen particles and lipofuscin granules.

8) In atrial fibers, there are granules which contain the ***Atrial Natriuretic Hormone***. Therefore, the atria of the heart have endocrine role.

الها دور في ال endocrine secretion (إفراز الهرمونات)

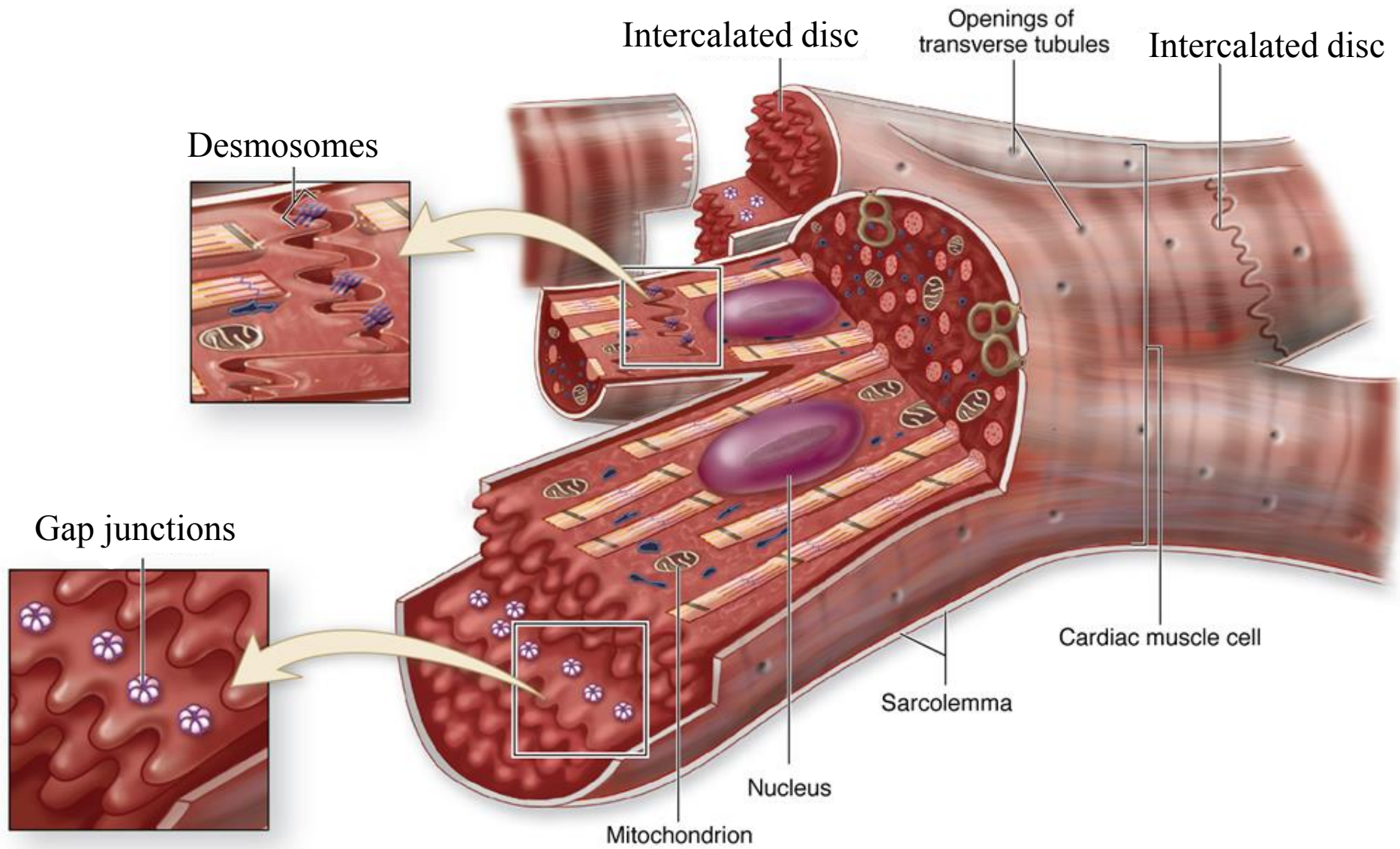
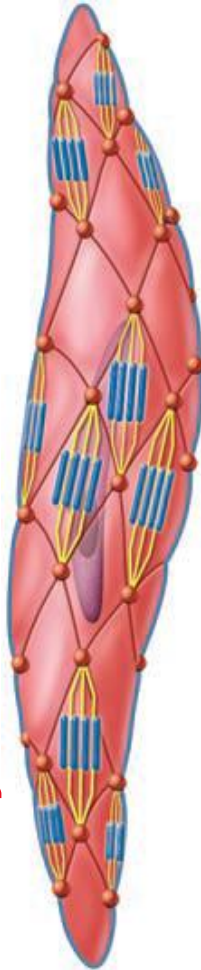


Fig.9: Cardiac muscles.

Smooth Muscles

*كل الأعضاء الداخلية عبارة عن smooth
*باستثناء القلب فهو cardiac

- ✓ These involuntary muscles are present in various organs in the body, like stomach, intestines, urinary bladder, arteries and many others.
- ✓ Characterized by:
 - 1) Cells are **small** and fusiform in shape (elongated and tapering at the ends).
 - 2) Have a **single centrally** located nucleus.
 - 3) **Lack** cross-striation. مش عدد ال myofilaments أقل, لكن ترتيبها مختلف
 - 4) Cells surrounded by basal lamina and a thin endomysium.

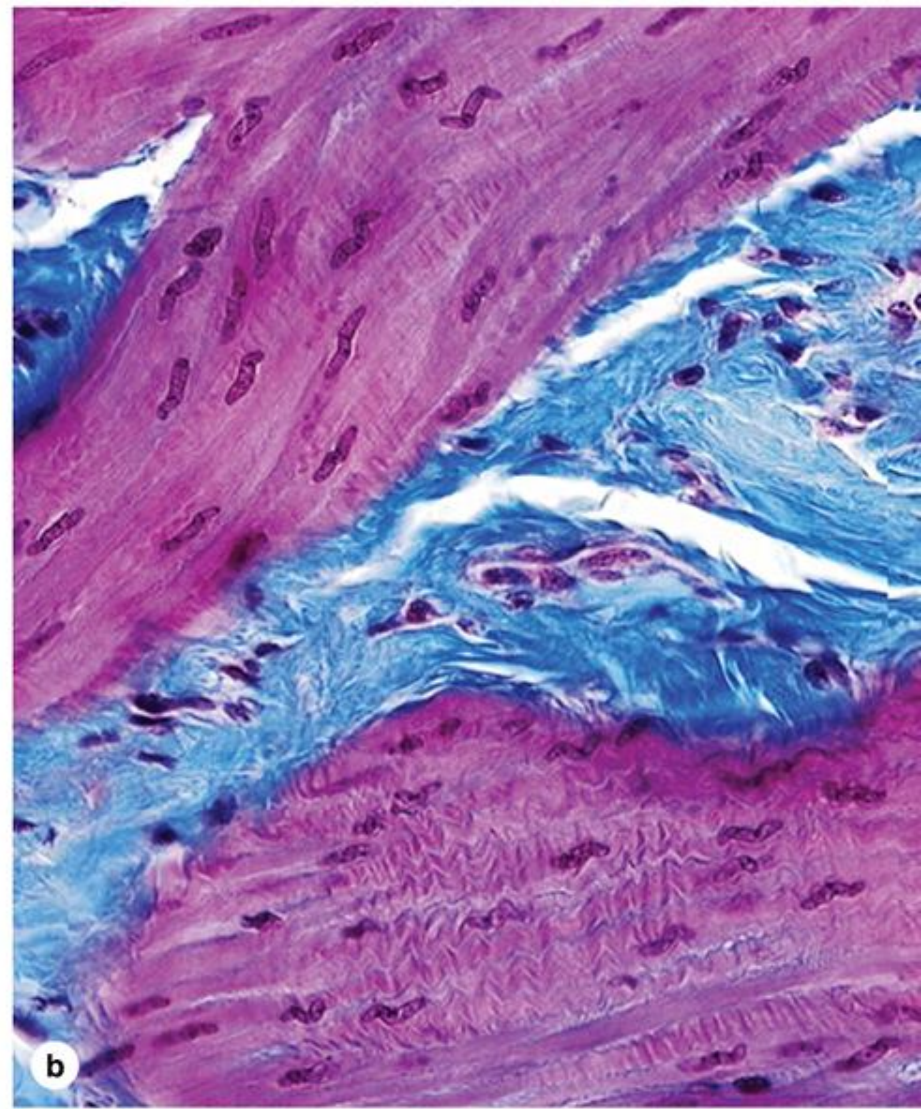
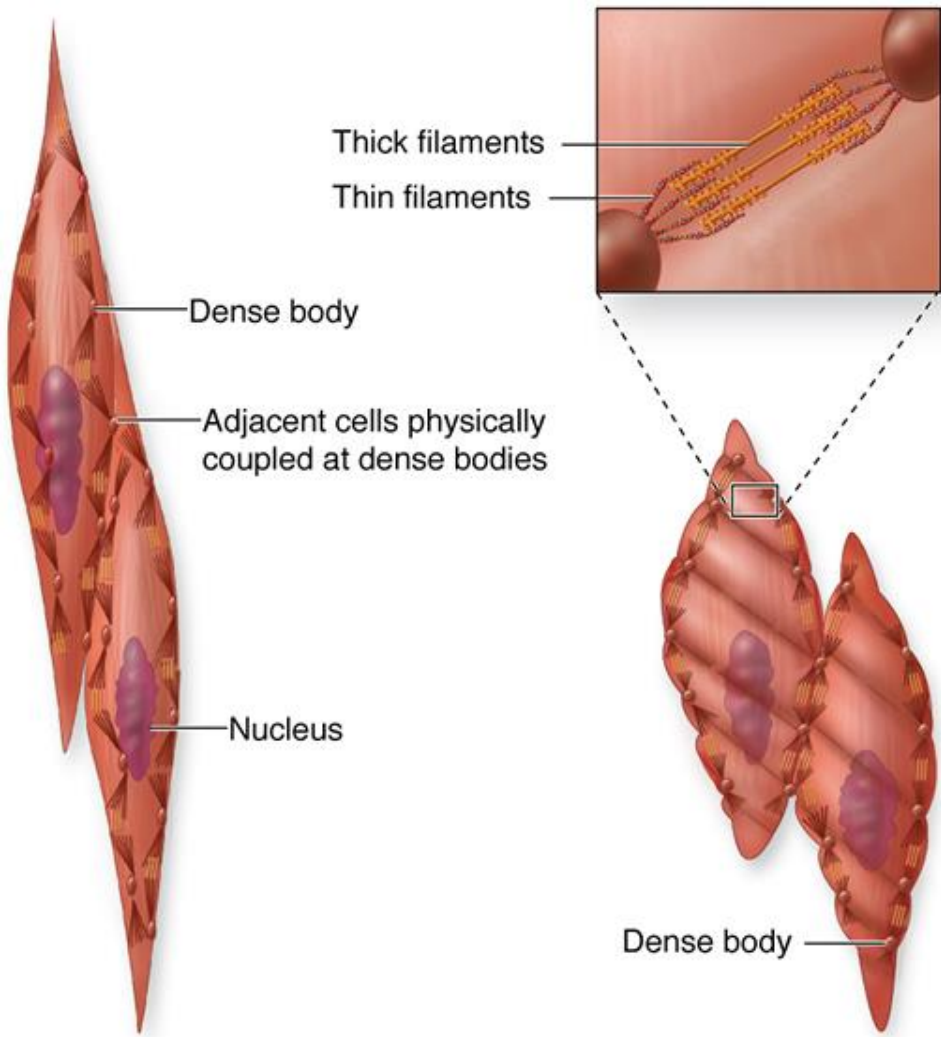


- 5) The cells are closely packed with each other.
- 6) Cytoplasm contains mitochondria, ribosomes, RER and Golgi complex. والتحتوي على هياكل أكبر من الcardiac structures والسبب إنها تفرز بروتينات و ECM بدرجة أكبر منهم
- 7) Cell has rudimentary SER, but no T-tubules. ما فيها T tubules والسبب إنه حجم الخلايا صغير فال impulses يتوصل للخلية بسهولة
- 8) The thin and thick myofilaments are not arranged like in the other muscle types. Here these filaments crisscross obliquely forming a network in the cell.
- 9) Smooth muscle cells are connected with each other by Gap junctions which allow the spread of Ca^{2+} (and thus contraction) rapidly between cells.

- 10) -Specialized structures called *Dense Bodies* are present in the cytoplasm and on the cell membrane.
- To these structures, the myofilaments (**sarcomeres**) and intermediate filaments are attached.
 - These may also be attached to dense bodies on the cell membrane of adjacent cells.
 - This allows cells to adhere to each other and to contract together.

وبتكون موجودة في أماكن التقاء الخلايا وبتربط بين ال filaments من خلايا مختلفة




- 11) Smooth muscles can produce the components of the extracellular matrix.



a من الأمور التي يمكن أميز ال smooth muscles فيها
 إنه بظهر عندي عدد كبير من الخلايا تحت المجهر والسبب انها صغيرة الحجم

Fig.10: smooth muscles. Note in (a) the close arrangements of the fibers. Also note how these muscles contract. In (b), the deformed nucleus indicate that the muscle is contracted.

Comparison between the three types of muscle cells:

	<i>Skeletal</i>	<i>Cardiac</i>	<i>Smooth</i>
<i>Location</i>	Attached to bones	The heart	Internal organs and skin
<i>Shape</i>	Elongated and cylindrical 	Branched 	Fusiform 
<i>Nucleus</i>	Several peripherally located nuclei	Single centrally located nucleus	Single centrally located nucleus
<i>Striation</i>	Striated	Striated	Non-striated
<i>Function</i>	<ul style="list-style-type: none"> • Movement of bone • Heat production 	Beating of the heart	Movement of the viscera
<i>Control</i>	Voluntary	Involuntary	Involuntary

Muscle Regeneration

- ❖ **Skeletal muscle cells cannot divide.** Inactive *Satellite cells* are present close to the muscle fibers. When injury occurs, the satellite cells become active, divide and form new skeletal muscle fibers. This is also thought to be the mechanism by which skeletal muscles hypertrophy after exercise.
ال skeletal ما عندها القدرة على الانقسام.. الأضرار يتم معالجتها عن طريق ال satellite cells المحيطة فيها.. أيضا احدى النظريات تقول انه ممارسة الرياضة بتحفز ال satellite cells عشان تكون خلايا عضلية جديدة وبالتالي بتكبر العضلة
- ❖ **Cardiac muscles cannot divide** and they lack satellite cells. After injury, the damaged muscles are replaced by a connective tissue scar.
ال ضرر يتم تعويضه ب CT scar لأنه ما فيه satellite cells وهاض بنسميه ال myocardial infarction
- ❖ **Smooth muscle cells can divide**, and, therefore, can easily replace damaged cells.

The End

Thank You
And
Good Luck

اللهم إني أستودعك ما درست
وقرأت وحفظت وفهمت..
فرُدّه لي عند حاجتي إليه

دعواتكم 

وهيك مشوار ال Histology بكون خالص.. إن شاء الله أكون فدتكوا, وبعذر عن أي تقصير أو خطأ سهوا, بالتوفيق.. 

**Knowledge is like a
spotlight in a dark
forest. The larger the
spotlight, the more it's
in contact with darkness**