Revised by
شوق الأحمري & طراد الوكيل

Histology of Integrated Muscle

HISTOLOGY TEAM 436

جامعة الملك سعود
King Saud University

436
MEDICINE
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Color index :

Doctor's slides

Important

Extra

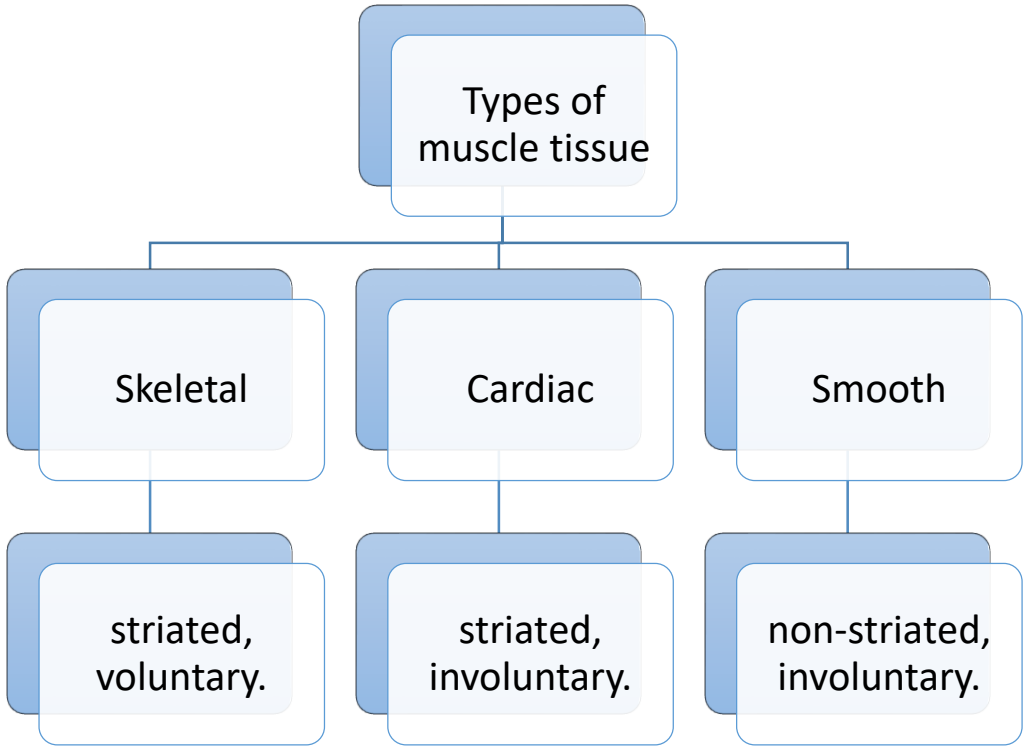
Objectives:

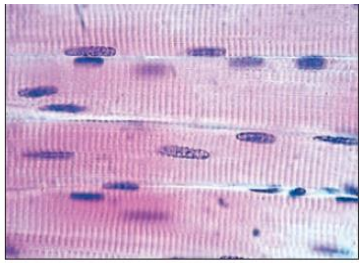
By the end of this lecture you should be able to:

Identify and describe the histological structure of the three types of muscle cells and list the differences between them.

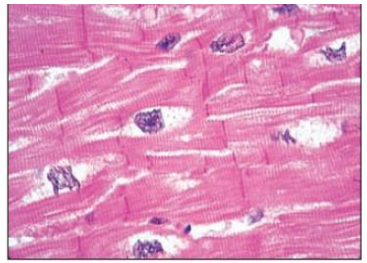
Types of muscle tissue:

- ✓ All Muscular tissue is Made of elongated muscle cells called (fibers).

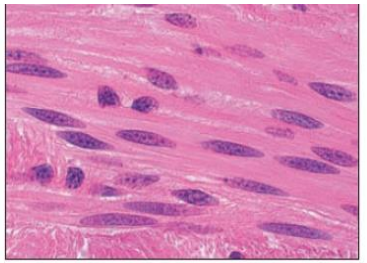




a Skeletal muscle



b Cardiac muscle



c Smooth muscle

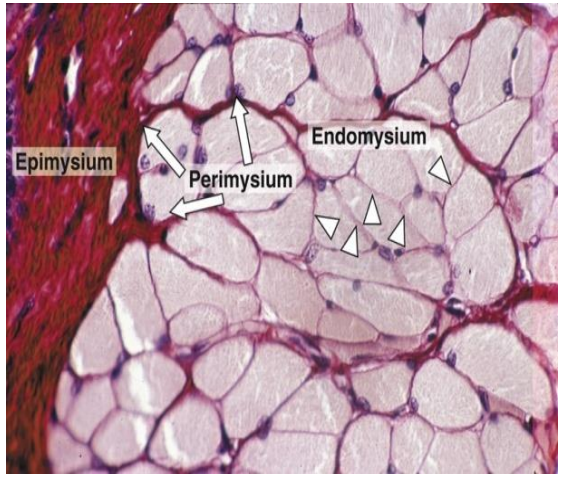
Skeletal muscle

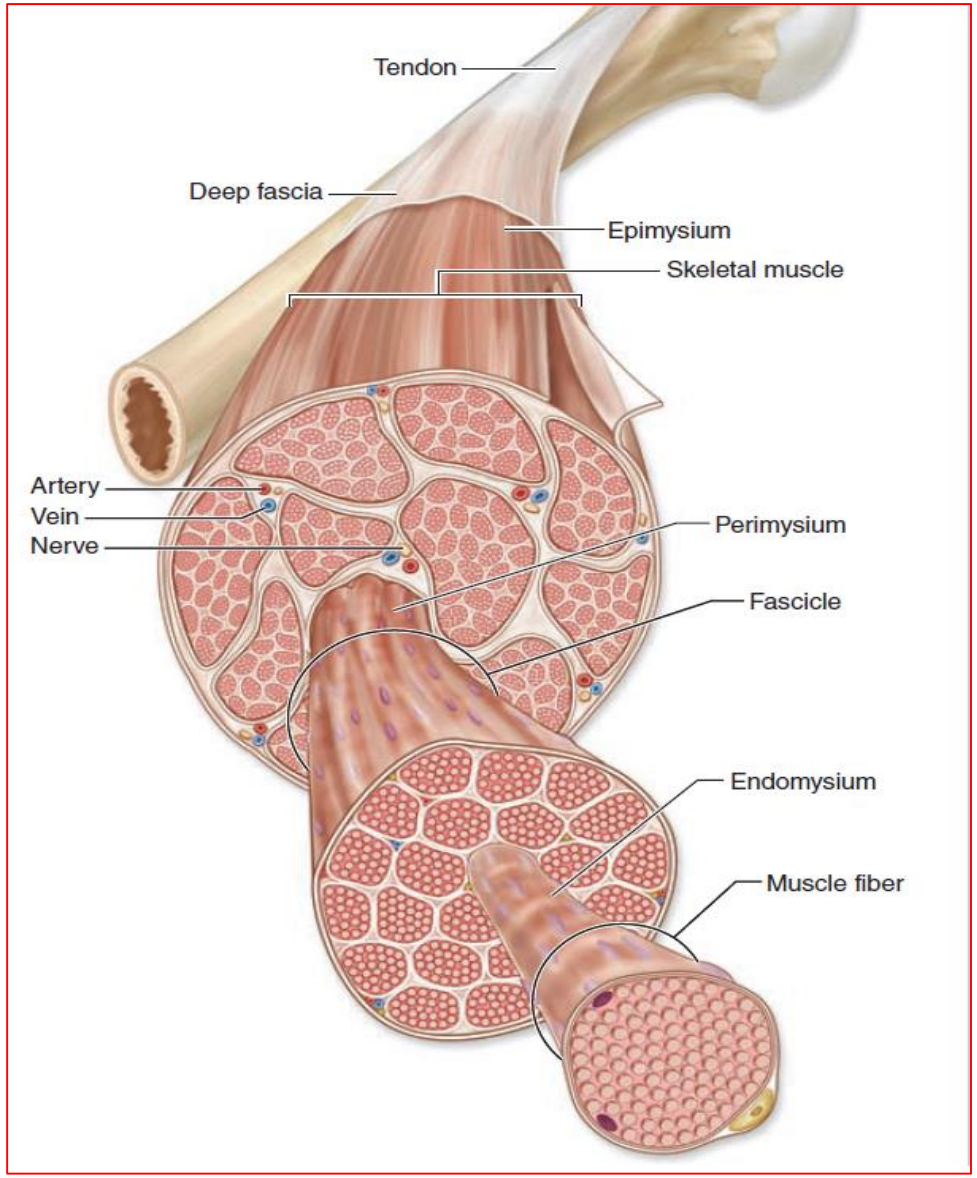
1. The whole muscle is covered by a C.T. covering, the epimysium (very thick dense irregular connective tissue)

2. Consists of parallel skeletal muscle fibers, arranged in bundles, separated by C.T. septa, the perimysium. (less thicker layer of dense irregular connective tissue)

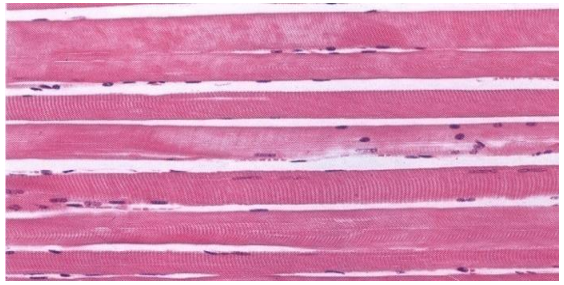
3. The individual fibers (muscle cells) are separated by C.T. called endomysium.

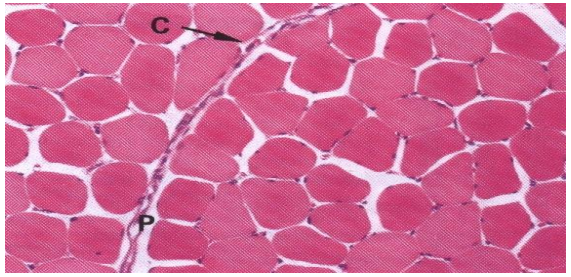
Mysium = Flesh
Epi = Over
Peri = Surrounding





Skeletal muscle fibers





Skeletal Muscle Fibers in Microscope

L.M. Picture

* Cylindrical in shape.

* Non-branched.

* Covered by a clear cell membrane, the **sarcolemma.**

* Multinucleated: nuclei are multiple and are peripherally located (close to the sarcolemma).

* Cytoplasm **(sarcoplasm)** is acidophilic and shows clear transverse striations

E.M. Picture

Sarcoplasm contains:

* Parallel myofibrils.

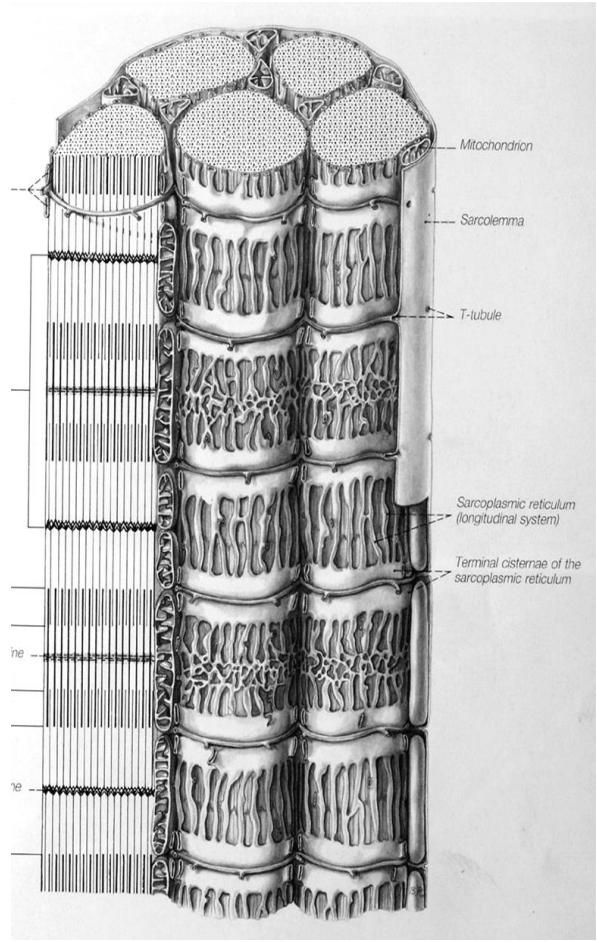
* Numerous mitochondria, arranged in rows between the myofibrils.

* Well developed smooth endoplasmic reticulum (sarcoplasmic reticulum-SR).

* Myoglobin pigment. [carry & store O2]

* Glycogen[store food]

skeletal muscle needs so much energy that's why it have so many mitochondria



* Myofibrils of Skeletal Muscles

E.M. Picture of Myofibrils :

- Myofibrils are contractile threads (organelles), arranged longitudinally in the sarcoplasm.
- Each myofibril shows alternating dark (A) and light bands (I).
- The A band shows a pale area in the middle (H band) which is divided by a dark line (M line).
- The (I) band shows a dark line in the middle (Z line).
- The sarcomere is the segment between 2 successive Z lines. It is the contractile unit of a myofibril.
- The myofibrils are formed of myofilaments (thick myosin and thin actin).
- The (A) band is formed of myosin myofilaments mainly and the terminal ends of actin myofilaments.
- The (I) band is formed of actin myofilaments.

note : The (A) band is dark because it contains both myosin and actin. The (I) band and the (H) zone are light because they have only one type of myofilaments (actin in I and myosin in H).

Video to help you understand better

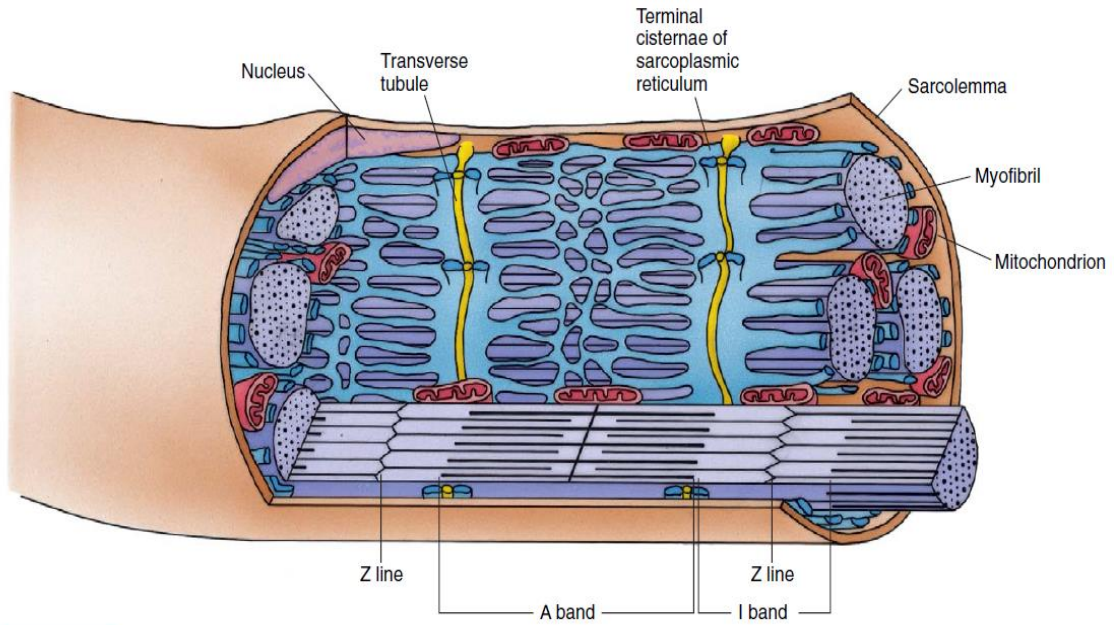


Figure 8–5 Organization of triads and sarcomeres of skeletal muscle. Note that in skeletal muscle the triad is always located at the junction of the A and I bands, permitting the quick release of calcium ions from the terminal cisternae of the sarcoplasmic reticulum just in the region where the interaction of the thick and thin filaments can produce efficient sarcomere shortening. Observe the presence of mitochondria around the periphery of the myofibrils.

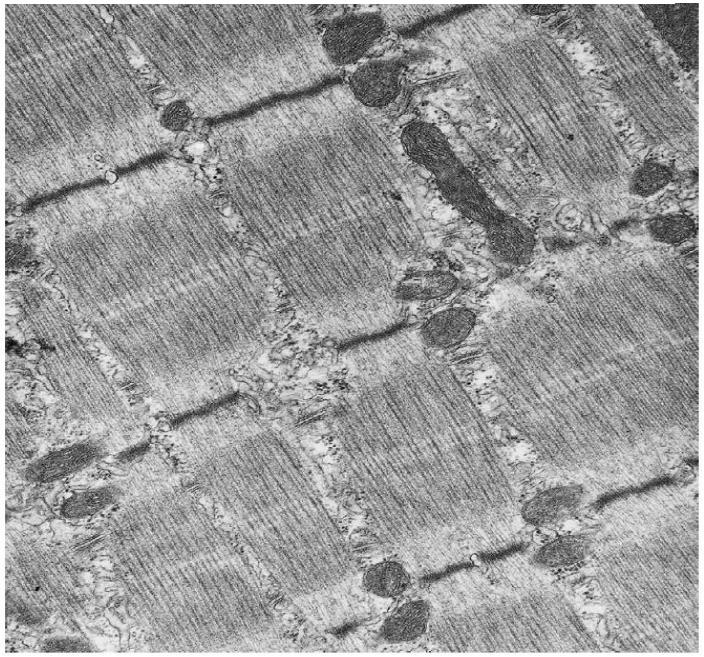
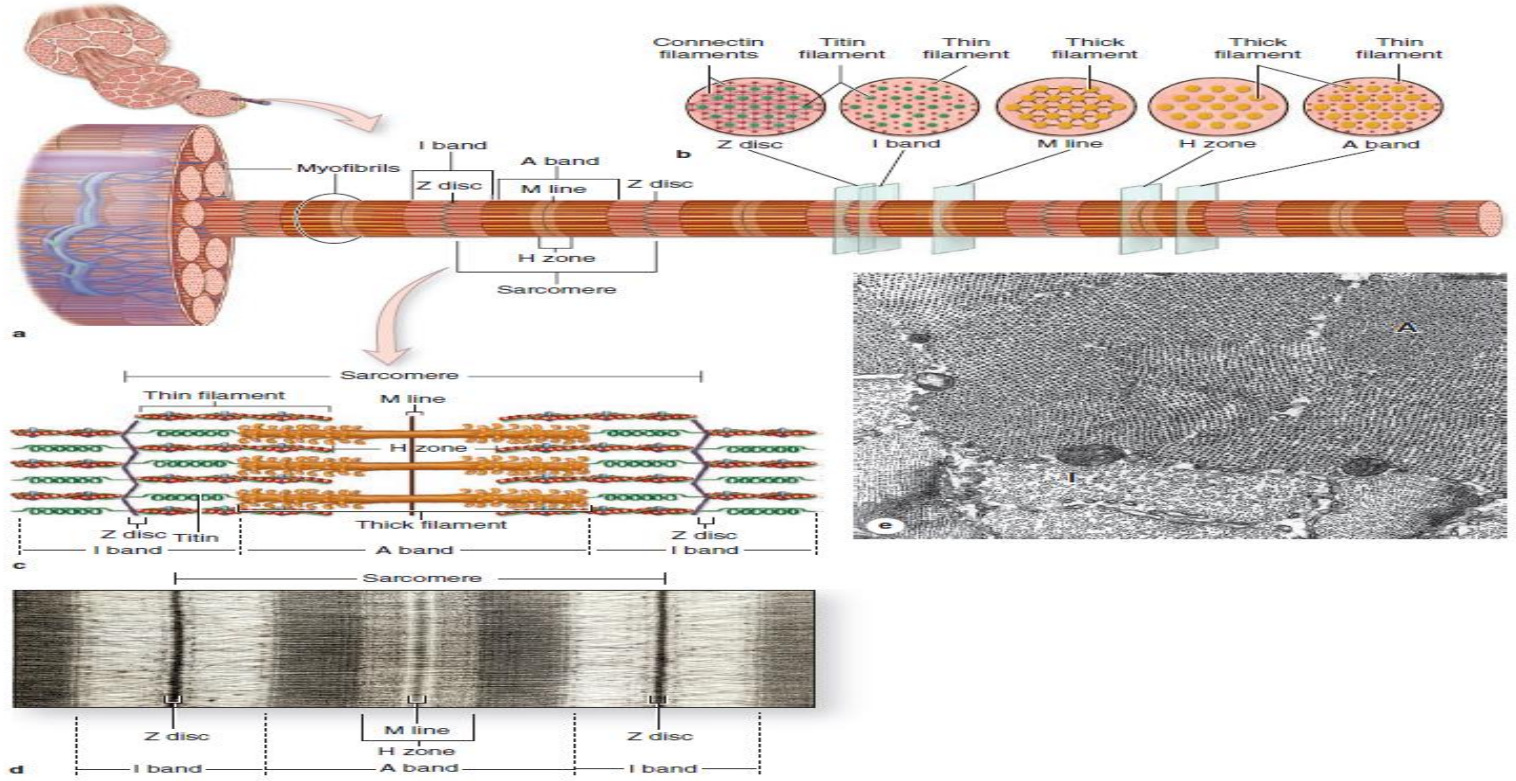


Figure 8–6 Electron micrograph of longitudinal section of rat skeletal muscle (×19,330). (Courtesy of Dr. J. Strum.)

* Extra slide for deeper understanding of skeletal myofibrils



(a) The diagram shows that each muscle fiber contains several parallel bundles called **myofibrils**.

(b) Each myofibril consists of a long series of sarcomeres, separated by Z discs and containing thick and thin filaments that overlap in certain regions.

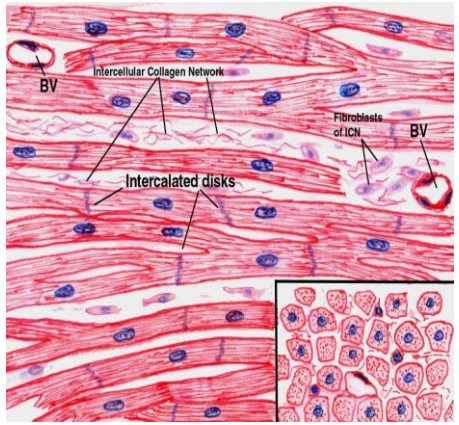
(c) Thin filaments are actin filaments with one end bound to **α-actinin** in the Z disc. Thick filaments are bundles of myosin, which span the entire A band and are bound to proteins of the M line and to the Z disc across the I bands by a very large protein called **titin**, which has springlike domains.

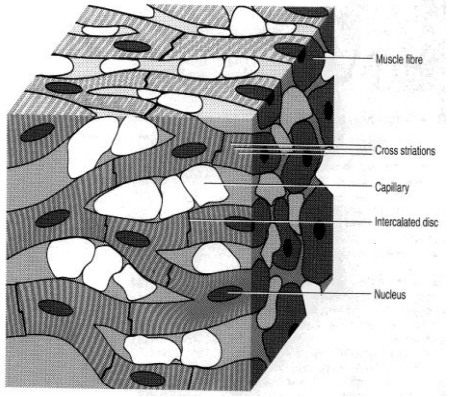
(d) The molecular organization of the sarcomeres produces staining differences that cause the dark- and light-staining bands seen by light microscopy and TEM. X28,000.

(e) With the TEM an oblique section of myofibrils includes both **A** and **I** bands and shows hexagonal patterns that indicate the relationships between thin and thick myofilaments and other proteins, as shown in part **b** of this figure. Thin and thick filaments are arranged so that each myosin bundle contacts six actin filaments. Large mitochondria in cross-section and SER cisternae are seen between the myofibrils. X45,000.

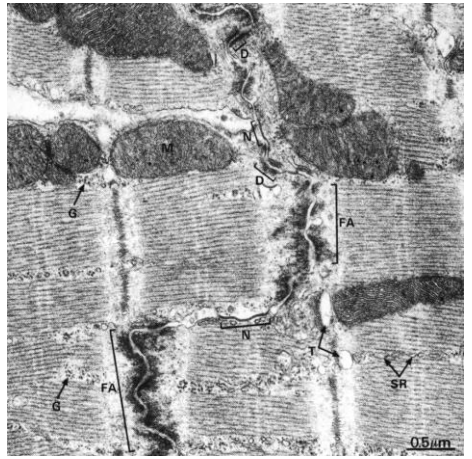
Cardiac muscle

- It’s Found in the myocardium and it’s Striated and involuntary.
- **Cardiac Muscle Fibers :**



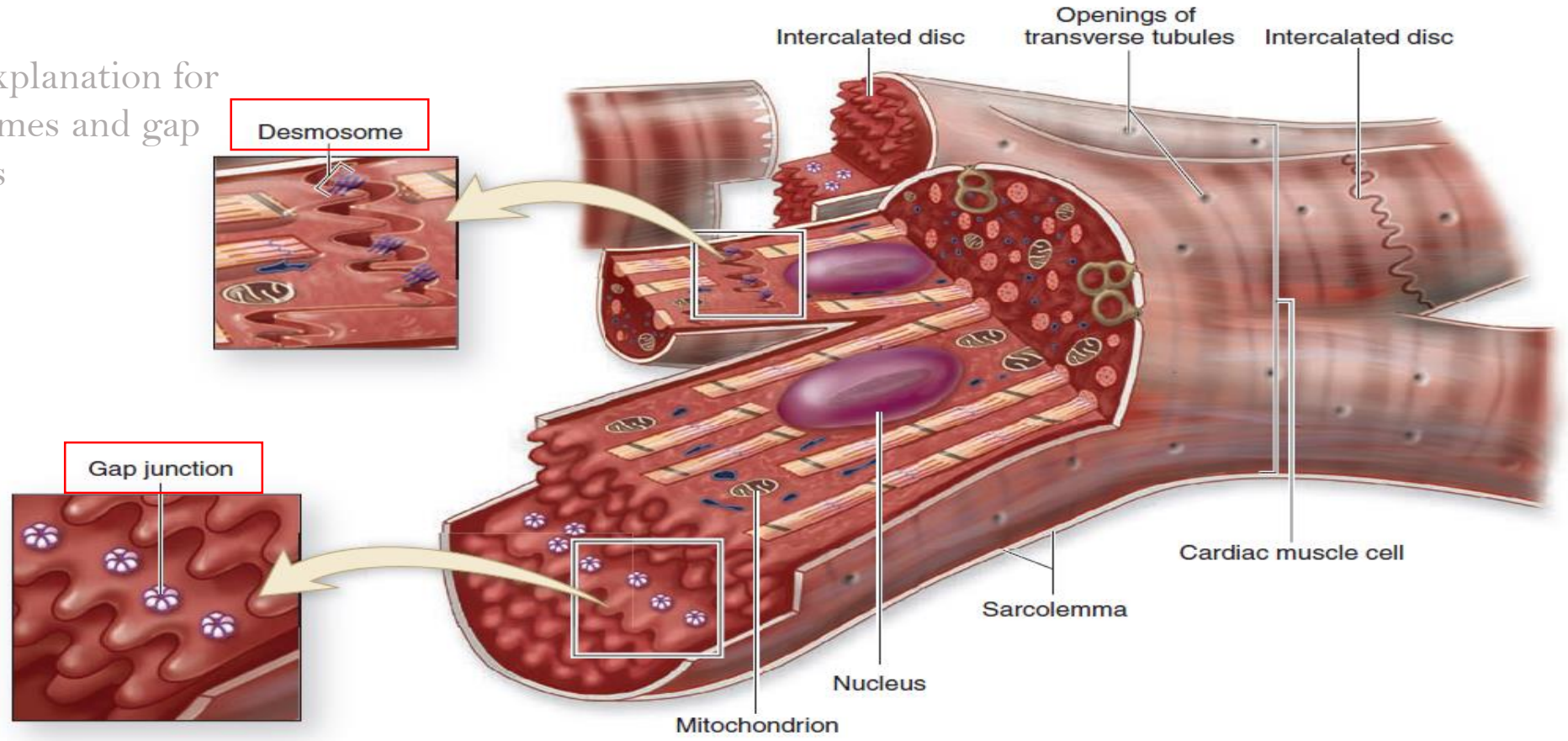


Light Microscope Picture.	Electronic Microscope Picture.
1) Cylindrical (اسطوانية) . 1) Intermediate in diameter between skeletal and smooth muscle fibers. 2) Branch and anastomose (متشابكة). 3) Covered by a thin sarcolemma. 4) Mononucleated. (as a cell or fiber it’s a Mononucleated, but as a tissue it’s a multinucleated) 5) The Nuclei are oval and central. 6) Sarcoplasm is acidophilic and shows non-clear striations (fewer myofibrils). 7) Divided into short segments (cells) by the intercalated discs.	1) Few myofibrils. 2) Numerous mitochondria. 3) Less abundant SR. 4) Glycogen (Food source) & myoglobin (oxygen source). 5) Intercalated discs: are formed of the two cell membranes of 2 successive cardiac muscle cells, connected together by junctional complexes (desmosomes and gap junctions).



- Skeletal muscle is not branched but cardiac muscle is branched because we need every part of the heart to contract at the same time

Extra Explanation for desmosomes and gap junctions



The diagram of cardiac muscle cells indicates characteristic features of this muscle type. The fibers consist of separate cells in a series with interdigitating processes where they are held together. These regions of contact are called the **intercalated discs**, which cross an entire fiber between two cells. The transverse regions of the steplike intercalated disc have abundant **desmosomes** and other adherent junctions for firm adhesion, while longitudinal regions of the discs contain many physiologically important **gap junctions**.

Cardiac muscle cells have central nuclei and myofibrils that are less dense and less well-organized than those of skeletal muscle. Also, the cells are often branched, allowing the muscle fibers to interweave in a more complicated arrangement within fascicles that produces an efficient contraction mechanism for emptying the heart.

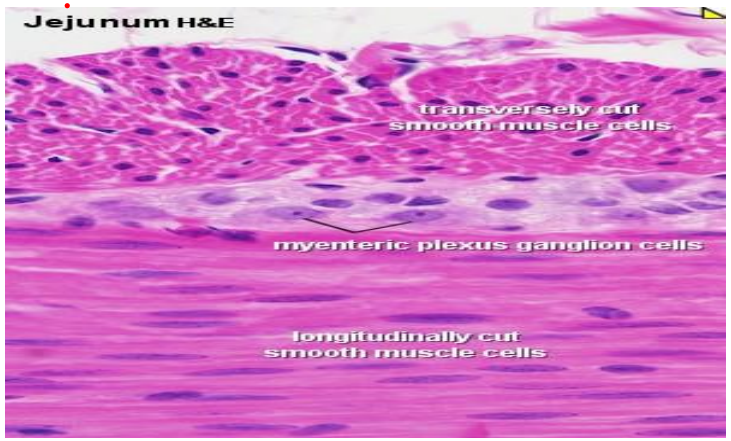
So briefly , **desomsomes** is a structure by which two adjacent cells are attached. and the **gap junctions** allow communication and passage of impulses between cardiac muscle cells.

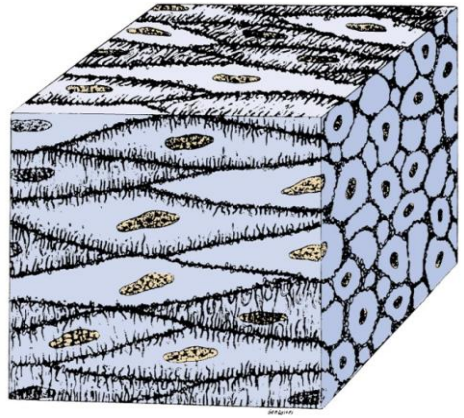
smooth muscles

- ✓ Present in walls of blood vessels and viscera (digestive, urinary, genital .... etc).
- ✓ Non-striated and involuntary.

L.M. Picture of Smooth Muscle Fibers:

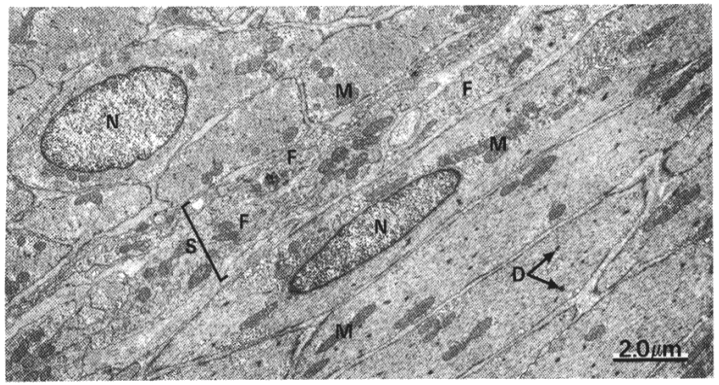
1) Fusiform in shape (spindle-shaped).
2) Small diameter.
3) Non-branched.
4) Thin sarcolemma.
5) Mononucleated. Nuclei are oval & central in position.
6) Sarcoplasm is non-striated and acidophilic.

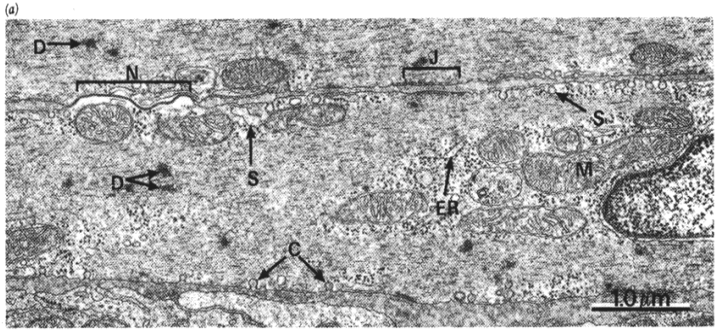




E.M. Picture:

1) Sarcoplasm contains mitochondria and sarcoplasmic reticulum.
2) Myosin & actin filaments are irregularly arranged (that's why no striations could be observed).
3) Cells are connected together by gap junctions for cell communication.





REGENERATION OF MUSCLE

(1) Skeletal muscle cells:

- Cannot divide.
- Limited regeneration by satellite cells (stem cells on the muscle cell's surface).

(2) Cardiac muscle cells:

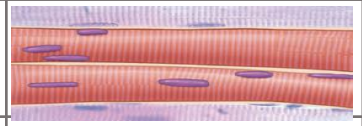
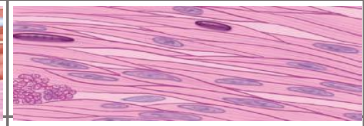
- No regenerative capacity.

(3) Smooth muscle cells:

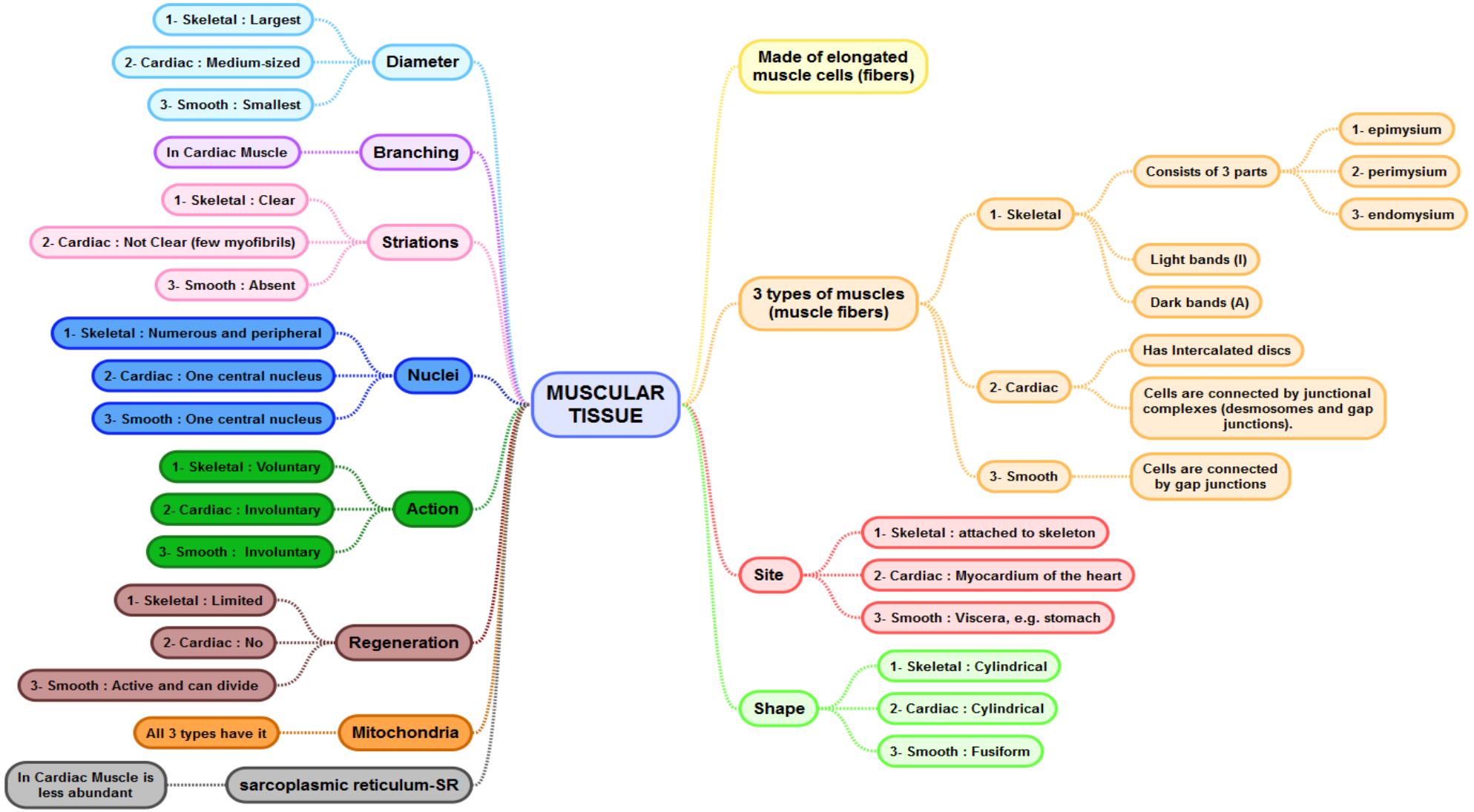
- Can divide. (like uterus in pregnency)
- Regenerate from pericytes. (which is the stem cell of the smooth muscle)

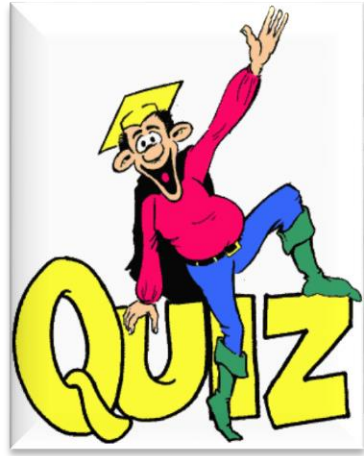
→ active regenerative response.

Comparison between different types of muscle fibers

	SKELETAL	CARDIAC	SMOOTH
			
Site	Muscle attached to skeleton	Myocardium of the heart	Viscera, e.g. stomach
Shape	Cylindrical	Cylindrical	Fusiform
Diameter	Largest	Medium-sized	Smallest
Branching	Non-branched	Branched	Non-branched
Striations	Clear	Not clear	Absent
Intercalated discs	Absent	Present	Absent
Nuclei	Numerous and peripheral	One central nucleus	One central nucleus
Action	Voluntary	Involuntary	Involuntary
Regeneration	Limited	No	Active

SUMMARY


MUSCULAR TISSUE
Made of elongated muscle cells (fibers)
3 types of muscles (muscle fibers)
1- Skeletal
Consists of 3 parts
1- epimysium
2- perimysium
3- endomysium
Light bands (I)
Dark bands (A)
2- Cardiac
Has Intercalated discs
Cells are connected by junctional complexes (desmosomes and gap junctions).
3- Smooth
Cells are connected by gap junctions
Site
1- Skeletal : attached to skeleton
2- Cardiac : Myocardium of the heart
3- Smooth : Viscera, e.g. stomach
Shape
1- Skeletal : Cylindrical
2- Cardiac : Cylindrical
3- Smooth : Fusiform
Diameter
1- Skeletal : Largest
2- Cardiac : Medium-sized
3- Smooth : Smallest
Branching
In Cardiac Muscle
Striations
1- Skeletal : Clear
2- Cardiac : Not Clear (few myofibrils)
3- Smooth : Absent
Nuclei
1- Skeletal : Numerous and peripheral
2- Cardiac : One central nucleus
3- Smooth : One central nucleus
Action
1- Skeletal : Voluntary
2- Cardiac : Involuntary
3- Smooth : Involuntary
Regeneration
1- Skeletal : Limited
2- Cardiac : No
3- Smooth : Active and can divide
Mitochondria
All 3 types have it
sarcoplasmic reticulum-SR
In Cardiac Muscle is less abundant


QUIZ

THANK YOU !

Lecture done by:

Ahmed Badahdah
Mutasem Alhasani
Omar Turkistani
Nawaf Aldarweesh
Mohammed Khojah
Amal Al Qarni

Team Leaders :

Reema AlOtaibi
Faisal AlRabaii

Contact us on
HistologyTeam436@gmail.com

جامعة الملك سعود
King Saud University

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