King Saud University
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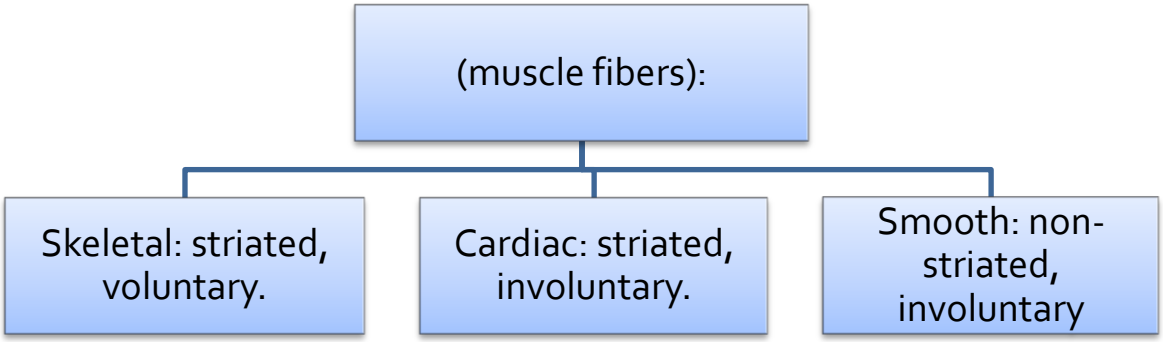
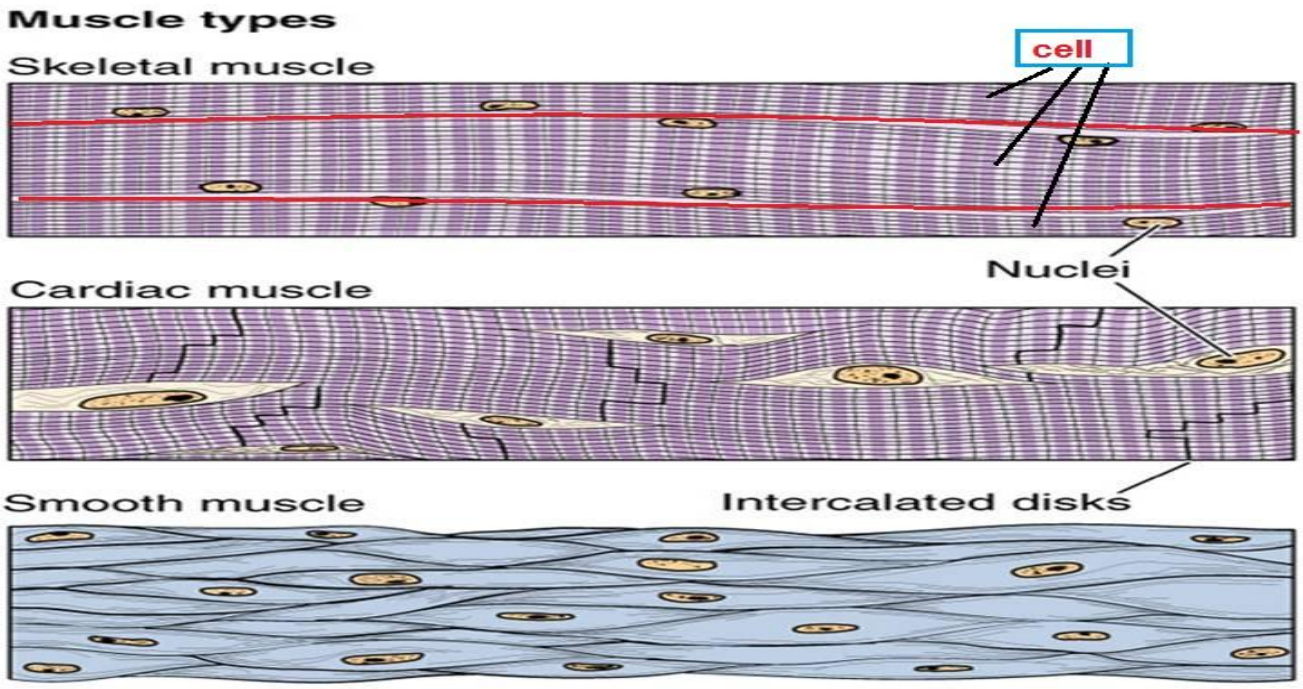
431 Histology team

MUSCULAR TISSUE

- Made of elongated muscle cells (fibers).
- It is a cell but because it is long and look like fibers they named as a " fiber"

3 types of muscles



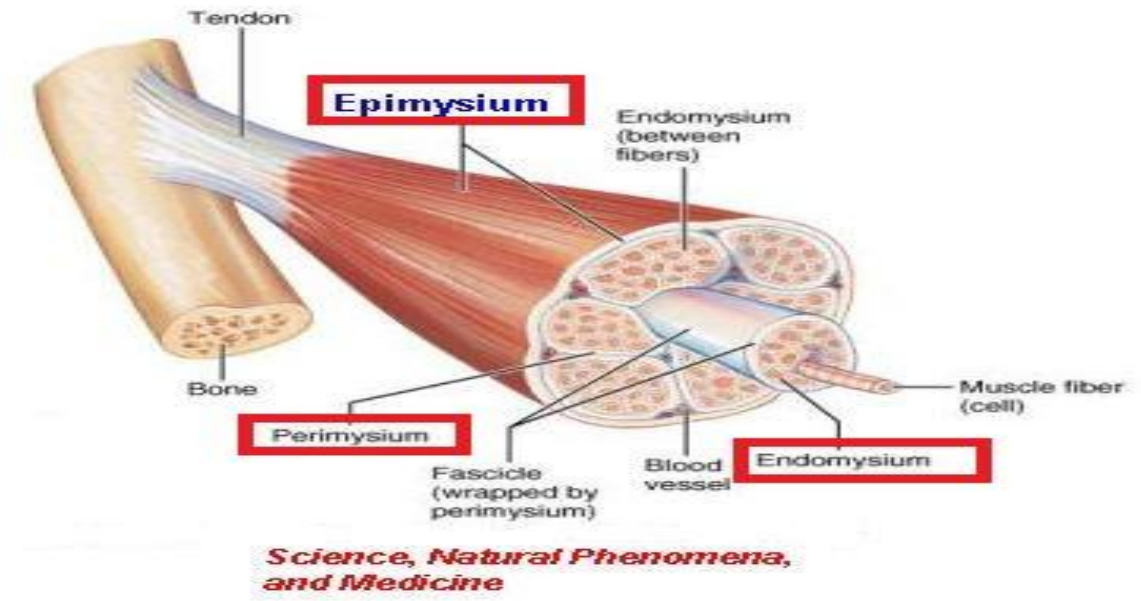


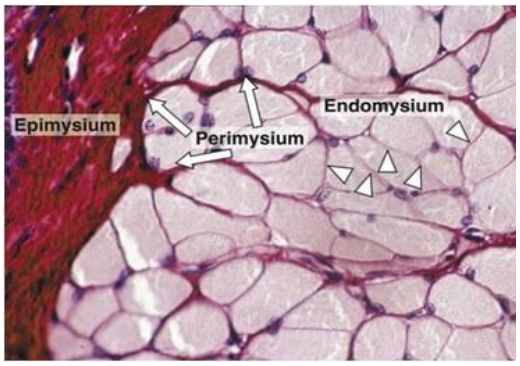
The whole muscle is covered by a C.T. covering, the epimysium.

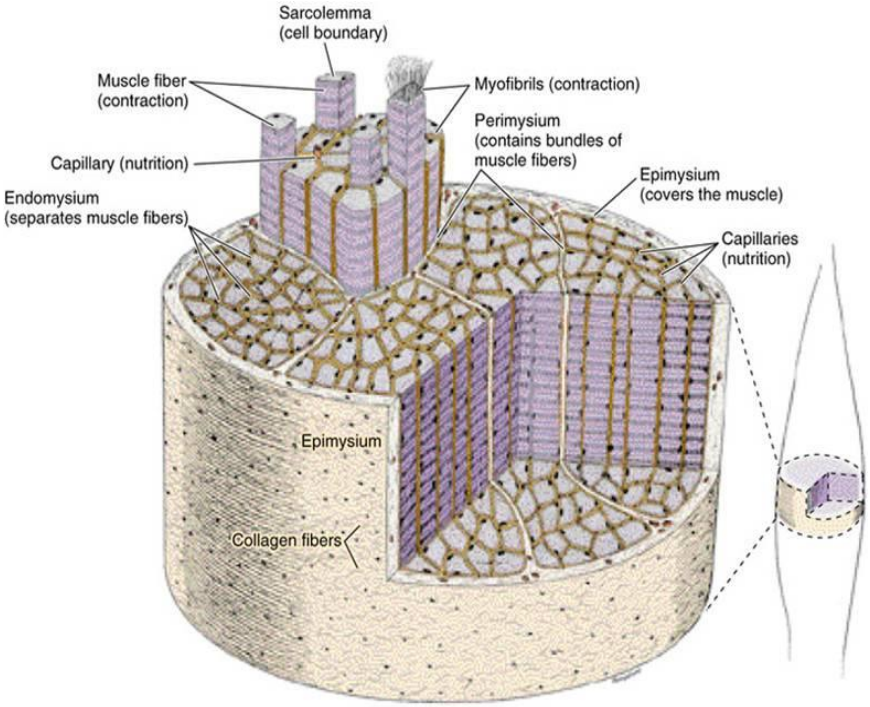
Consists of parallel skeletal muscle fibers, arranged in bundles, separated by C.T. septa, the perimysium.

Peri =mean around mysium = from muscle

The individual fibers are separated by C.T., endomysium,







Skeletal Muscle Fibers

Light microscope Picture:

Cylindrical in shape.

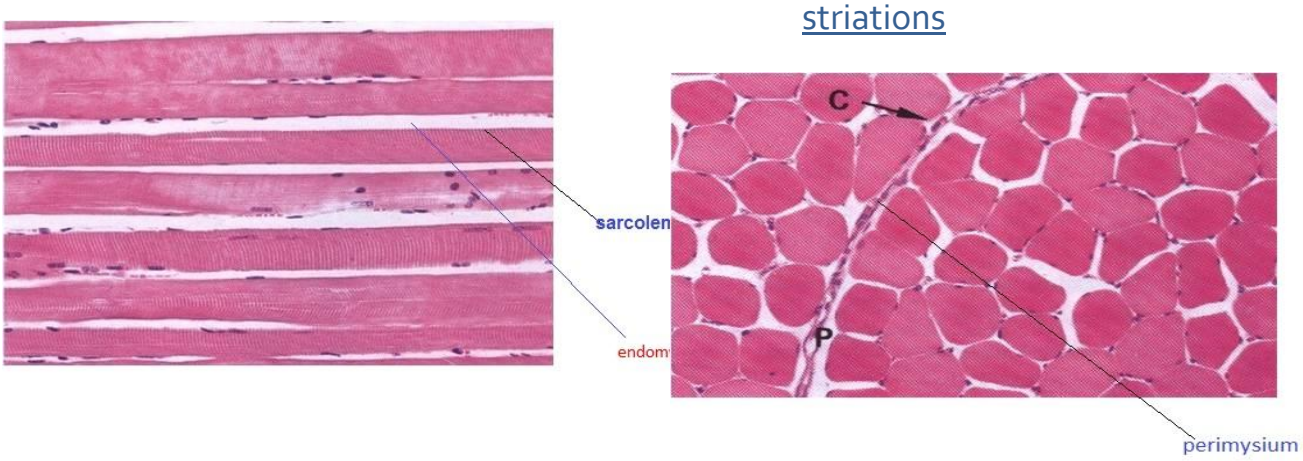
Non-branched.

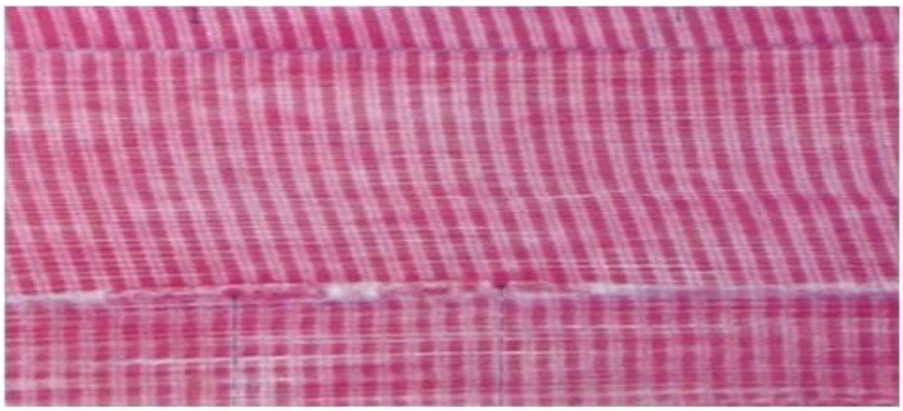
Covered by a clear cell membrane, the **sarcolemma.**

= cytoplasm but in muscle called sarcolemma

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

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





showing clear transverse striations

- **Electron microscope Picture:**

Sarcoplasm contains:

- Parallel myofibrils.

Bundle -→ many muscles fiber -→ one muscle fiber contain many myofibrils -→ myofilaments

- Numerous mitochondria, arranged in rows between the myofibrils.
- Well developed smooth endoplasmic reticulum (sarcoplasmic reticulum).
- Myoglobin pigment.
- Glycogen.

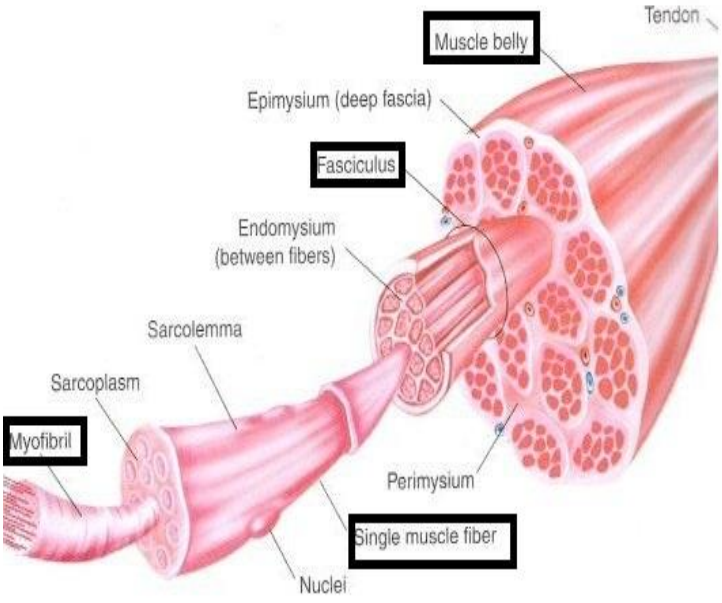
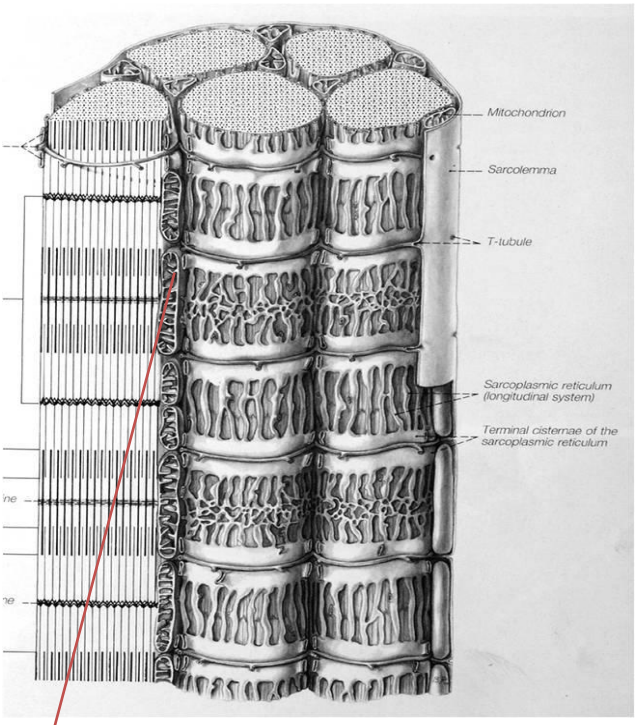


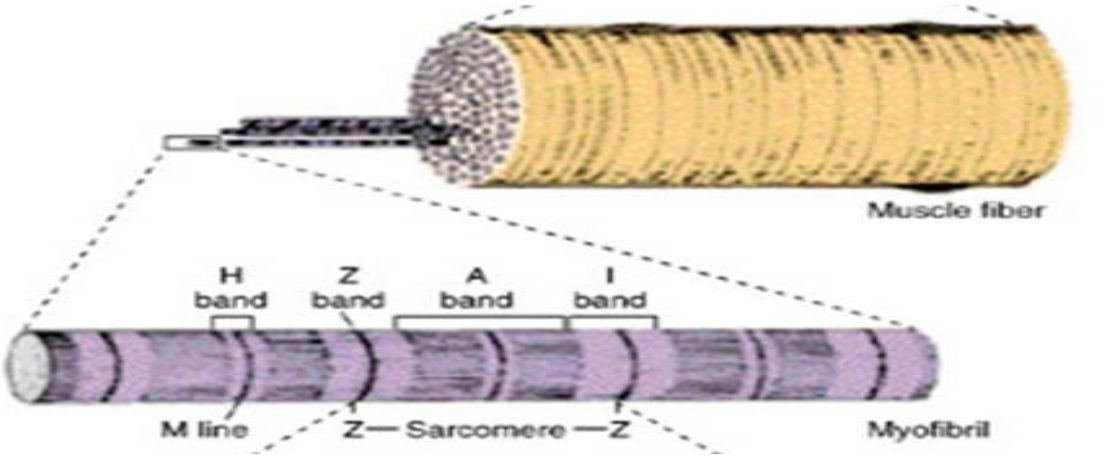
Figure 1: Muscle belly split into various component parts (from Essentials of Strength Training & Conditioning, National Strength & Conditioning Association)



Mitochondria arrangement in row

- **Electron Microscope Picture of Myofibrils:**
  - Contractile threads (organelles), arranged longitudinally in the sarcoplasm.

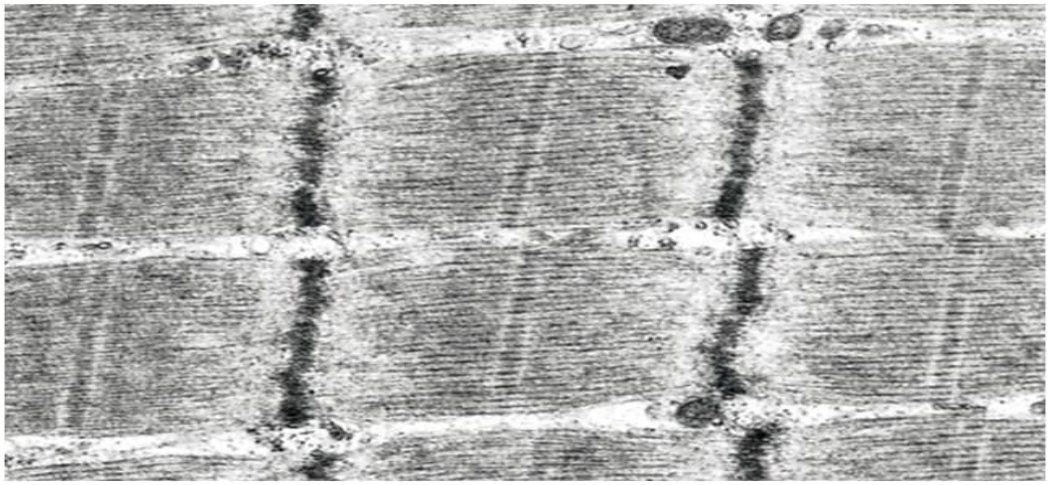
    These threads help in contraction .
  - Each myofibril shows alternating dark (A) and light bands (I).
  - The A band shows a pale area in the middle (H band) which is divided by a dark line (M line).
  - The (I) band shows a dark line in the middle (Z line).

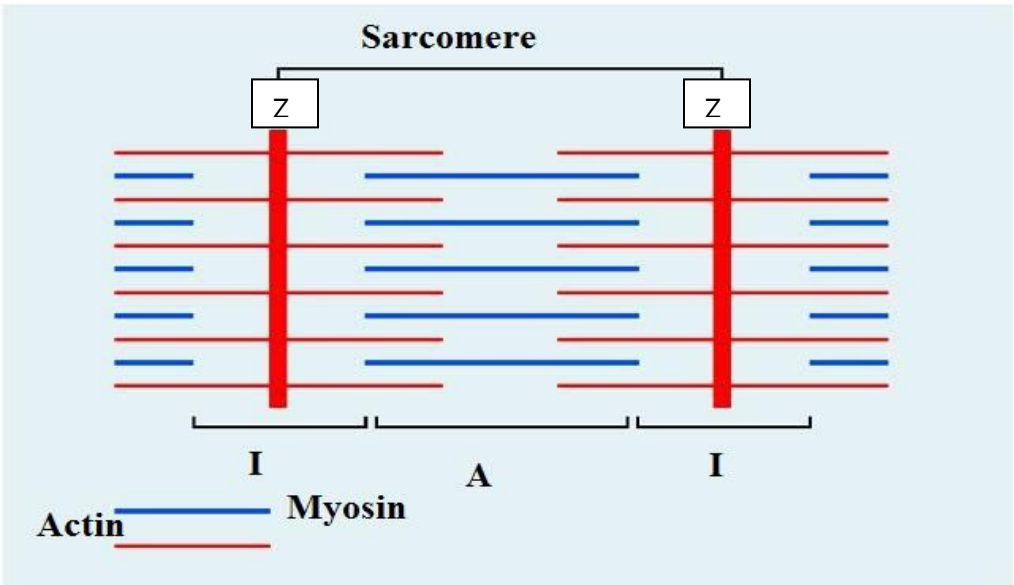


Showing alternating dark and light bands arranged longitudinally

- **E.M. Picture of Myofibrils:**
  - The sarcomere is the distance between 2 successive Z lines.
  - 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





Dark band in the middle (H band) it look lighter because at the terminal there are actin and myosin therefore it appear lighter .

But there is a special kind of protein in the middle make it dark

Light band contain (Z line) which is look dark due to overlapping from actin

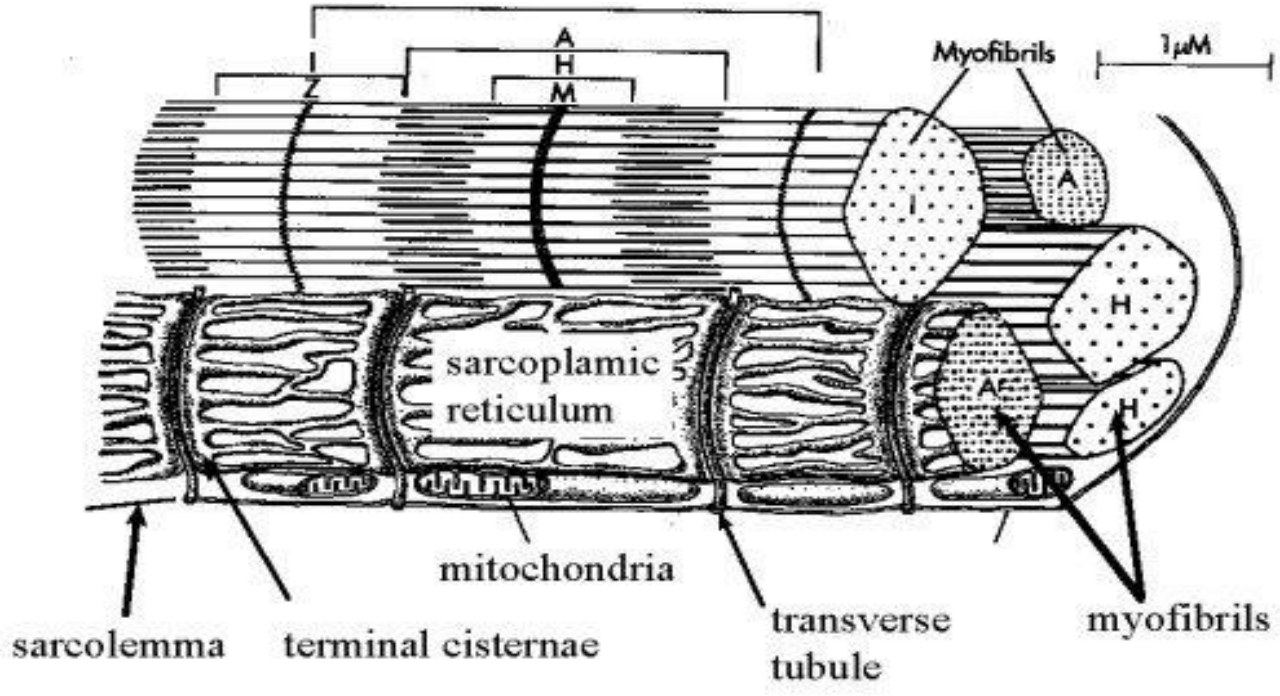
The distance between two Z lines called sarcomer and this is the function unit of striated muscle.

Because when our muscles contract the sarcomer become shorter and the (H band) will disappear.

What happen is the actin will slip on each other.

Skeletal Muscle Fibers

- The TRIAD tubular system:
  - The sarcolemma sends transverse invaginations into the sarcoplasm, the T-tubules. They form collars around the myofibrils at the level of theA - I junctions.
  - The SR forms transverse wider cisternae (terminal cisternae) on either side of the T-tubule.
  - The 2 terminal cisternae of the SR and the T-tubule in-between them form the triad tubular system, which plays an important role during muscle contraction.



on the left and right of transverse tubule there are terminal cisternea because of that they named as TRIAD tubular system

CARDIAC MUSCLE

Found in the myocardium.

Striated and involuntary.

L.M. Picture of Cardiac Muscle Fibers:

Cylindrical in shape.

Intermediate in diameter between skeletal and smooth muscle fibers.

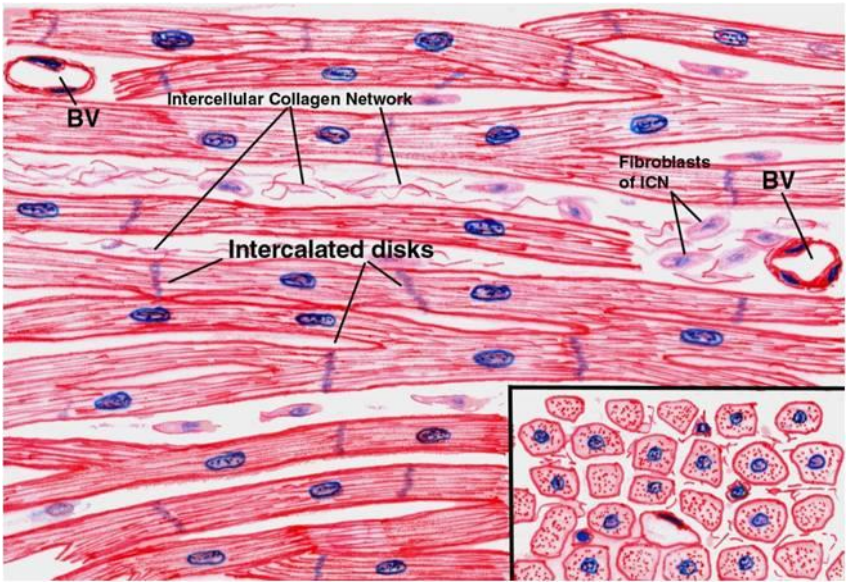
Branch and anastomose.= The direct or indirect connection of separate parts of a branching system to form a network.

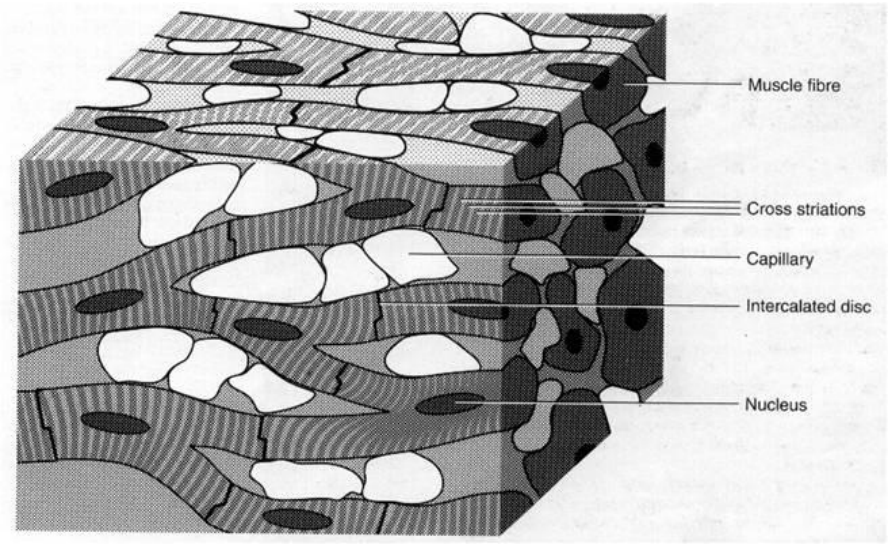
Covered by a thin sarcolemma.

Mononucleated. Nuclei are oval and central.

Sarcoplasm shows non-clear striations (fewer myofibrils).

Divided into short segments (cells) by the intercalated discs.


BV
Intercellular Collagen Network
Fibroblasts of ICN
BV
Intercalated disks


Muscle fibre
Cross striations
Capillary
Intercalated disc
Nucleus

Questions

1-What is the covering of an individual muscle fiber?
a. Sarcoplasm
b. Perimysium
c. Endomysium
d. Epimysium
e. Sarcolemma

Answer: c

2-What are the thick filaments composed of?
a. Myofilaments
b. Myosin
c. Muscle fibers
d. Myofibrils
e. Myocardium

Answer: b

3-What type of muscle contains centrally placed nuclei?
a. Smooth muscle
b. Cardiac muscle
c. Skeletal muscle
d. Both "a" and "b"
e. "a" "b" and "c"

Answer: d

4-What is the dark band in muscle?
a. A band
b. I band
c. Z line
d. H band
e. M line

Answer: a

5-What bisects the H band
a. A band
b. I band
c. Z line
d. E band
e. M line

Answer: e

6-What type of muscle has intercalated discs?
a. Skeletal muscle
b. Cardiac muscle
c. Smooth muscle
d. Both "a" and "b"
e. "a" "b" and "c"

Answer: b

Intercalated discs are seen in cardiac muscle. Intercalated discs are specialized junctions between cardiac cells.

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* The A band is the darker staining band. The I band is the light band. The I band is made of thin filaments. The Z line runs through the I band. The H band bisects the A band. The M line runs through the H band.

*A sarcomere is the segment that runs from Z line to Z line.

Cardiac Muscle Fibers

E.M. Picture:

- **Few** myofibrils.
- **Less** abundant sarcoplasmic reticulum.
- **Numerous** mitochondria.
- T-tubules come in contact with **only one cisterna of SR** forming **"Diads"** (not triads).
- Glycogen & myoglobin.
- Intercalated discs: are formed of the two **cell membranes of 2 successive cardiac muscle cells**, connected together by junctional complexes (desmosomes and gap junctions).

Smooth Muscle

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

L.M. Picture of Smooth Muscle Fibers:

- **Fusiform** in shape (spindle-shaped).
- **Small** diameter.
- **Non-branched.**
- Thin sarcolemma.
- **Mononucleated.** Nuclei are oval & central in position.
- Sarcoplasm is **non-striated**.

E.M. Picture:

- Sarcoplasm contains mitochondria and sarcoplasmic reticulum.
- **Myosin & actin filaments are irregularly arranged** (that's why no striations could be observed).
- 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.**
- Regenerate from pericytes. (pericytes maintain plasticity and thus can differentiate into various other cell types including, smooth muscle cells as well as fibroblasts and other mesenchymal stem cells.)

→ active regenerative response.

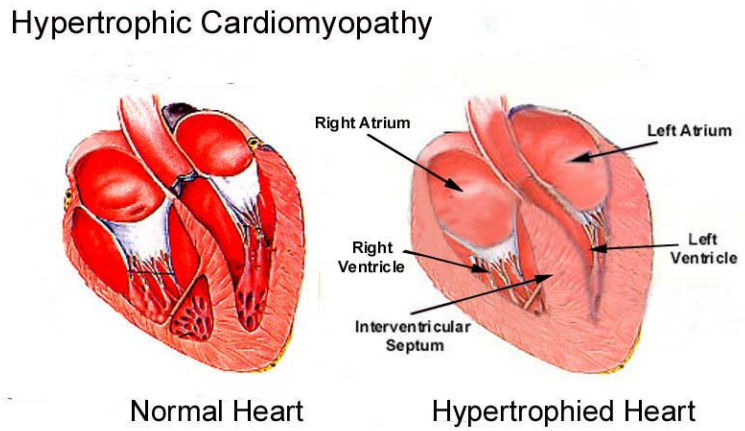
Comparison between different types of muscle fibers

	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	Yes

Clinical Applications

Cardiac hypertrophy:

Cardiac muscle cells are long and large; number is not affected.



Cardiac damage:

Dead cardiac muscles are replaces by fibrous CT and not regenerated.

Myasthenia gravis: (Autoimmune Disease)

Acetylcholine receptors are blocked by auto antibodies leading to decreased availability to acetylcholine. Skeletal muscles including diaphragm are affected.